

# REPORT

## GROUNDWATER AND HYDROCHEMISTRY OF KELSEY CREEK LANDFILL Whitsunday Regional Council

### Data Review Report



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Submitted to:  
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The Chief Executive Officer

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## EXECUTIVE SUMMARY

Whitsunday Regional Council (WRC) operates and manages the Kelsey Creek Landfill near Proserpine. This report evaluated potential migration pathways from the landfill into the surrounding environment using seepage pathway identification methods or geochemical characterisation of water monitoring data.

The landfill is located in an area where intense agricultural activity is taking place and impacts associated with nitrogen, and phosphorous analysis could be detected. Secondly, a contaminant source is present up gradient from the landfill, and it could impact monitoring performance of the landfill in the near future.

The landfill is located on clays and sand/sandstone that limit migration of contaminants off-site via groundwater pathway. Some limited form of dewatering is taking place near the landfill, with groundwater gradient towards the landfill from the west. Secondly, localised mounding under the landfill was expected but as noted water levels were below surrounding water levels to the north and west of the site.

Surface water analysis does not indicate an interaction with a contaminant source within the monitoring network indicating limited transport potential of contaminants to sampling points. Cluster analysis indicates that the majority of surface and groundwater monitoring points belong to the same system.

The WRC require additional monitoring bores to assist with reducing liability from off-site contamination migrating onto the landfill area. Annual or bi-annual sampling should be performed for these monitoring bores in addition to the other sites.

Monitoring systems indicate that contaminants of concern are limited to the landfill area, and migration off-site has not been observed in the groundwater. Due to engineering works undertaken at the site, i.e., cells constructed with liners or capping of old landfills; the potential for leachate generation is limited, and dewatering under the landfill area is occurring and should be continued.

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# 1 INTRODUCTION

The Whitsunday Regional Council have received a notice to conduct or commission an environmental evaluation (EPPR00190813, 2017) that relates to the Kelsey Creek Landfill. In the notice, a set of assessment requirements is stipulated (Appendix A) and addressed as part of this document (Darvall, 2017). The groundwater and geochemical review will consider all parameters that are relevant. Statistical analysis included in this investigation and summary statistics, and descriptive figures collected in Appendix B and C.

The document is set out in the following format:

1. Background information on the surrounding land and setting
2. Description of Kelsey Creek Landfill
3. Analysis of monitoring data
4. Conceptual interpretation of current setting at the landfill
5. Recommendations and conclusions

# 2 DESCRIPTION OF SURROUNDING LAND

## 2.1 Location of landfill

The landfill site is located approximately 2.9 km north-west of Proserpine on the Kelsey Creek Road (Figure 1). The area has a gentle sloping gradient from north-west to the south-east with a total elevation change of 10 m over a vertical distance of 2.3 km (gradient 0.004).

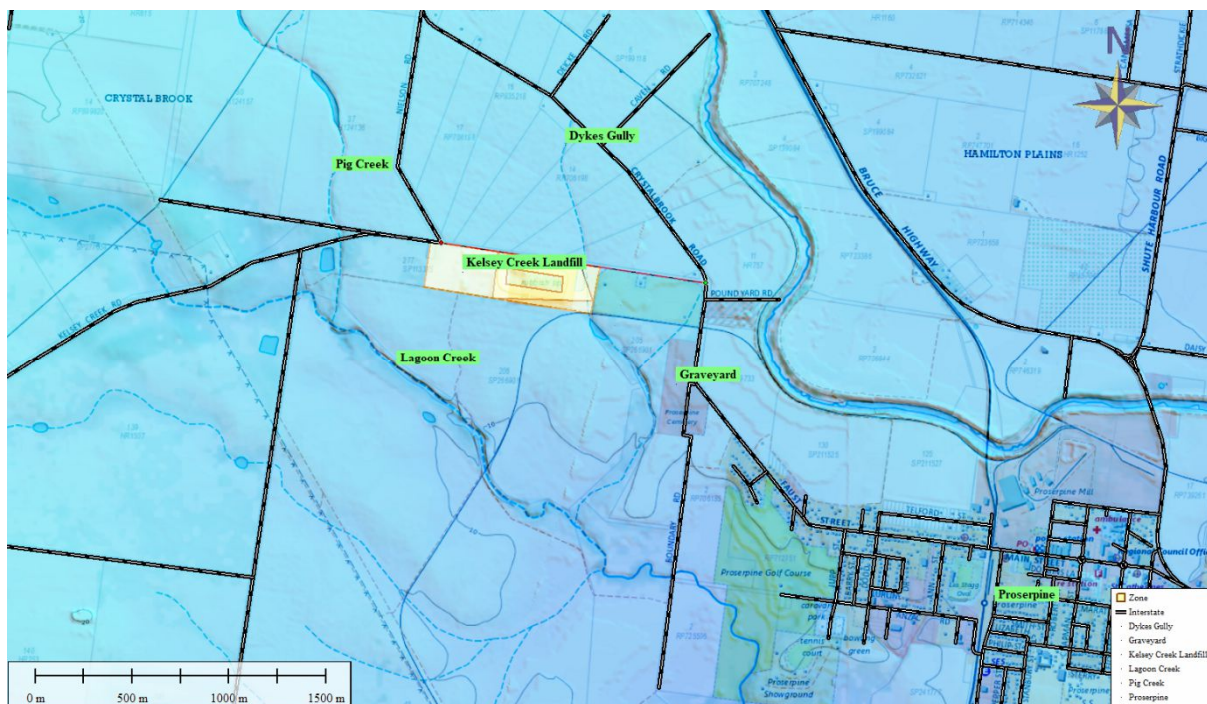


Figure 1 General location of Kelsey Creek (Proserpine) Landfill

Intensive sugar cane farming is practiced to the north and south of the site while the Council sports facility is to the east and recycling facility is to the west.

Pig Creek forms the western catchment border which is approximately 500 m from the site entrance before joining Lagoon Creek to the south. The Northern extent of the surface catchment is defined by the Proserpine River and can be a potential source of groundwater in the area. Dykes Gully abuts the eastern boundary of the landfill, where it flows further south past the graveyard, located 600 m downstream from the landfill, before joining Lagoon Creek in the south. The total area of the catchment is approximately five hundred hectares with the landfill located in the lower third down gradient portion of the zone.

## 2.2 Climate

Proserpine mean annual maximum temperature range is 23 – 32 °C with highest recorded values reaching 42.4 °C (BOM, 2017). Mean annual days with temperatures greater than 30 °C is 123 days. Mean annual minimum temperature range from 11 – 23 °C with the lowest temperature recorded in winter of 1.4 °C. The average annual rainfall 1795 mm with highest recorded volume of 3499 mm and the lowest recorded volume is 698 mm. The mean annual number of rain days are 115 days with a mean total number of clear days exceeding 75 days (BOM, 2017). The annual evaporation rate in the Proserpine area is approximately 2060 mm while Townsville Airport has an actual measured average pan evaporation rate of 2574 mm from 1970 to 2014 (DNRM<sup>1</sup>)

## 2.3 Soil types

The Kelsey Creek landfill is situated in sodosol soil setting (Hardy, 2003). Main soil types are Slater (Sk), Koolachu (Ko) and Foxdale (Fo) that surround or underlay the landfill (Figure 2). Slater soil type is located to the east, north, and south, with a small corridor on the eastern flank of the landfill site overlying it. The Koolachu soil type is overlain by the main landfill structure and extends to the west where it abuts the Slater soil type. The Foxdale soil type is located east of the landfill site and extends nearly to the river where alluvium deposits are dominating the soils types.

- Soil characteristics (Hardy, 2003)
  - Slater – Moderate to deep, sodic duplex soil, with a sandy loam to sandy clay loam topsoil, bleached over an acid to neutral, pale grey, clay subsoil (Subnatric, grey sodosol, Dy3.33).
  - Koolachu – Moderately deep, duplex soil with a bleached, sandy loam topsoil, over an acid, grey, clay subsoil (Mesonatric, grey sodosol, Dy3.31).
  - Foxdale – Deep duplex to gradational soil with a clay loam topsoil over an acid to neutral, grey to dark grey, light medium to medium heavy clay subsoil (Grey chromosol, Dy3.12, Gn4)
  - Classification of soil depths are: moderate depth 0.5 to <1 m and deep 1 to <1.5m

Sodosols have abrupt clay increase down the profile and high sodium content and can result in seasonally perched water table where these soil types are dominant. Sodosols are found in poorly drained sites with rainfall between 50 mm and 1100 mm. It has very low agricultural potential with high sodicity leading to high erodibility, poor structure, and low permeability. These soils have low to moderate chemical fertility and can be associated with soil salinity.

Chromosols have a strong contrasting texture and are not strongly acidic or sodic in the upper B horizon. These soils are found in imperfectly drained sites (yellow and grey chromosol) where

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<sup>1</sup> <https://www.ehp.qld.gov.au/state-of-the-environment/finding/?id=4.1.0.3>

rainfall is between 250 mm and 900 mm. They are also found in well-drained sites (brown and red chromosol) with rainfall between 350 mm and 1400 mm. Interestingly, the Foxtale soil type grey to dark grey with a light medium to medium heavy clay subsoil indicating it will be imperfectly drained site material. These soils have moderate agricultural potential with moderate chemical fertility and water-holding capacity. They can be susceptible to soil acidification and soil structure decline.

The upper limit of the saturated hydraulic conductivity ( $K_{sat}$ ) of the soils with potential contact with the landfill area is Sodosol  $K_{sat}$  0.5 – 0.05 m/d and Chromosol 1 – 0.5 m/d. During site visits, water ponding has been observed days after a rainfall event in the adjacent cane paddocks bordering the landfill site which would indicate that infiltration rates could be significantly lower.

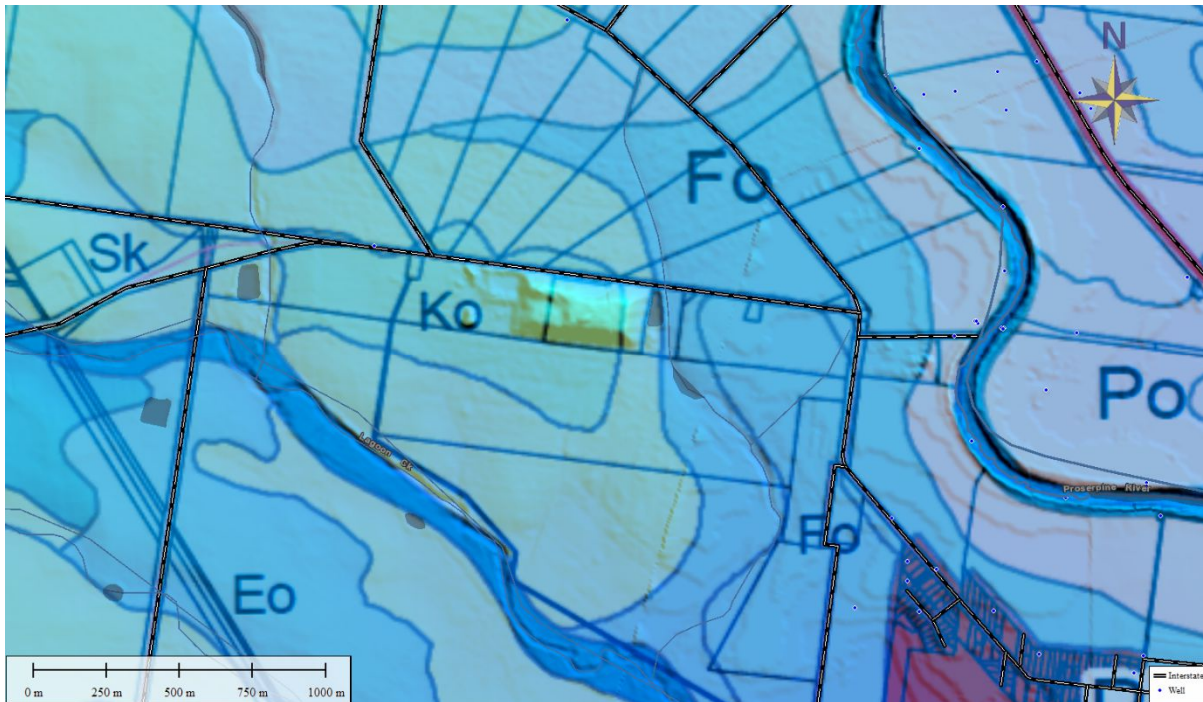


Figure 2 Map is showing soil types surrounding landfill.

## 2.4 Geological setting

The geological setting of the Proserpine area consists of a dynamic geological process that is continuing at the present stage. The geology of the Whitsunday Coast is diverse and has undergone periods of intense tectonic activity such as faulting which has influenced the shape of the current landscape (Hardy, 2003). The landscape is dominated by alluvial deposits which include braided river depositional environments and reworking of the deposited material.

The following section are an excerpt from Hardy (2003):

“The Tertiary - Pliocene consolidated, and semi-consolidated sediments (TQAs) have been formed by outwash from hills and mountains. This younger Tertiary landscape may also have formed from the weathering of the Tertiary landscape. These deposits generally occur as flat to undulating rises with thick hardened silica pans or sandstones above the present floodplains which are in places deeply dissected but have not been altered by tectonic movements. Some semi-consolidated sedimentary layers may underlie the Pliocene silica pans and sandstones.

The unconsolidated Cainozoic alluvium is generally found adjacent to the Tertiary sandstones and Tertiary - Pliocene consolidated sediments. The Cainozoic alluvium is found in elevated flood free areas or dissected peneplains. This sediment was formed by fluvial and colluvial processes which no longer operate or are less active. The Cainozoic alluvium could have been formed under different climatic conditions to the more recent Quaternary alluvium. The Cainozoic alluvium consists of sand, gravel and clay and may represent alluvial – colluvial material derived from the Tertiary sediments.

Quaternary alluvium is found in areas which experience periodic or frequent flooding. This alluvium is usually interbedded with a variety of sediment including clay, silt, sand and gravel. The Quaternary marine sediments represent areas that have been formed from estuarine and nearshore sediments. Large areas of these marine sediments are found in the Goorganga Plains area. Beach ridges occur adjacent to the Quaternary marine alluvium. The Quaternary beach ridges (Qr) include inland and coastal dunes formed in the Pleistocene and Holocene epochs. The most extensive area of Quaternary beach ridges occurs in the Goorganga plains area with a series of parallel ridges.”

The Quaternary alluvial sediments are found in large areas adjacent to the Proserpine River, and the alluvial plains are flat to very gently undulating. The soils formed from the flood events usually have layers of buried material from clay to gravel being built up in successive layers (Hardy, 2003).

The near surface geology of the Kelsey Creek Landfill site was explored using available drill data in the area, although not extensive is sufficient to give a general understanding of subsurface conditions. A geological block model was constructed using this data, and two cross sections were taken that underlay the landfill (Figure 3). It should be kept in mind that logging between drillers can result in different naming conventions for the same strata. In Figure 3, the landfill site is underlain by a sandy layer, most probably Ko soil type from soil mapping, and to the east a more dominant clay soil which is associated with Sk soil type. Deeper sand formations are associated with competent sandstone layers that could occur as shallow as two metres below the landfill. For this assessment, this layer could have a permeability ranging from 0.01 – 8 m/d and was assigned a permeability of 1 m/d which is overly conservative due to the expected interbedded structure of semi-consolidated material with sandstone layers.

Coarse weathered rock is reported, and for this analysis, it was assumed to be a weathered granite which is commonly called Grus. The grus is typically associated with clay like interfill such as illite or kaolinite. No smectitic or montmorillonite is present within this subsurface layer. The hydraulic permeability within this zone is limited and hydraulic conductivity of 1.2 m/day (Hutchison and Hicks, 1985).

Shale beds have been observed in the area, and these beds will act as a barrier to groundwater movement at a depth of 20 – 23 metres below ground level (mbgl) limiting any chemical of concern transport to the upper layers.

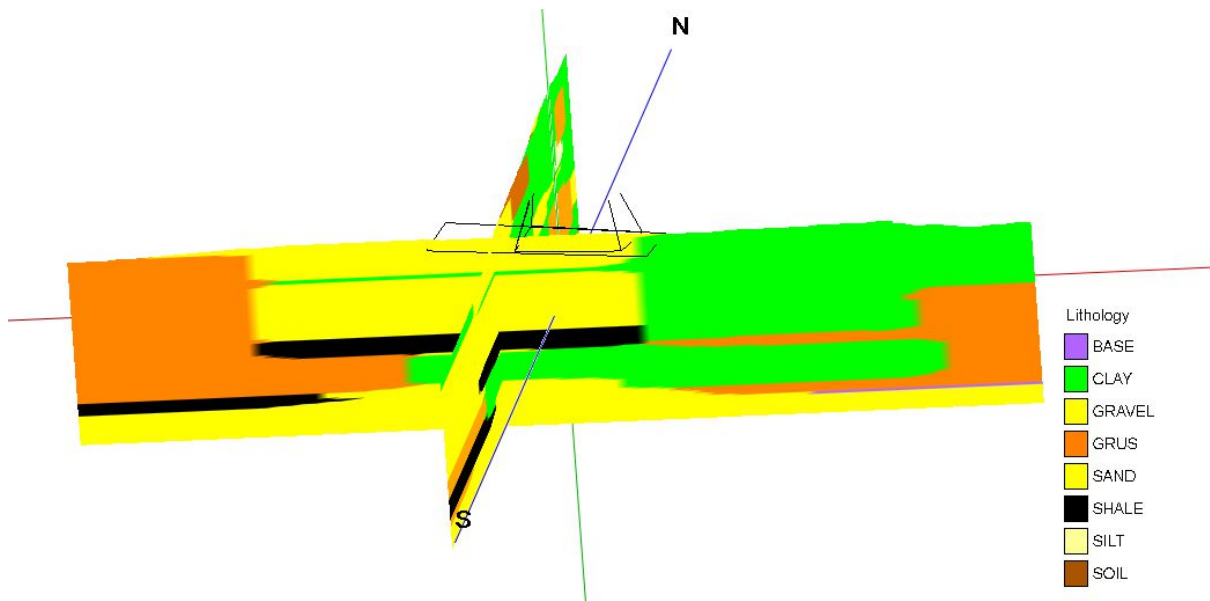


Figure 3 Interpretation of geological setting in the subsurface at Kelsey Creek Landfill

### 3 WATER RESOURCES

#### 3.1 Surface water

The Proserpine dam is located 57 kilometres up stream of the Proserpine River mouth with a volumetric capacity of 500,000 megalitres. Annual mean discharge of the Proserpine River is approximately 630,000 megalitres per annum with a catchment area of approximately 1060 square kilometres (Hardy, 2003). The mean annual discharge of the Proserpine River at Peter Faust Dam is approximately 414 815 megalitres (Hardy, 2003). Creeks and ephemeral streams in the area flow during the summer and autumn corresponding to the annual rainfall pattern (Figure 4).

Surface water features that form the catchment boundary (Figure 5) for the Kelsey Creek Landfill is Pig Creek to the west, Proserpine River to the north, Dykes Gully to the east and south-east, and Lagoon Creek to the south (Figure 1). Pig Creek flows into Lagoon Creek before it is joined downstream by Dykes Gully (Figure 4).

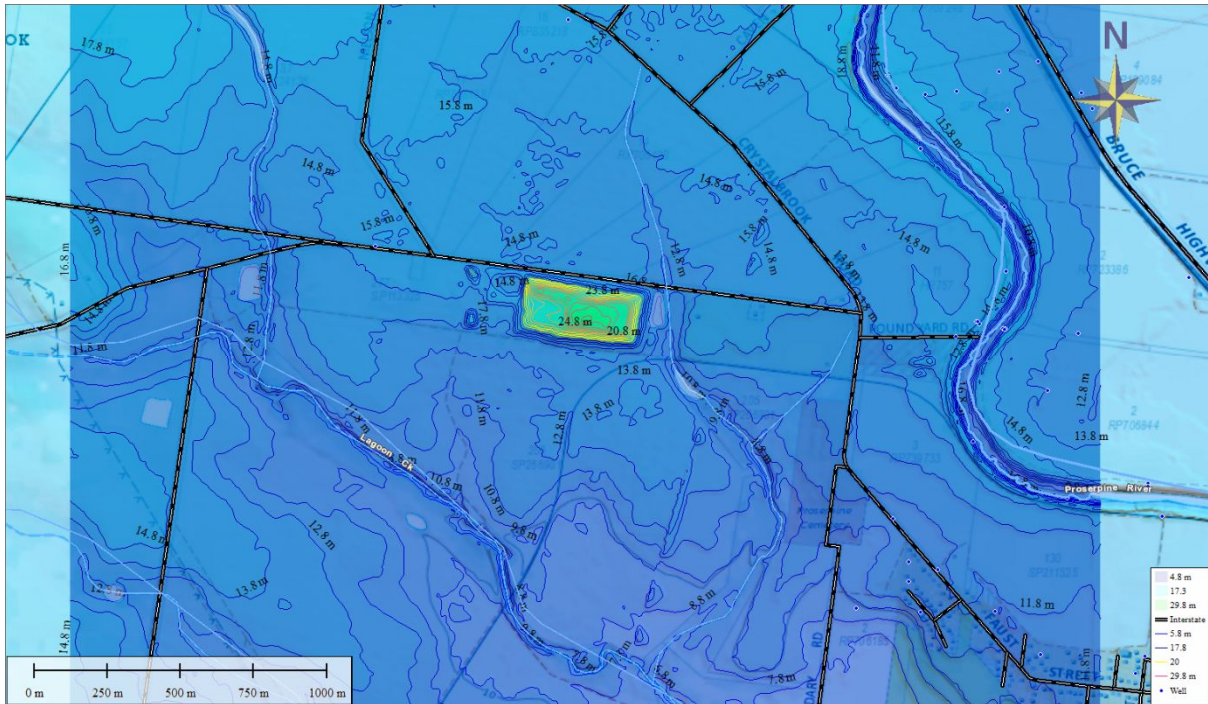


Figure 4 Contour map of the Kelsey Creek Landfill area

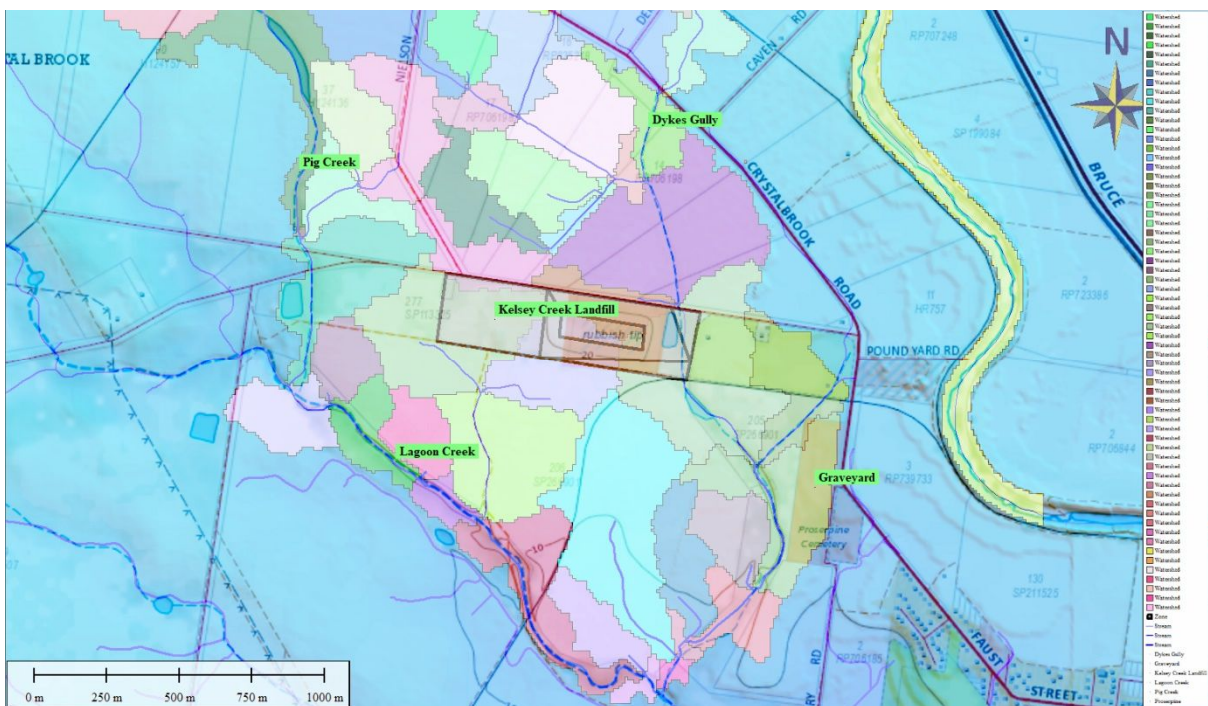


Figure 5 Calculated water shed areas surrounding Kelsey Creek Landfill

Considering the general topography of the landscape and geometry of surface catchment areas (Figure 4 and Figure 5) a theoretical analysis of the general estimated flow direction that surface water might have if it could migrate off site (Figure 6). The waterdrop topographic analysis indicates that limited migration potential exists to the east, north or west of the site. In all instances, water will flow towards Lagoon Creek via Dykes Gully or the unknown gully located to the south-west of the site (Figure 6). It is anticipated that due to the low flow conditions in these gullies that migration of contaminants in the surface water system will be limited.

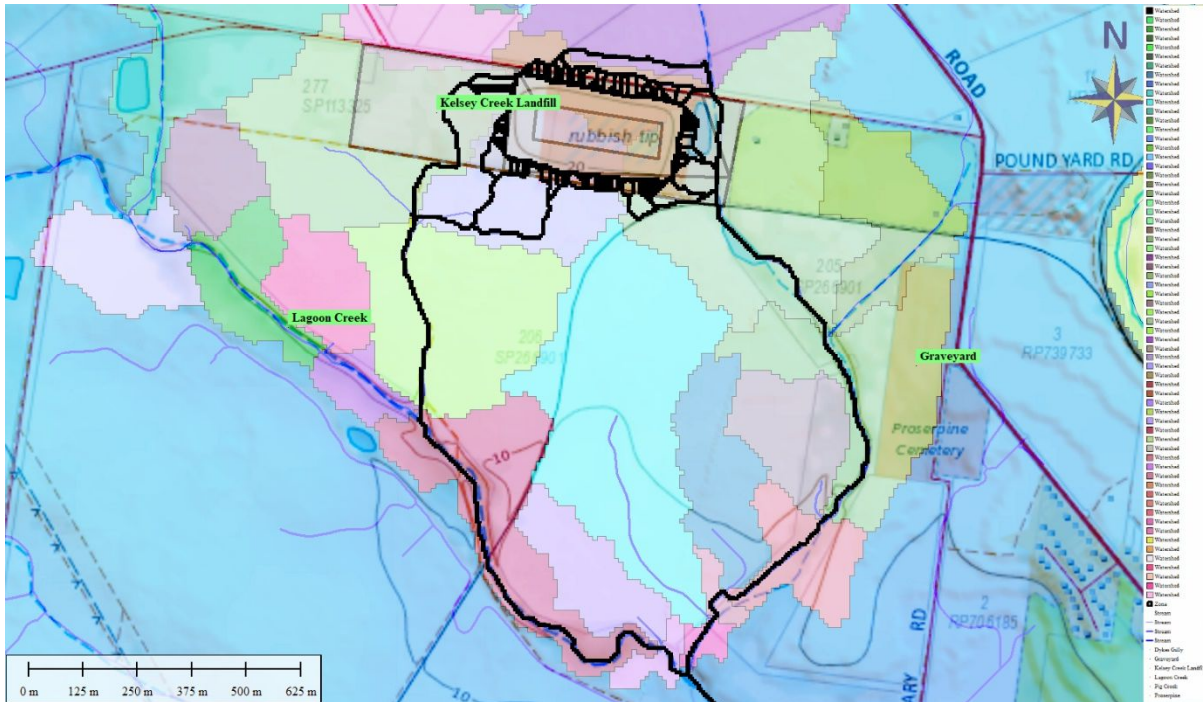


Figure 6 Water drop analysis of potential surface water migration pathway from landfill without any physical barriers

### 3.2 Groundwater system

The Proserpine River catchment area may have a groundwater yield of 21,200 megalitres per annum (Hardy, 2003). The groundwater supplies associated with the Proserpine River are estimated to have less than 3000 milligrams per litre in total dissolved solids (TDS). It is estimated that 70% of the groundwater in the Proserpine River alluvium groundwater sources have low salinity levels.

Regional water level data was extracted from the groundwater database<sup>2</sup>, 106 bores were identified within 2.6 km radius of the landfill. Chemical and water level data obtained from this resource was used without modification and presented in Figure 7 and Figure 8.

Groundwater contours indicate that the Proserpine River is acting as a losing stream to the north with groundwater flow towards the south-east. Lagoon Creek and the southern zone of the Proserpine River acts as gaining reaches; this is observable to the east of the landfill site where contours form a v-shape indicating flow into the Proserpine River. Discharge to surface water is likely along the southern sections of Lagoon Creek, and Dykes Gully as topographic land surface values approach groundwater levels.

An inherent issue that Kelsey Creek Landfill is faced with is the contamination of the upstream area, located in the vicinity of Nielson Road, Bore 12200036. Electrical conductivity (EC) values have exceeded the 1000 uS/cm level since 1973 (Figure 9). Elevated levels of chloride (>200 mg/L), sodium (>100 mg/L), nitrate (>7 mg/L) and sulphate (>8 mg/L) has been recorded in this bore since 2000. Also, iron and manganese have also been measured with reported levels of 0.01 mg/L and 0.03 mg/L, respectively. A limited set of additional analytes is reported within the groundwater database for this bore. These values can be considered as the upgradient background values for the landfill.

<sup>2</sup> © State of Queensland (Department of Natural Resources and Mines)

The second source of contamination, downstream of the site has been identified in Bore 12200039. EC values exceed 8500 uS/cm since 2000. Elevated levels of chloride (>2700 mg/L), sodium (>1400 mg/L), nitrate (>5 mg/L) and sulphate (>35 mg/L) has been recorded at this location.

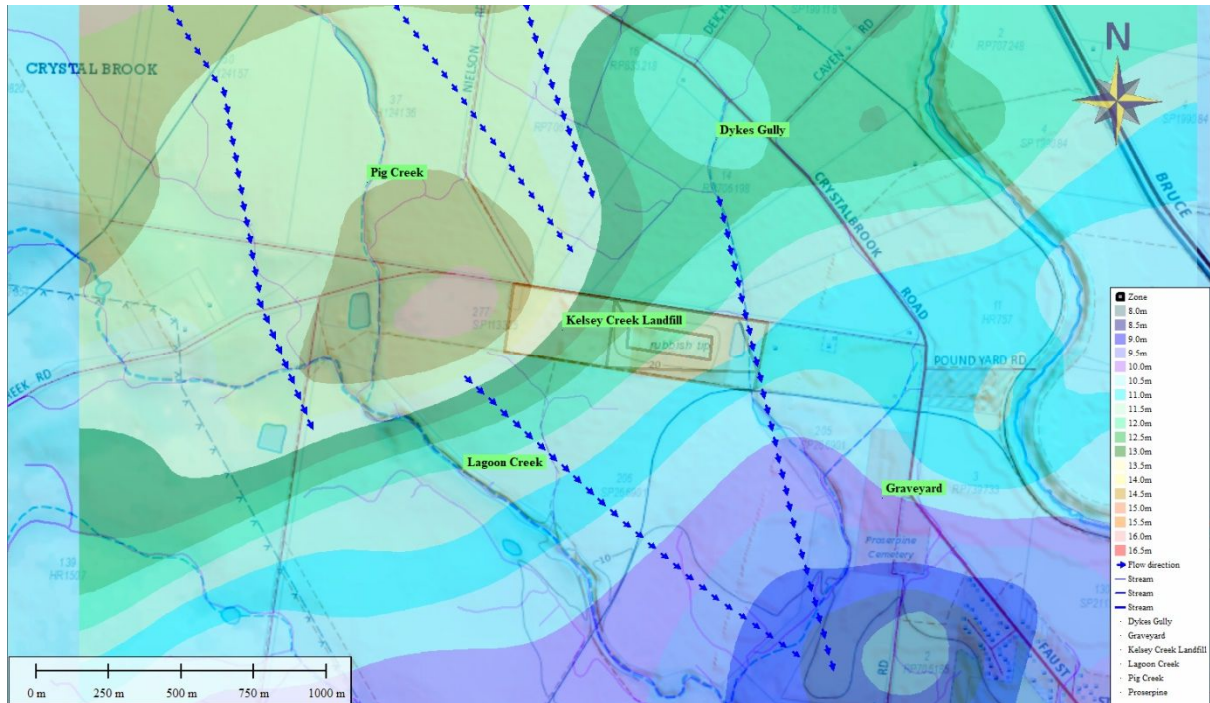


Figure 7 Groundwater levels surrounding Kelsey Creek Landfill and the town of Proserpine. Interpreted groundwater flow direction is shown as blue arrow lines

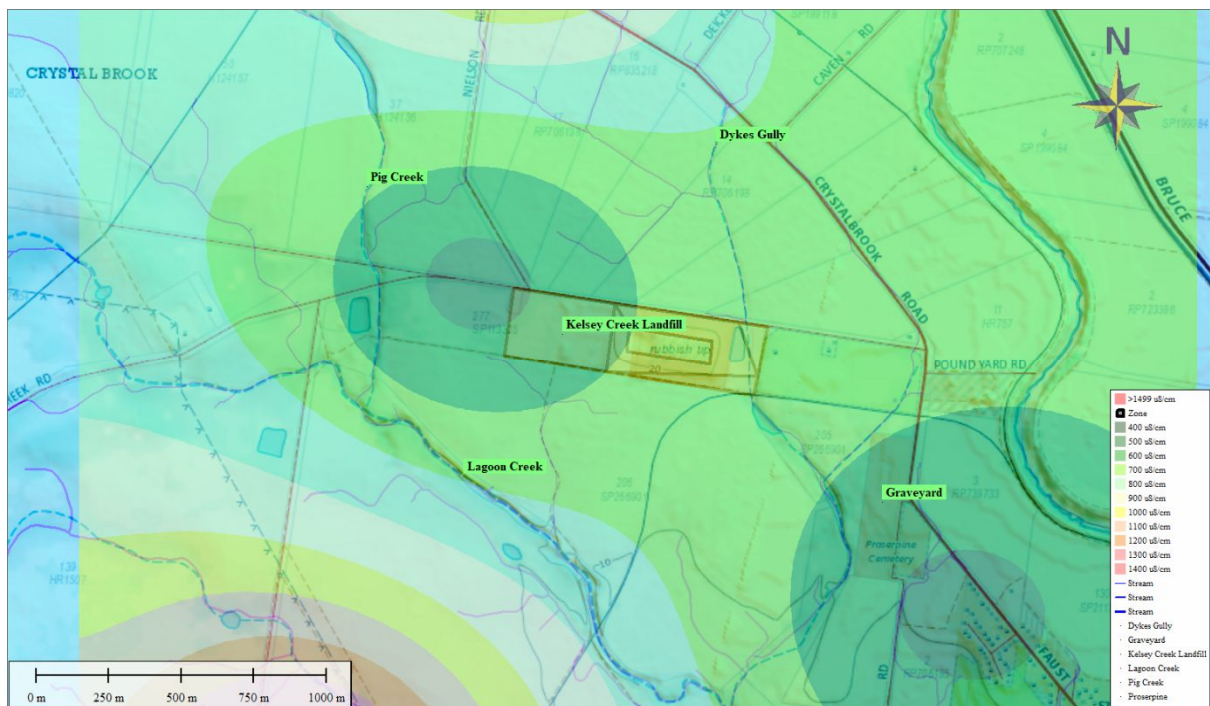


Figure 8 Contour map of electrical conductivity in uS/cm

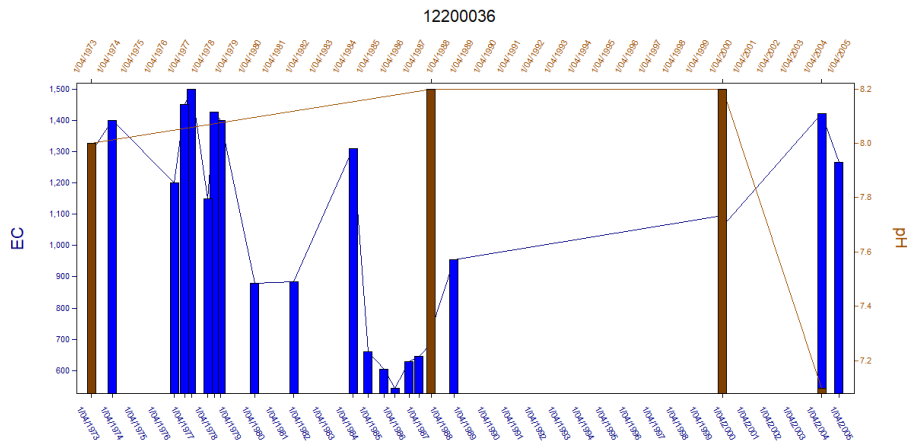


Figure 9 Monitoring bore 12200036, DNRM groundwater database

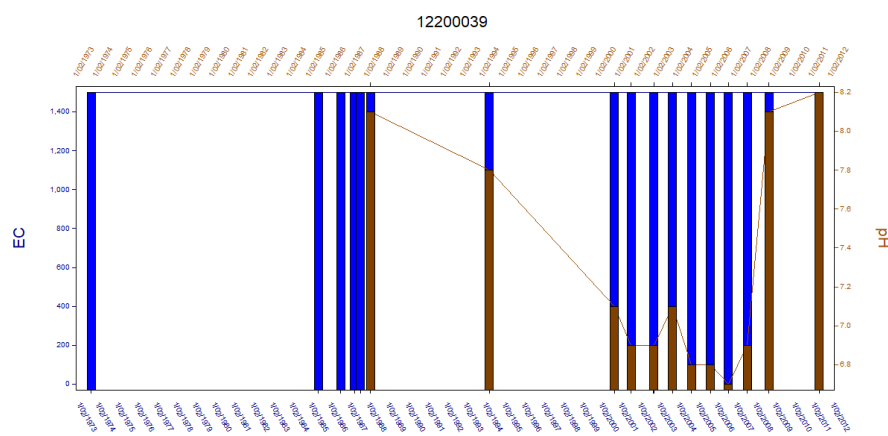


Figure 10 Monitoring bore 12200039, DNRM groundwater database

#### 4 DESCRIPTION OF KELSEY CREEK LANDFILL

It is located on Kelsey Creek Road approximately two kilometres from the town of Proserpine (Figure 1). The facility is situated on lot 160 on SP171910, Lot 277 on SP113325, and Lot 299 on SP113325. The Kelsey Creek Landfill was established in the 1970's to service the town of Proserpine. A separate landfill was constructed at Airlie beach around the same time to service the Cannonvale and Airlie beach areas.

The landfill is comprised of the old landfill (1970's), and three Geotextile Clay Lined cells. The old landfill has not accepted general or regulated waste since 2005. Cell 1 was constructed in August 2005; Cell 2 was constructed in 2007 and Cell 3 was constructed in June 2010. Cell 2 is full, Cell 3 is full, and Cell 1 is accepting waste. Estimated volume of water that each cell could hold without waste is approximately 25 mega litres. Leachate is collected at the base of each of the lined landfill cells. A leachate sump is in cell 2 and cell 1. The leachate sump in cell 1 collects leachate from cell 1 and 3. The Landfill leachate is evaporated on the plateau of cell 1 (Hardy, 2011).

The stormwater which falls on the landfill is shed into grassed swale drains which allow the transport of this water to the stormwater detention dam. The stormwater dam is about 95 m long and an average width of 25 m and about 2 m deep. The dam covers an area of approximately 0.24 ha and has a capacity of approximately 6 mega litres. When the dam is full, excess stormwater is shed over the rock spillway into Dykes gully.

## 4.1 Leachate Management<sup>3</sup>

Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that it contains (KCL, 2015). It can usually contain both dissolved and suspended material. The generation of leachate is caused principally by precipitation percolating through waste deposited in a landfill (Murdoch, 2013). Once in contact with decomposing solid waste, the percolating water becomes contaminated, and if it then flows out of the waste material, it is termed leachate. Additional leachate volume is produced during this decomposition of carbonaceous material producing a wide range of other materials including methane, carbon dioxide and a complex mixture of organic acids, aldehydes, alcohols and simple sugars.

Whitsunday Regional Council has installed a leachate irrigation system at Kelsey Creek Landfill (KCL, 2015). The system is configured so that it can pump leachate from all lined cells by using two submersible pressure pumps. A valve allows leachate to be pumped from the two pressure pumps to a holding tank (Figure 11). When a pressure pump is turned on, it takes approximately 2 hours for the pump to fill the holding tank. The holding tank pressure pump will empty the holding tank quicker than it is recharged.

There are two sensors installed in the holding tank, which automates the irrigation system. The sensors turn the holding tank pump on at 90% capacity and turn the holding tank pump off at 5% capacity.

The holding tank pressure pump that delivers the leachate from the holding tank to the sprinklers is adjustable. The two pumps which feed the holding tank from the two-leachate wells continuously run and cannot be remotely turned off.

On a setting of 4 for example, with six sprinklers open, the tank will empty (from 100% full) in a little over 2 hours while being recharged by the well pump, so that the cycle of the full tank to empty tank to full tank takes 4 to 4.5 hours. With a pump setting of 8, and with seven sprinklers open, the tank will empty in a little over 1 hour while being recharged by the well pump, meaning that the cycle takes approximately 3 to 3.5 hours. This means that during a normal working day it is possible to carry out two cycles of emptying / refilling the holding tank, thereby allowing approx. 75,000 to 80,000 litres of leachate to be irrigated per day.

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<sup>3</sup> Kelsey Creek Site Based Management Plan 2015

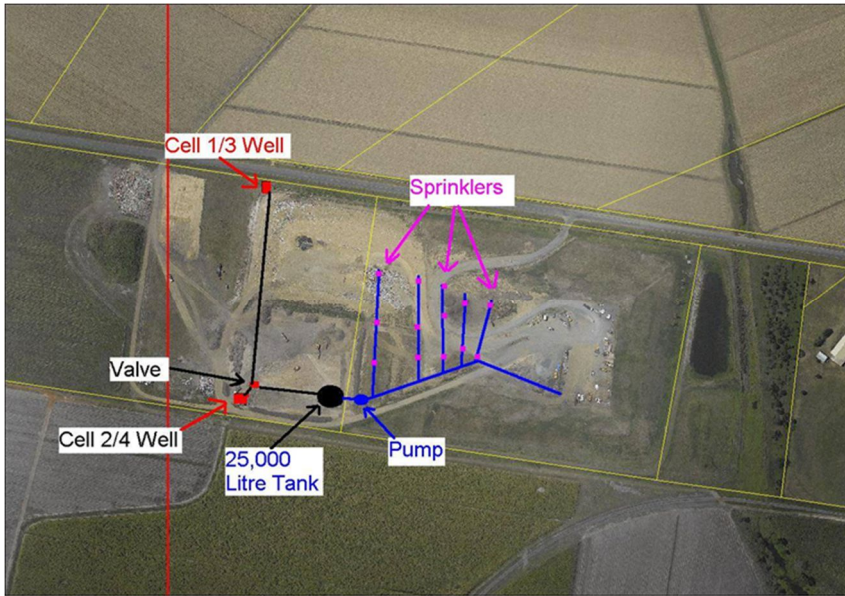


Figure 11 Sprinkler system to manage leachate volumes at site

The WRC Waste Management Officer will inspect the system to ensure they continue to operate according to design specifications and prevent ground and surface water contamination. Ground and surface water is tested twice a year and the results forwarded to DEHP.

Procedures for minimising leachate generation are:

- The daily covering of all waste.
- Stormwater diversion away from active faces. This is undertaken at the top of the face as well as at the base of the face.
- Only water contacting the active zones is dealt with as leachate.

## 4.2 Groundwater sampling and testing programme

Monitoring the quality of the groundwater must be performed bi-annually to ensure that no environmental impact of the operation has occurred or if, relevant measures are to be taken immediately (KCL, 2015). The WRC has actively implemented this monitoring program and results from 2010 till 2017 will be presented in the following sections.

## 5 LANDFILL GROUNDWATER SYSTEM

### 5.1 Local water level data

Groundwater water level data collected since 2010 has been plotted with Bore 12200038, Bore 12200039, Bore 32132 and Bore 43989 (Figure 12). The contoured data indicates that there is a high probability that groundwater flow direction is from Pig Creek to Dykes Gully (west to east) and then southward towards the confluence of Lagoon Creek and Dykes Gully. The change in groundwater direction due to hydraulic heads is associated with dewatering which must occur at the landfill site or reduced recharge into groundwater. In the latter instance, it could be associated with liners and capping systems shedding water to surface water structures and reduced seepage from the landfill as it matures and compacts under its weight. It is particularly relevant if the remediated “old” landfill footprint is considered.

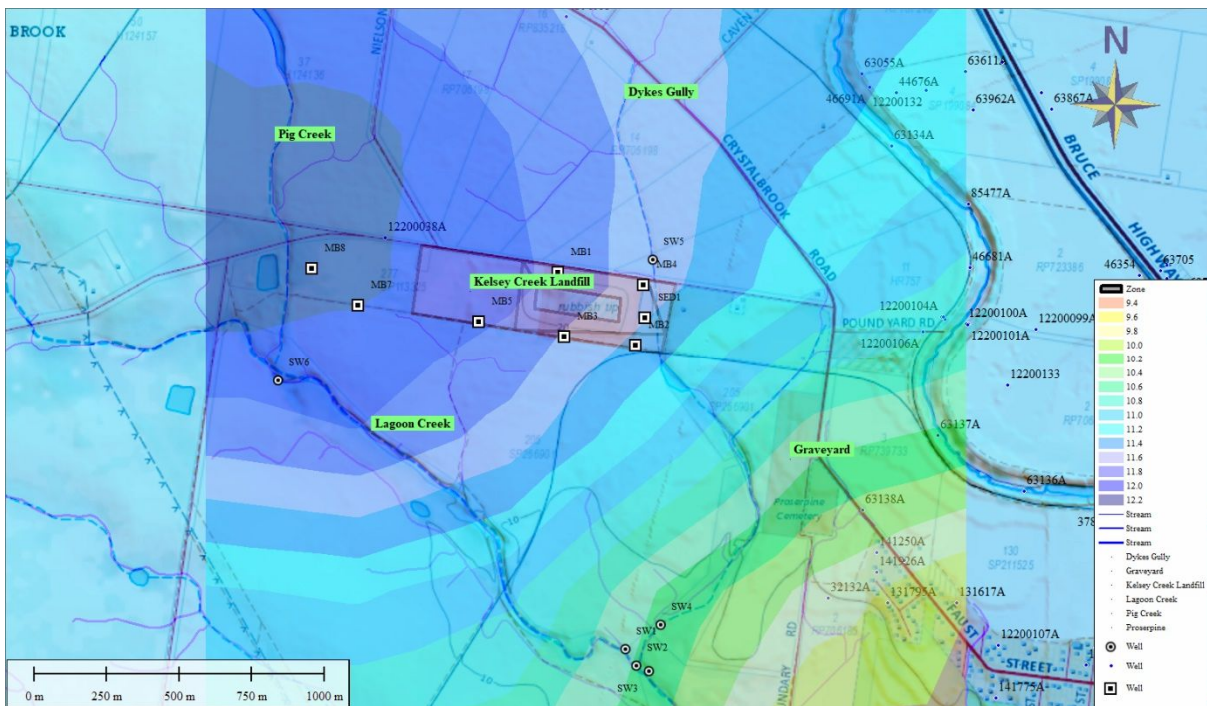


Figure 12 Localised presentation of contoured water levels at the Kelsey Creek Landfill (data range 2010 - 2017)



Figure 13 Detailed placement of surface water monitoring points at the confluence of Lagoon Creek and Dykes Gully

## 5.2 Chemical data

Monitoring data from 2010 till 2017 were assessed for the groundwater and surface water sampling points indicated in Figure 12. Surface water points are identified with the prefix of SW, sediment dam located on the east of the site is denoted by SED1, while monitoring bore data uses an MB prefix. It should be kept in mind that SW5 is upstream of the site and is regarded as background data point for the current analysis of surface and groundwater data. Also, Bore 12200038 (Table 1) is a historical monitoring point with data collected in 1988 and 2000. Considering the lifetime of the landfill this bore should have recorded upstream impacts from the landfill if it were present.

Table 1 Available analytical data for Bore 12200038

RDATE	EC	pH	SiO <sub>2</sub>	Alk	Na	K	Ca	Mg	Fe	Mn	HCO <sub>3</sub>	CO <sub>3</sub>	Cl	F	NO <sub>3</sub>	SO <sub>4</sub>
29/03/1988	330	6.4	33	5	61	0.4	0.1	0.1	0.8	0	6.1	0	87	0.1	4.2	4.7
15/08/2000	432	6.7	27	17	79.9	0.4	0	0.5	0.03	0.01	20.7	0	115.1	0.01	3.3	4

A set of 56 parameters were analysed for which includes macro, micro chemical analytes, metals and organic based contaminants. All data is reported in mg/L and sample descriptive statistics is collated in Appendix B: General statistical analysis of monitoring data. Due to the extensive number of analytes sampled only key components will be highlighted in this section with a full list of interpretive graphs available in Appendix C: Graphical summary of analyte data. In each figure, a graph of time series points is presented on the right side of the figure as presented in Figure 14. Secondly, a violin plot (left-side) of each sampling site was included to highlight the median value (black diamond shape) and the P25 and P75 range. The width of the violin plot at a point indicates the number of samples in that area which is illustrated in the time series section of Figure 14. Secondly, some violin plots include a log-scaled y-axis to illustrate the difference in the median value of the samples as well as interquartile range.

In Figure 14 a clear distinction between the landfill seepage monitoring bores and the surface water sampling points can be observed. Monitoring bores are above the 5000 uS/cm level, but a slight downward trend can be observed. Secondly, the sediment pond indicates that some impacted runoff from the landfill site has entered this water structure. All surface water monitoring points are similar with reported median values within 300 – 400 uS/cm.

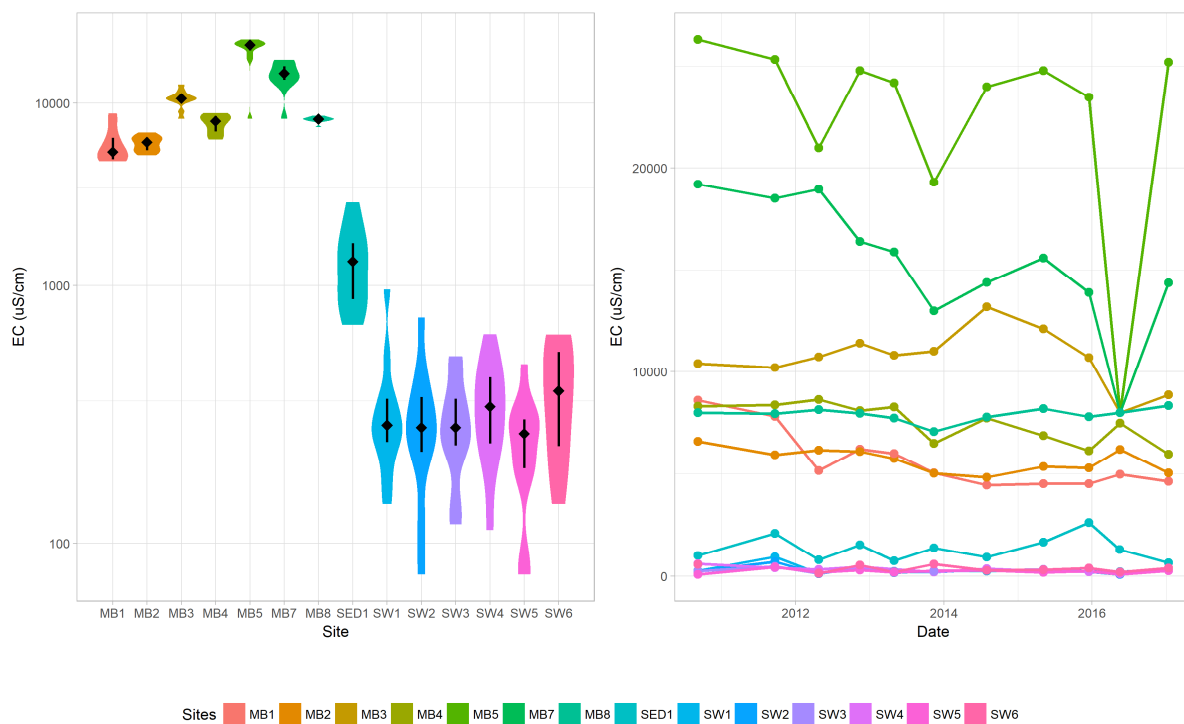


Figure 14 EC monitoring data for the site

Local agricultural practices have impacted surface water monitoring bore SW5 which has elevated total nitrogen levels (Figure 15) above that reported for the landfill monitoring network. A similar trend is observed for total phosphorous levels.

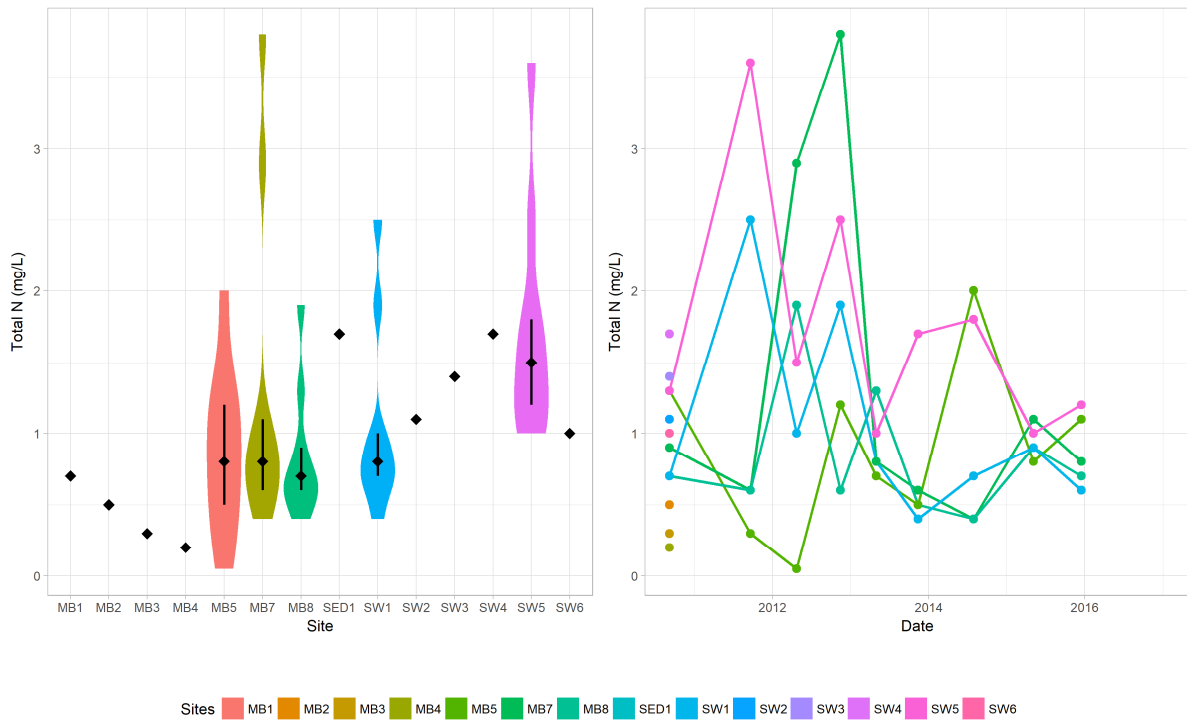


Figure 15 Total nitrogen results for sampling points

Review of the analytes indicates that limited interaction is occurring between water qualities reported in the seepage monitoring network and the surface water system. To conclude this section an analysis of water types will be done to evaluate if off-site impacts can be observed.

A review of macro-chemical components (Figure 16, Na, K, Ca, Mg, Alkalinity, Cl, and SO<sub>4</sub>) indicate that a clear distinction exists for the analytes. The seepage monitoring bores are dominated by a sodium-chloride water type while surface waters are indicative of a mixture of coastal rainwater with a strong alkalinity signature. The data indicates that the water types have not mixed in the analysis period. In the surface water samples, groundwater monitoring bore RN1220038 was included, and it is distinct from the seepage and surface water monitoring water quality data. Bore RN1220038 is a sodium chloride dominated water which is expected for a system in close proximity to the ocean.

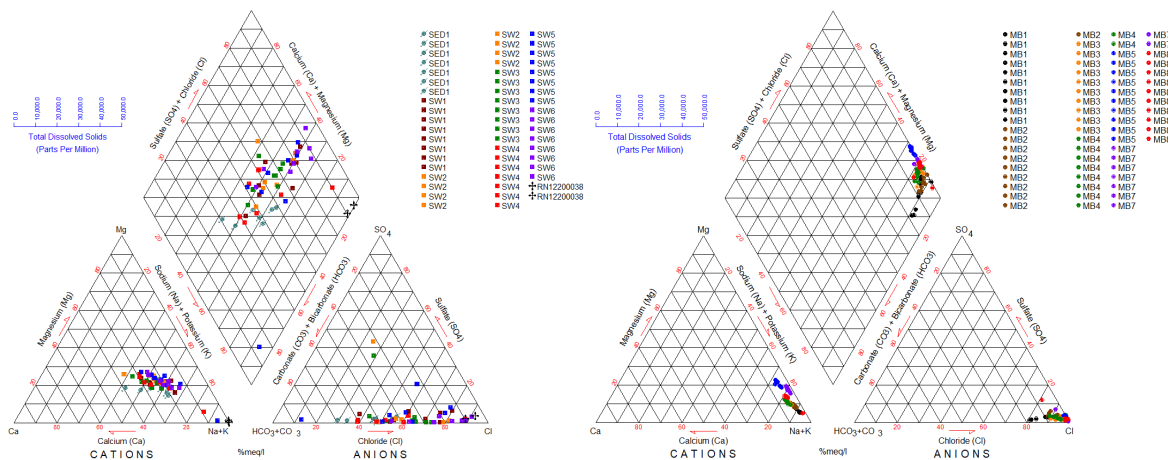


Figure 16 Piper diagram of surface water and groundwater monitoring data

Micro-chemical analysis and association between monitoring bores were performed using k-means cluster. The cluster analysis used a principal component analysis to perform a dimension reduction on the normalised data. Data selection was based on availability of metal and organic component analysis data as this was the focus of this assessment. Identified clusters are reported in Table 2 with minor clustering components, cluster data is illustrated in Figure 17.

Table 2 Clustering data for monitoring bores

Site ID	1	2	3	Cluster	Site ID	1	2	3	Cluster
MB1	7	1	0	1	SED1	3	2	0	1
MB2	7	0	0	1	SW1	8	0	0	1
MB3	5	3	0	1	SW2	8	0	0	1
MB4	8	0	0	1	SW3	8	0	0	1
MB5	0	0	7	3	SW4	7	0	0	1
MB7	0	8	0	2	SW5	7	0	0	1
MB8	2	6	0	2	SW6	1	0	0	1

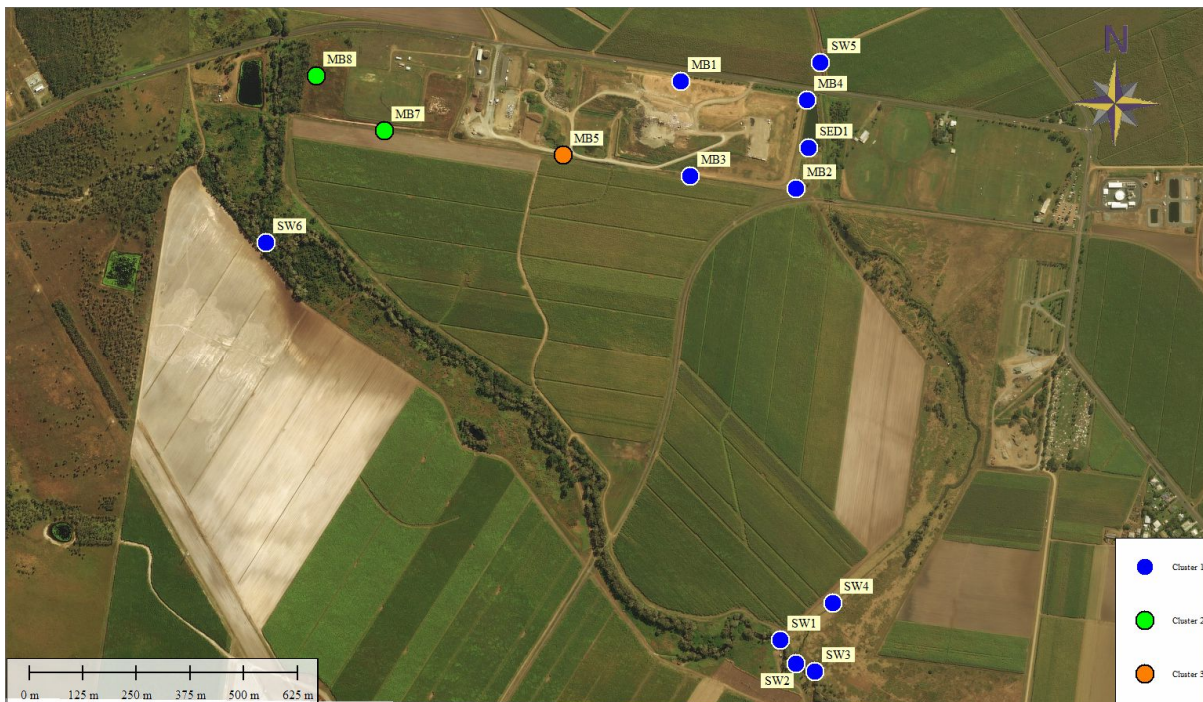


Figure 17 Identified cluster groups for landfill monitoring bore data; MB7, MB8, SW6, SW5 are located up-gradient of the site

A set of three clusters were identified during the analysis of the data.

- Cluster 1 (blue points) is the most dominant cluster at the site and includes bores MB1 – MB4, SW1 – SW6 and SED1. These monitoring points represent water types that have been influenced by saline water as well as limited or below detection limits of nitrogen compounds, phosphorous and metal species.
- Cluster 2 (green points) is the second most abundant group consisting of MB7 and MB8. This group consists of bores located on the western side of the landfill, which is upgradient and receives water from the creek.

- Cluster 3 (orange point) is located due south of the landfill and trends towards a Mg/Ca-Cl water type.

Cluster analysis indicates that although different environments exist on site, the majority of samples (Cluster 1) contain background values or water quality associated with creek system.

### 5.3 Statistical analysis

Data presented in Section 5.2 will be statistically analysed to assess if there is a statistical significant difference between MB7, MB8, SW5 and SW6 (potentially background values) and the remainder of the on-site monitoring points.

Analysis includes the general macro-chemical, micro-chemical and metals, where data has sufficient number of samples (Appendix D: Statistical Analysis). Only statistically significant differences could be observed for Fe (MB1 – MB5, p-value <0.0001, Figure 19) and SO<sub>4</sub> (MB5 – p-value <0.0001, Figure 18). Macro-chemical components include Ca (MB3, MB4), K (SED1), Na (MB5) and Cl (MB5).

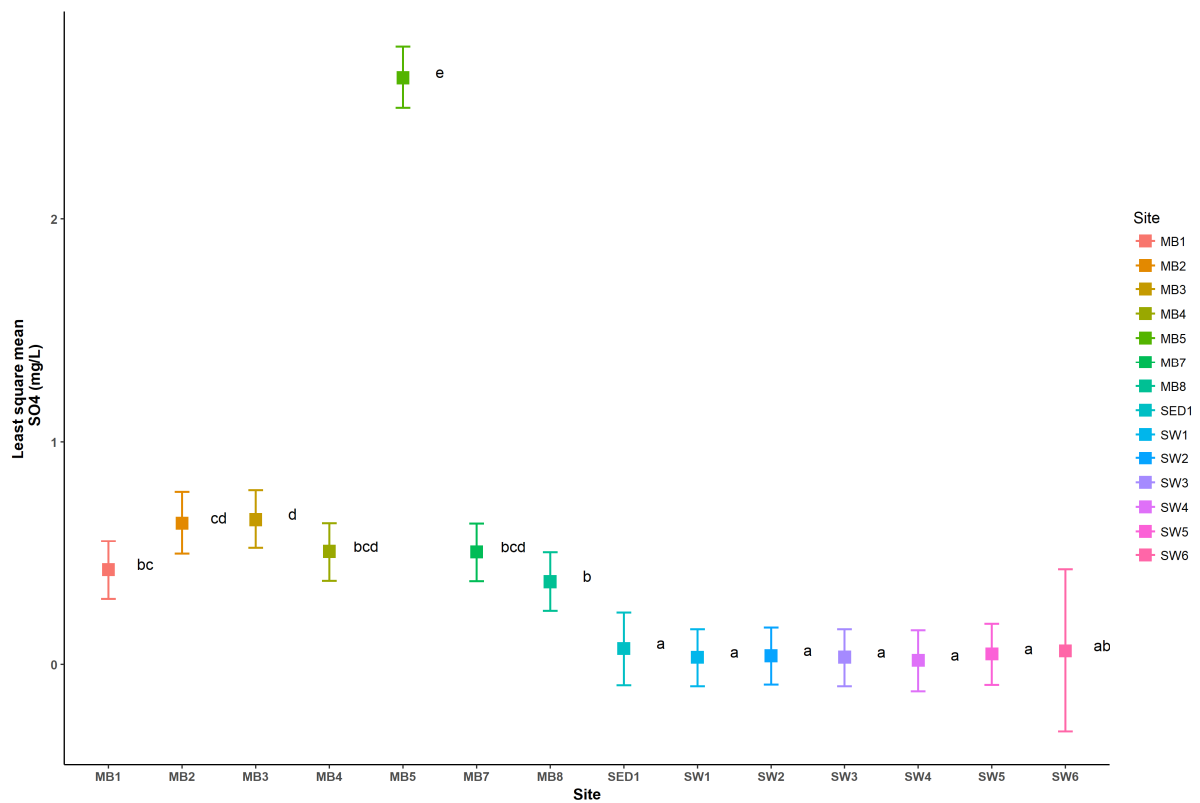


Figure 18 SO<sub>4</sub> means, confidence intervals, and mean-separation letters

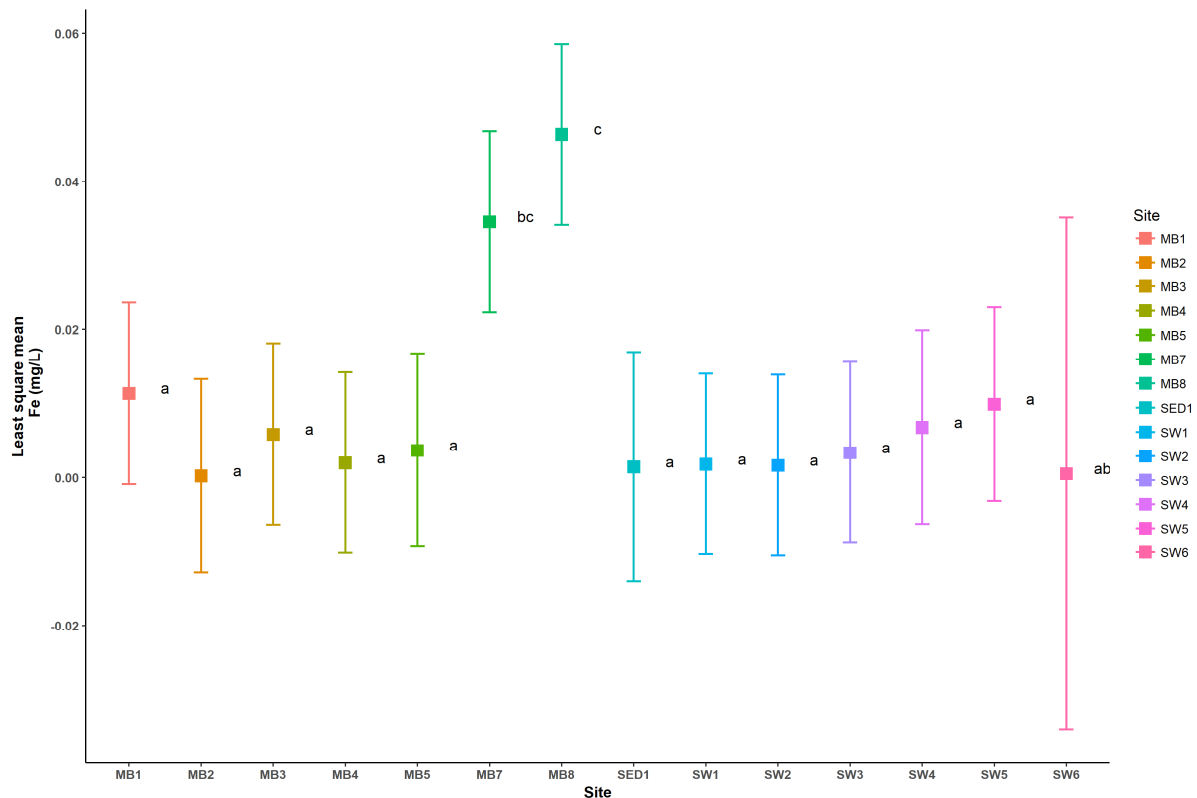


Figure 19 Fe means, confidence intervals, and mean-separation letters

## 6 CONCEPTUAL MODEL

The hydrogeological and contaminant transport conceptual model for the site is:

1. The site is underlain by clays and sand/sandstone formations that limit migration of contaminants of the site via the groundwater pathway.
2. Current activities at the site do indicate that there is a groundwater gradient towards the landfill, with the potential for localised off-site migration of contaminants via a cone of depression. It should be noted that localised mounding under the landfill was expected but as noted water levels were below surrounding water levels to the north and west of the site.
3. The landfill monitoring system is subject to off-site contaminants migrating onto the site due to a contaminant source in the upgradient groundwater system identified at Nielson Road (Bore 12200036).
4. Kelsey Creek Landfill contains an old cell which has been capped and remediated and is maturing with reduced groundwater losses to the environment which could be an indication why macro-chemical components are decreasing in concentration levels over time. The new lined landfill cells are effective if data is considered, which indicate a reduction in concentration levels.
5. Surface water analysis does not indicate an interaction with a contaminant source within the monitoring network indicating limited transport potential of contaminants to sampling points.

## 7 RECOMMENDATIONS AND CONCLUSIONS

### 7.1 Recommendations

The WRC require additional monitoring bores to assist with reducing liability from off-site contamination migrating onto the landfill area.

Two bores up gradient from Kelsey Creek Landfill. The first monitoring point could be either Bore 12200036 or installing a groundwater monitoring bore where Nielson Road and Crystalbrook Road join. The second should be across the road from Kelsey Creek Landfill on the road reserve.

A single bore to the south off Kelsey Creek Landfill near Dykes Gully as it is indicative of the general groundwater flow direction.

Annual or bi-annual sampling should be performed for these monitoring bores in addition to the other sites.

### 7.2 Conclusions

Monitoring systems indicate that contaminants of concern are limited to the landfill area, and migration of site has not been observed in the groundwater. Due to engineering works undertaken at the site, i.e., cells constructed with liners or capping of old landfills; the potential for leachate generation is limited and dewatering under the landfill area. Chemical analysis indicated a similar assessment with no variation in water types being observed or concentration changes in off-site monitoring systems. A clear distinction between the seepage data and relevant groundwater and surface water monitoring points could be characterised.

## 8 REFERENCES

- BOM (2017) Climate Statistics for Australian locations. Bureau of Meteorology.
- Darvall, D. (2017) Notice Environmental Protection Act 1994, Environmental Evaluation, in: Protection, D.o.E.a.H. (Ed.). Department of Environment and Heritage Protection, Mackay, Level 1, 22-30 Wood Street, QLD 4740, p. 5.
- Hardy, S. (2003) Soils and land suitability of the Whitsunday Coast area, Central Queensland. Whitsunday Regional Council, Proserpine, QLD 4800, p. 214.
- Hardy, S. (2011) Environmental evaluation of Kelsey Creek Landfill leachate and stormwater management practises, in: Compliance, P.M.E.a. (Ed.). Whitsunday Regional Council, Proserpine, p. 83.
- Hutchison, B.A. and Hicks, B.B. (1985) The forest-atmosphere interaction : proceedings of the Forest Environmental Measurements Conference held at Oak Ridge, Tennessee, October 23-28, 1983. D. Reidel; Sold and distributed in the U.S.A. and Canada by Kluwer Academic Publishers, Dordrecht ; Boston Hingham, MA, U.S.A.
- KCL (2015) Site Based Management Plan, in: Planning, C.a.E. (Ed.). Whitsunday Regional Council, Proserpine, p. 26.
- Murdoch, K. (2013) Leachate irrigation at Kelsey Creek Landfill Procedure, in: Planning, C.a.E. (Ed.). Whitsunday Regional Council, Proserpine, p. 6.

## 9 APPENDIX A: EE CONDITIONS SET OUT UNDER SECTION B. REQUIREMENTS (ASSESSMENT)

1. Conduct an assessment of the nature and extent of groundwater and surface water contamination from the landfill, and the effects on surrounding environmental values.
2. The scope of the assessment must at minimum:
  - a. Provide a description of all surface and subsurface infrastructure (e.g. pipes, tanks, sumps, dams, bores) that could:
    - i. have been a source of contaminants;
    - ii. be affected by contaminants; and
    - iii. be a barrier to and/or facilitate the migration of contaminants.
  - b. Provide a description of the surrounding land, including:
    - i. all environmentally sensitive areas;
    - ii. The quality of existing environmental values, in the context of the Environmental Protection(Water) Policy 2009;
    - iii. surface water, groundwater, wetlands and surface drainage that could be affected by or disperse contaminants; and
    - iv. any potentially impacted groundwater and/or surface water users.
  - c. Provide information on the leachate analysis of any contaminants identified in the surface and subsurface soil directly beneath the site; under the areas (cells) where waste is buried and actively deposited.
  - d. Identify the type(s), depth(s), location(s) and hydrogeology of groundwater aquifer(s) in the area.
  - e. Determine ground water movement (transmissivity) based on the local hydrogeology.
  - f. Investigate and report on whether any leachate from under the areas (cells) where waste is buried and actively deposited, is causing groundwater contamination.
  - g. Determine the extent of contamination of groundwater by conducting a contamination plume assessment.
  - h. Establish an appropriate background control(s) groundwater monitoring well location to establish background quality data of each aquifer identified.
  - i. Compare the results from the background wells to the results within the plume and consider the impact of the areas (cells) where waste is buried and is actively deposited, measured against relevant water quality guidelines (ANZECC 2000).
  - j. Investigate and report on whether any leachate from under the areas (cells) where waste is buried and actively deposited, is causing surface water contamination;
3. The assessment report containing the above information must be submitted to the department on or before 31 July 2017

# 10 APPENDIX B: GENERAL STATISTICAL ANALYSIS OF MONITORING DATA

Table 3 Summary statistical data for MB1

	Min	P25	Median	Mean	P75	Max	NA's
Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	5.80	5.99	6.41	6.45	6.54	7.83	1
TDS (mg/L)	2410	2825	3230	3475	3725	5500	
EC (uS/cm)	4450	4585	5050	5634	6110	8600	
Cl (mg/L)	1120	1215	1630	1827	2270	3060	1
BOD (mg/L)	0.500	0.750	1.000	0.833	1.000	1.000	8
COD (mg/L)	114	140	166	201	244	322	8
Na (mg/L)	863	952	1130	1186	1245	1760	1
K (mg/L)	0.50	0.50	1.00	1.20	1.75	3.00	1
Ca (mg/L)	21.0	25.5	38.0	41.2	46.2	81.0	1
Mg (mg/L)	26.0	32.5	51.0	55.9	63.0	112.0	1
Total Anions (meq/L)	40.2	43.2	53.4	59.1	70.8	92.4	1
Total Cations (meq/L)	40.8	45.3	55.4	58.7	63.6	89.8	1
SO4 (mg/L)	27.0	37.8	67.0	64.1	86.8	106.0	1
HCO3 (mg/L)	194	247	281	301	354	442	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Total Alk (mg/L)	194	247	281	301	354	442	2
TKN (mg/L)	0.6	0.6	0.6	0.6	0.6	0.6	10
Oxidised N (mg/L)	0.0050	0.0075	0.0100	0.0250	0.0350	0.0600	8
Organic N (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	10
Ammonia (mg/L)	0.06	0.09	0.12	0.36	0.51	0.90	8
Total N (mg/L)	0.7	0.7	0.7	0.7	0.7	0.7	10
Total P (mg/L)	0.05	0.05	0.05	0.07	0.08	0.11	8
As (mg/L)	0.000500	0.000625	0.002000	0.003450	0.005250	0.011000	1
Cd (mg/L)	5.00e-05	5.00e-05	5.00e-05	1.75e-04	8.75e-05	7.00e-04	1
Cr (mg/L)	0.0005	0.0005	0.0005	0.0012	0.0005	0.0070	1
Cu (mg/L)	0.00050	0.00125	0.00200	0.00270	0.00375	0.00700	1
Fe (mg/L)	0.025	0.530	0.730	1.694	0.890	9.690	2
Pb (mg/L)	0.0005	0.0005	0.0005	0.0219	0.0196	0.1600	1
Mn (mg/L)	0.0005	0.2110	0.2400	0.2489	0.3300	0.4450	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.00050	0.00250	0.00500	0.00635	0.00925	0.01400	1
Zn (mg/L)	0.0025	0.0140	0.0280	0.0367	0.0390	0.1530	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.025	0.025	0.060	21.187	0.230	190.000	2
TPH C15-C28 (mg/L)	0.05	0.05	0.17	94.93	1.56	850.00	2
TPH C29-C36 (mg/L)	0.025	0.025	0.025	11.233	0.370	100.000	2
TPH C10-C40 (mg/L)	0.05	0.05	0.16	125.12	2.46	1120.00	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.090	34.142	0.352	340.000	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.375	78.568	1.560	780.000	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.146	0.165	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1

Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00150	0.00250	0.00186	0.00250	0.00250	4
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	1
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1

Table 4 Summary statistical data for MB2

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	5.80	6.03	6.50	6.53	6.86	7.84	1
TDS (mg/L)	2620	3095	3340	3446	3870	4220	
EC (uS/cm)	4830	5178	5760	5668	6140	6600	
Cl (mg/L)	1310	1498	1730	1724	1845	2360	1
BOD (mg/L)	0.500	0.750	1.000	0.833	1.000	1.000	8
COD (mg/L)	0.0	20.5	41.0	76.3	114.5	188.0	8
Na (mg/L)	928	1020	1080	1086	1135	1280	1
K (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Ca (mg/L)	27.0	33.5	36.0	35.6	37.0	45.0	1
Mg (mg/L)	44.0	50.0	57.0	56.5	60.0	76.0	1
Total Anions (meq/L)	42.7	48.6	54.2	54.1	56.7	70.9	1
Total Cations (meq/L)	45.3	50.2	53.5	53.7	56.1	64.3	1
SO4 (mg/L)	80	97	102	104	104	149	1
HCO3 (mg/L)	104	120	144	159	184	228	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Total Alk (mg/L)	104	120	144	159	184	228	2
TKN (mg/L)	0.2	0.2	0.2	0.2	0.2	0.2	10
Oxidised N (mg/L)	0.0100	0.0150	0.0200	0.0967	0.1400	0.2600	8
Organic N (mg/L)	0.2	0.2	0.2	0.2	0.2	0.2	10
Ammonia (mg/L)	0.00500	0.00500	0.00500	0.00667	0.00750	0.01000	8
Total N (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	10
Total P (mg/L)	0.0050	0.0225	0.0400	0.0317	0.0450	0.0500	8
As (mg/L)	0.00050	0.00050	0.00050	0.00055	0.00050	0.00100	1
Cd (mg/L)	5.0e-05	5.0e-05	5.0e-05	5.5e-05	5.0e-05	1.0e-04	1
Cr (mg/L)	0.00050	0.00050	0.00050	0.00065	0.00050	0.00200	1
Cu (mg/L)	0.0005	0.0010	0.0020	0.0015	0.0020	0.0020	1
Fe (mg/L)	0.0250	0.0250	0.0250	0.0294	0.0250	0.0600	3
Pb (mg/L)	0.00050	0.00050	0.00050	0.01435	0.00762	0.12000	1
Mn (mg/L)	0.125	0.167	0.176	0.188	0.216	0.248	2
Hg (mg/L)	0.00005	0.00005	0.00005	0.00007	0.00005	0.00025	1
Ni (mg/L)	0.000500	0.000625	0.001000	0.001050	0.001000	0.002000	1
Zn (mg/L)	0.0025	0.0025	0.0025	0.0118	0.0095	0.0710	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0294	0.0250	0.0900	2
TPH C15-C28 (mg/L)	0.050	0.050	0.050	0.123	0.130	0.500	2

TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0261	0.0250	0.0600	2
TPH C10-C40 (mg/L)	0.050	0.050	0.050	0.127	0.140	0.500	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.119	0.117	0.500	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00200	0.00250	0.00194	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	1
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1

Table 5 Summary statistical data for MB3

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	5.80	6.22	6.71	6.68	6.98	8.02	1
TDS (mg/L)	5120	6590	6670	6760	7035	8230	
EC (uS/cm)	8000	10300	10720	10671	11200	13200	
Cl (mg/L)	3200	3555	3825	3883	4115	4750	1
BOD (mg/L)	0.500	0.500	0.500	0.667	0.750	1.000	8
COD (mg/L)	0	34	68	190	285	502	8
Na (mg/L)	1900	1922	1995	2114	2255	2610	1
K (mg/L)	0.5	1.0	1.0	1.1	1.0	2.0	1
Ca (mg/L)	86.0	91.8	112.5	116.5	141.5	159.0	1
Mg (mg/L)	111	123	141	150	171	208	1
Total Anions (meq/L)	99	105	116	117	126	143	1
Total Cations (meq/L)	96.5	98.2	104.5	110.1	119.0	139.0	1
SO4 (mg/L)	80.0	88.5	96.0	107.4	103.0	212.0	1
HCO3 (mg/L)	99	106	162	235	321	482	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Total Alk (mg/L)	99	106	162	235	321	482	2
TKN (mg/L)	0.3	0.3	0.3	0.3	0.3	0.3	10
Oxidised N (mg/L)	0.0050	0.0050	0.0050	0.0100	0.0125	0.0200	8
Organic N (mg/L)	0.2	0.2	0.2	0.2	0.2	0.2	10
Ammonia (mg/L)	0.0200	0.0300	0.0400	0.0333	0.0400	0.0400	8
Total N (mg/L)	0.3	0.3	0.3	0.3	0.3	0.3	10
Total P (mg/L)	0.050	0.065	0.080	0.133	0.175	0.270	8
As (mg/L)	0.0005	0.0010	0.0010	0.0014	0.0020	0.0030	1
Cd (mg/L)	0.000050	0.000050	0.000050	0.000105	0.000050	0.000600	1
Cr (mg/L)	0.00050	0.00050	0.00050	0.00065	0.00050	0.00200	1
Cu (mg/L)	0.00050	0.00100	0.00150	0.00190	0.00275	0.00500	1
Fe (mg/L)	0.380	0.440	0.960	0.921	1.250	1.770	2
Pb (mg/L)	0.0005	0.0005	0.0005	0.0018	0.0005	0.0120	1
Mn (mg/L)	0.335	0.364	0.390	0.420	0.478	0.522	2

Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.00100	0.00200	0.00200	0.00220	0.00275	0.00400	1
Zn (mg/L)	0.00500	0.00625	0.01100	0.01250	0.01175	0.03100	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0406	0.0250	0.1900	2
TPH C15-C28 (mg/L)	0.05	0.05	0.05	13.42	0.17	120.00	2
TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0294	0.0250	0.0900	2
TPH C10-C40 (mg/L)	0.05	0.05	0.05	12.33	0.19	110.00	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.104	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	11.088	0.155	110.000	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00200	0.00250	0.00194	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	1
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1

Table 6 Summary statistical data for MB4

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	6.20	6.55	6.91	7.01	7.50	8.01	1
TDS (mg/L)	3570	4095	4790	4641	5195	5530	
EC (uS/cm)	5970	6680	7730	7486	8285	8640	
Cl (mg/L)	1880	2360	2710	2563	2892	2940	1
BOD (mg/L)	0.500	0.750	1.000	0.833	1.000	1.000	8
COD (mg/L)	0.0	15.5	31.0	125.3	188.0	345.0	8
Na (mg/L)	1080	1302	1505	1414	1535	1570	1
K (mg/L)	1.0	1.0	1.5	1.5	2.0	2.0	1
Ca (mg/L)	64.0	76.0	92.0	86.5	95.8	104.0	1
Mg (mg/L)	68.0	85.8	112.5	102.4	115.5	126.0	1
Total Anions (meq/L)	60.7	73.7	82.5	78.6	86.8	88.2	1
Total Cations (meq/L)	55.9	66.7	79.4	74.3	81.7	83.0	1
SO4 (mg/L)	67.0	72.0	89.5	89.8	101.0	119.0	1
HCO3 (mg/L)	175	183	199	213	228	277	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Total Alk (mg/L)	175	183	199	213	228	277	2
TKN (mg/L)	0.2	0.2	0.2	0.2	0.2	0.2	10
Oxidised N (mg/L)	0.01	0.01	0.01	0.23	0.34	0.67	8
Organic N (mg/L)	0.2	0.2	0.2	0.2	0.2	0.2	10
Ammonia (mg/L)	0.0200	0.0300	0.0400	0.0333	0.0400	0.0400	8
Total N (mg/L)	0.2	0.2	0.2	0.2	0.2	0.2	10
Total P (mg/L)	0.05	0.09	0.13	0.11	0.14	0.15	8

As (mg/L)	5e-04	5e-04	5e-04	6e-04	5e-04	1e-03	1
Cd (mg/L)	5.00e-06	5.00e-05	5.00e-05	5.05e-05	5.00e-05	1.00e-04	1
Cr (mg/L)	0.00050	0.00050	0.00050	0.00065	0.00050	0.00200	1
Cu (mg/L)	0.00050	0.00050	0.00075	0.00155	0.00175	0.00600	1
Fe (mg/L)	0.025	0.025	0.050	0.294	0.540	0.960	2
Pb (mg/L)	0.000500	0.000500	0.000500	0.071850	0.000875	0.711000	1
Mn (mg/L)	0.182	0.273	0.380	0.369	0.439	0.599	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.000500	0.000625	0.001000	0.000950	0.001000	0.002000	1
Zn (mg/L)	0.0070	0.0102	0.0120	0.0135	0.0135	0.0340	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C15-C28 (mg/L)	0.05	0.05	0.05	0.10	0.05	0.50	2
TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C10-C40 (mg/L)	0.05	0.05	0.05	0.10	0.05	0.50	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00200	0.00250	0.00194	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	1
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1

Table 7 Summary statistical data for MB5

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	5.70	5.85	6.29	6.39	6.71	7.34	1
TDS (mg/L)	5120	14400	15600	14529	16150	16800	
EC (uS/cm)	8000	22250	24200	22405	25005	26300	
Cl (mg/L)	8360	8675	8950	9053	9372	10200	1
BOD (mg/L)	0.500	0.750	1.000	0.833	1.000	1.000	8
COD (mg/L)	0.5	33.2	66.0	648.8	973.0	1880.0	8
Na (mg/L)	4050	4170	4270	4390	4380	5730	1
K (mg/L)	5.00	5.00	6.00	6.50	7.75	10.00	1
Ca (mg/L)	227	266	272	273	286	321	1
Mg (mg/L)	601	636	679	671	710	740	1
Total Anions (meq/L)	246	254	264	266	274	298	1
Total Cations (meq/L)	240	250	254	260	261	325	1
SO4 (mg/L)	376	410	443	434	450	480	1
HCO3 (mg/L)	60.0	65.0	66.0	81.4	69.0	162.0	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1

Total Alk (mg/L)	60.0	65.0	66.0	81.4	69.0	162.0	2
TKN (mg/L)	0.050	0.500	0.700	0.839	1.200	2.000	2
Oxidised N (mg/L)	0.0050	0.0150	0.0400	0.0632	0.0650	0.2700	
Organic N (mg/L)	0.050	0.212	0.375	0.375	0.537	0.700	9
Ammonia (mg/L)	0.010	0.340	0.475	0.378	0.512	0.550	7
Total N (mg/L)	0.050	0.500	0.800	0.883	1.200	2.000	2
Total P (mg/L)	0.005	0.185	0.310	0.324	0.405	0.810	
As (mg/L)	0.00050	0.00050	0.00050	0.00110	0.00175	0.00250	1
Cd (mg/L)	0.000050	0.000125	0.000300	0.000465	0.000600	0.001700	1
Cr (mg/L)	0.000500	0.000500	0.000500	0.001250	0.000875	0.006000	1
Cu (mg/L)	0.00050	0.00213	0.00275	0.00320	0.00400	0.00700	1
Fe (mg/L)	0.025	0.255	0.365	0.541	0.895	1.250	3
Pb (mg/L)	0.0005	0.0005	0.0005	0.0053	0.0025	0.0400	1
Mn (mg/L)	3.16	3.30	3.49	3.62	3.80	4.28	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.0260	0.0302	0.0315	0.0316	0.0340	0.0360	1
Zn (mg/L)	0.0140	0.0152	0.0170	0.0213	0.0225	0.0440	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.000	0.025	0.025	0.025	0.025	0.050	2
TPH C15-C28 (mg/L)	0.050	0.050	0.050	0.108	0.050	0.500	2
TPH C29-C36 (mg/L)	0.025	0.025	0.025	5.599	0.090	50.000	2
TPH C10-C40 (mg/L)	0.050	0.050	0.050	0.131	0.160	0.500	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.118	0.133	0.500	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00200	0.00250	0.00194	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	1
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	1

Table 8 Summary statistical data for MB7

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	5.50	5.59	6.28	6.16	6.49	7.16	1
TDS (mg/L)	5120	9160	9540	9717	10835	12300	
EC (uS/cm)	8000	14135	15600	15294	17450	19200	
Cl (mg/L)	910	5295	5640	5353	5992	6870	1
BOD (mg/L)	0.500	0.750	1.000	0.833	1.000	1.000	8
COD (mg/L)	0.5	33.2	66.0	325.5	488.0	910.0	8
Na (mg/L)	2430	2785	2980	2957	3125	3330	1
K (mg/L)	1.0	2.0	2.0	2.1	2.0	3.0	1
Ca (mg/L)	57.0	61.5	69.5	67.8	73.2	76.0	1

Mg (mg/L)	259	310	351	347	382	436	1
Total Anions (meq/L)	151	156	165	171	188	199	1
Total Cations (meq/L)	131	150	160	160	171	184	1
SO4 (mg/L)	67.0	68.2	76.0	81.0	92.0	112.0	1
HCO3 (mg/L)	33	38	54	50	55	70	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Total Alk (mg/L)	33	38	54	50	55	70	2
TKN (mg/L)	0.40	0.60	0.80	1.32	1.10	3.80	2
Oxidised N (mg/L)	0.0050	0.0075	0.0100	0.0141	0.0150	0.0400	
Organic N (mg/L)	0.050	0.138	0.225	0.225	0.312	0.400	9
Ammonia (mg/L)	0.490	0.520	0.535	0.532	0.547	0.570	7
Total N (mg/L)	0.40	0.60	0.80	1.32	1.10	3.80	2
Total P (mg/L)	0.050	0.140	0.240	0.308	0.400	0.750	
As (mg/L)	0.00050	0.00200	0.00250	0.00245	0.00300	0.00400	1
Cd (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Cr (mg/L)	0.000500	0.000500	0.000500	0.000950	0.000875	0.003000	1
Cu (mg/L)	0.0005	0.0005	0.0010	0.0021	0.0020	0.0100	1
Fe (mg/L)	3.33	3.81	4.98	5.71	6.04	11.10	2
Pb (mg/L)	0.0005	0.0005	0.0005	1.9206	0.0005	19.2000	1
Mn (mg/L)	1.24	1.31	1.49	1.55	1.71	1.90	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.0100	0.0110	0.0130	0.0132	0.0152	0.0190	1
Zn (mg/L)	0.0060	0.0100	0.0120	0.0167	0.0205	0.0370	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0272	0.0250	0.0700	2
TPH C15-C28 (mg/L)	0.05	0.05	0.05	13.38	0.05	120.00	2
TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C10-C40 (mg/L)	0.05	0.05	0.05	15.60	0.05	140.00	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.05	0.05	0.05	14.04	0.05	140.00	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00250	0.00250	0.00219	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

Table 9 Summary statistical data for MB8

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	5.60	5.75	6.45	6.30	6.65	7.13	1
TDS (mg/L)	4510	4790	5090	4986	5155	5430	

EC (uS/cm)	7080	7785	7960	7907	8075	8340	
Cl (mg/L)	337	2785	2845	2602	2900	2950	1
BOD (mg/L)	0.500	0.750	1.000	0.833	1.000	1.000	8
COD (mg/L)	0.5	15.2	30.0	122.5	183.5	337.0	8
Na (mg/L)	1320	1460	1465	1760	1500	4530	1
K (mg/L)	2	2	2	2	2	2	1
Ca (mg/L)	65.0	68.0	69.0	69.8	70.8	76.0	1
Mg (mg/L)	120	128	130	129	132	133	1
Total Anions (meq/L)	80.7	81.2	82.5	82.7	84.2	85.6	1
Total Cations (meq/L)	71.1	77.2	78.0	77.7	79.6	80.5	1
SO4 (mg/L)	41.0	57.0	66.5	63.3	68.0	87.0	1
HCO3 (mg/L)	40.0	49.0	51.0	55.7	62.0	78.0	2
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	1
Total Alk (mg/L)	40.0	49.0	51.0	55.7	62.0	78.0	2
TKN (mg/L)	0.400	0.600	0.700	0.844	0.900	1.900	2
Oxidised N (mg/L)	0.0050	0.0050	0.0100	0.0168	0.0300	0.0500	
Organic N (mg/L)	0.100	0.175	0.250	0.250	0.325	0.400	9
Ammonia (mg/L)	0.260	0.297	0.340	0.350	0.393	0.460	7
Total N (mg/L)	0.400	0.600	0.700	0.844	0.900	1.900	2
Total P (mg/L)	0.005	0.080	0.190	0.176	0.230	0.480	
As (mg/L)	0.0005	0.0020	0.0030	0.0034	0.0040	0.0080	1
Cd (mg/L)	5.0e-05	5.0e-05	5.0e-05	6.5e-05	5.0e-05	2.0e-04	1
Cr (mg/L)	5e-04	5e-04	5e-04	7e-04	5e-04	2e-03	1
Cu (mg/L)	0.000500	0.000500	0.000500	0.000850	0.000875	0.002000	1
Fe (mg/L)	1.51	5.11	5.55	7.48	11.10	13.80	2
Pb (mg/L)	0.00050	0.00050	0.00050	0.00145	0.00162	0.00600	1
Mn (mg/L)	1.20	1.28	1.33	1.33	1.41	1.47	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.00200	0.00225	0.00400	0.00350	0.00400	0.00500	1
Zn (mg/L)	0.0070	0.0080	0.0085	0.0099	0.0105	0.0160	1
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C15-C28 (mg/L)	0.05	0.05	0.05	0.10	0.05	0.50	2
TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C10-C40 (mg/L)	0.05	0.05	0.05	0.10	0.05	0.50	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.01	0.01	10.00	1
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00250	0.00250	0.00219	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

Table 10 Summary statistical data for SED1

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	7.94	8.34	8.54	8.50	8.61	9.05	1
TDS (mg/L)	422	534	803	814	901	1560	
EC (uS/cm)	660	866	1310	1347	1610	2630	
Cl (mg/L)	71	131	211	257	327	625	3
BOD (mg/L)	1.0	5.0	8.0	9.6	12.0	23.0	1
COD (mg/L)	7.0	37.5	68.0	56.0	80.5	93.0	8
Na (mg/L)	62	110	152	184	224	427	3
K (mg/L)	19.0	25.8	34.0	42.1	46.8	92.0	3
Ca (mg/L)	25.0	48.0	62.5	58.1	66.5	93.0	3
Mg (mg/L)	17.0	20.8	29.0	27.8	33.2	39.0	3
Total Anions (meq/L)	1.49	7.90	12.50	13.23	16.20	27.40	2
Total Cations (meq/L)	1.53	7.99	12.00	12.85	15.90	24.60	2
SO4 (mg/L)	2.0	4.0	7.0	10.5	12.2	33.0	3
HCO3 (mg/L)	228	278	324	321	348	446	4
CO3 (mg/L)	0.5	15.0	30.5	26.6	40.0	45.0	5
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	4
Total Alk (mg/L)	256	278	355	344	381	480	4
TKN (mg/L)	1.7	1.7	1.7	1.7	1.7	1.7	10
Oxidised N (mg/L)	0.0050	0.0138	0.0225	0.0225	0.0312	0.0400	9
Organic N (mg/L)	1.6	1.6	1.6	1.6	1.6	1.6	10
Ammonia (mg/L)	0.01	0.02	0.03	0.03	0.04	0.05	9
Total N (mg/L)	1.7	1.7	1.7	1.7	1.7	1.7	10
Total P (mg/L)	0.17	0.29	0.41	0.41	0.53	0.65	9
As (mg/L)	0.00200	0.00400	0.00550	0.00560	0.00775	0.00900	1
Cd (mg/L)	0.00005	0.00005	0.00005	0.00063	0.00005	0.00570	1
Cr (mg/L)	0.000500	0.000625	0.002000	0.001750	0.002000	0.004000	1
Cu (mg/L)	0.00050	0.00100	0.00200	0.00235	0.00375	0.00500	1
Fe (mg/L)	0.025	0.025	0.165	0.199	0.340	0.490	3
Pb (mg/L)	0.00050	0.00050	0.00075	0.02865	0.00175	0.27700	1
Mn (mg/L)	0.003	0.144	0.236	0.290	0.373	0.801	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.00400	0.00500	0.00600	0.00789	0.00900	0.01500	2
Zn (mg/L)	0.0025	0.0025	0.0090	0.0108	0.0110	0.0330	2
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0261	0.0250	0.0600	2
TPH C15-C28 (mg/L)	0.05	0.05	0.05	74.57	0.34	670.00	2
TPH C29-C36 (mg/L)	0.025	0.025	0.025	21.163	0.090	190.000	2
TPH C10-C40 (mg/L)	0.05	0.05	0.05	99.05	0.38	890.00	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	79.138	0.297	790.000	1
TRH C34-C40 F4 (mg/L)	0.05	0.05	0.05	10.05	0.05	100.00	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1

Phenols (mg/L)	0.00000	0.00250	0.00250	0.00219	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	6
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	6
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	6

Table 11 Summary statistical data for SW1

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	6.80	7.03	7.26	7.29	7.57	7.70	1
TDS (mg/L)	85.7	145.0	166.0	214.3	213.5	612.0	
EC (uS/cm)	134	221	255	326	322	957	
Cl (mg/L)	18.0	34.0	53.0	71.7	85.0	206.0	2
BOD (mg/L)	1.00	1.00	1.50	2.50	2.25	9.00	3
COD (mg/L)	13.0	20.0	36.0	43.1	57.0	108.0	2
Na (mg/L)	16.0	27.0	28.0	38.4	38.0	105.0	2
K (mg/L)	3.0	4.0	5.0	10.2	5.0	46.0	2
Ca (mg/L)	7.0	8.0	12.0	14.4	15.0	30.0	2
Mg (mg/L)	4.00	6.00	6.00	8.33	10.00	17.00	2
Total Anions (meq/L)	1.43	2.22	2.58	3.49	4.01	8.83	3
Total Cations (meq/L)	1.63	2.34	2.71	3.58	4.03	8.64	3
SO4 (mg/L)	0.50	1.00	3.00	4.89	8.00	12.00	2
HCO3 (mg/L)	23.0	33.2	41.0	56.5	63.2	143.0	3
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	3
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Total Alk (mg/L)	23.0	33.2	41.0	56.5	63.2	143.0	3
TKN (mg/L)	0.40	0.60	0.80	1.01	0.90	2.50	2
Oxidised N (mg/L)	0.00500	0.00875	0.02500	0.04350	0.08500	0.10000	1
Organic N (mg/L)	0.28	0.36	0.44	0.44	0.52	0.60	9
Ammonia (mg/L)	0.030	0.085	0.140	0.130	0.180	0.220	8
Total N (mg/L)	0.40	0.70	0.80	1.06	1.00	2.50	2
Total P (mg/L)	0.0050	0.0775	0.1450	0.2245	0.2575	0.8200	1
As (mg/L)	0.000050	0.000500	0.000500	0.000705	0.000875	0.002000	1
Cd (mg/L)	5.0e-05	5.0e-05	5.0e-05	9.5e-05	5.0e-05	5.0e-04	1
Cr (mg/L)	0.000050	0.000500	0.000500	0.000505	0.000500	0.001000	1
Cu (mg/L)	5e-04	5e-04	5e-04	1e-03	1e-03	3e-03	1
Fe (mg/L)	0.025	0.100	0.230	0.308	0.400	0.800	2
Pb (mg/L)	0.0005	0.0005	0.0005	0.0163	0.0035	0.0960	1
Mn (mg/L)	0.004	0.078	0.141	0.641	0.711	3.360	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.000500	0.000500	0.000500	0.000833	0.000500	0.002000	2
Zn (mg/L)	0.00250	0.00250	0.00600	0.00961	0.00900	0.02700	2
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C15-C28 (mg/L)	0.05	0.05	0.05	0.10	0.05	0.50	2
TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C10-C40 (mg/L)	0.05	0.05	0.05	0.10	0.05	0.50	2

TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00250	0.00250	0.00219	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

Table 12 Summary statistical data for SW2

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	6.80	7.06	7.21	7.27	7.47	7.78	1
TDS (mg/L)	51	136	155	183	196	456	
EC (uS/cm)	80	204	250	288	328	712	
Cl (mg/L)	18.0	25.0	40.0	48.8	56.0	106.0	2
BOD (mg/L)	0.500	0.625	0.750	0.750	0.875	1.000	9
COD (mg/L)	40.0	56.8	73.5	73.5	90.2	107.0	9
Na (mg/L)	14.0	20.0	26.0	28.2	32.0	48.0	2
K (mg/L)	2.00	3.00	5.00	5.78	7.00	11.00	2
Ca (mg/L)	6.0	11.0	12.0	12.1	15.0	16.0	2
Mg (mg/L)	4.00	5.00	7.00	6.89	9.00	10.00	2
Total Anions (meq/L)	1.29	1.94	2.18	2.50	3.06	3.80	2
Total Cations (meq/L)	1.31	1.95	2.22	2.55	3.16	3.85	2
SO4 (mg/L)	0.50	0.50	0.50	5.72	2.00	43.00	2
HCO3 (mg/L)	28.0	38.8	42.0	48.4	60.8	71.0	3
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	3
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Total Alk (mg/L)	28.0	38.8	42.0	48.4	60.8	71.0	3
TKN (mg/L)	0.8	0.8	0.8	0.8	0.8	0.8	10
Oxidised N (mg/L)	0.0050	0.0688	0.1325	0.1325	0.1963	0.2600	9
Organic N (mg/L)	0.7	0.7	0.7	0.7	0.7	0.7	10
Ammonia (mg/L)	0.0500	0.0775	0.1050	0.1050	0.1325	0.1600	9
Total N (mg/L)	1.1	1.1	1.1	1.1	1.1	1.1	10
Total P (mg/L)	0.050	0.265	0.480	0.480	0.695	0.910	9
As (mg/L)	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	1
Cd (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Cr (mg/L)	0.0005	0.0005	0.0005	0.0192	0.0005	0.1880	1
Cu (mg/L)	0.00050	0.00050	0.00075	0.00105	0.00100	0.00300	1
Fe (mg/L)	0.070	0.170	0.220	0.273	0.470	0.480	2
Pb (mg/L)	0.00050	0.00050	0.00225	0.01875	0.01250	0.09500	1
Mn (mg/L)	0.002	0.060	0.080	0.205	0.182	0.676	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.000500	0.000500	0.000500	0.000556	0.000500	0.001000	2

Zn (mg/L)	0.0025	0.0025	0.0070	0.0109	0.0170	0.0250	2
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	2.51	2.51	10.00	7
TPH C10-C14 (mg/L)	0.0000	0.0187	0.0250	0.0187	0.0250	0.0250	7
TPH C15-C28 (mg/L)	0.05	0.05	0.05	30.04	30.04	120.00	7
TPH C29-C36 (mg/L)	0.0000	0.0187	0.0250	0.0187	0.0250	0.0250	7
TPH C10-C40 (mg/L)	0.05	0.05	0.05	35.04	35.04	140.00	7
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	2.51	2.51	10.00	7
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
TRH C16-C34 F3 (mg/L)	0.05	0.05	0.05	35.04	35.04	140.00	7
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
Benzene (mg/L)	0.0005	0.0005	0.0005	0.1254	0.1254	0.5000	7
Toluene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Phenols (mg/L)	0.000000	0.000625	0.001250	0.001250	0.001875	0.002500	9
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Xylene (o) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Xylene total (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

Table 13 Summary statistical data for SW3

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	6.80	7.30	7.38	7.36	7.46	7.70	1
TDS (mg/L)	74	140	160	171	193	308	
EC (uS/cm)	115	214	250	272	322	481	
Cl (mg/L)	19.0	28.0	50.0	54.9	87.0	96.0	2
BOD (mg/L)	0.50	1.88	3.25	3.25	4.62	6.00	9
COD (mg/L)	46.0	59.5	73.0	73.0	86.5	100.0	9
Na (mg/L)	15.0	23.0	27.0	28.9	35.0	46.0	2
K (mg/L)	2.00	4.00	5.00	9.67	6.00	47.00	2
Ca (mg/L)	9	11	13	14	18	21	2
Mg (mg/L)	4.00	6.00	7.00	7.22	9.00	10.00	2
Total Anions (meq/L)	1.46	2.03	2.33	2.78	3.87	4.09	2
Total Cations (meq/L)	1.51	2.18	2.51	2.80	3.87	4.02	2
SO4 (mg/L)	0.50	0.50	1.00	4.83	3.00	32.00	2
HCO3 (mg/L)	38.0	42.0	53.5	55.4	63.5	80.0	3
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	3
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Total Alk (mg/L)	38.0	42.0	53.5	55.4	63.5	80.0	3
TKN (mg/L)	1.3	1.3	1.3	1.3	1.3	1.3	10
Oxidised N (mg/L)	0.0050	0.0288	0.0525	0.0525	0.0762	0.1000	9
Organic N (mg/L)	1.2	1.2	1.2	1.2	1.2	1.2	10
Ammonia (mg/L)	0.0500	0.0725	0.0950	0.0950	0.1175	0.1400	9
Total N (mg/L)	1.4	1.4	1.4	1.4	1.4	1.4	10
Total P (mg/L)	0.150	0.343	0.535	0.535	0.728	0.920	9
As (mg/L)	0.00050	0.00050	0.00050	0.00055	0.00050	0.00100	1
Cd (mg/L)	0.00005	0.00005	0.00005	0.00039	0.00005	0.00240	1

Cr (mg/L)	0.00050	0.00050	0.00050	0.00055	0.00050	0.00100	1
Cu (mg/L)	0.0005	0.0005	0.0005	0.0019	0.0005	0.0110	1
Fe (mg/L)	0.090	0.340	0.420	0.534	0.650	1.120	2
Pb (mg/L)	0.00050	0.00050	0.00075	0.02725	0.00200	0.25900	1
Mn (mg/L)	0.067	0.259	0.361	1.050	0.695	4.600	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.000500	0.000500	0.000500	0.000889	0.000500	0.004000	2
Zn (mg/L)	0.0025	0.0025	0.0100	0.0257	0.0120	0.1590	2
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	2.51	2.51	10.00	7
TPH C10-C14 (mg/L)	0.0000	0.0187	0.0250	0.0187	0.0250	0.0250	7
TPH C15-C28 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
TPH C29-C36 (mg/L)	0.0000	0.0187	0.0250	0.0187	0.0250	0.0250	7
TPH C10-C40 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	2.51	2.51	10.00	7
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	7
Benzene (mg/L)	0.0005	0.0005	0.0005	0.1254	0.1254	0.5000	7
Toluene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Phenols (mg/L)	0.000000	0.000625	0.001250	0.001250	0.001875	0.002500	9
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Xylene (o) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Xylene total (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

Table 14 Summary statistical data for SW4

Date	2010-09-07	2012-06-14	2014-03-23	2014-01-27	2015-10-21	2017-01-13	
pH	7.20	7.42	7.67	7.73	7.80	8.60	1
TDS (mg/L)	70	129	184	198	246	384	
EC (uS/cm)	110	218	302	318	393	600	
Cl (mg/L)	22.0	33.5	47.0	61.4	81.0	145.0	2
BOD (mg/L)	3.00	3.25	3.50	3.50	3.75	4.00	8
COD (mg/L)	73	81	89	89	97	105	8
Na (mg/L)	20.0	23.2	30.0	36.2	32.8	98.0	2
K (mg/L)	2.0	3.0	7.5	13.5	12.8	56.0	2
Ca (mg/L)	5.0	10.8	14.0	15.6	21.0	27.0	2
Mg (mg/L)	2.00	5.00	7.00	8.12	11.25	16.00	2
Total Anions (meq/L)	1.78	2.26	3.02	3.34	3.52	7.21	2
Total Cations (meq/L)	1.91	2.23	2.99	3.37	3.61	7.23	2
SO4 (mg/L)	0.50	0.50	1.25	2.62	2.25	12.00	2
HCO3 (mg/L)	16.0	62.0	86.0	79.7	94.0	144.0	3
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	3
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Total Alk (mg/L)	16.0	62.0	86.0	79.7	94.0	144.0	3
TKN (mg/L)	1.6	1.6	1.6	1.6	1.6	1.6	9

Oxidised N (mg/L)	0.0050	0.0187	0.0325	0.0325	0.0462	0.0600	8
Organic N (mg/L)	1.5	1.5	1.5	1.5	1.5	1.5	9
Ammonia (mg/L)	0.0200	0.0275	0.0350	0.0350	0.0425	0.0500	8
Total N (mg/L)	1.7	1.7	1.7	1.7	1.7	1.7	9
Total P (mg/L)	0.220	0.415	0.610	0.610	0.805	1.000	8
As (mg/L)	0.00050	0.00050	0.00050	0.00106	0.00100	0.00400	1
Cd (mg/L)	0.000050	0.000050	0.000050	0.000278	0.000050	0.002100	1
Cr (mg/L)	0.000500	0.000500	0.000500	0.000556	0.000500	0.001000	1
Cu (mg/L)	0.00050	0.00050	0.00050	0.00139	0.00200	0.00500	1
Fe (mg/L)	0.025	0.265	0.360	1.039	1.188	4.160	2
Pb (mg/L)	0.0005	0.0005	0.0020	0.0397	0.0030	0.2460	1
Mn (mg/L)	0.0020	0.0882	0.4515	0.9550	1.3425	3.2800	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.000500	0.000500	0.000500	0.000687	0.000500	0.002000	2
Zn (mg/L)	0.00250	0.00250	0.00750	0.01119	0.00925	0.04800	2
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	2.51	2.51	10.00	6
TPH C10-C14 (mg/L)	0.0000	0.0187	0.0250	0.0187	0.0250	0.0250	6
TPH C15-C28 (mg/L)	0.05	0.05	0.05	62.54	62.54	250.00	6
TPH C29-C36 (mg/L)	0.025	0.025	0.025	20.019	20.019	80.000	6
TPH C10-C40 (mg/L)	0.05	0.05	0.05	75.04	75.04	300.00	6
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	2.51	2.51	10.00	6
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	6
TRH C16-C34 F3 (mg/L)	0.05	0.05	0.05	75.04	75.04	300.00	6
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.163	0.163	0.500	6
Benzene (mg/L)	0.0005	0.0005	0.0005	0.1254	0.1254	0.5000	6
Toluene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	6
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	6
Phenols (mg/L)	0.000000	0.000625	0.001250	0.001250	0.001875	0.002500	8
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	6
Xylene (o) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	6
Xylene total (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	6
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	6
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	6
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	6

Table 15 Summary statistical data for SW5

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	6.75	6.96	7.33	7.39	7.49	8.90	1
TDS (mg/L)	51.2	119.5	157.0	160.3	194.0	293.0	
EC (uS/cm)	80	178	237	225	268	445	
Cl (mg/L)	25	34	36	46	47	107	2
BOD (mg/L)	1.00	3.25	5.50	5.50	7.75	10.00	9
COD (mg/L)	47.0	73.8	100.5	100.5	127.2	154.0	9
Na (mg/L)	16.0	22.0	24.0	32.1	31.0	80.0	2
K (mg/L)	3	5	6	7	9	12	2
Ca (mg/L)	4.00	7.00	10.00	9.22	11.00	16.00	2
Mg (mg/L)	0.50	6.00	6.00	6.06	7.00	11.00	2
Total Anions (meq/L)	1.58	1.86	2.23	2.48	2.41	4.03	2

Total Cations (meq/L)	1.59	1.97	2.40	2.53	2.56	3.93	2
SO4 (mg/L)	0.50	2.00	5.00	6.33	6.00	18.00	2
HCO3 (mg/L)	22.0	24.0	31.0	34.8	45.0	54.0	3
CO3 (mg/L)	0.5	0.5	0.5	17.8	0.5	139.0	3
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Total Alk (mg/L)	24.0	29.2	37.5	52.1	49.5	161.0	3
TKN (mg/L)	1.00	1.10	1.30	1.52	1.80	2.60	2
Oxidised N (mg/L)	0.005	0.005	0.075	0.168	0.188	0.840	1
Organic N (mg/L)	1.20	1.32	1.45	1.45	1.57	1.70	9
Ammonia (mg/L)	0.020	0.050	0.080	0.413	0.610	1.140	8
Total N (mg/L)	1.00	1.20	1.50	1.73	1.80	3.60	2
Total P (mg/L)	0.180	0.212	0.290	0.366	0.347	1.200	1
As (mg/L)	0.00050	0.00050	0.00075	0.00095	0.00100	0.00200	1
Cd (mg/L)	0.000050	0.000050	0.000050	0.000365	0.000050	0.003200	1
Cr (mg/L)	5e-04	5e-04	5e-04	8e-04	5e-04	2e-03	1
Cu (mg/L)	0.00200	0.00200	0.00200	0.00310	0.00375	0.00800	1
Fe (mg/L)	0.11	0.57	1.03	1.52	1.41	5.21	2
Pb (mg/L)	0.00050	0.00050	0.00100	0.00733	0.00300	0.05000	2
Mn (mg/L)	0.008	0.273	0.455	0.574	0.772	1.640	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	1
Ni (mg/L)	0.000500	0.000500	0.001000	0.000889	0.001000	0.002000	2
Zn (mg/L)	0.00250	0.00600	0.00900	0.00928	0.01200	0.02000	2
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TPH C10-C14 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C15-C28 (mg/L)	0.050	0.050	0.050	0.107	0.050	0.500	2
TPH C29-C36 (mg/L)	0.0000	0.0250	0.0250	0.0222	0.0250	0.0250	2
TPH C10-C40 (mg/L)	0.050	0.050	0.050	0.108	0.050	0.500	2
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	1.12	0.01	10.00	2
TRH C10-C16 F2 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
TRH C16-C34 F3 (mg/L)	0.050	0.050	0.050	0.102	0.050	0.500	1
TRH C34-C40 F4 (mg/L)	0.050	0.050	0.050	0.095	0.050	0.500	1
Benzene (mg/L)	0.0005	0.0005	0.0005	0.0505	0.0005	0.5000	1
Toluene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Phenols (mg/L)	0.00000	0.00250	0.00250	0.00219	0.00250	0.00250	3
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene (o) (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
Xylene total (mg/L)	0.001	0.001	0.001	0.101	0.001	1.000	1
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

Table 16 Summary statistical data for SW6

Date	2010-09-07	2012-08-04	2013-11-13	2014-01-03	2015-08-26	2017-01-13	
pH	6.10	6.90	7.09	7.04	7.20	7.49	2
TDS (mg/L)	85.7	136.2	218.0	229.5	324.8	378.0	1
EC (uS/cm)	134	216	348	361	508	597	1
Cl (mg/L)	24	64	87	101	151	213	2

BOD (mg/L)	1.00	1.25	1.50	1.50	1.75	2.00	9
COD (mg/L)	75	88	101	101	114	127	9
Na (mg/L)	17.0	32.0	36.0	43.8	67.0	80.0	2
K (mg/L)	2.00	5.00	6.00	9.44	8.00	39.00	2
Ca (mg/L)	8.0	9.0	10.0	14.2	17.0	28.0	2
Mg (mg/L)	5.00	7.00	8.00	9.33	11.00	18.00	2
Total Anions (meq/L)	1.34	2.49	3.67	3.63	4.88	6.70	2
Total Cations (meq/L)	1.60	2.59	3.55	3.62	4.82	6.62	2
SO4 (mg/L)	0.50	0.50	2.00	2.94	4.00	10.00	2
HCO3 (mg/L)	24.0	27.2	31.5	33.1	34.8	52.0	3
CO3 (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	3
Hydroxy Alk (mg/L)	0.5	0.5	0.5	0.5	0.5	0.5	2
Total Alk (mg/L)	24.0	27.2	31.5	33.1	34.8	52.0	3
TKN (mg/L)	1	1	1	1	1	1	10
Oxidised N (mg/L)	0.00500	0.00875	0.01250	0.01250	0.01625	0.02000	9
Organic N (mg/L)	0.9	0.9	0.9	0.9	0.9	0.9	10
Ammonia (mg/L)	0.0200	0.0392	0.0585	0.0585	0.0777	0.0970	9
Total N (mg/L)	1	1	1	1	1	1	10
Total P (mg/L)	0.130	0.398	0.665	0.665	0.932	1.200	9
As (mg/L)	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	9
Cd (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	9
Cr (mg/L)	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	8
Cu (mg/L)	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	9
Fe (mg/L)	0.080	0.140	0.260	0.374	0.400	1.140	2
Pb (mg/L)	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	9
Mn (mg/L)	0.002	0.158	0.187	0.249	0.351	0.645	2
Hg (mg/L)	5e-05	5e-05	5e-05	5e-05	5e-05	5e-05	8
Ni (mg/L)	5e-04	5e-04	5e-04	5e-04	5e-04	5e-04	9
Zn (mg/L)	0.006	0.006	0.006	0.006	0.006	0.006	10
Cyanide (mg/L)	0.002	0.002	0.002	0.002	0.002	0.002	2
TPH C6-C9 (mg/L)	0.01	0.01	0.01	2.01	0.01	10.00	6
TPH C10-C14 (mg/L)	0.000	0.025	0.025	0.020	0.025	0.025	6
TPH C15-C28 (mg/L)	0.05	0.05	0.05	0.14	0.05	0.50	6
TPH C29-C36 (mg/L)	0.000	0.025	0.025	0.020	0.025	0.025	6
TPH C10-C40 (mg/L)	0.05	0.05	0.05	0.14	0.05	0.50	6
TRH C6-C10 F1 (mg/L)	0.01	0.01	0.01	2.01	0.01	10.00	6
TRH C10-C16 F2 (mg/L)	0.05	0.05	0.05	0.14	0.05	0.50	6
TRH C16-C34 F3 (mg/L)	0.05	0.05	0.05	0.14	0.05	0.50	6
TRH C34-C40 F4 (mg/L)	0.05	0.05	0.05	0.14	0.05	0.50	6
Benzene (mg/L)	0.0005	0.0005	0.0005	0.1254	0.1254	0.5000	7
Toluene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Ethylbenzene (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Phenols (mg/L)	0.000000	0.000625	0.001250	0.001250	0.001875	0.002500	9
Xylene (m/p) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Xylene (o) (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
Xylene total (mg/L)	0.001	0.001	0.001	0.251	0.251	1.000	7
CCl4 (mg/L)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	7
Chloroethane (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7
Vinyl chloride (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	7

# 11 APPENDIX C: GRAPHICAL SUMMARY OF ANALYTE DATA

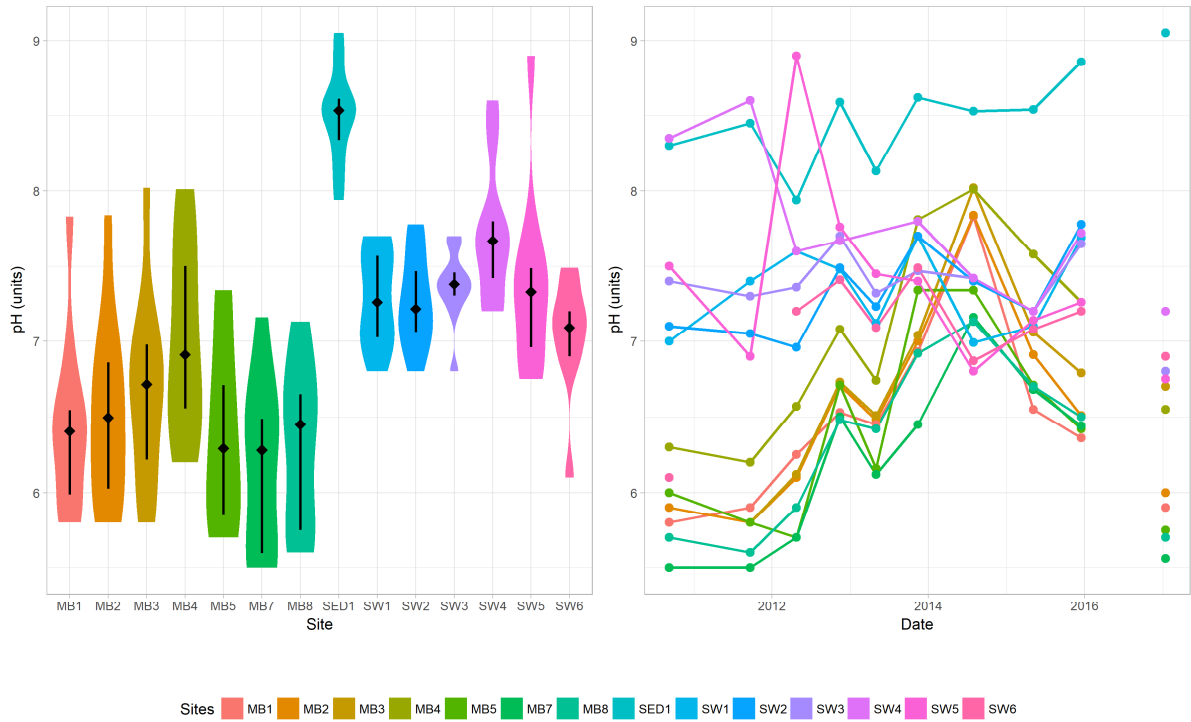


Figure 20 pH monitoring data for the site

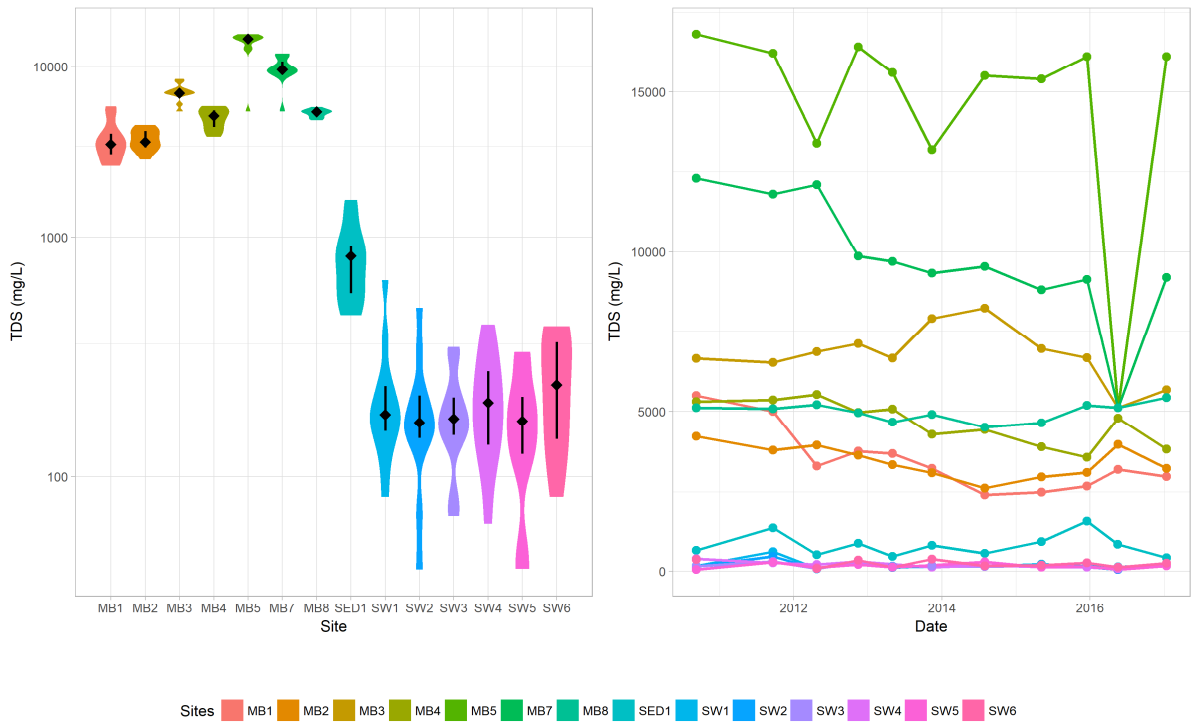


Figure 21 TDS monitoring data for the site

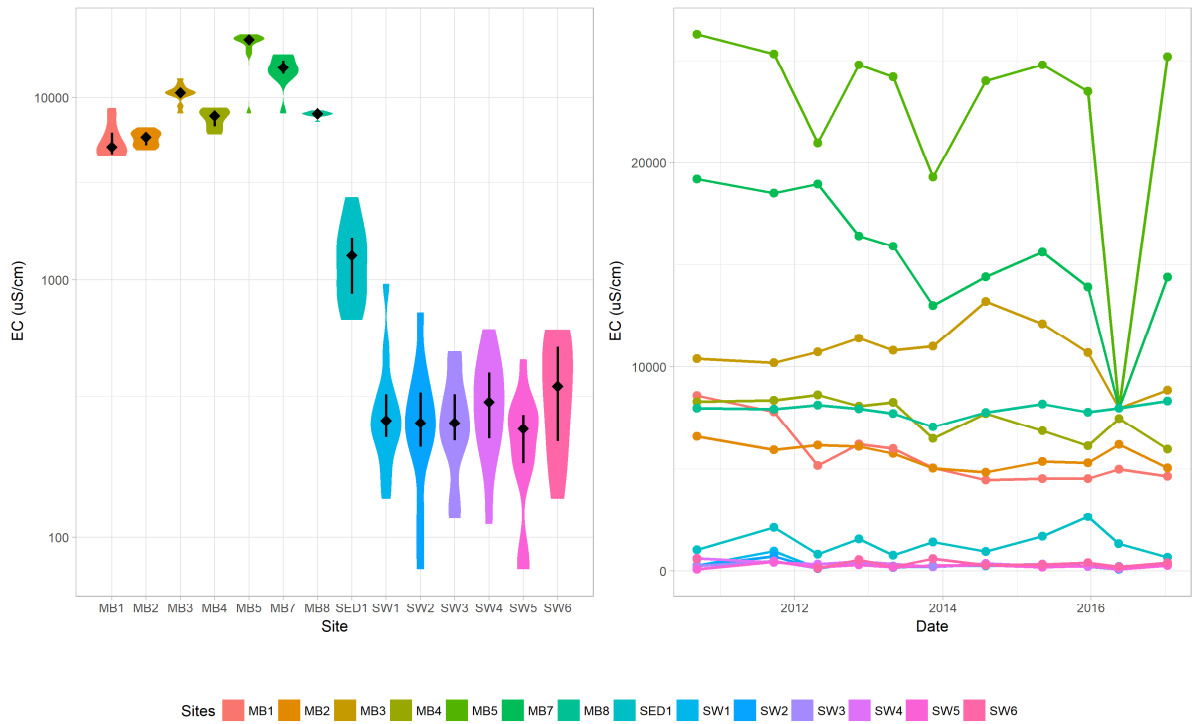


Figure 22 EC monitoring data for the site

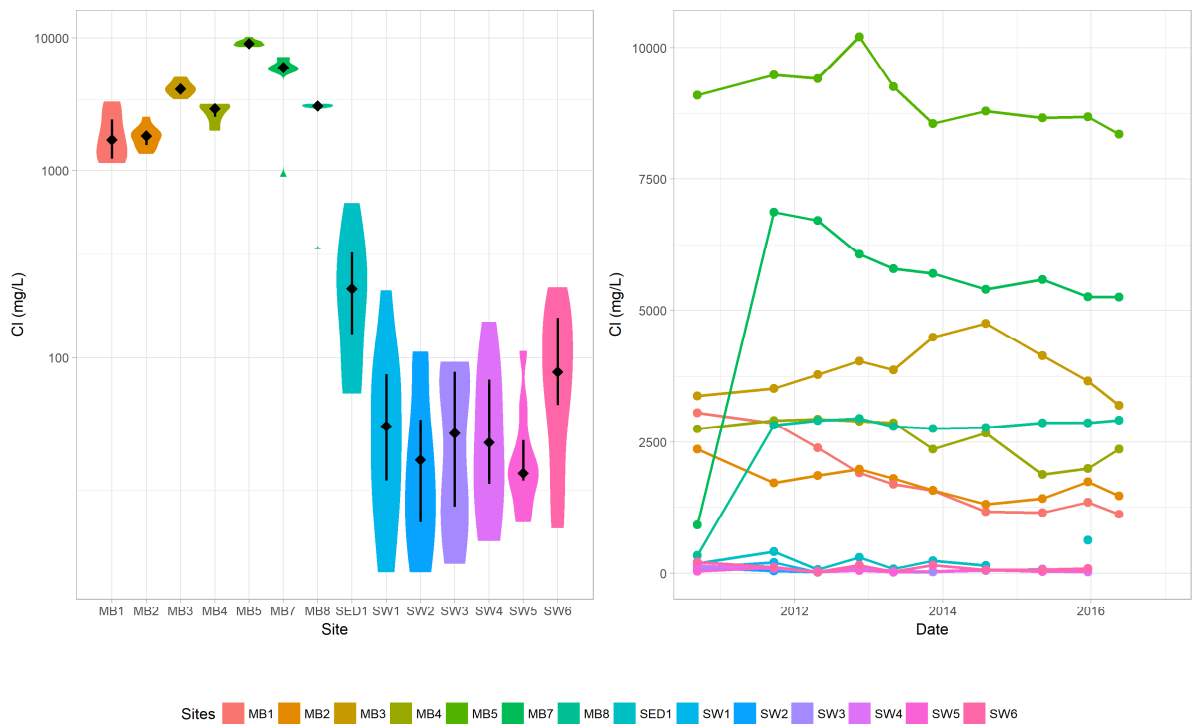


Figure 23 Cl monitoring data for the site

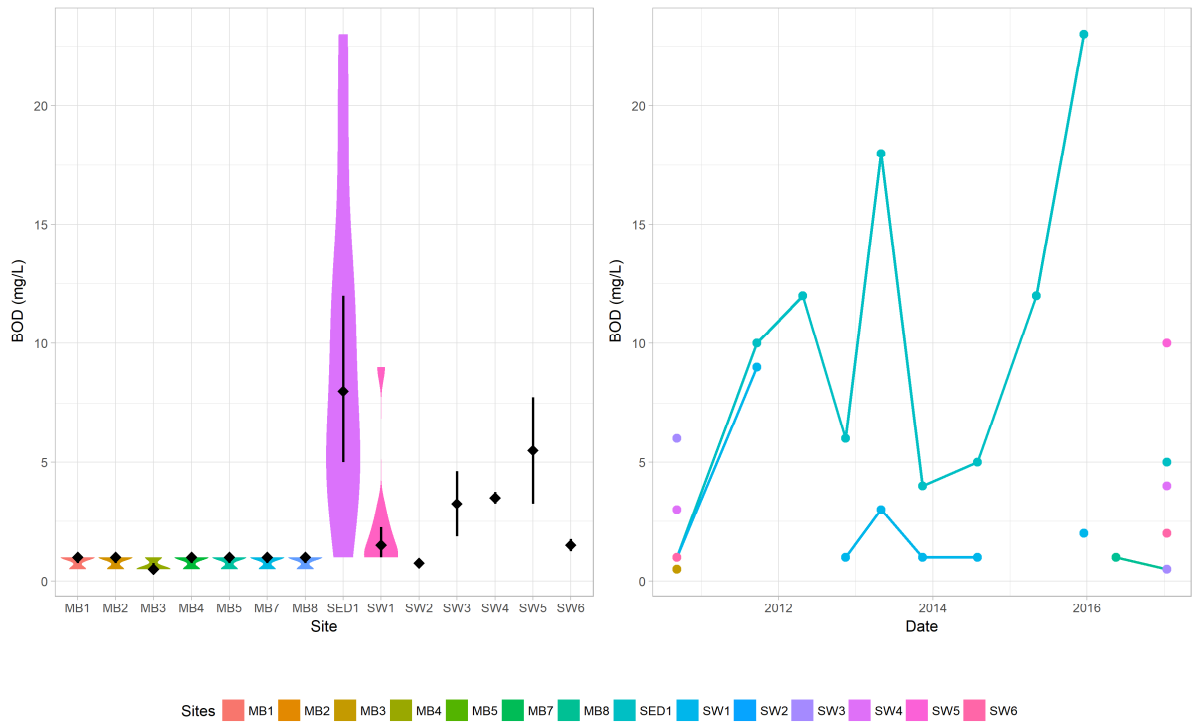


Figure 24 BOD monitoring data for the site

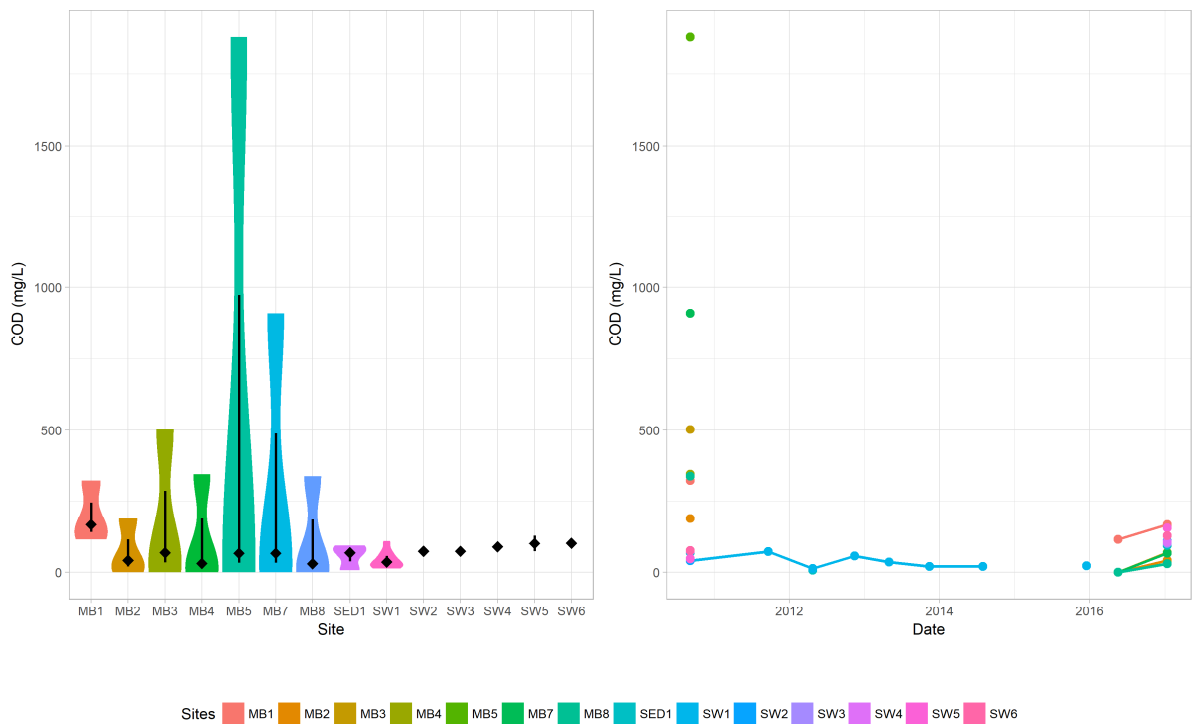


Figure 25 COD monitoring data for the site

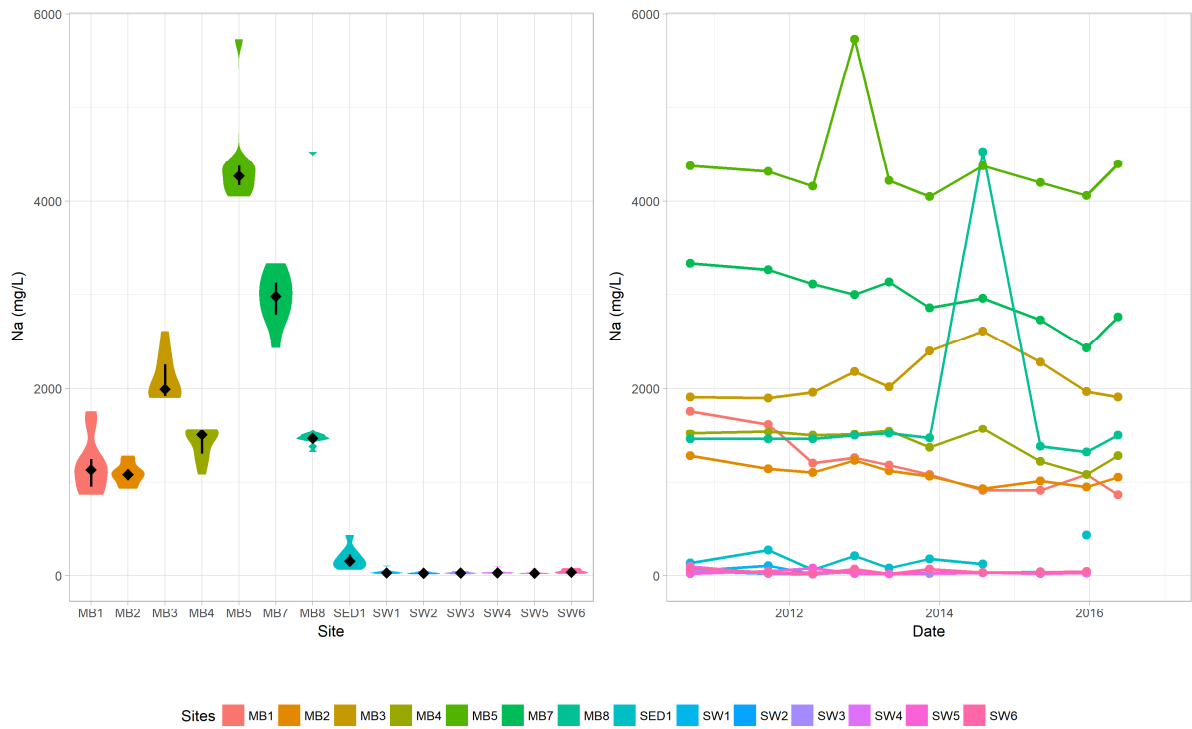


Figure 26 Na monitoring data for the site

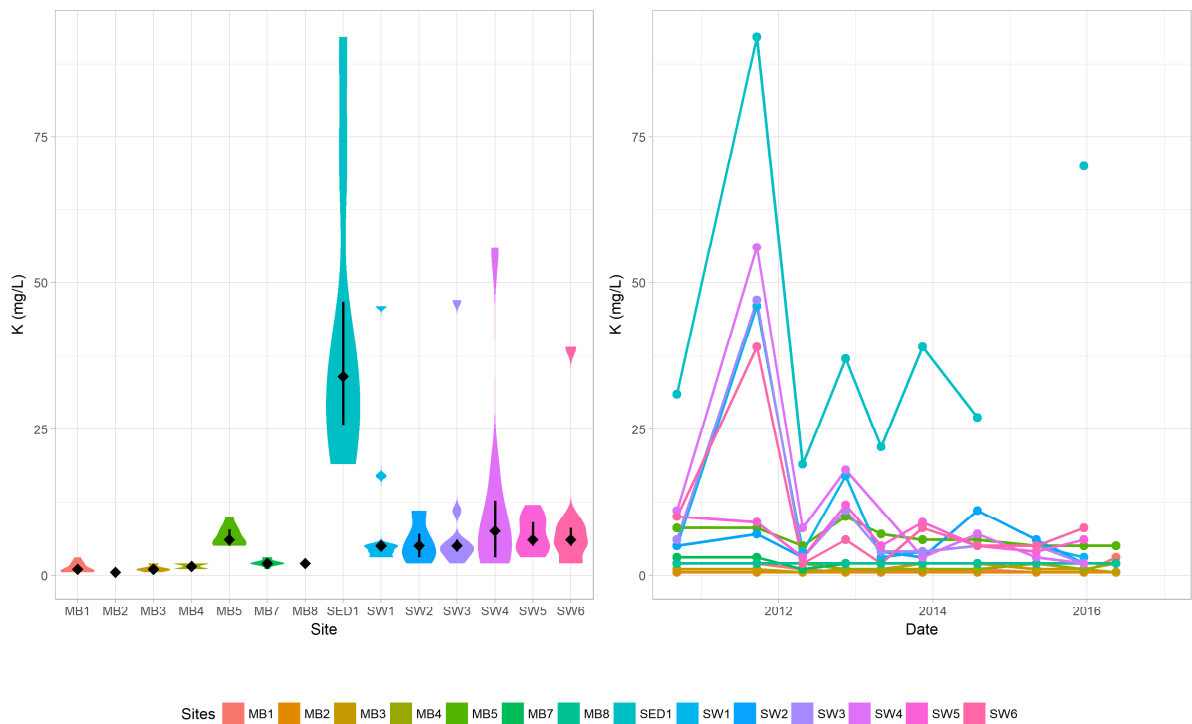


Figure 27 K monitoring data for the site

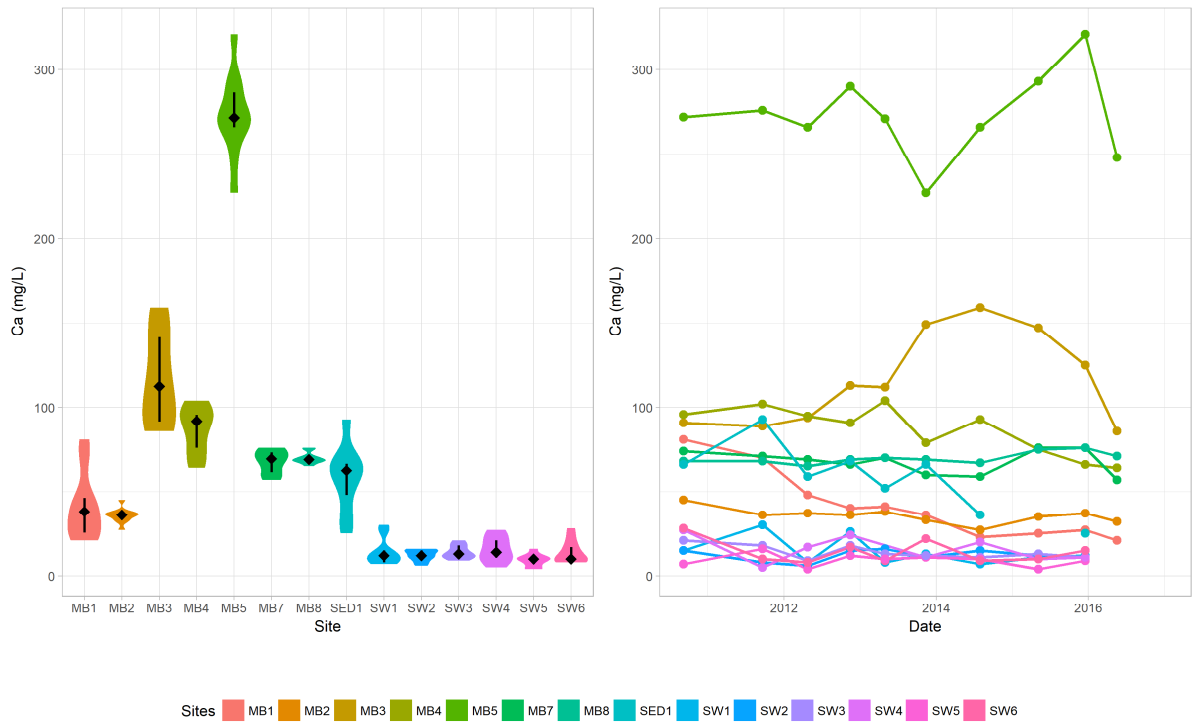


Figure 28 Ca monitoring data for the site

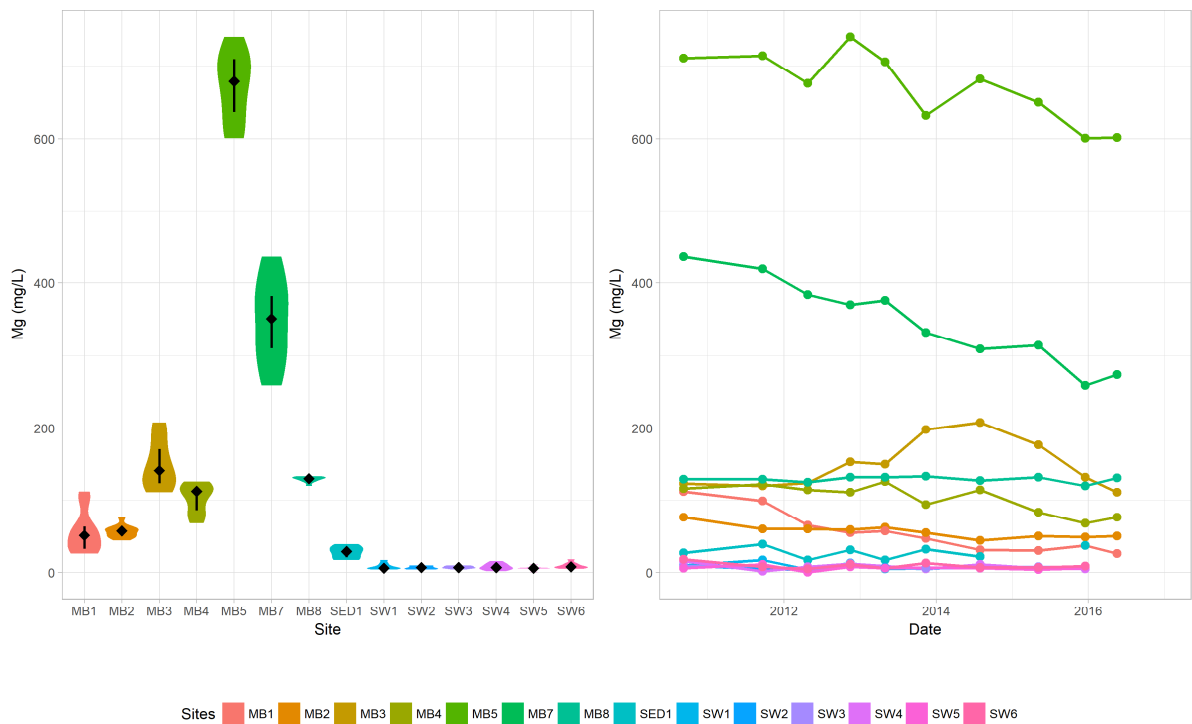


Figure 29 Mg monitoring data for the site

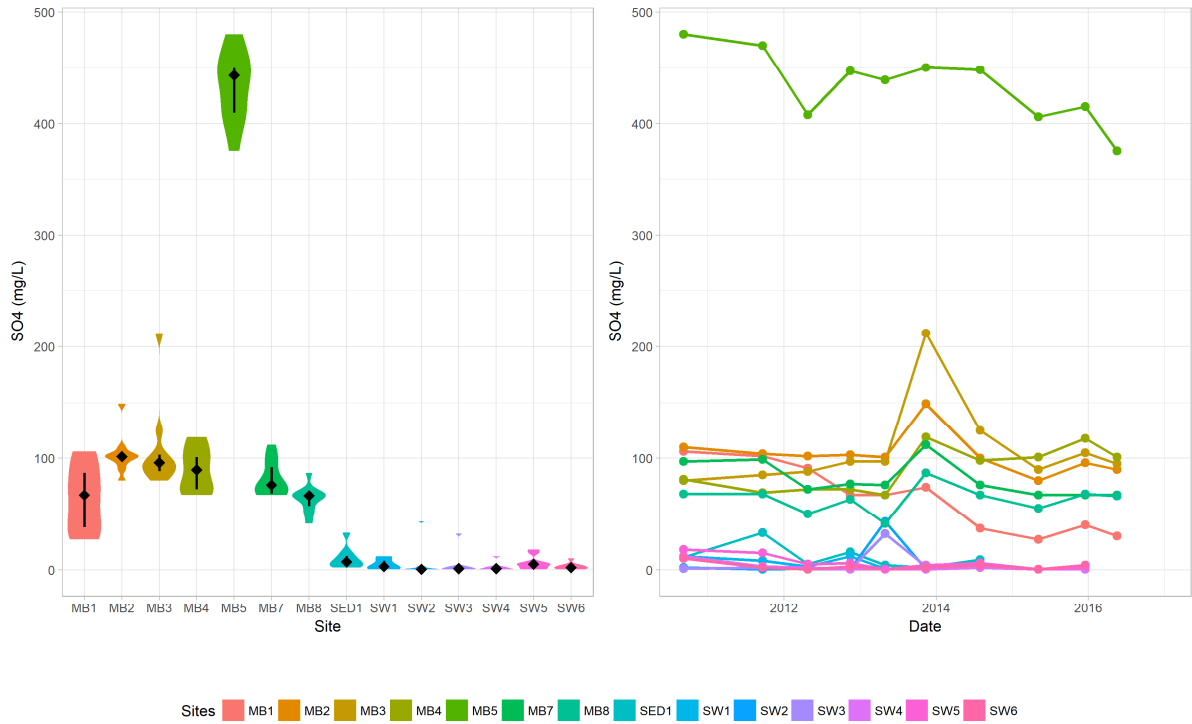


Figure 30 Sulphate monitoring data for the site

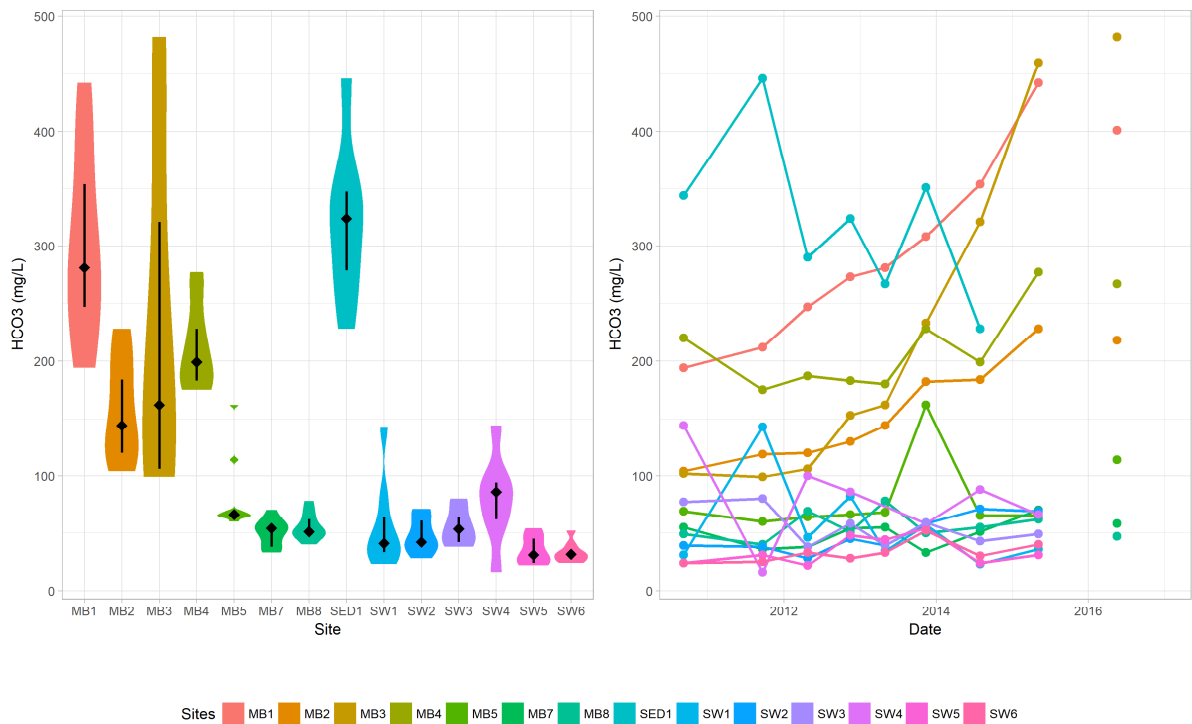


Figure 31  $\text{HCO}_3$  monitoring data for the site

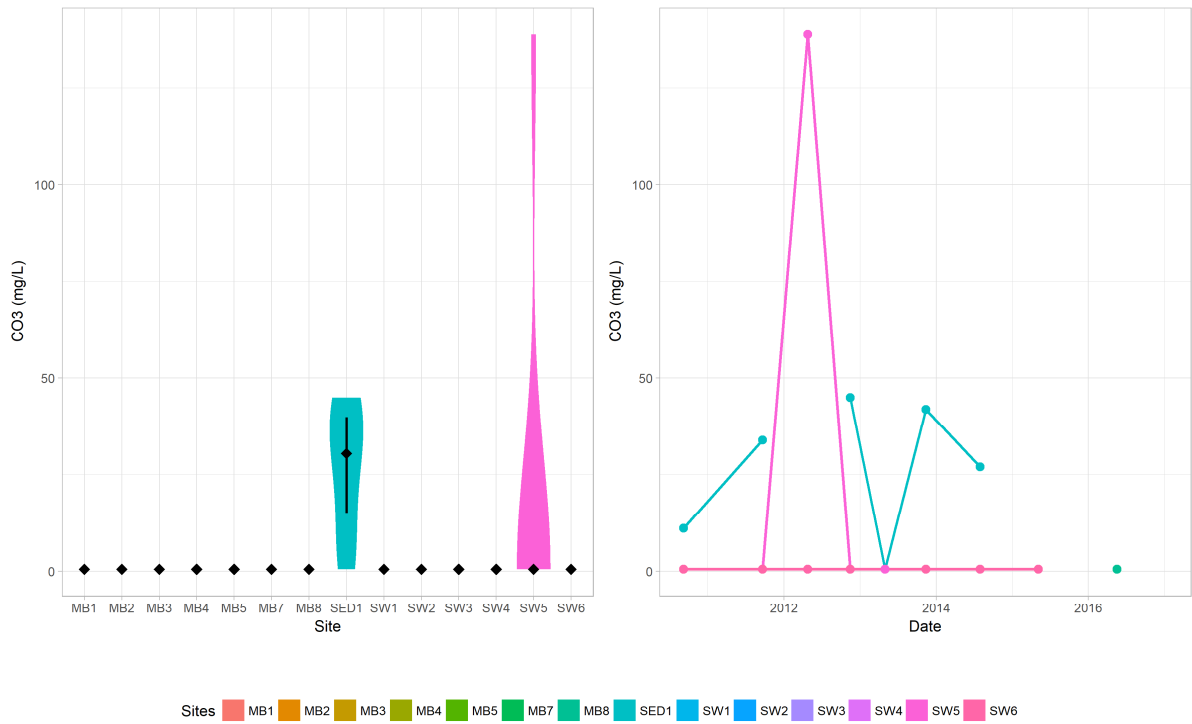


Figure 32 CO3 monitoring data for the site

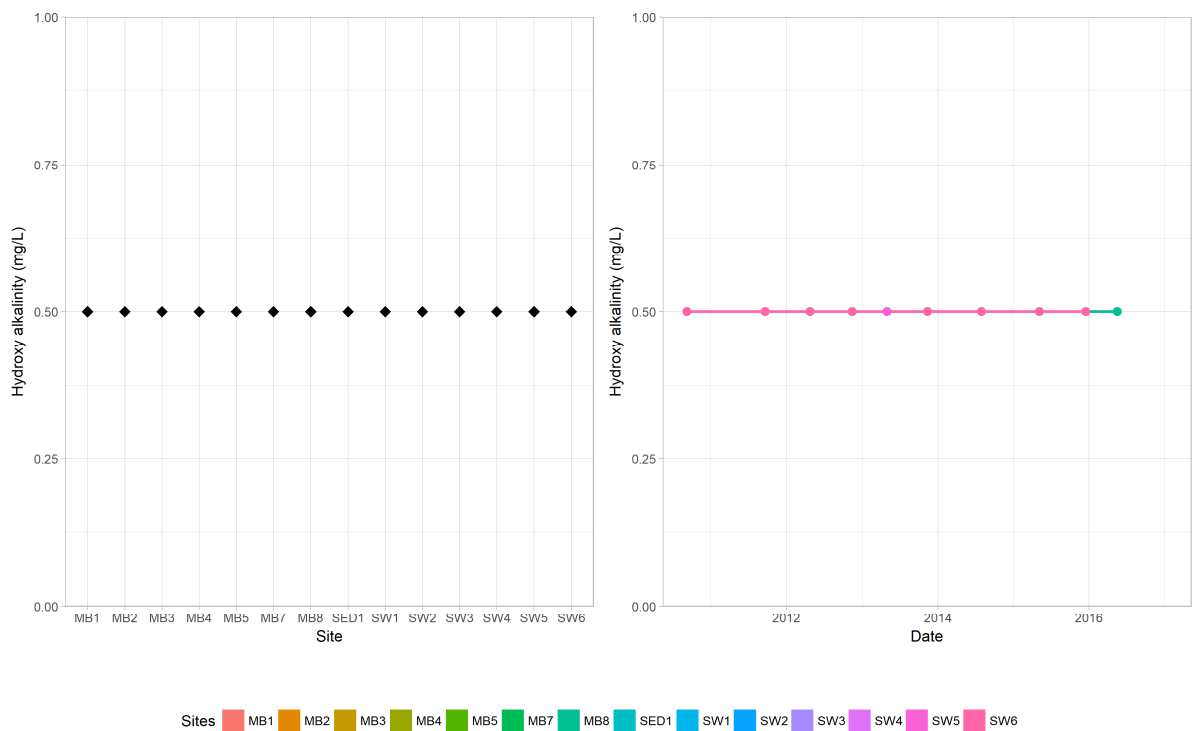


Figure 33 Hydroxy alkalinity monitoring data for the site

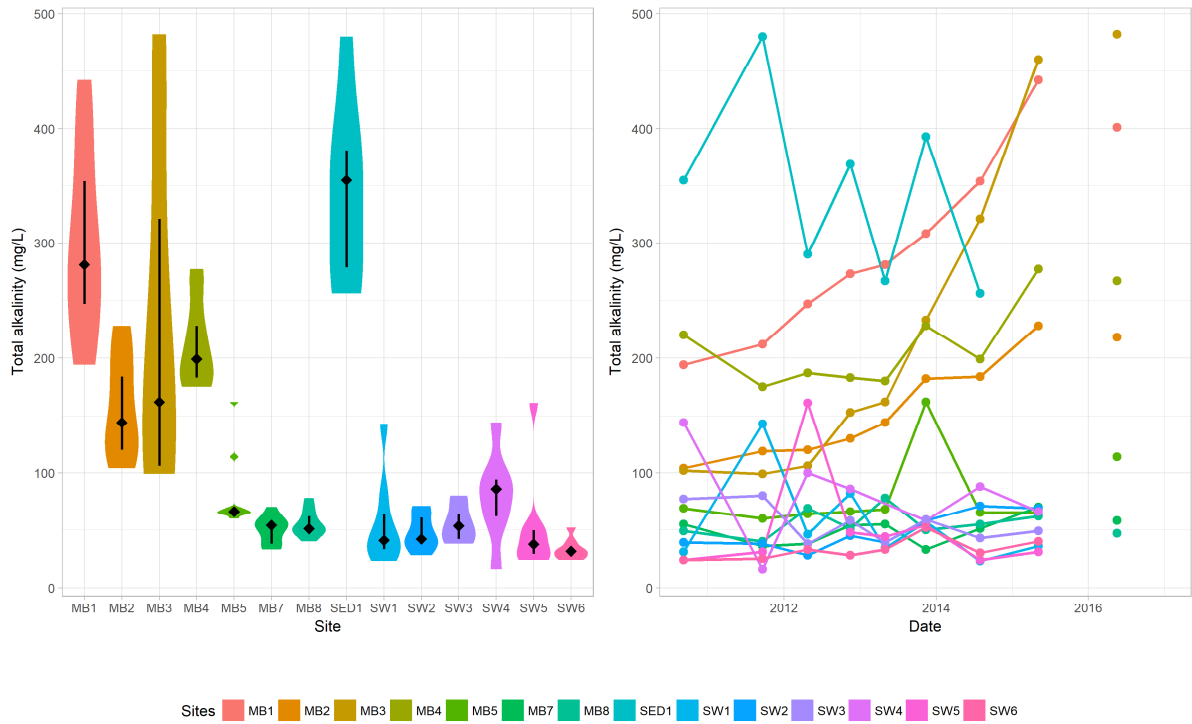


Figure 34 Total alkalinity monitoring data for the site

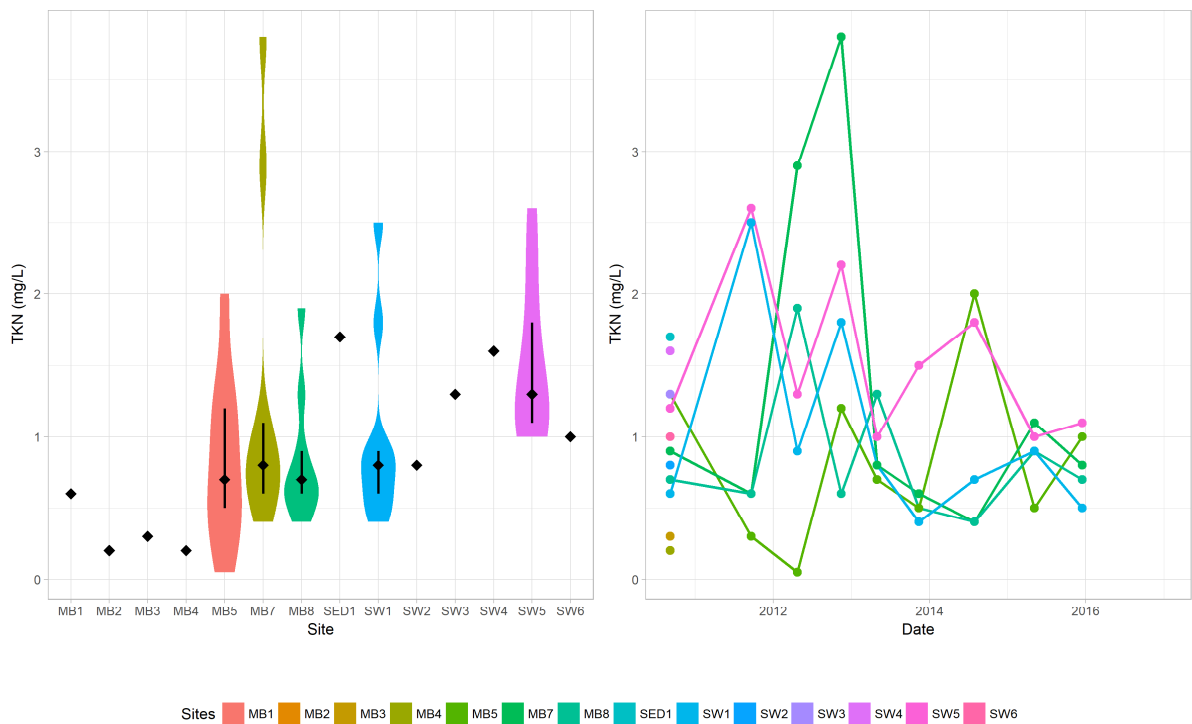


Figure 35 TKN monitoring data for the site

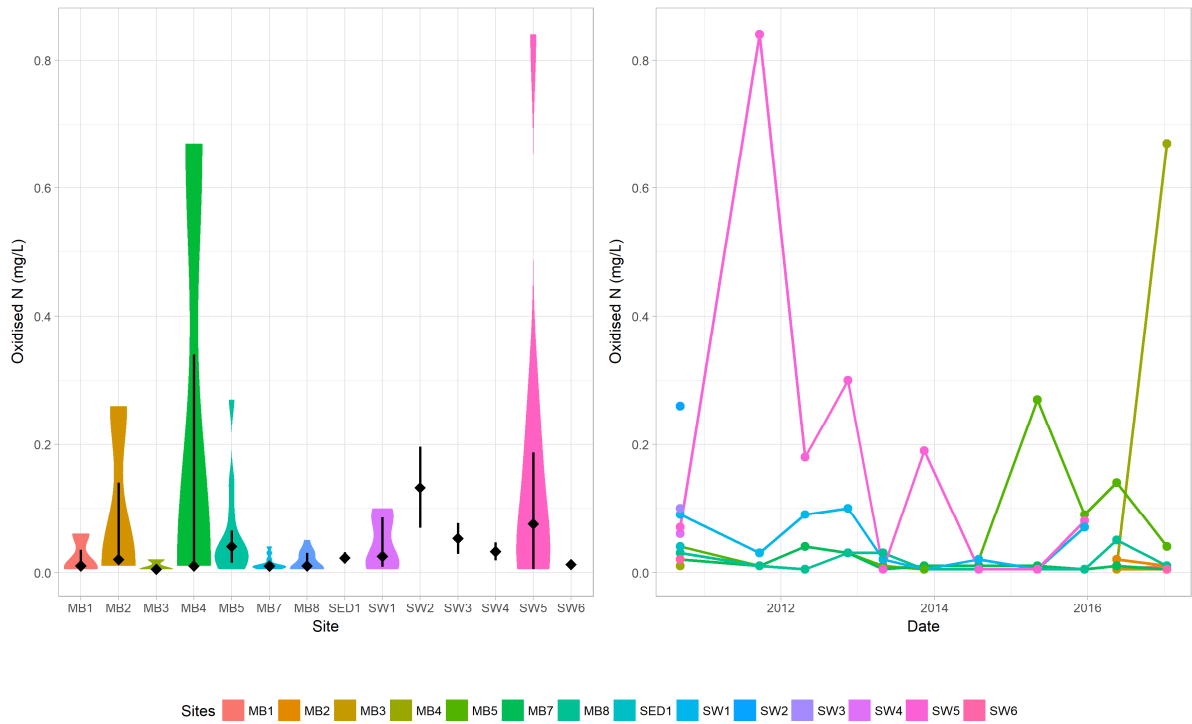


Figure 36 Oxidised N monitoring data for the site

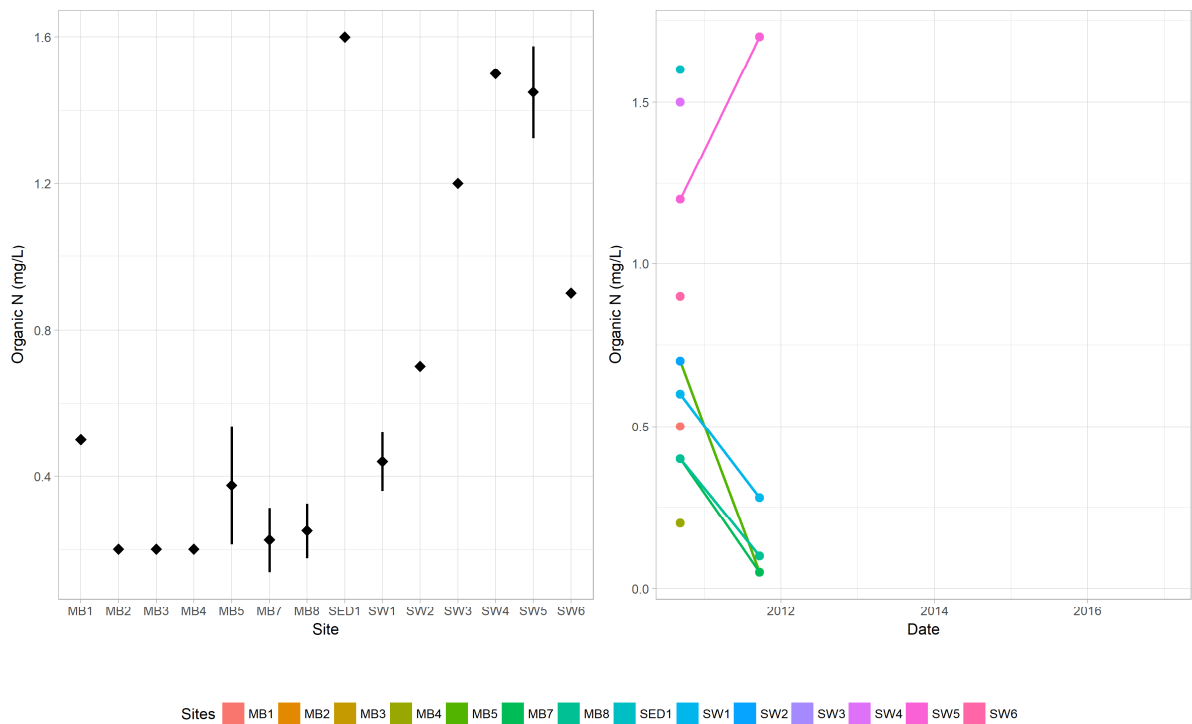


Figure 37 Organic N monitoring data for the site

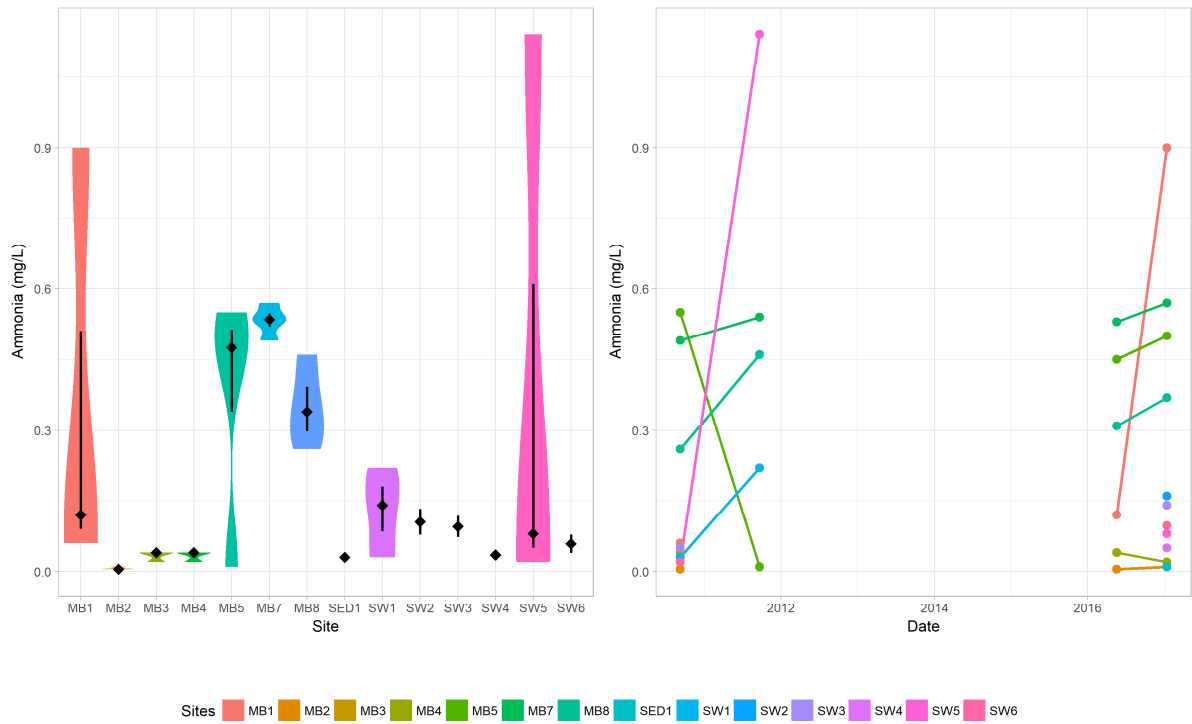


Figure 38 Ammonia monitoring data for the site

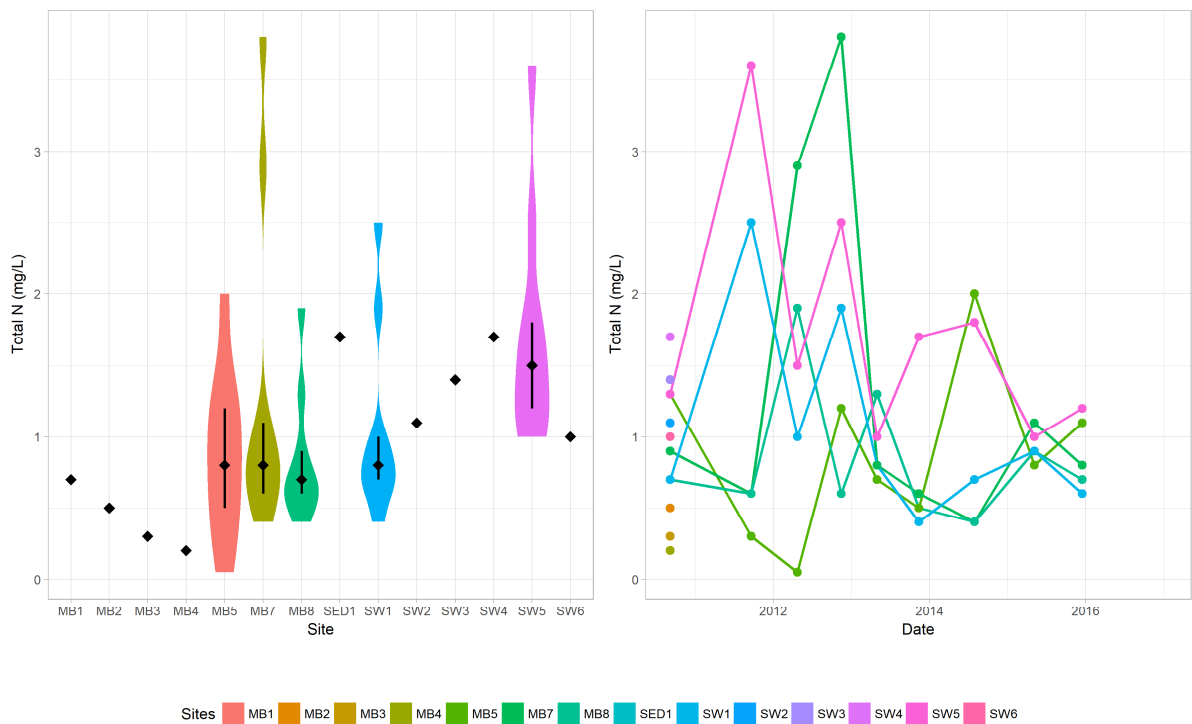


Figure 39 Total N monitoring data for the site

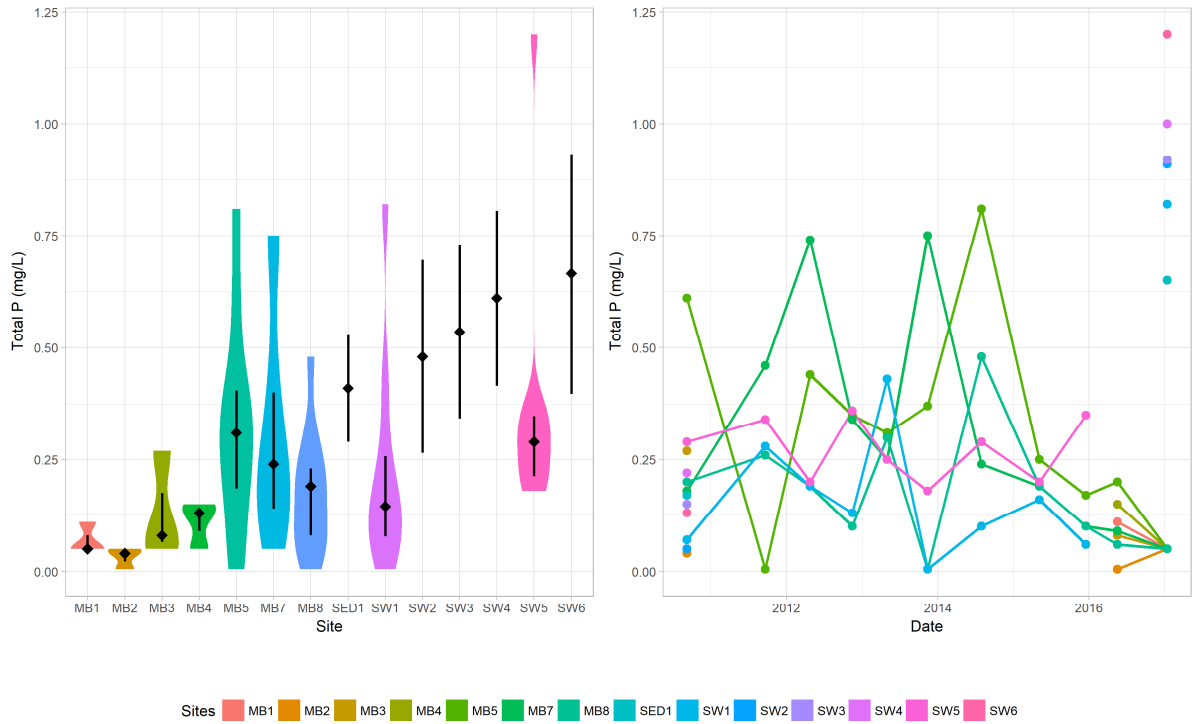


Figure 40 Total P monitoring data for the site

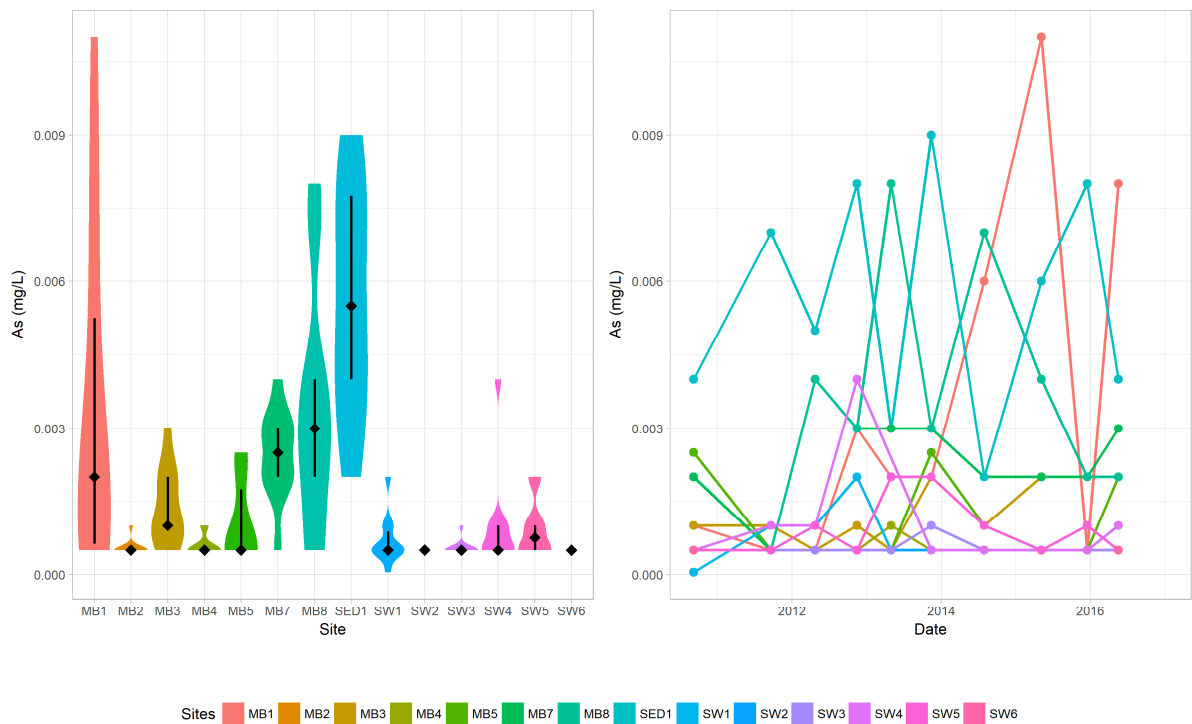


Figure 41 As monitoring data for the site

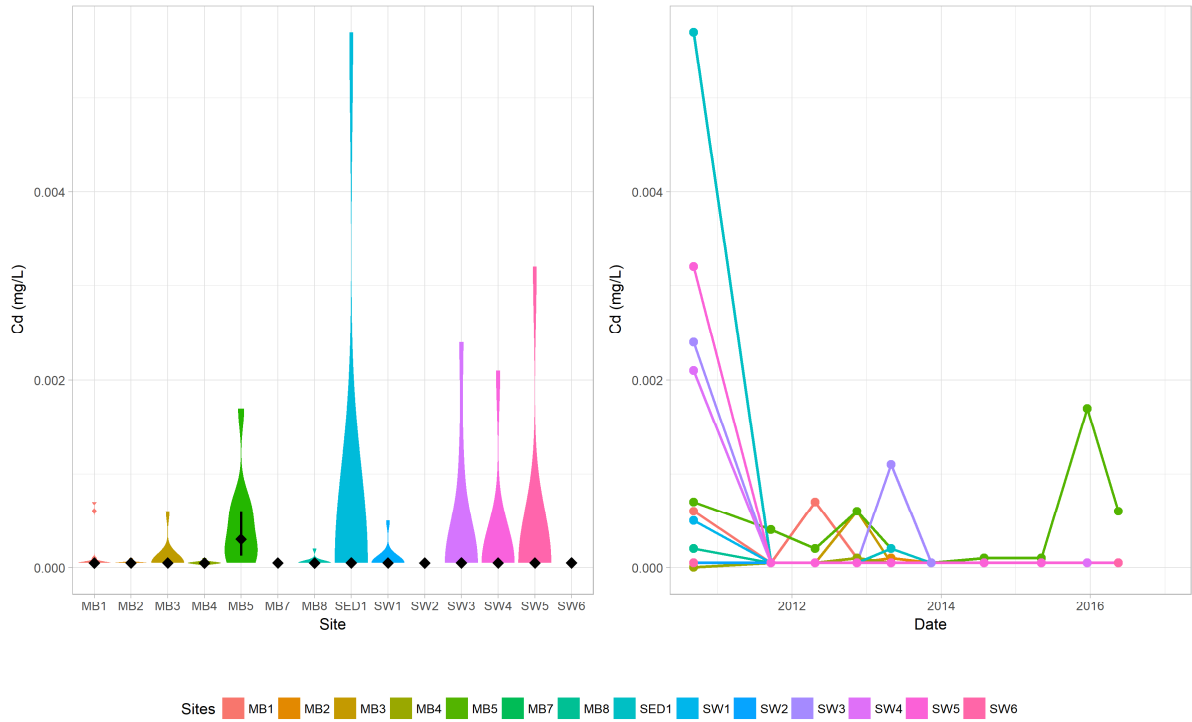


Figure 42 Cd monitoring data for the site

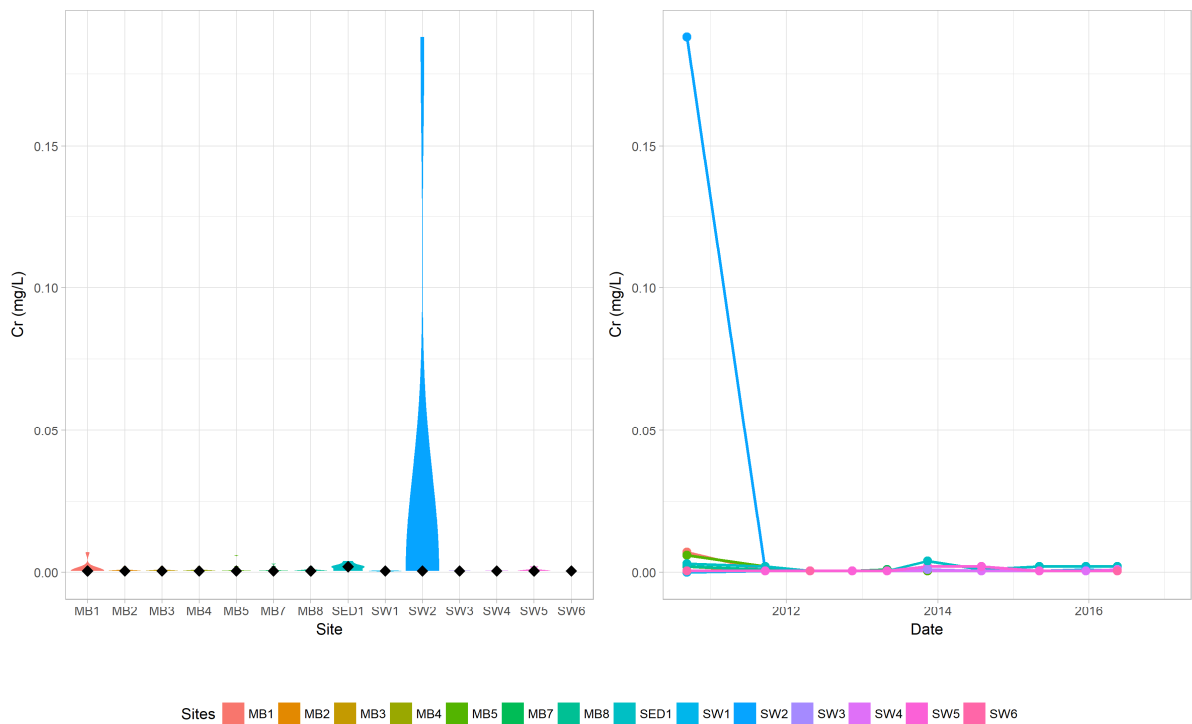


Figure 43 Cr monitoring data for the site

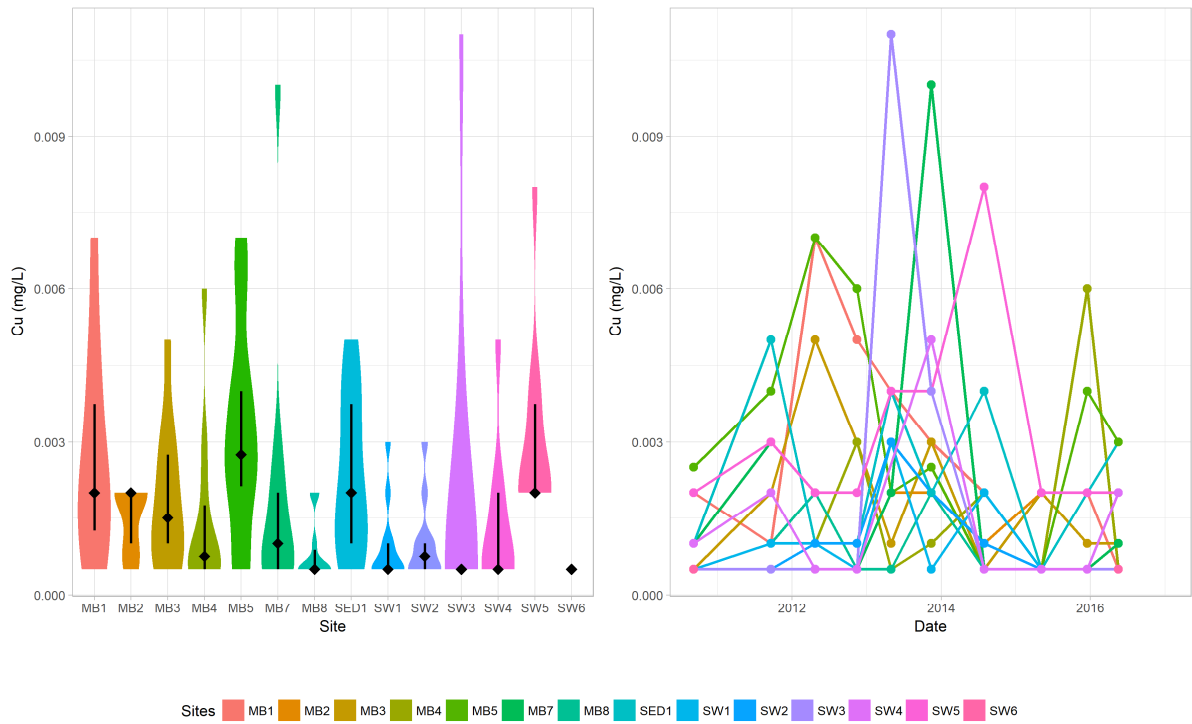


Figure 44 Cu monitoring data for the site

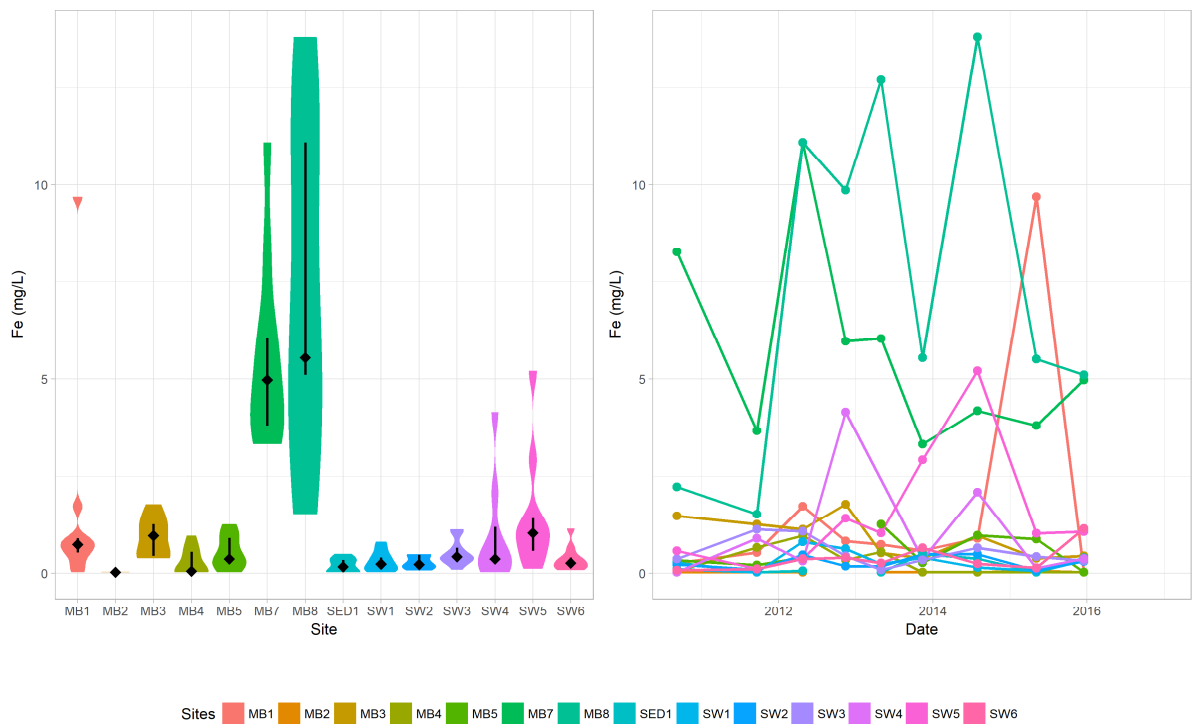


Figure 45 Fe monitoring data for the site

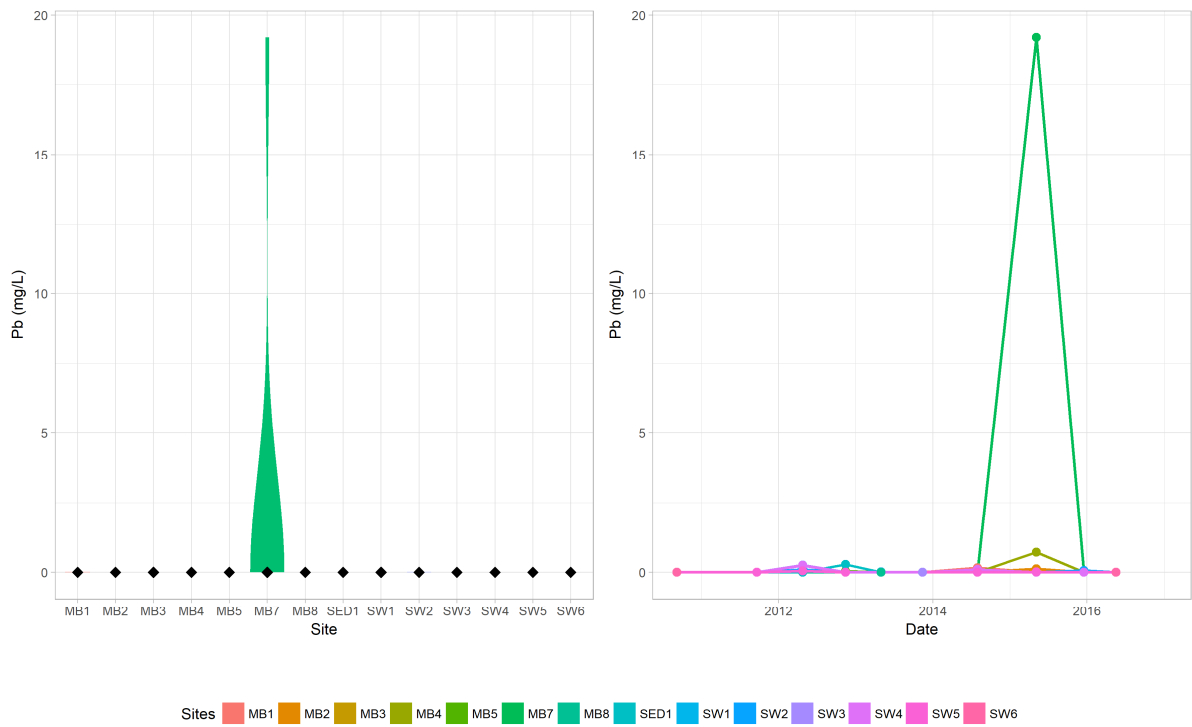


Figure 46 Pb monitoring data for the site

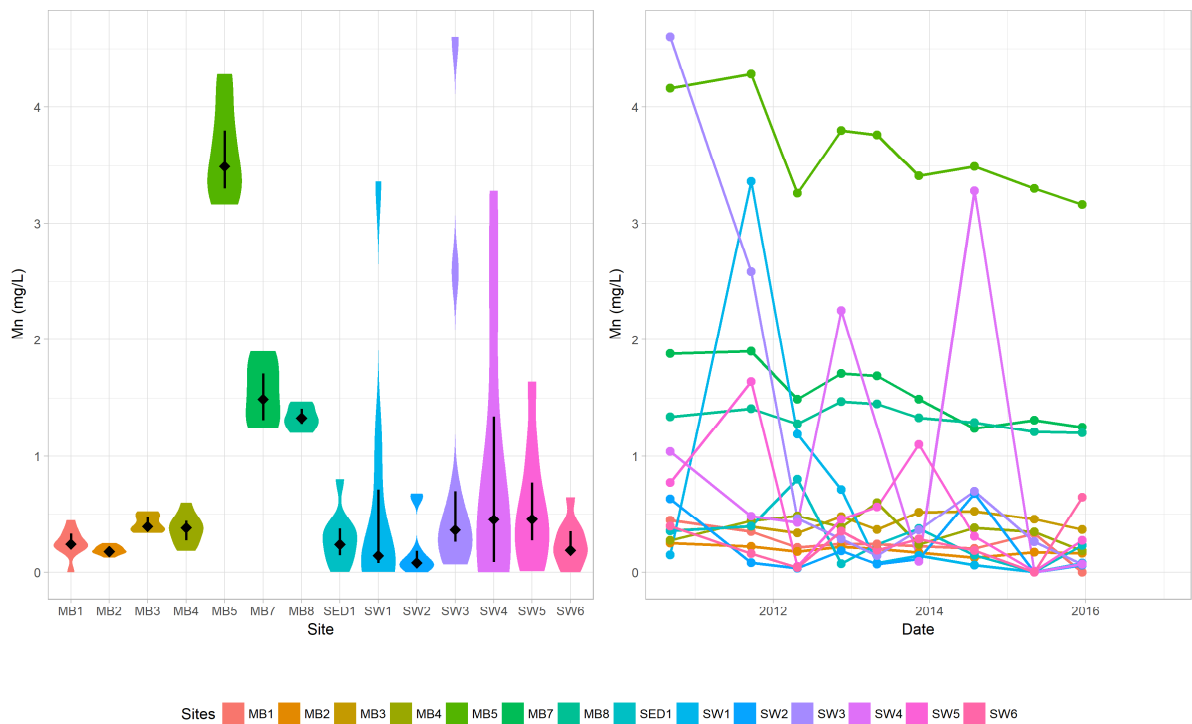


Figure 47 Mn monitoring data for the site

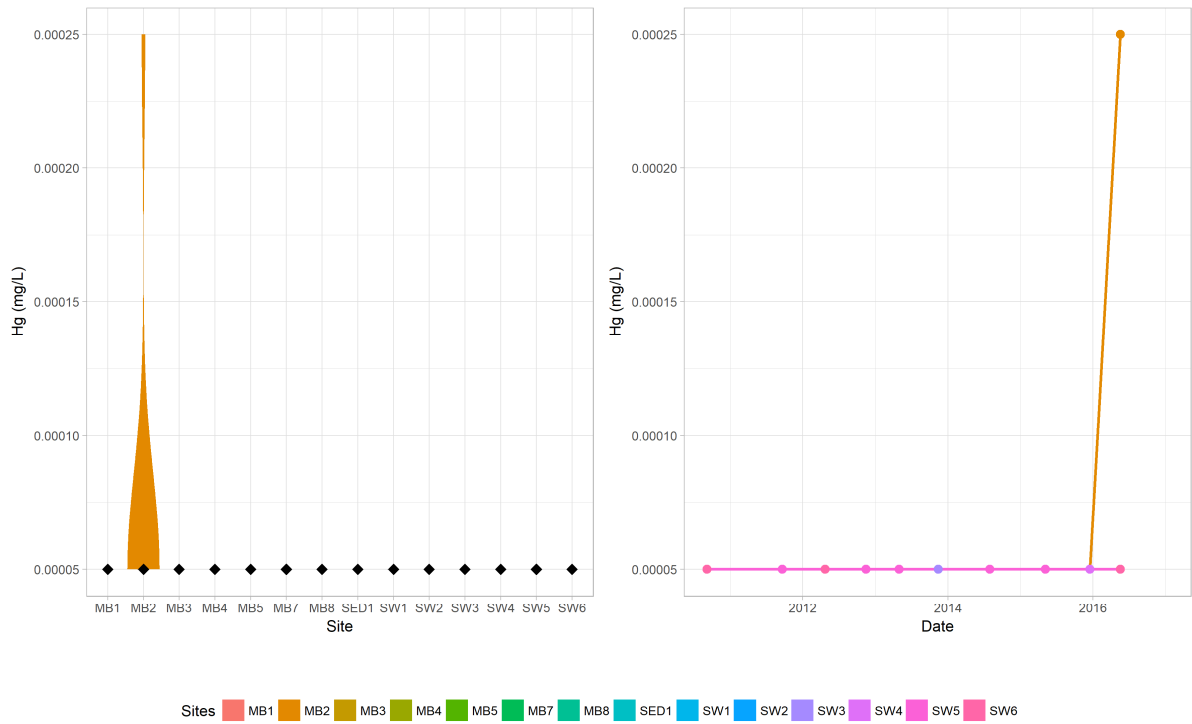


Figure 48 Hg monitoring data for the site

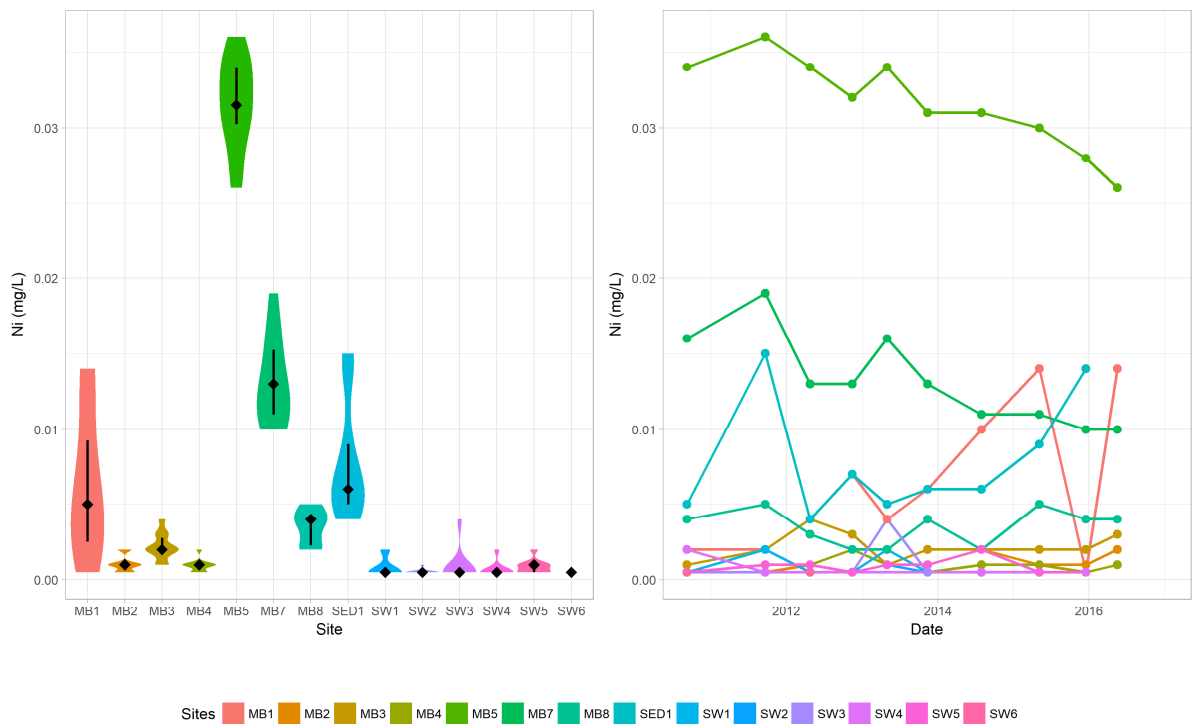


Figure 49 Ni monitoring data for the site

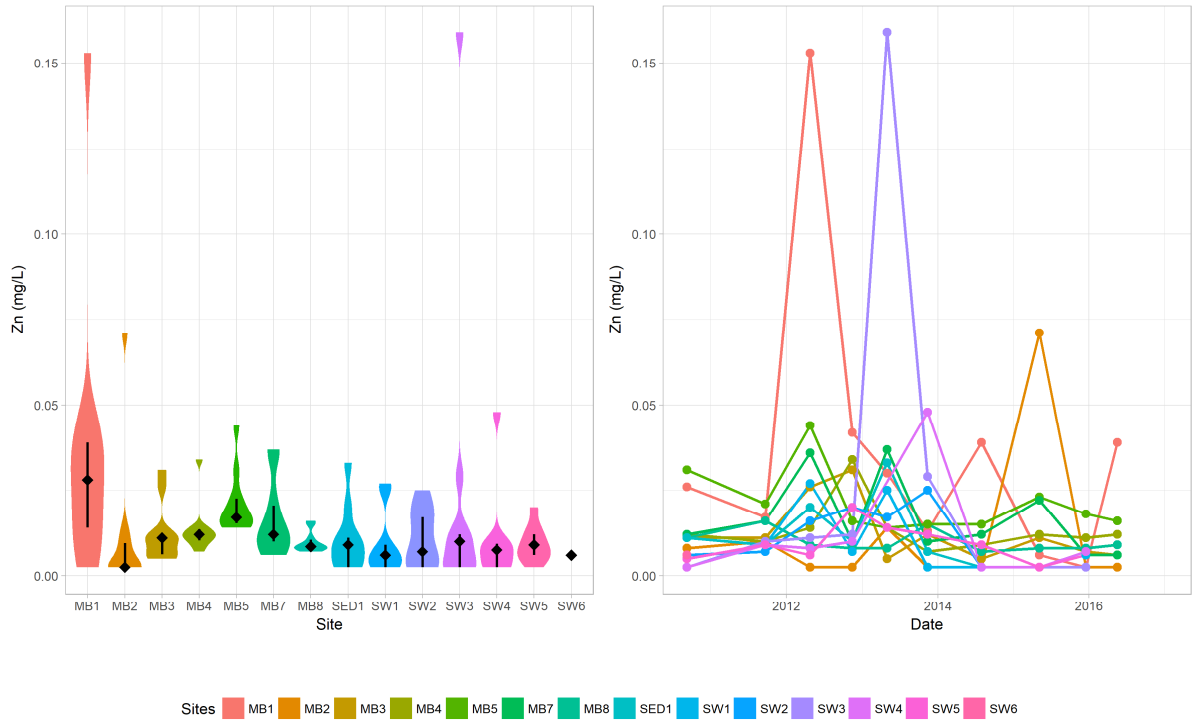


Figure 50 Zn monitoring data for the site

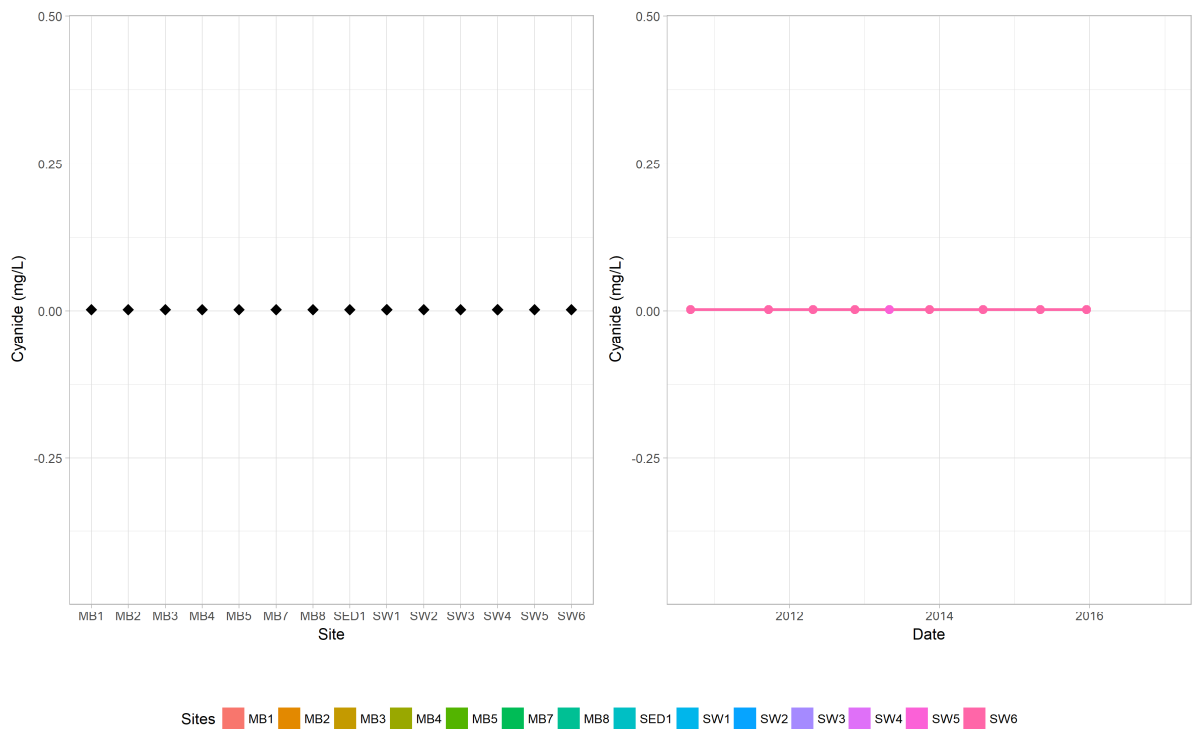


Figure 51 Cyanide monitoring data for the site

## 12 APPENDIX D: STATISTICAL ANALYSIS

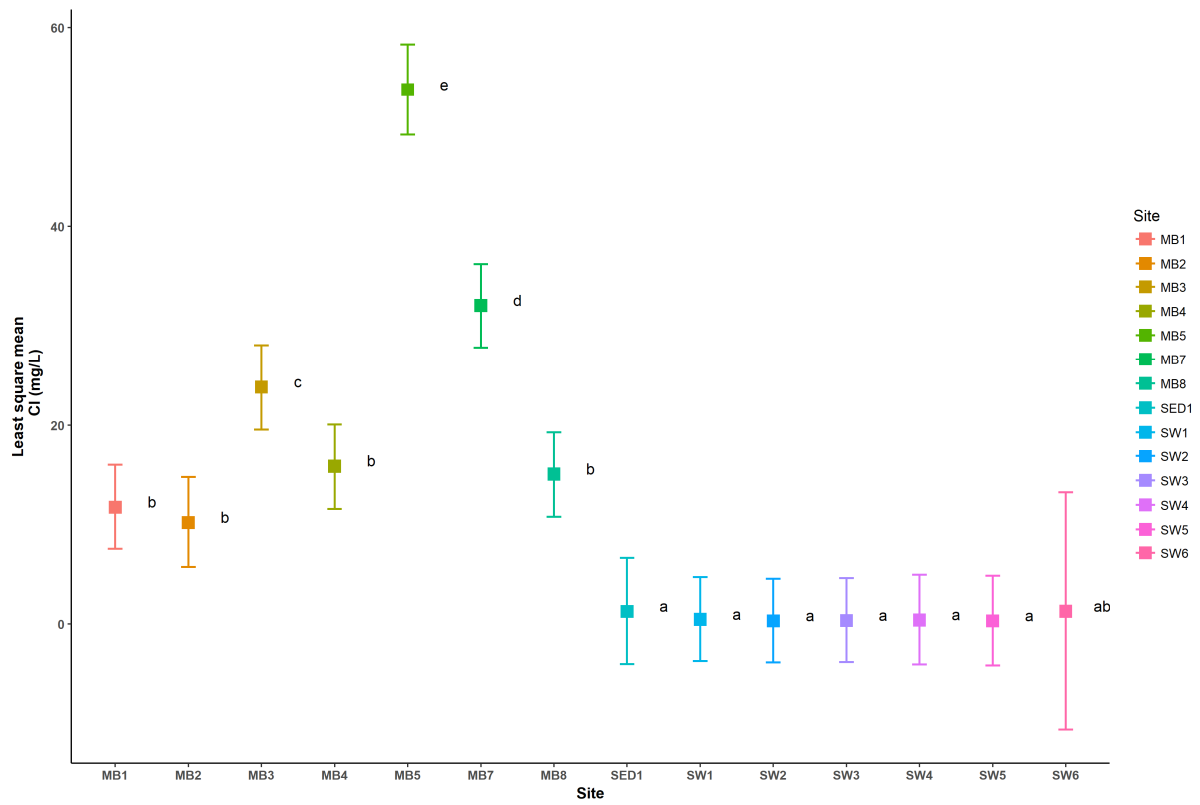


Figure 52 Cl means, confidence interval and mean-separation letters

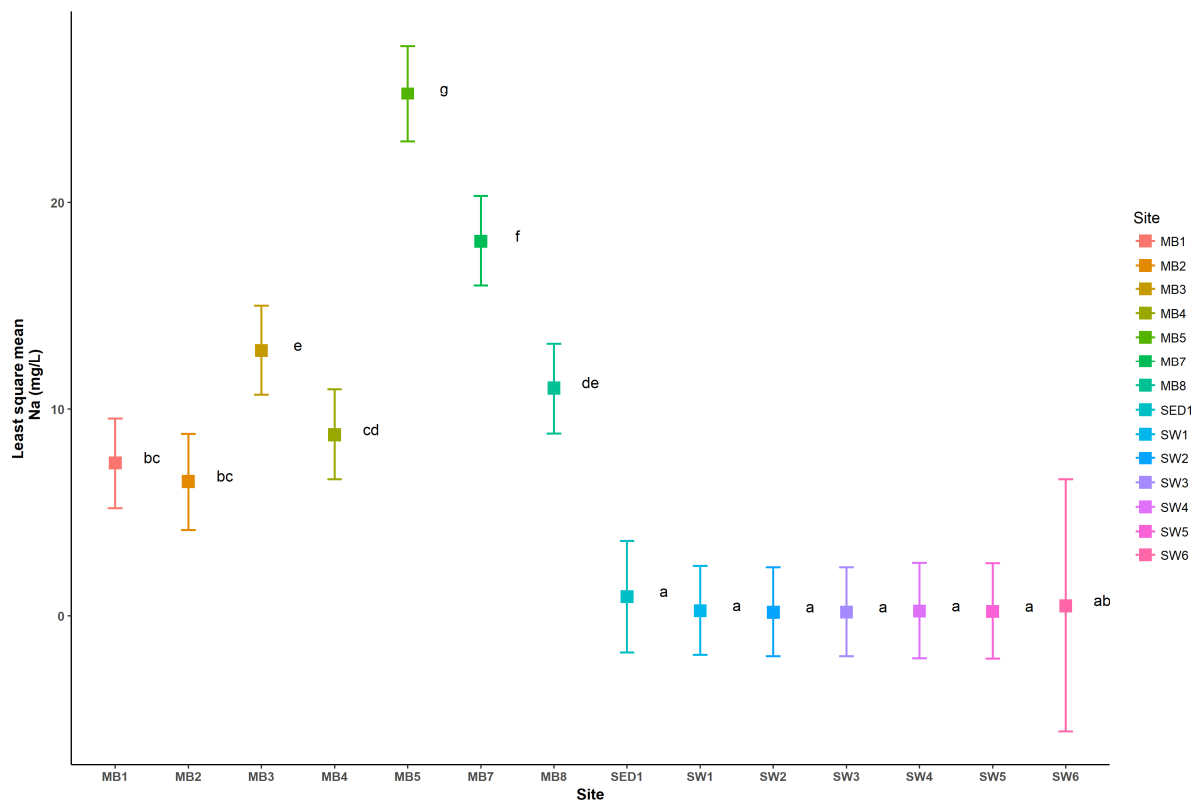


Figure 53 Na means, confidence interval and mean-separation letters

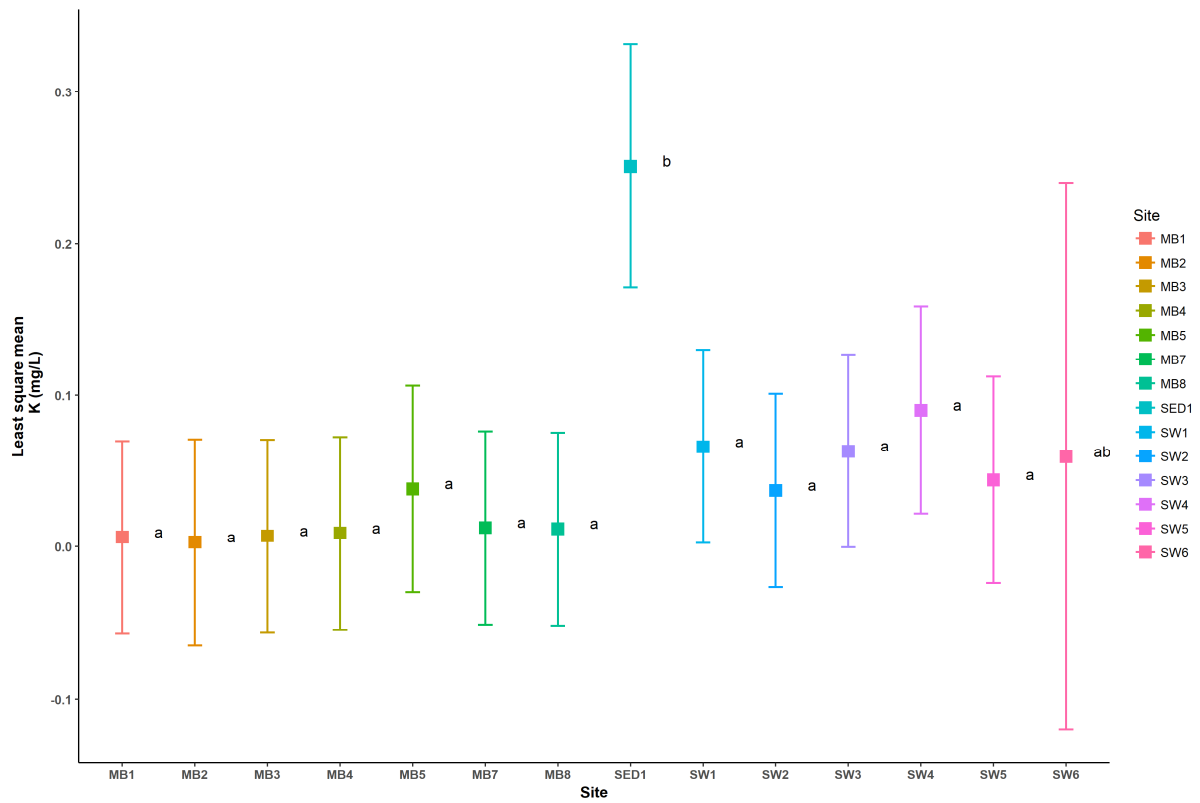


Figure 54 K means, confidence interval and mean-separation letters

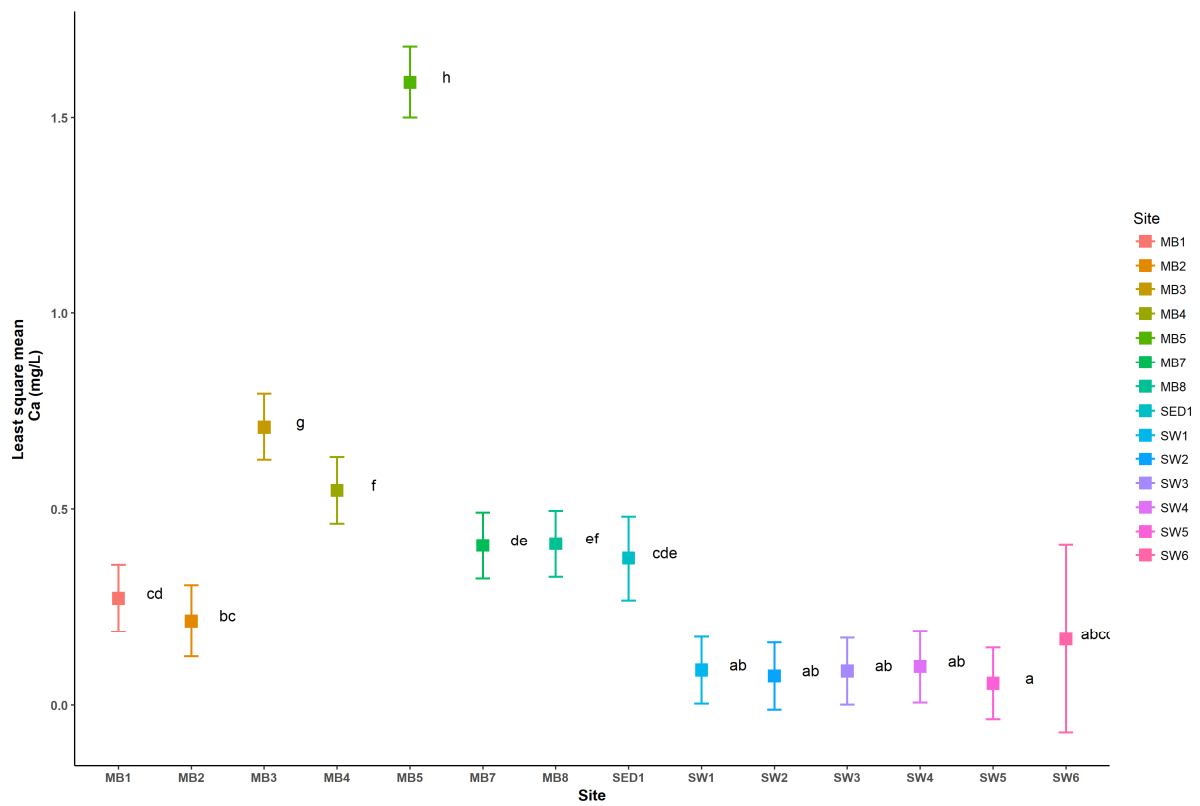


Figure 55 Ca means, confidence interval and mean-separation letters

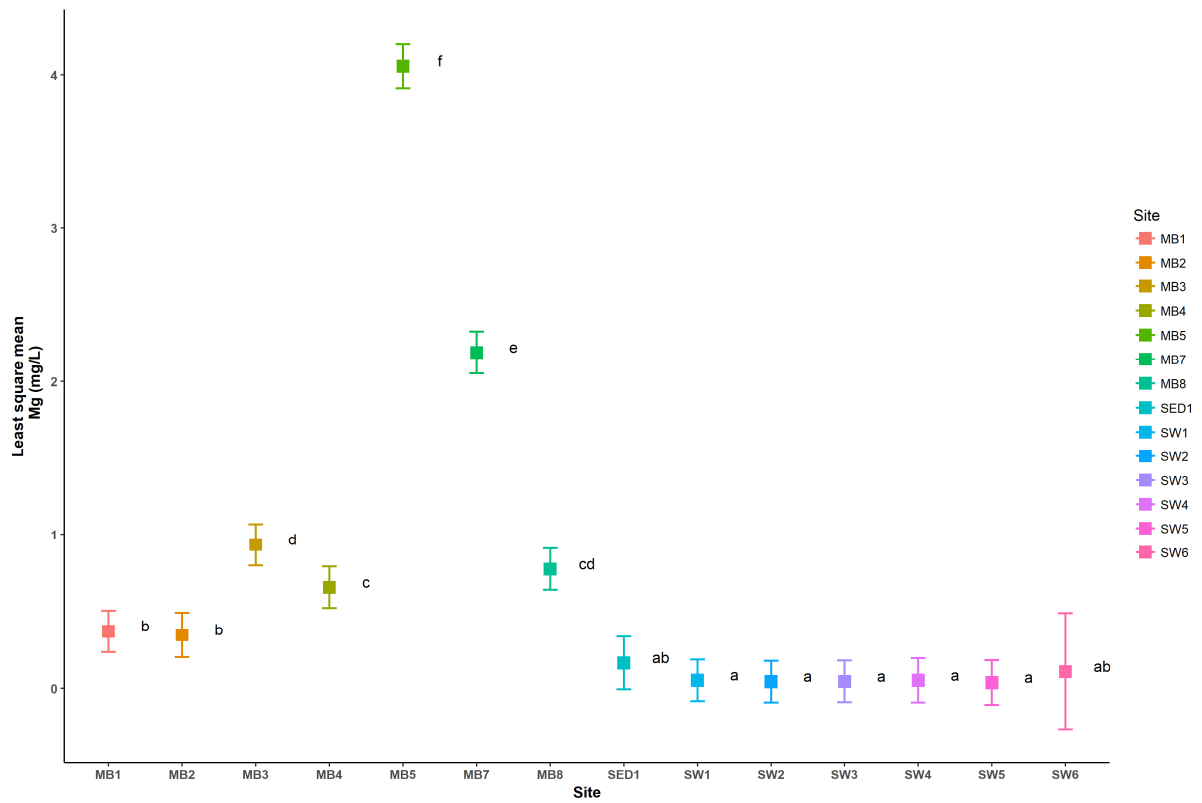


Figure 56 Mg means, confidence interval and mean-separation letters

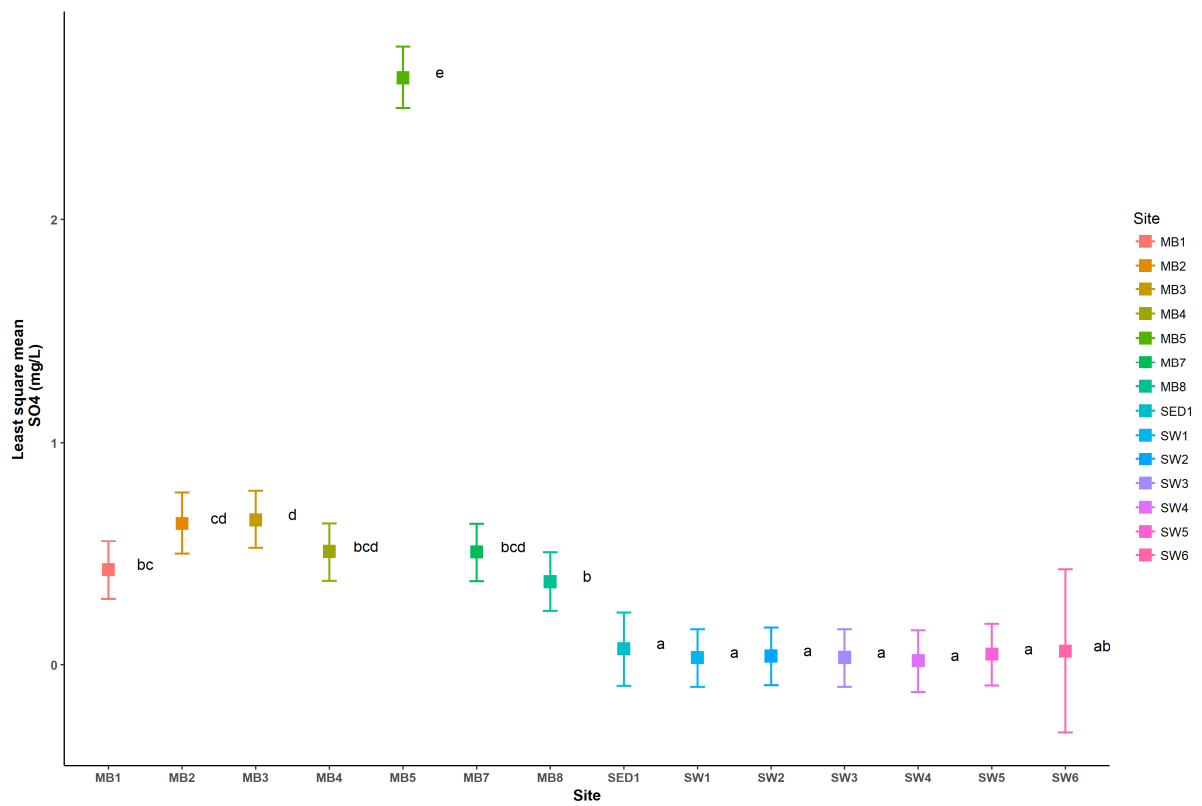


Figure 57 SO4 means, confidence interval and mean-separation letters

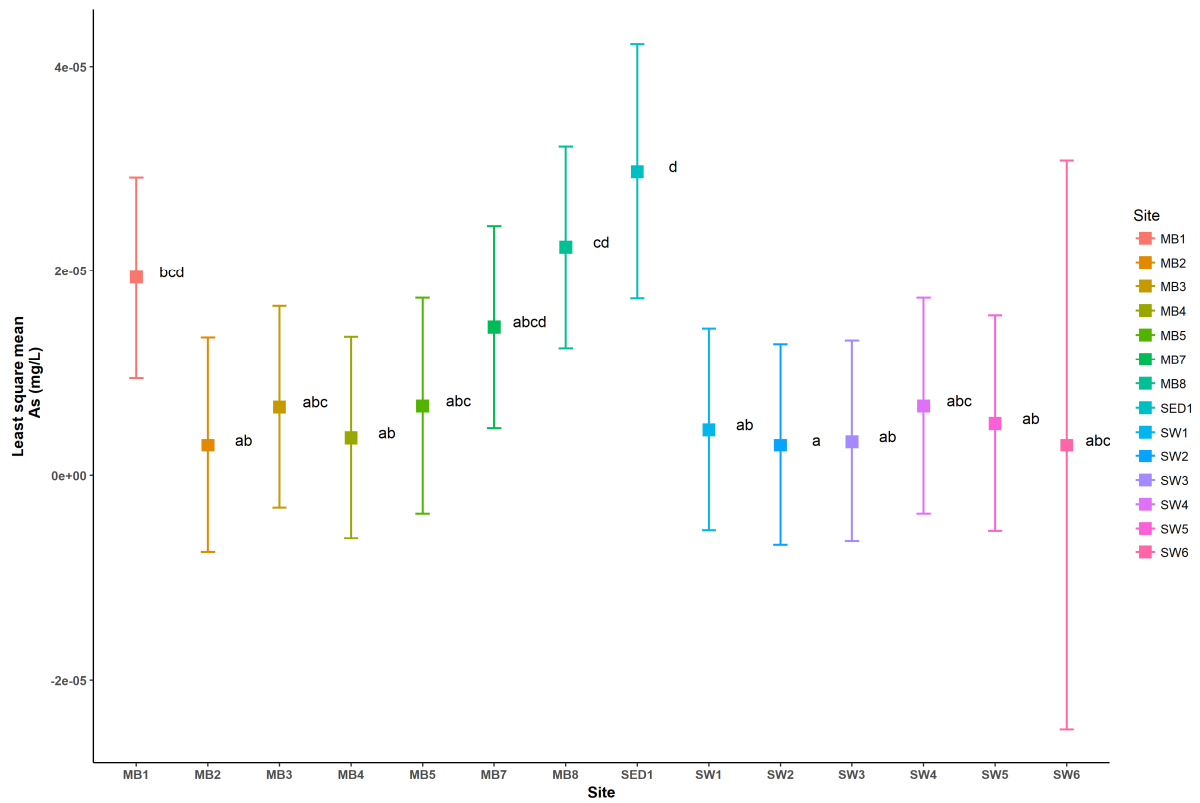


Figure 58 As means, confidence interval and mean-separation letters

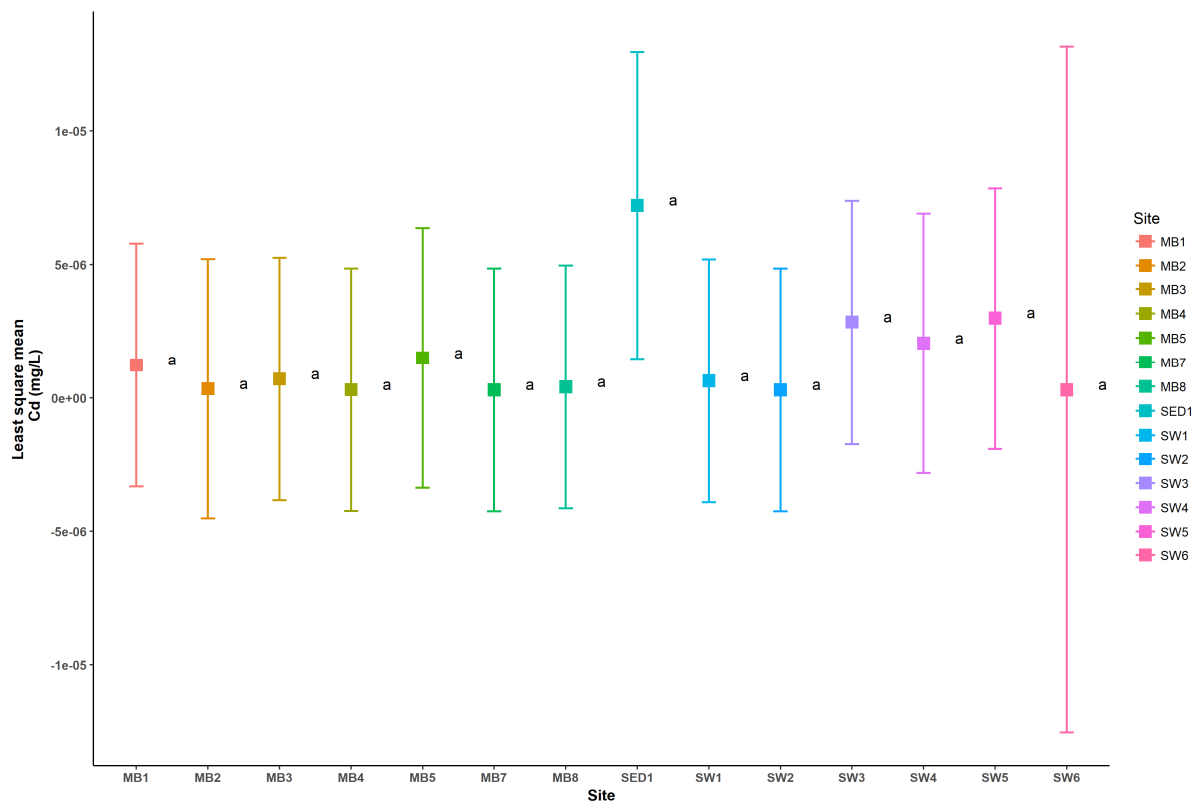


Figure 59 Cd means, confidence interval and mean-separation letters

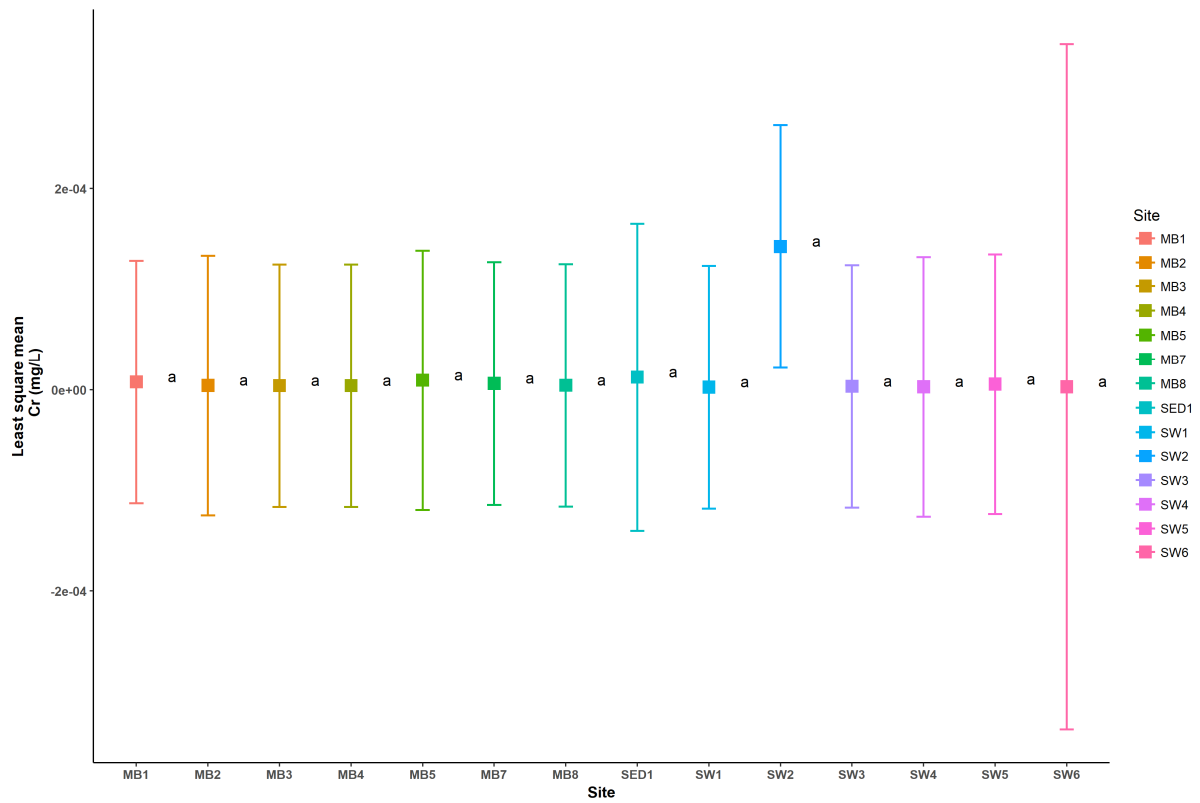


Figure 60 Cr means, confidence interval and mean-separation letters

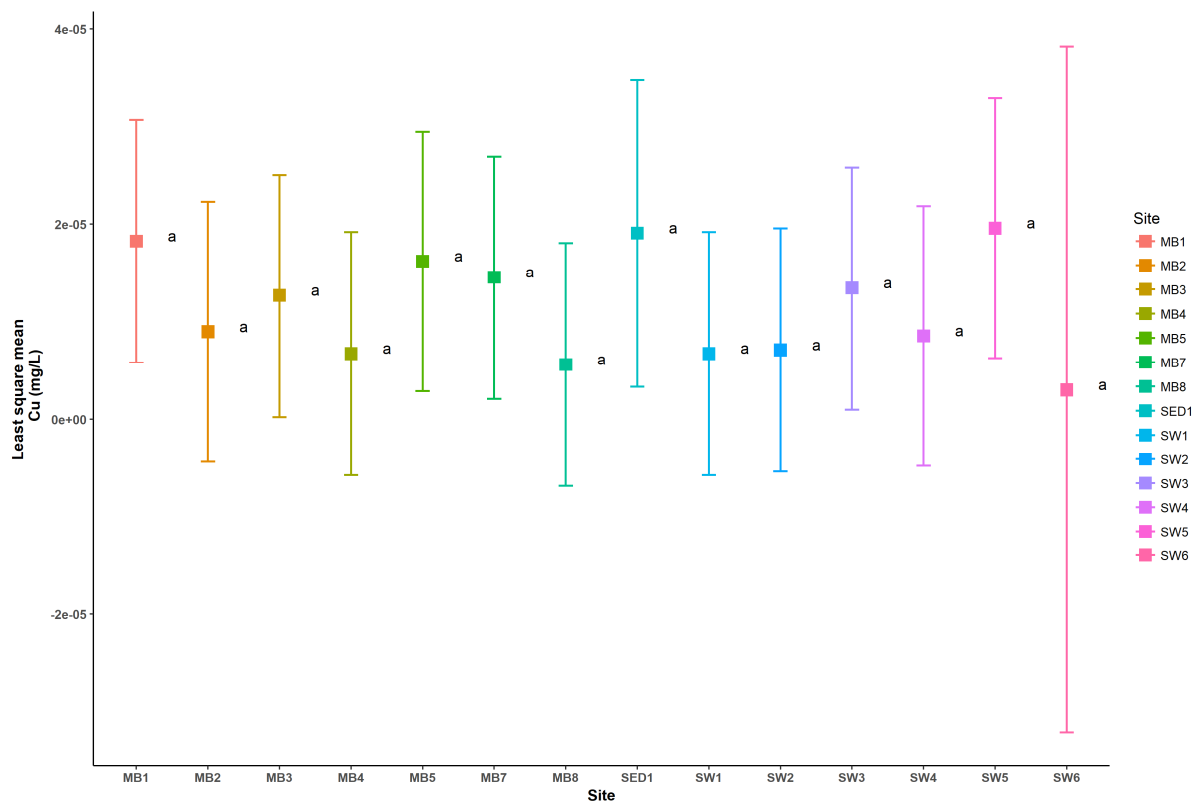


Figure 61 Cu means, confidence interval and mean-separation letters

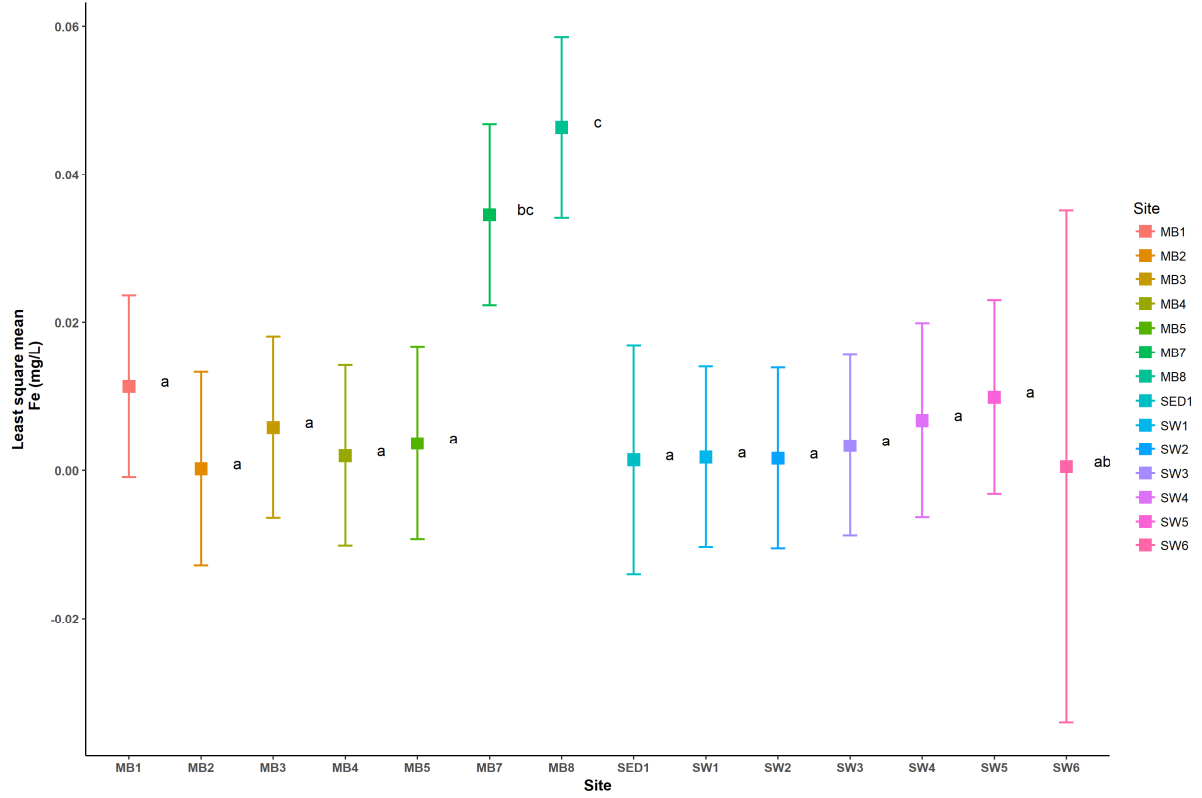


Figure 62 Fe means, confidence interval and mean-separation letters

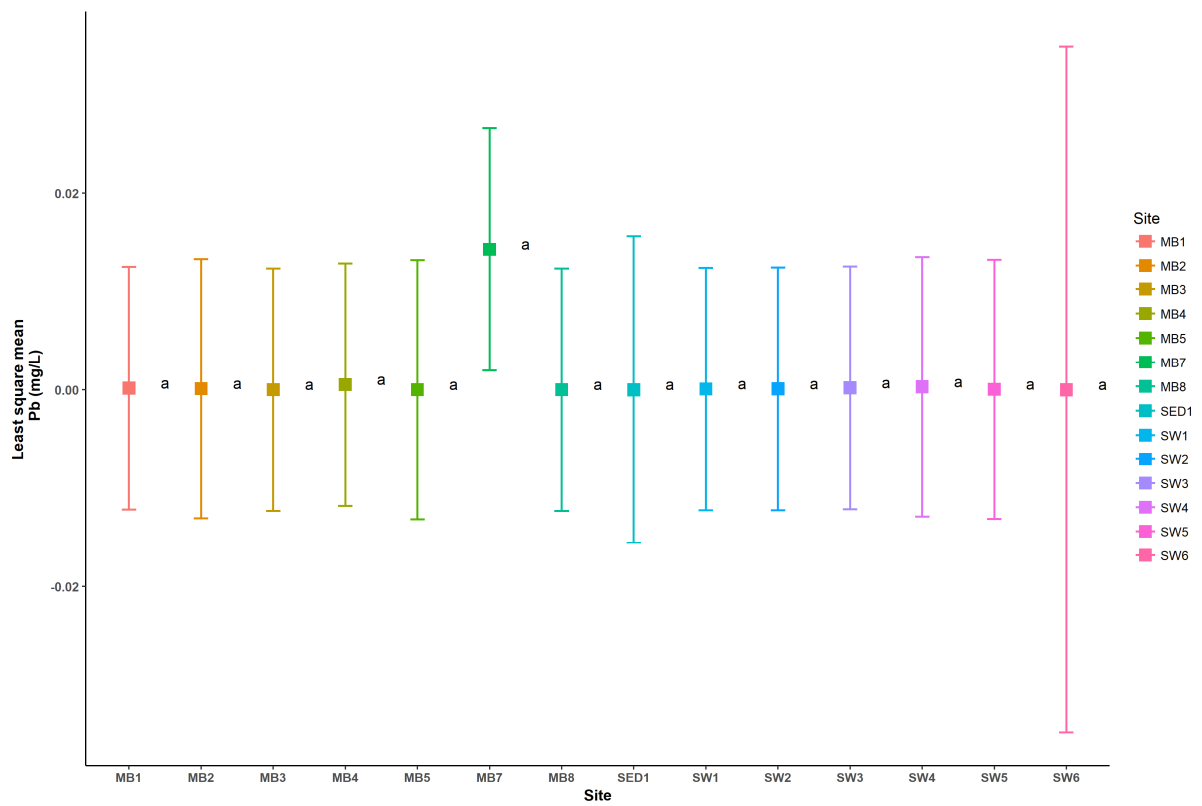


Figure 63 Pb means, confidence interval and mean-separation letters

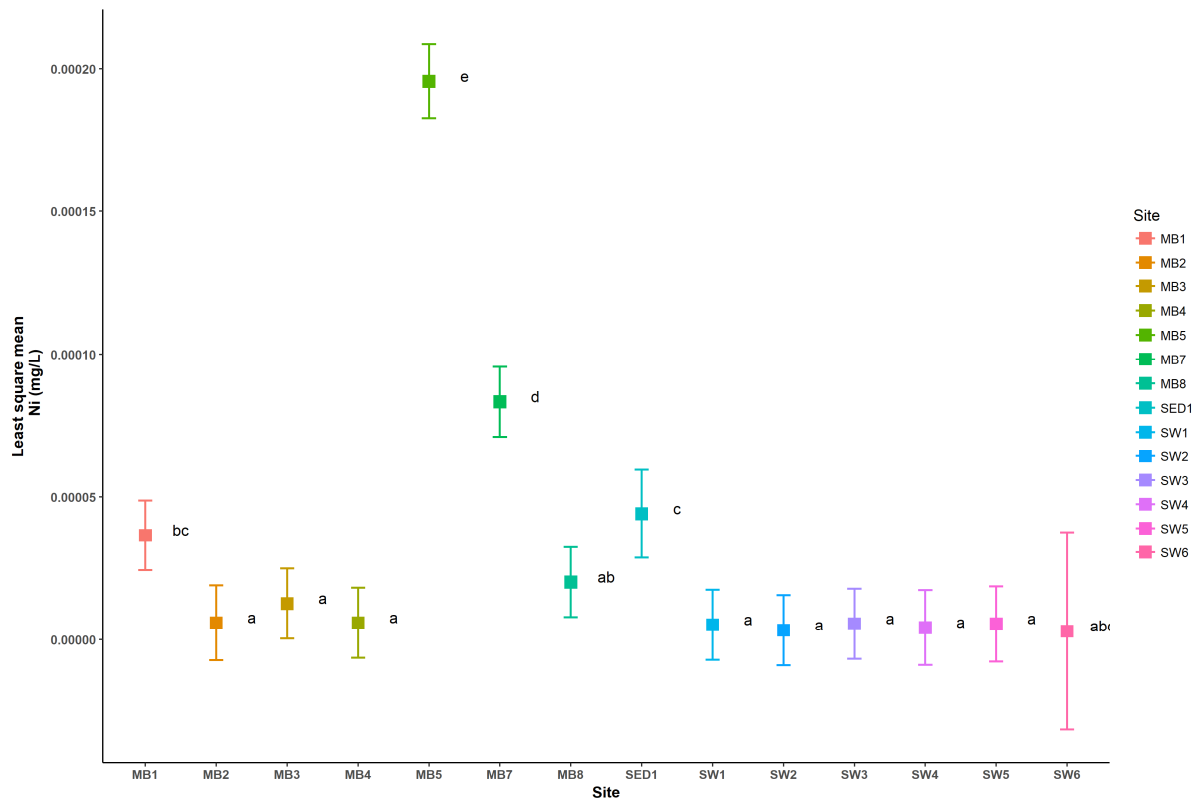


Figure 64 Ni means, confidence interval and mean-separation letters

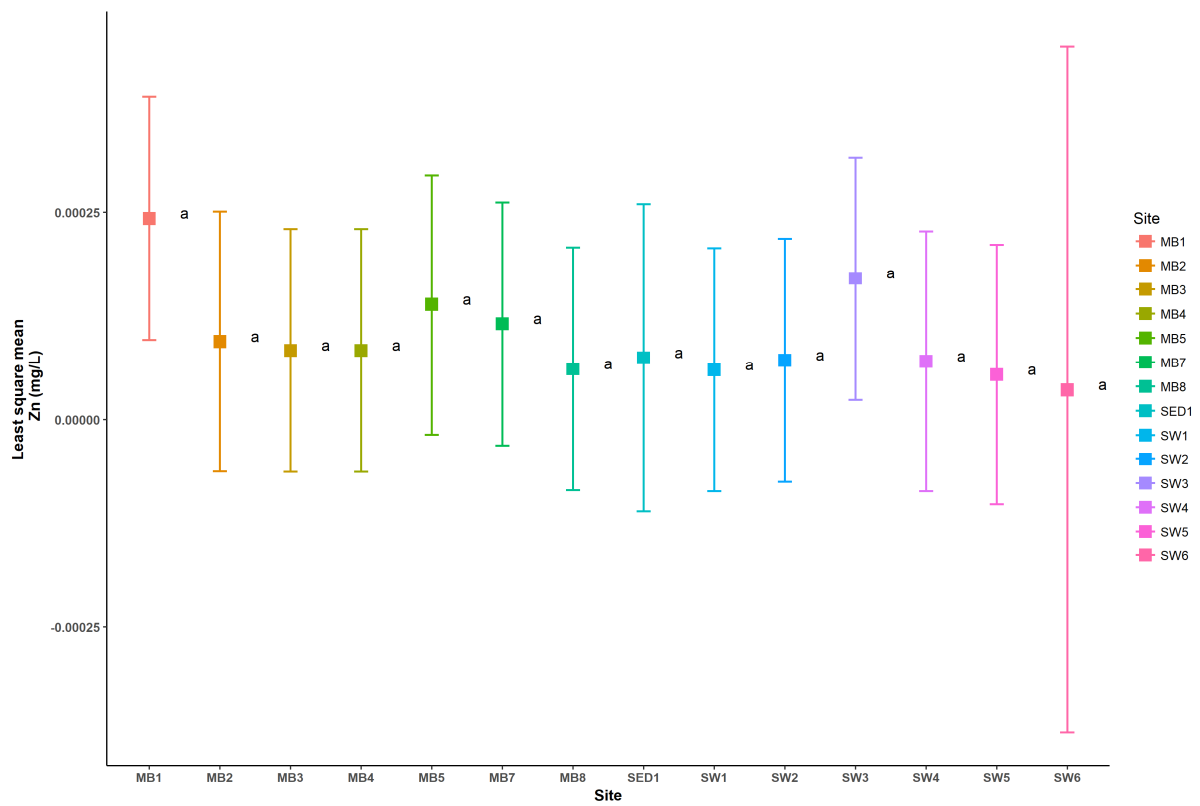


Figure 65 Zn means, confidence interval and mean-separation letters





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