

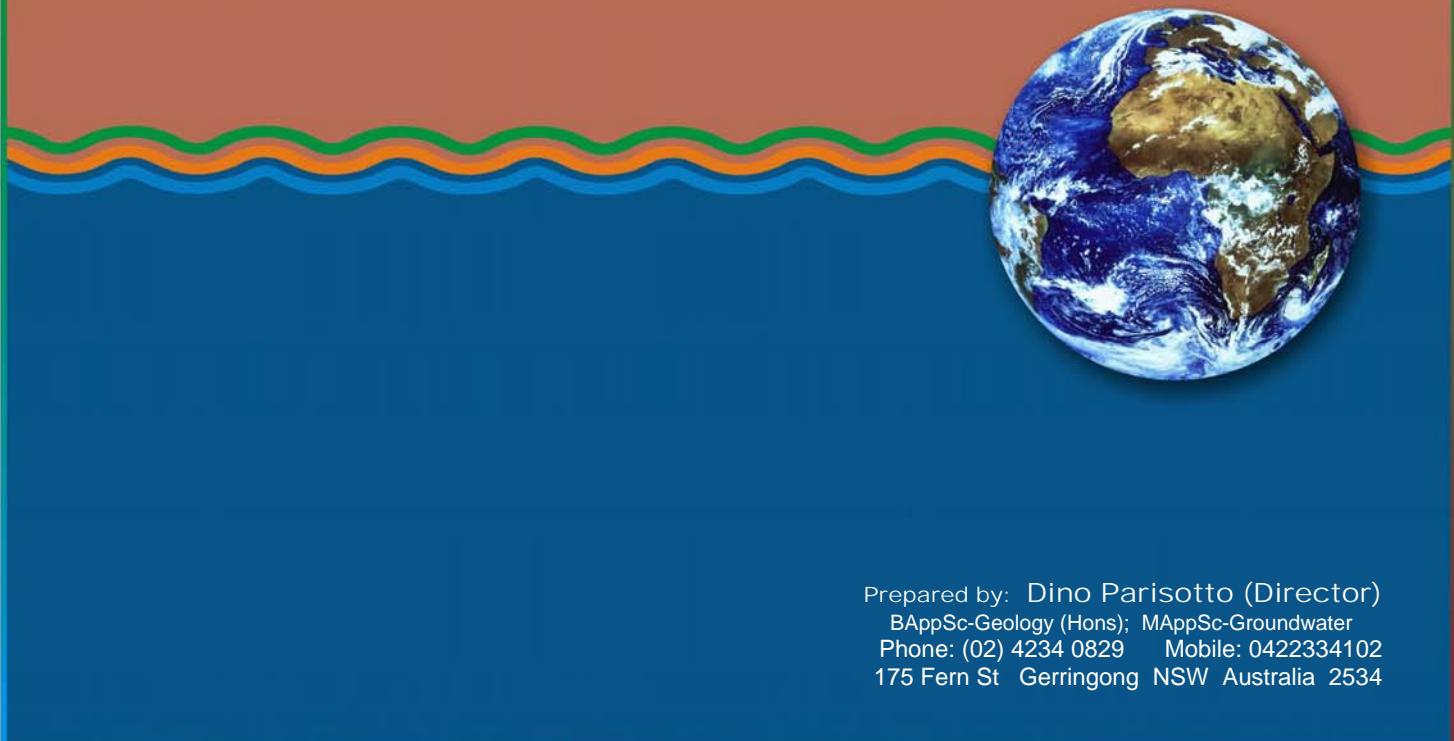


Kiama Municipal Council

# Minnamurra Waste Disposal Depot Annual Groundwater & Surface Water Monitoring Report – 2016 to 2017

Report E2W-059 (R001 v1)

20 November 2017



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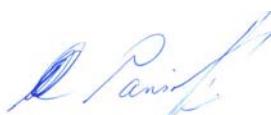
**Project: Annual Surface and Groundwater Monitoring Report Minnamurra  
Waste Disposal Depot  
(EPL 2016 to 2017)**

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## 1. INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Kiama Municipal Council (KMC) to provide the 2016 to 2017 annual surface and groundwater monitoring report for the Minnamurra Waste Disposal Depot (MWDD).

This report is based on information provided in field and laboratory reports provided by ALS Environmental Pty Ltd, and previous monitoring reports by E2W (2004 - 2016), Eco-engineers Pty Ltd and Forbes Rigby Pty Ltd (pre 2004).

This monitoring report for the MWDD is based on quarterly monitoring results (9 November 2016, 20 February 2017, 19 May 2017, and 17 August 2017) and NSW EPA Environmental Protection Licence (EPL) conditions (R1.10). E2W completed the landfill closure plan (LCP in October 2005) and construction quality assurance (April 2008) for the landfill rehabilitation works completed by KMC in January 2008.

### 1.1 Background

KMC has owned and operated the MWDD from the 1960's until its closure in October 2006. The MWDD operated as a Solid Waste Class 1 Landfill under the EPL No. 5958. The MWDD formerly comprised a night soil depot for liquid pump out sullage, which ceased in 1998. The existing licence and amendments required the submission of a Landfill Closure Plan (LCP), which was completed by E2W in October 2005.

Since November 2012, Minnamurra Landfill has accepted mixed food and garden organics, together with small loads of recyclable materials. All general waste materials are diverted to the waste facility at Shellharbour (Dunmore Waste Disposal Depot).

### 1.2 Objectives

The objective of surface and groundwater monitoring in the 2015 to 2016 reporting period was to assess actual or potential impacts associated with the MWDD on the surrounding aquatic environment. Gas monitoring is undertaken by KMC to measure the performance of landfill rehabilitation works.

The objective of this annual report is to provide KMC and the NSW EPA with a summary of the monitoring results obtained in the 2016-2017 reporting period (i.e. EPL 5958 conditions).

## 2. SCOPE OF WORK

E2W was commissioned by KMC to collate and assess surface and groundwater monitoring data provided by ALS during 2016 and 2017. The annual reporting period covers four quarterly monitoring events in November 2016, February 2017, May 2017 and August 2017 (Figures 1 & 2).

Each monitoring event comprised the following:

- Sampling of onsite and offsite groundwater wells MD1B, MD1A, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, and MD10B<sup>1</sup>.
- Sampling of surface water at three locations along Rocklow Creek (Rocklow-Up, Rocklow-Middle and Rocklow-Down).

Landfill gas monitoring was conducted by KMC (G.Hardy) at gas monitoring wells, biofilter pads and inside buildings. Monitoring was conducted using a calibrated landfill gas meter (GT402).

E2W undertook the following scope of work to satisfy KMC's surface and groundwater monitoring program at MWDD:

- Provide advice to KMC (in relation to monitoring results- as required).
- Prepare this annual report for monitoring period (November 2016 to August 2017) and comply with Section R1.10 of the EPL (No. 5958). The annual report is to include the following:
  1. Tabulation of the monitoring data obtained for the period.
  2. Graphical representation of the current and previous monitoring data (minimum - last three years). Statistically significant variations or anomalies will be highlighted.
  3. Analyses and interpretation of monitoring data.
  4. Analyses and response to any complaints received.
  5. Identification of any deficiencies in the environmental performance of the MWDD, as highlighted by the monitoring data, trends and/or accidents.
  6. Recommendations to address the above identified deficiencies.
  7. Recommendations on improving the overall environmental performance of the facility.

Rehabilitation of the landfill commenced in August 2006 and was completed by KMC in January 2008. The work included reshaping, cut/fill of waste materials and capping with clays and soil/compost mix (i.e. evapotranspiration layer). The rehabilitation works may have temporarily degraded the runoff and shallow groundwater (2007) due to exposure and leaching of buried putrescible waste which was redistributed during the reshaping. In early to mid 2016, E2W and Council commenced testing of new extraction bores near MD-9C to assess yields, water quality and the potential for reducing the leachate impact (i.e. ammonia >100 mg/L) by irrigation on the mound. Groundwater remedial works are progressing and include the installation of three extraction bores and five monitoring wells in proximity to the MD-9C. Groundwater pumps and infrastructure are currently being sourced from an interstate company.

### **3. ENVIRONMENTAL SETTING**

The Minnamurra Waste Disposal and Recycling Depot (MWDD) is located 1 km north of the Minnamurra town ship (Figures 1 and 2). The site is located within a swamp environment, bounded to the west by the rail line and Riverside Drive (formerly a part of the Princes Highway), and to the north and east by the confluence of Rocklow Creek and Minnamurra River. The site is approximately 1 km west of Mystics (Minnamurra) Beach (Figure 1).

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<sup>1</sup> The shallow well was consistently dry MD4A. The well (MD1A) was dry, and MD1B was sampled twice.

The MWDD covers an area of approximately 50 acres (~20 ha), while the landfill mound occupies approximately 6 ha. At present, the MWDD comprises the following features:

- An elevated landfill mound (capped) ranging from 1 to 14 m AHD. The landfill mound was rehabilitated in 2006/2007 according to the LCP submitted by E2W in October 2005,
- A weighbridge and administration office/toilet block,
- KMC truck parking area,
- KMC storage sheds,
- Dog impounding facility,
- Green waste/composting,
- Waste/recycling receival & transfer station.

### **3.1 Climate**

The long-term mean and median rainfall values available for the Kiama Bowling Club (Latitude 344033 N and Longitude 1055103E) between 1897 and 2001 indicate that average yearly rainfall at the MWDD is 1261 mm/year. On average, the MWDD would receive approximately 1220 mm, based on rainfall records obtained from Shellharbour and Albion Park (Forbes Rigby, 1996).

The annual rainfall from August 2016 to July 2017 was 923 mm which is less than previous years (August 2015 to July 2016 was 1260 mm, August 2014 to July 2015 was 1269<sup>2</sup> mm).

The annual rainfall in previous years are as follows; August 2013 to July 2014 = 873.0 mm<sup>3</sup>, 1201.8 mm =August 2012 to July 2013, 1282.8 mm =August 2011 to July 2012, 1308 mm =August 2010 to July 2011, 1054.4 mm =August 2009 to July 2010.

Periods of high monthly rainfall occurred in March 2016 (309.6 mm) and are reflected in higher water levels in the following months (note: the pattern with ammonia trends is not clear or consistent).

### **3.2 Topography**

A plan of the existing site topography and surrounds is presented in Figure 1. The site is located within mangrove tidal flats, an estuarine environment associated with Rocklow Creek and Minnamurra River (Figure 7 of Appendix B).

Local relief is less than 3 m AHD around the footprint of the landfill (except southern wall), with slopes generally less than 5%. The landfill forms a mound, which reaches a maximum of 14 m AHD above the surrounding low-lying ground surface (approximately 1 m AHD).

The RL of the landfill footprint area ranges from approximately 0.6 m AHD (north-east corner) to 5.2 m AHD (southern wall). On the western side of Riverside Drive the land rises rapidly to a small east and north-east facing ridge where Dunmore House is situated (Figures 1 and 2).

<sup>2</sup> Bombo Headland

<sup>3</sup> Note: data from Kiama (Bombo Headland) (Station ID 068242), ~4.5 km SSE of MWDD.

### 3.3 Geology

The site is located within Quaternary alluvial sediments comprising sands and silts. Based on drilling investigations undertaken by Forbes Rigby in 1996 and recent investigations at the site by KMC and E2W in 2005, the geology is dominated by fine to medium sandy sediments with minimal sandy silt and sandy clays. In most places, the sand is overlain by a 0.5 m thick organic silty loam.

Drill cores by the Geological Survey of NSW in the Rocklow Creek valley predominantly consist of poorly to well-sorted very fine to medium-grained quartz lithic sands. Sand deposits typically extend to a maximum depth of 14 m, with increasing clay content below about 7 m (Forbes Rigby, 1996).

### 3.4 Hydrogeology and Groundwater Flow Regime

The hydrogeology at the site is dominated by a semi-confined sandy aquifer. Groundwater is encountered at depths of approx 1 m below natural ground level (~0.5 m AHD) along the west, north and east sides of the landfill mound. The depth to water along the southern wall is not well known.

The groundwater quality at the site varies from fresh to saline, with electrical conductivity ranging from 0.85 to 44.6 mS/cm (E2W, October 2005). Groundwater generally becomes more saline in the vicinity of mangroves and tidal saline water bodies (i.e. Rocklow Creek and Minnamurra River).

Recharge to the aquifer system beneath and surrounding the waste disposal facility occurs from rainfall infiltration mainly outside of the capped landfill mound. Infiltration of rainfall is moderate (~30%) around the footprint area, due to the low elevation and leakage through the organic silt layer.

Groundwater gradients in the area of the waste mound are controlled by topography, permeable sands and the nearby tidal water bodies (Rocklow Creek and Minnamurra River). The predominant groundwater flow direction at the site is considered to be north-east and towards the confluence of Rocklow Creek and Minnamurra River. The hydraulic gradient is likely to be variable, depending on the tidal regime and proximity to the river. It is interpreted that the groundwater gradient is at a maximum during low tide and potentially reverses at high tide or high rainfall.

Groundwater discharge at Rocklow Creek and Minnamurra River is influenced by the presence of a fresh groundwater/salt water interface. The interface results from the density difference between groundwater and seawater. It is a dynamic and complex region with upward hydraulic gradients, tidal fluctuations, diverse microbiological processes, surface and groundwater interaction and salinity variations. The groundwater/salt water interface is generally associated with natural attenuation processes (biodegradation, dilution, sorption etc.), which tend to reduce levels of contaminants prior to discharge to marine ecosystems. The groundwater salt water interface is interpreted to exist at the boundary of the casuarinas and mangroves at the site.

The contamination of deep and shallow groundwater arises from nutrient enrichment at the MWDD and has been reported on in previous annual monitoring reports by Ecoengineers Pty Ltd (2004) and E2W (2005, 2006 and 2007).

The leachate plume originating from the MWDD is likely to persist for many years after landfill remediation due to the age (1960s) of the waste mound. Improvements in groundwater quality is expected over the short to medium term (up to ~10 years) reflecting the rate of natural attenuation and groundwater flushing effects from rainfall recharge.

### 3.5 Hydrology

The hydrology of the area is dominated by Rocklow Creek and Minnamurra River. Groundwater discharge, with possible leachate from both the Minnamurra and Shellharbour landfills, may be contributing to the nutrients detected in Rocklow Creek (Figure 1).

The Minnamurra River drains a catchment of approximately 142 km<sup>2</sup>. Seventy percent of the catchment is natural, mainly located on the steeper slopes of the Illawarra escarpment. The middle section of the catchment is characterised by a broad floodplain area called Terragong Swamp. This area, which comprises approximately 30% of the catchment, is used extensively for cattle grazing/dairying. The township of Jamberoo is located within this catchment. It can be expected that the Terragong Swamp farming area and Jamberoo itself are significant sources of nutrients and pollutants entering the river.

The entrance of Minnamurra River is permanently open, and the estuary is tidally influenced. The estuarine portion of the river extends approximately 7 km upstream from the mouth and has the suburb of Minnamurra on its western bank. The lower section of the river is an ecologically significant aquatic environment, comprising areas of seagrass, mangrove and salt marsh communities (Forbes Rigby, 1996).

Rocklow Creek catchment has an area of 23 km<sup>2</sup> and occupies the northern most portion of the Minnamurra River catchment. Rocklow Creek flows into the main arm of the Minnamurra River downstream of the MWDD, approximately 2 km upstream of the river entrance. Potential up-gradient sources of contamination may include the Shellharbour landfill, Princes Highway, Riverside Drive and nearby sand mining operations.

Water samples from Rocklow Creek and Minnamurra River have been collected by the DECCW/NSWEPA in 1991 and 2005 (Denis Pascall, August 2005), as part of a water quality and landfill impact assessment for the area (Forbes Rigby, 1996).

The following opinions were offered as a result of DECCW's sampling work:

- Concentrations of most indicators (except dissolved oxygen) are considerably higher in Rocklow Creek than in Minnamurra River; and
- Concentration of nutrients (ammonia) measured at several locations along Rocklow Creek indicate that Shellharbour and Minnamurra landfills may be contributing leachate into the aquatic ecosystem.

One upstream and one downstream Rocklow Creek location are sampled as part of the quarterly MWDD water quality monitoring program. Since 2009, a third location midstream of the creek has also been sampled. Access to the downstream location has been restricted due to mangrove growth along the track (no sample for past three years). Sampling is undertaken by ALS (formerly Ecowise- the sample location was re-established in 2014 once access was available through the mangroves).

## 4. LICENCE CRITERIA AND RELEVANT GUIDELINES

Under the NSW EPA requirements for Licence No. 5958, the criteria for surface and groundwater quality are based on the ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

The ANZECC guidelines include risk-based trigger levels and indicative interim working levels (IIWLs). The IIWLs are used when insufficient data is available to calculate a trigger level and are of low reliability. It should be noted that the ANZECC water quality guidelines are applicable to receiving water and not groundwater. However, they form an appropriate basis for undertaking a screening level assessment of groundwater quality. Selection of the applicable guideline values are based on an assessment of potential pathways by which human or environmental exposure might take place, as well as the beneficial end use of the groundwater.

The beneficial use classification for groundwater at the site depends on the quality of the water and its potential use in the long term. Although groundwater in the shallow aquifer surrounding (upgradient) the waste disposal facility is likely to be of relatively good quality (depending on the presence of saline intrusions), there are no known groundwater extraction bores (agricultural or domestic) within the immediate vicinity of the site. Therefore, the appropriate beneficial use category of the groundwater is considered to be for the protection of aquatic marine and fresh water ecosystems in discharge zones at Rocklow Creek and Minnamurra River, the closest aquatic environmental receptors for the site.

The adopted groundwater assessment guidelines are presented with the summary analytical results (i.e. Tables GW-1, SW-1). Exceedances of the ANZECC (2000) trigger values for marine water ecosystems have been highlighted on the tables.

### 4.1 EPL Requirements

The Environmental Protection Licence (EPL No. 5958) details 17 monitoring points for the MWDD (two for landfill gas and fifteen for groundwater monitoring). The landfill gas monitoring points are required to be analysed for methane every 6 months (i.e. twice in the reporting period). Landfill gas monitoring was conducted on a quarterly basis by KMC (Appendix C) at gas wells and trenches, however annually for inside buildings.

The frequency of testing of the groundwater monitoring points (MD1A, MD1B, MD2A, MD2B, MD2C, MD4A, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) is also half yearly (EPL requirement). However, KMC conducts the groundwater monitoring on a quarterly basis (November 2016, February 2017, May 2017 and August 2017 of each reporting period) to establish water quality trends post landfill rehabilitation works.

Some of the groundwater monitoring locations (i.e. MD4A, and previously MD2A, MD6A, MD9A, MD10A) are sampled on some occasions (i.e. shallow wells are commonly dry or do not have enough water for sampling). Other available wells onsite including MD3B, MD3C, MD7, MD5A/B/C and MD8 however are not part of the EPL (previously tested prior to landfill closure for characterising the local groundwater).

Table 4.1 (below) lists the analytes that are included in the groundwater testing suite.

**Table 4.1: Half yearly groundwater analytical suite (as per the EPL)**

Alkalinity (as CaCO <sub>3</sub> )	Dissolved Oxygen	Nitrate	Temperature
Ammonia	Fluoride	Potassium	Total Phenolics
Calcium	Iron	Sodium	Total Organic Carbon
Chloride	Magnesium	Standing Water Level	pH
Conductivity	Manganese	Sulphate	

Surface water monitoring is not a requirement of the EPL, however is also undertaken quarterly by KMC in conjunction with groundwater monitoring. Surface water samples are collected and analysed from an up-stream (Rocklow-Up) and mid-gradient (Rocklow-Middle) locations. An alternative sample location was established in May and August 2015 for the down-gradient location (Rocklow-Down, Figure 2).

The mid sample location was included to assess the performance of the landfill rehabilitation works and requirement for a bund wall around the landfill (i.e. access to the downstream location was impeded due to the thick vegetation and relocated in May 2015).

## 4.2 Previous Monitoring Results

The previous annual monitoring reports have been provided by E2W, Ecoengineers and Forbes Rigby. Groundwater ammonia results presented in these earlier reports are included in graphical form and attached in this report (Graphs 1, 2 & 3).

Ammonia is a key landfill leachate indicator based on the results obtained from monitoring wells placed around the MWDD. Landfill leachate has impacted the local groundwater system, with potential or actual impact to Rocklow Creek and Minnamurra River (Appendix B, Figure 7).

## 5. ENVIRONMENTAL MONITORING

Prior to May 2005, surface and groundwater monitoring was undertaken by KMC. Ecowise were (since August 2005) engaged to sample and analyse the surface and groundwater monitoring points as per the EPL and performed the November 2009 sampling round. Ecowise were acquired by ALS in November 2009, who carried out the subsequent surface and groundwater sampling in the reporting period (2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2016-2017). Quarterly sampling in the 2015 to 2016 reporting period was undertaken on the following dates:

- 9 November 2016,
- 20 February 2017,
- 19 May 2017; and
- 17 August 2017.

The procedure for sample collection, storage and handling employed by KMC and Ecowise/ALS are generally in accordance with NEPM (2013) and ANZECC (2000).

The following subsections outline the nature of the site's monitoring and analytical program, as well as conditions at the time of sample collection (from information provided by KMC).

## 5.1 Landfill Gas Monitoring

The landfill gas testing locations (areas where intermediate or final cover has been placed and inside all buildings within 250 m of the deposited waste) were tested by KMC (24 January 2016, 15 June 2017, and 6 October 2017) during the 2016/17 reporting period (Appendix C).

Six onsite landfill gas wells (Gas 1 to Gas 6) were installed by E2W on 2 August 2006 and gas monitoring has been performed since then as part of the landfill rehabilitation work. Landfill gas monitoring is a requirement of the EPL, but only relates to onsite buildings/sheds and the waste mound (over the capped area).

Two gas monitoring wells (i.e. Gas 5 and Gas 6) have not been monitored since November 2009 as they are located at the same location as Trench 1 (i.e. alternative gas test location, Refer to Figure 1 in Appendix C). The gas well (Gas-2) was removed end of 2014 due to construction of the CRC shed.

Monitoring data (2016/2017) from the trenches (biofilter pads, Trench 1 to Trench 7) and gas monitoring wells (Gas 1, Gas 3 & Gas 4) showed similar concentrations to previous years (i.e. 2010/2011/2012/2013/2014/2015/2016). Methane gas readings were consistent at each sampling event through the monitoring period. The maximum methane (stable) gas reading was 100 ppm at several Trenches (1,3,5,7) in 2017. The lowest readings were 90 ppm at trench7 in January 2017. Gas well locations (Gas; 1, 2, 3) reported non detectable concentrations during 2017.

Buildings were sampled for landfill gas in 2017, with all locations recording no methane gas readings (non-detectable and compliant with EPL conditions).

E2W interpret that landfill gas is unlikely to be present in the buildings due to the previous results, landfill capping, and type of onsite buildings (i.e. well vented or air conditioned office).

## 5.2 Surface and Groundwater Monitoring Locations

Groundwater monitoring was undertaken from up to 16 existing groundwater wells (shallow, intermediate and deep) located on the landfill mound perimeter and surface water monitoring at two locations along Rocklow Creek (up, middle and down-gradient of the landfill mound, whilst access was re-established at Rocklow-down in May 2015). Monitoring locations are shown on Figure 2.

The wells and surface water locations sampled in the 2015 and 2016 reporting period are outlined below:

- 9 November 2016. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle (no access to Rocklow-dn);
- 20 February 2017. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down.

- 19 May 2017. Groundwater wells: MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down;
- 17 August 2017. Groundwater wells: MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, & Rocklow-Down.

Out of the 16 wells that were “not” tested in the 2016 and 2016 reporting period, but are part of the EPL include:

- MD1A. Dry in all 4 rounds
- MD1B. Dry in 2 rounds
- MD4A. Dry/damaged well in all 4 rounds

*Shallow wells tend to be dry. One well has been damaged and requires repair (i.e. MD4A).*

The nature of saline water stratification within the local groundwater system and well network is presented in Table 5.2.1 (below) and Appendix B (Figure 7).

**Table 5.2.1: Summary of Groundwater Salinity Changes with Depth**

Well ID	Salinity (EC, $\mu\text{S}/\text{cm}$ )	Comment
MD1B	850	Fresh- water 10 m away is saline
MD2A	25,200	surface water from high tide
MD2B	29,100	saline groundwater
MD2C	44,600	saline groundwater
MD4A	NA	Damaged well (shallow/dry)
MD4B	15,300	saline groundwater
MD4C	33,100	saline groundwater
MD6A	11,100	surface water from high tide
MD6B	2,221	fresh - brackish groundwater
MD6C	27,400	saline groundwater
MD9A	3,375	fresh - brackish groundwater
MD9B	3,207	fresh - brackish groundwater
MD9C	3,600	fresh - brackish groundwater
MD10A	40,900	saline groundwater
MD10B	2,797	fresh - brackish groundwater

*Note: Electrical Conductivity data is from sampling by E2W on 29 June 2005.*

*Well suffix ‘A’ and ‘B’ = shallow well screen (less than 3 m into water table).*

*Well suffix ‘C’ = well screen greater than 3 m below water table (refer to Figure 7 in Appendix B).*

Several of the groundwater wells (MD4A/B/C, MD6A/B/C etc.) comprise nested wells, which target various depths within the coastal sand aquifer. The sampling frequency and depth of the groundwater samples are presented in Table 5.2.2 (below).

**Table 5.2.2: Monitoring Summary for the 2016 to 2017 Reporting Period**

<b>Sample ID</b>	<b>Screen Interval (m AHD) - or Sample Location</b>	<b>Nov 2016</b>	<b>Feb 2017</b>	<b>May 2017</b>	<b>Aug 2017</b>
(MD1A)	0.5 to -0.5	No Access/dry	No Access/dry	No Access/dry	No Access/dry
MD1B	-4.7 to -5.7	X	X	No Access/dry	No Access/dry
MD2A	0.525 to -0.475	X	X	X	X
MD2B	-2.93 to -3.93	X	X	X	X
MD2C	-5.2 to -6.2	X	X	X	X
(MD3B)	-3.22 to -4.22*				
(MD3C)	-5.55 to -6.55*				
MD4A	1.2 to 0.2	Dry	Dry	Dry	Dry
MD4B	-3.22 to -4.22	X	X	X	X
MD4C	-5.55 to -6.55	X	X	X	X
MD6A	0.71 to -0.30	X	X	X	X
MD6B	-1.05 to -2.05	X	X	X	X
MD6C	-8.8 to -9.8	X	X	X	X
(MD7)	0.5 to -0.5 *				
(MD8)	0.5 to -0.5*				
MD9A	0.58 to -0.42	X	Dry	X	Dry
MD9B	-2.3 to -3.3	X	X	X	X
MD9C	-4.75 to -5.75	X	X	X	X
MD10A	0.68 to -0.32	X	X	X	X
MD10B	-2.85 to -3.85	X	X	X	X
Rocklow-Up	Upstream of landfill	X	X	X	X
Rocklow-Middle	Midstream of landfill	X	X	X	X
Rocklow-Down	Downstream and opposite landfill	No Access	X (new location)	X (new location)	X (new location)

Note: \*= to be confirmed (logs not available). X = Sample collected.

(MD7), well in brackets = well is not an EPL requirement. Blank space = not sampled.

# = Not enough water for sampling

The groundwater monitoring wells and sampling depths for each event are summarised in Table 5.2 (above) and Table 5.3 (rear of report). The sampling labels for the nested wells ('A' to 'C') are attached to each of the depths associated with these wells (e.g. MD1A, MD1B, MD1C).

## 6. MONITORING RESULTS

All surface and groundwater analytical results for the 2016/17 reporting period are presented in Tables GW-1, and SW-1, SW-2, and SW-3. The ALS field records and laboratory reports are presented in Appendix A.

A summary of all groundwater monitoring data (1999 to 2017) for ammonia (mg/L) is presented in Graph-1, Graph-2 and Graph-3. The graphs highlight ammonia groundwater quality trends over the past ~ 17 years (January 1999 to August 2017). Ammonia is considered to be a key landfill leachate indicator for the site.

A summary of previous ammonia surface water results for Rocklow Creek is presented in Table SW-2. Ammonia is considered as the key landfill leachate indicator in surface water, however other sources of ammonia exist in the same catchment (i.e. fertiliser use in paddocks and Dunmore landfill on the opposite side of Rocklow Creek).

## 6.1 Groundwater Data

Groundwater for the 2016/17 reporting period was collected from a network of seventeen monitoring wells (mostly downgradient locations) at the MWDD (Figure 2). The results of the groundwater testing are summarised in Table GW-1, Graphs-1 to 3, Figure 2 and in the following subsections.

### 6.1.1 Groundwater Depth

The depth to groundwater was measured prior to each sampling event using a water level probe. Depth to the groundwater below top of casing and relative to a common reference (i.e. Australian Height Datum, m AHD) is presented in Table GW-1. The inferred radial groundwater flow direction for the site is presented in Figure 2. Given the proximity to Rocklow Creek, the groundwater flow direction and gradients would be influenced by tides.

The groundwater levels recorded from the 2016/17 reporting period are similar to previous years and reflect changes in rainfall and tide levels.

The reduced groundwater levels (m AHD) from the 16 wells sampled in 2016/17<sup>4</sup> indicate a relatively low water table elevation (<1 m AHD), which is characteristic of the swamp/estuarine environment. The annual rainfall from August 2016 to July 2017 was 923 mm (Bombo Headland), which is similar to the previous year.

Recharge to the aquifer system beneath and surrounding the waste disposal facility mainly occurs from rainfall infiltration and storm water runoff around the footprint. Minor recharge may occur through the landfill mound (e.g. <5% of annual rainfall). The infiltration of rainfall is interpreted to be moderate/high around the footprint area (uncapped areas) due to the sandy soils, low elevation and run-off.

### 6.1.2 Field Parameters

The field parameters measured during groundwater sampling are indicative only, due to the low purge volumes (ALS sampling) and dominant reduced/anaerobic condition of the groundwater (Table GW-1).

Insitu measurements (within borehole) are likely to provide a more accurate rendition of the field chemistry, especially with respect to dissolved oxygen (parameters are not considered critical for the quarterly monitoring).

<sup>4</sup> Note: MD2A, MD4A, MD10A, MD10B have no RL measurement.

### **6.1.2.1 Field pH**

The pH from the 15 wells (MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) ranged from pH 6.5 to 7.8 in the 2016-17 reporting period, indicating relatively neutral groundwater.

Fluctuation (minor) in pH is likely to relate to a combination of factors including leachate quality, acid sulphate soils, tidal influences (together with a rise in electrical conductivity) and surface water quality.

E2W considers that field pH measurements may be more reliable than laboratory, as the pH of waters can change once out of equilibrium with the natural environment and stored within containers (holding time for pH is less than 4 hrs).

### **6.1.2.2 Electrical Conductivity (EC)**

The EC in groundwater collected from the site vary and range from approximately 546 to 58,300 uS/cm in the 2016/17 reporting period. The salinity reflects the transgression/regression of fresh and marine groundwater and presence of saline groundwater at depth (Figure 2 & Appendix B).

The distribution of EC indicates fresh water is located under the landfill mound and close to the landfill footprint, with sharp salinity increases near Rocklow Creek and Minnamurra River (Figure 7, Appendix B). The saline water correlated with the fresh/salt water interface and presence of mangroves/sedges (tidal area).

### **6.1.2.3 Dissolved Oxygen (DO)**

The 15 wells recorded field dissolved oxygen (DO) concentrations ranging between 0.15 to 6.59 mg/L in the 2016/17 reporting period. The concentrations of dissolved oxygen were similar to those reported in previous annual monitoring reports.

It is likely the concentrations of DO would be lower if measured insitu, as opposed to during the purging and sampling process. Wells with low purge volumes (& sampling via a bailer) are unlikely to provide representative groundwater DO concentrations.

Landfill leachate and the organic rich sediments (estuary) are likely to deplete DO in the groundwater (e.g. MD9C). This phenomenon is seen on many landfill sites, where organic carbon and nutrients provide surplus electron acceptors, which react with and consume the available DO in groundwater.

## **6.1.3 Nutrients (groundwater)**

### **6.1.3.1 Nitrogen-based compounds**

Groundwater collected from the MWDD monitoring wells were analysed for ammonia and nitrate in the 2016/17 reporting period (note: Total nitrogen is not an EPL requirement).

Four (MD1B, MD2A, MD2C, MD6A) out of the 15 wells reported one or more samples with nitrate concentrations above the ANZECC (2000) trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level). In 2016/2017 concentrations ranged from <0.01 (non-detected/below LOR) to 6.09 mg/L, which is lower than previous years.

Nitrate has been detected in fewer wells in the 2016/2017 monitoring round (nine wells above ANZECC 2000) in comparison to the 2012/2013 monitoring round (eight wells above ANZECC 2000). The majority of nitrate concentrations in groundwater in 2016/2017 are generally very low (except 4 wells, below ANZECC 2000) relative to the ammonia concentrations.

Nitrogen species in the groundwater is predominantly ammonia, and indicative of a reducing groundwater environment. Thus, potential impact to the aquatic environment is interpreted to arise from ammonia, and to a lesser extent, the oxidised nitrogen form (nitrate).

The guidelines (ammonia) for the protection of freshwater and marine ecosystems vary according to pH and temperature. Given the range of pH and temperature measured across the site and in Rocklow Creek, the guideline values have been calculated as 1.88 and 2.84 mg/L for fresh and marine waters, respectively (at pH of 7.3).

Fourteen (14) out of 15 wells (excluding MD4C) reported ammonia concentrations in excess of the ANZECC (2000) trigger value for marine ecosystems (2.84 mg/L, based on a pH of 7.3) in the 4 rounds of sampling.

Groundwater from the wells MD1B, MD2A, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C and MD10B, located on the north and eastern landfill perimeters (plume centreline path) reported the highest concentrations of ammonia (Figure 2).

The Well (MD9C) reported the maximum ammonia of 162 mg/L in February 2017. The results are similar to May 2016 (160 mg/L) and November 2014 (170 mg/L). The recent monitoring results are higher than the ammonia (maximum of 122 mg/L) in 2012/13. Ammonia trends are presented in the time series Graphs 1 to 3.

Highest ammonia concentrations correlate with the main downgradient area (plume centreline) of the waste mound and above average rainfall events. The ammonia concentrations from 2015 to 2017 are variable and elevated reflecting leachate spikes which are interpreted to reflect the heavy rainfall events in late summer/autumn (e.g. March 2017 @309 mm).

It is noted that rehabilitation works were completed in early 2008, and the 2008/09 and 2009/10 ammonia concentrations have generally decreased since then at most well locations. Well locations MD2B, MD2C and MD9B have decreased in maximum ammonia concentrations in 2012/13 in comparison to the previous 2011/12 period. Well (MD10B) has a variable to rising trend, however has significantly decreased in the past two monitoring events (Note: further monitoring is required to verify the 2016 change to a possible declining ammonia trend).

#### **6.1.4 Ammonia Trends**

The groundwater ammonia trends from 1999 to 2017 are presented in Graphs-1, Graph-2 and Graph-3. The data indicates ammonia in most monitoring wells exceed the ANZECC (2000) marine water trigger value. A summary the ammonia trends are presented in Table 6.1.4.

**Table 6.1.4 Summary of Ammonia Trends in Groundwater (1999 to 2017)**

South-east of Landfill (Across-gradient)		North of Landfill (Down-gradient, plume centreline)	
Well ID	Trend	Well ID	Trend
MD1B	Overall Decreasing, but variable	MD4B	Variable with possible <b>rising</b> trend
MD2B	Overall Decreasing, but variable	MD4C	Overall Decreasing
MD2C	Overall Decreasing, but variable	MD9B	Variable and Overall Decreasing
MD6B	Decreasing but variable trend	MD9C	<b>Rising trend</b> & peaks in late 2011, late 2012, mid & late 2014. Elevated and ammonia spikes late 2015, 2016 to 2017
MD6C	Overall decreasing, & recently stable	MD10B	Variable trend- 2015 to 2017

Note: "B" and "C" denote shallow and deep wells, respectively.

The ammonia trends are generally variable over time; however most locations show a downward or stable trend. The ammonia from the quarterly monitoring events may reflect a combination of seasonal rainfall, plume movement, tidal fluctuations and landfill rehabilitation works.

Monitoring reports (e.g. E2W, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2013-2014, 2014-2015, 2016-2017) have identified spikes in ammonia concentrations that are interpreted to result from high rainfall in preceding months. For example, in February 2008, high rainfall (169.2 mm, 5 February) was followed by a rise in ammonia in early to mid 2008. In October 2009, 187.8 mm of rainfall, which was the highest monthly rainfall recorded for the 2009 calendar year (next highest December 2009, 106.2 mm). During the 2010-11 monitoring period, 22 March 2011 (163.8 mm rainfall) was followed by a rise in ammonia (May 2011, Graphs 1-3)<sup>5</sup>. Over the 2011/12 period, a combined 176.2mm rainfall from 20 to 23 July was followed by an increase in ammonia (November 2011, Graph 1-3). Rainfall of 289 mm in February and 213.2mm in March 2012 (502.2mm combined in 2 months) was followed by rises in ammonia (May 2012, Graph 1-3)<sup>7</sup>.

During the 2012/13 period, high rainfall was experienced in January 2013 (170.8 mm) and February 2013 (153.2 mm) resulting in elevated ammonia during the February monitoring. In addition, high rainfall in April 2013 (183.6 mm) was followed by a rise in ammonia in May 2013. This occurred again in the 2013/14 period with high rainfall in November 2013 followed by a rise in Ammonia in the November 2013 samples and high rainfall again in March and April 2014 followed by an increase in Ammonia in the May 2014 samples. The ammonia peak in November 2014 (170 mg/L) and November 2015 are interpreted to be associated with high recharge rainfall events. The reduced ammonia in August 2016 (107 mg/L) indicates a potential beginning from a decreasing trend even though high rainfall occurred in preceding months (June 2016 rainfall =328 mm).

Heavy rain occurred in February (158.8 mm) and March (309 mm) 2017, however rainfall during the 2016 -2017 (923 mm) monitoring period below the annual average.

<sup>5</sup> Rainfall data taken from the Kiama (Bombo Headland) Weather Station, (Station ID 068242)

Rainfall events before or on the dates of sampling may contribute to rising ammonia concentrations in the groundwater due to flushing effects (e.g. leachate migration/generation and/or rising water table).

During 2014 to 2017 ammonia concentrations are generally variable at MD9C (hotspot area). An increase in ammonia occurs in 2015 where concentrations exceed 100 mg/L and range between 100 and 170 mg/L. The elevated ammonia concentrations are reported at the north east corner of the landfill as measured by wells at MD10B/MD9C.

Review of aerial photographs taken of the landfill in late 2007 shows that the NE corner (where most of the wells are situated) was the last to be reshaped, capped and vegetated (& increase the potential for leachate generation and migration, as would have disturbance of soil and waste in that area). Continued monitoring of ammonia concentrations and climate is required to establish seasonal trends.

The amount of landfill leachate generated would decline following the closure of the landfill and completion of rehabilitation works. The groundwater quality is likely to take years (5+) to show improvements due to the scale of the mound, flat hydraulic gradients (in estuary) and tidal movements (some reversal of gradient at high tide) around the landfill footprint.

Groundwater remedial works are recommended at the site to reduce risk to aquatic ecosystems and improve the groundwater quality, especially at the plume centreline (MD9C).

Results from 2012 to 2017 monitoring periods show cyclical seasonal trends (i.e. a variable, but generally decreasing ammonia trend). Future monitoring is required to assess ammonia trends and characteristics (nature of trends and variations), especially at MD9C, MD10B, and MD4B well locations, representing the centreline and core of leachate plume.

#### **6.1.4.1 Total Phosphorus (TP, groundwater)**

The total phosphorus (TP) is not an EPL requirement, and was not sampled during the 2016-2017 monitoring period. In the 2007/08 monitoring period the majority of TP results from twelve wells exceeded the ANZECC (2000) trigger values for the protection of marine ecosystems.

#### **6.1.5 Hydrochemical Indicators**

Concentrations of major ions (chloride, sulphate, calcium, magnesium, sodium and potassium) in the groundwater at the site are presented in Table GW-1. The concentrations of major ions in all monitoring wells are within previously reported ranges and generally dominated by one cation (sodium) and anion (chloride). In wells with freshwater, (MD6B and MD10B) calcium concentrations are similar to, and sometimes greater than sodium concentrations.

The landfill leachate may be contributing concentrations of ions including calcium, potassium and magnesium. Contribution of sodium and chloride is difficult to ascertain as these ions are typically associated with marine environments (e.g. salt spray, tidal influence).

### **6.1.6 Inorganic Contaminants (Iron, Manganese and Fluoride)**

Dissolved iron (filtered at the laboratory) ranges from the 0.05 mg/L to 19.7 mg/L. With the exception of MD6B, MD1B all the groundwater wells reported ANZECC (2000) exceedances (freshwater ecosystems, 0.3 mg/L) in at least one of the four sampling rounds.

It is noted that the ANZECC (2000) guideline for iron is an indicative interim working level (IIWL) and is of low reliability. No guideline is available for iron in marine water, which has a higher relevance to Rocklow Creek and receiving water bodies.

Concentrations of manganese ranged from 0.019 mg/L to 0.598 mg/L. The ANZECC (2000) guideline for manganese in fresh water is 1.9 mg/L. All results were reported below the ANZECC fresh water guidelines.

The levels of filterable iron and manganese are similar to those reported in previous reporting periods.

Concentrations of fluoride ranged from 0.1 mg/L to 1.0 mg/L. No recommended reliable ANZECC (2000) guidelines exist for fluoride in fresh or marine waters. The data ranges between the minimum and maximum values are similar to previous levels. The results indicate that fluoride levels are generally associated with landfill leachate.

### **6.1.7 Organic Contaminants (DOC, TOC and Phenols- Groundwater)**

Concentrations of total organic carbon (TOC) ranged from 7 to 594 mg/L in the 2016/17 reporting period. ANZECC (2000) guidelines do not exist for TOC. The TOC may relate to landfill leachate and/or naturally occurring organic matter/content associated with lowland/estuary.

Concentrations of phenols were below LOR (0.05 mg/L) to 0.35 mg/L (MD9A in November 2016). The single result from MD9A (0.35 mg/L) was below the marine water trigger value (ANZECC 2000, 0.4 mg/L), all other result were reported below the guidelines. Phenols have been previously detected at MD9A in February 2016 (0.6 mg/L) and August 2016 (0.33 mg/L).

The November 2016 (0.35 mg/L) results from MD9A indicate phenol concentrations are likely to relate to the landfill leachate. Speciation of phenols is recommended to assess the risks to aquatic ecosystems.

## **6.2 Surface Water**

Surface water sampling was undertaken quarterly during the 2016/17 reporting period (EPL requirement is only six-monthly sampling). Samples were collected from three locations along the estuarine reach of Rocklow Creek on November 2014, whilst three locations (excluding Rocklow down in November 2016) were tested on November 2016, and February 2017, May 2017 and August 2017 (Figure 2).

The three surface water locations provide a general indication of water quality impacts from the MWDD (Figure 2). Impacts to the water quality in Rocklow Creek may also occur from

the neighbouring Shellharbour Waste Disposal Depot situated on the northern side of Rocklow Creek.

The three surface water locations are not sampled according to consistent tide (a low tide with outflow). Rocklow Creek represents a mix of tidal water and groundwater baseflow discharges. Therefore, variations in water quality can occur due to tide dilution.

The surface water monitoring data is variable and possibly reflecting a combination of tide sampling regimes and influence from the broader catchment area. Timing of the samples should be coordinated with the tide so that creek samples are collected during a run-out tide when the maximum amount of groundwater discharges into the creek.

## **6.2.1 Physical Parameters**

### **6.2.1.1 pH**

The pH in Rocklow Creek at the middle and upstream location is generally neutral (6.9 to 7.8) in 2016/17, and has not changed significantly from previous reporting periods.

### **6.2.1.2 TDS (and EC)**

The conductivity (EC, mS/cm) of waters at the upstream location are generally lower than those recorded downstream (Rocklow-Middle), reflecting the tidal range and groundwater discharge from the catchment area.

Water collected from Rocklow Creek is fresh to brackish (1.79 to 0.30 mS/cm). Sampling at low tide would result in decreased salinity due to an increased baseflow (fresh groundwater) contribution.

### **6.2.1.3 Dissolved Oxygen (DO)**

The DO of waters ranged from 4.57 to 10.30 mg/L. Higher Do values are associated with up stream section of Rocklow Creek.

## **6.2.2 Nutrients (surface water)**

### **6.2.2.1 Nitrogen**

Rocklow Creek surface water samples collected in the 2016/17 reporting period reported ammonia below the ANZECC (2000) guidelines for marine and fresh water ecosystems (2.84 and 1.88 mg/L, respectively, Tables SW-1 and SW-2).

Nitrate was not analysed during the 2016-2017 reporting period for the creek samples.

Water samples collected from Rocklow Creek during 2016/17 reporting period generally show variable concentrations of ammonia an upstream to downstream locations. The greatest increase in ammonia from upstream to downstream location occurs on 17 August 2017 (0.05 mg/L to 1.59 mg/L). The ammonia increments between the upper, mid and down stream samples are presented in Table SW-2 and Graph-4 (note: mid-stream location is downgradient to MD-9C, MD4B and MD-10B which have elevated and irregular ammonia trends).

Ammonia concentrations in Rocklow Creek (2016/17) are generally comparable to previous results (2014/2015, 2013/2014, 2012/13 and 2011/12, Table SW-2). However, the ammonia increments, and seasonal variability in the Rocklow-Mid and Rocklow-Low is evident from 2011 to 2017 (spiking of ammonia), which is interpreted to reflect tidal influences, climate and potentially the groundwater (MD9C) discharges.

Increases in ammonia from upstream to downstream of the landfill have been observed during previous monitoring periods (Graph-4). While these increases could be attributable to the discharge of groundwater impacted by ammonia from the MWDD, other sources of nitrogen input such as polluted runoff from the catchment (Shellharbour Landfill, agricultural areas) and nutrients bound in sediments is not discounted.

Graph-4 shows the ammonia increments in all monitoring periods since 1999 and illustrates a decreasing difference between upstream and downstream ammonia concentrations. Ammonia concentrations at Rocklow-Up have remained relatively stable over time while ammonia concentrations at Rocklow-Middle and Rocklow-Down show a variable trend.

The ammonia contribution from the MWDD into Rocklow Creek is complicated by the sampling regime (i.e. sampling at various tides level with dilution from tidal water) and other potential sources of nitrogen in the area (Dunmore Landfill and nutrients from upstream agricultural areas). Surface water results should be interpreted as indicative only due to the dynamic nature of the catchment and multiple nutrient sources.

#### **6.2.2.2 Total Phosphorous (surface water)**

Total phosphorus (TP) is not an EPL requirement and were not analysed during the 2016/17 monitoring period.

Monitoring from previous years indicate that TP concentrations decrease from up to downstream of the landfill (except in August 2008), implying there is nutrient contribution from other (agricultural) sources in the catchment area.

#### **6.2.3 Organic Contaminants (TOC/DOC, Phenols & Fluoride)**

Concentrations of total organic carbon (TOC) ranged from 6 to 594 mg/L in the 2016/17 reporting period. No recommended ANZECC (2000) guidelines exist for DOC (concentrations could be related to natural waters or leachate).

Concentrations of phenols were reported all below LOR (0.05 mg/L) in all other surface water samples in all monitoring rounds. Concentrations of fluoride ranged from 0.2 mg/L to 0.9 mg/L, with concentrations showing a general increase in the Rocklow-Mid & Rocklow-Low sampling locations relative to the upstream sample.

### **7. CHEMICALS OF CONCERN AND CONTAMINANT PLUMES**

The results of 2016/17 monitoring have been assessed to determine the surface and groundwater conditions with respect to the relevant guidelines which serve to protect aquatic ecosystems (both fresh and marine), as this is considered to be the dominant beneficial (environmental) use of local groundwater.

The primary landfill leachate indicator at the site is ammonia. Ammonia represents the analyte which exceeds ANZECC (2000) guidelines in the majority of monitoring wells. The landfill is also a source of dissolved salts, metals (i.e. iron, which was generally above interim guidelines) and potentially organics. The dissolved salts, metals and organics are associated with the dissolution of ions from various types of waste material.

Results of the sampling (1999 to 2017) confirm that ammonia concentrations are elevated above background levels. Improvement in groundwater quality (i.e. a decreasing ammonia trend) is evident in several wells (MD2B, MD2C, MD4C, MD6C) since landfill rehabilitation works commenced (2006).

High rainfall periods since landfill rehabilitation completion are interpreted to have resulted in periodic ammonia increases (e.g. February 2008, March 2011, July 2011, February/March 2012, January/February 2013, April 2013, November 2013, March-April & late 2014, August 2015, June 2016, March 2017). Some wells (MD-6B, MD-10B) show variable trends, whilst two wells show an increasing trend (MD-9C, MD-4B) in 2016/2017.

It is likely the leachate plume arising from the landfill mound would migrate radially (local system) with (regional) flow mainly directed towards the north-east and east (MD9 centreline). It is likely that landfill leachate infiltrates the underlying sandy aquifer and consequently migrates under the predominant groundwater flow regime towards Rocklow Creek and Minnamurra River.

The extent of natural attenuation and degradation of the nutrient plume prior to discharge is not well known, however the groundwater/saltwater interface and mangrove environment are likely to enhance attenuation of the ammonia plume (Appendix B, Figure 7).

## 7.1 Ecological Issues

Groundwater migrating from under the landfill mound to Rocklow Creek and Minnamurra River will be diluted by the dynamic and tidal nature of the environment. Contaminants contained within this discharge will be diluted and dispersed via biological, chemical and physical processes which occur at the groundwater/salt water interface. Uptake of the nutrients by plants (mangroves, sedges) dependent on groundwater will also occur at the creek and river.

The adverse effects arising from landfill leachate on the Rocklow Creek and Minnamurra River aquatic environments is unclear and difficult to ascertain, given the multiple sources of nutrients present and disturbance in the catchment area. No obvious evidence of degradation is evident in the water bodies or surrounding vegetation (Note; some trees were damaged/removed during landfill rehabilitation works in 2007/2008).

Discharges of landfill leachate to Rocklow Creek would be at a maximum when the tide is low and groundwater gradients are steeper. The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in the 2014/15, ~0.96 mg/L the 2015/16, and ~0 mg/L in the 2016/2017 (or 0.146 mg/L, excluding February 2017) reporting period (Table SW-2). This net increment in 2016-2017 is also dependant on tidal regime during sampling. The reduced net increment of ammonia may also reflect the below average climate (923 mm) during the 2016-2017 monitoring period.

The ammonia in groundwater (MD-9C, MD-10B, MD-4B) during 2016/17 may be contributing to the minor nutrient concentrations in the surface water (Rocklow-Middle & Down), however this is not confirmed due to the other potential sources (Dunmore landfill) and variables (climate, tide). Downstream ammonia concentrations have generally declined, but show significant variability since monitoring commenced in 1999 (Graph-4).

While it is likely that some nitrogen-impacted groundwater may discharge into Rocklow Creek and Minnamurra River, it is unclear as to the extent of attenuation of the nitrogen plume prior to discharge. Attenuation is likely to occur through a combination of dilution, through mixing of groundwater from north of the creek, by flows and tidal movements within the creek and estuary itself, oxidation of the ammonia to nitrate, and finally as conversion to nitrogen gas.

Since early 2016, Council and E2W have investigated groundwater near MD9C and installed test bores in order to evaluate groundwater remedial options. Leachate management is proposed to include extraction of groundwater at MD9C and irrigation of the landfill mound (work is in progress with Council, E2W, and the DPI, NSW EPA).

Ammonia and nitrate concentrations in all surface water samples collected in the 2016/17 reporting period were below ANZECC (2000) trigger values for fresh and marine water ecosystems.

## 8. CONCLUSIONS

Surface and groundwater monitoring was undertaken at the Minnamurra Waste Disposal Facility by ALS on a quarterly basis<sup>6</sup> from November 2016 to August 2017 (EPL reporting period). Monitoring data collected during the 2016/2017 period was assessed by E2W to determine the impact of the landfill facility on local groundwater and aquatic ecosystems.

Based on the environmental data reviewed and assessed, E2W offer the following conclusions:

- Elevated concentrations of nutrients, in particular ammonia, continue to be detected in groundwater at the former landfill site. Ammonia levels reported by the laboratory exceed the ANZECC (2000) guidelines for the protection of fresh and marine water ecosystems in 14 out of 15 monitoring wells sampled (i.e. MD-1A & MD-4A dry, MD10A ammonia below guidelines).
- The impacted wells are located on the footprint (downgradient) of the landfill mound, indicating contaminant migration towards Rocklow Creek and Minnamurra River (north-east and east).
- Elevated ammonia concentrations (above ANZECC 2000) were reported at several wells including; MD2B (8.59 mg/L), MD4B (42.4 mg/L), MD4C (3.55 mg/L), MD6B (36.6 mg/L), MD6C (44.2 mg/L), MD9B (40.2 mg/L), MD10B (73.7 mg/L) and the maximum at MD9C (162 mg/L). Elevated ammonia in the groundwater is located on the north and eastern landfill perimeters coinciding with the predominant groundwater flow direction.
- Nitrate concentrations in groundwater during the 2016/17 reporting period ranged from not detected to 6.09 mg/L (MD6A). Four (MD1B, MD-2A, MD-6A, MD-6C) out of 15 wells reported one or more samples with nitrate concentrations above the ANZECC (2000) trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level).

<sup>6</sup> Council has conducted additional monitoring at the site as the EPL only requires 6 monthly sampling.

Nitrate concentrations in 2016/2017 are comparable or lower than previous years (2015/2016, 2014/2015).

- Ammonia concentrations in the 2016/17 monitoring period continue to be elevated and variable, however show an overall decreasing trend. Some exceptions include MD10B/MD-6B (variable trend), and MD9C, and MD4B have rising trends. Variations in ammonia are inferred to reflect seasonal trends (high rainfall resulting in increased concentrations) and decreased leachate generation due to the landfill rehabilitation works.
- During the 2016/17 monitoring period Rocklow-Down (downstream) was sampled three out of four times due to restricted access. Generally low concentrations of ammonia (below ANZECC 2000) were reported from the upstream, mid and down stream locations during 2016/17 reporting period. A general increase in ammonia is evident in the downstream or Rocklow-Mid surface water locations relative to upstream. The net increment of ammonia between upstream, mid stream and downstream concentrations is variable since 1999, however a decrease is evident in the 2016/2017 results (Graph 4).
- The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in 2014/15, ~0.96 mg/L in 2015/16, and ~ 0 mg/L in the 2016/17 reporting period (Table SW-2). The "net incremental average" for ammonia in Rocklow Creek is lower than previous years. The elevated ammonia in nearby groundwater (MD-9C, MD-10B) may be contributing ammonia concentrations in the surface water (Rocklow-Mid/downstream). Further monitoring is required to verify this interpretation, as tidal dilution and multiple sources are situated around the creek (e.g. Dunmore landfill).
- While downstream ammonia concentration increases could be attributable to the discharge of groundwater impacted by ammonia from the MWDD, contribution from other sources of nitrogen input such as polluted runoff from the catchment (Dunmore Landfill, agricultural areas) is not discounted.
- All other water quality indicators were consistent with the results of previous monitoring periods.
- The testing of the gas monitoring wells (Gas 1, Gas 3, Gas 4) and trenches (Trench 1 to Trench 7 -the biofilter pads) indicated that gas levels are comparable or lower than previous years. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings in January 2017, June 2017 and October 2017 (annual monitoring). KMC (& E2W) are unaware of any reportable pollution incidences or complaints from the community related to the MWDD during the 2016/17 reporting period.

The nutrients in the local surface and groundwater are likely to decrease over time due to the landfill closure and rehabilitation works. Given that the landfill capping commenced in August 2006 and completed in January 2008 the leachate generation has substantially decreased. Monitoring data in 2016/17 supports this interpretation and improvement in the local water quality.

The elevated ammonia concentrations reported at MD-9C and MD-10B is interpreted to relate to the remnant deeper centre/core plume migrating from under the landfill mound to the site boundary. Other areas are showing a decrease in leachate strength associated with landfill closure works.

Monitoring over the next few years will continue to provide the relevant environmental data to assess the effectiveness and performance of the landfill rehabilitation. The scale of the landfill mound (6 ha) and movement of the deep groundwater/plume is likely to be influencing results at MD-9C.

Groundwater remediation and monitoring of elevated ammonia at wells (MD-9C, MD-10B, MD-4B at centreline of plume) and Rocklow Creek (mid-downstream creek) is recommended to assess water quality trends. Remedial works are proposed to include groundwater extraction (MD-9C) and irrigation of the landfill mound. In early 2017, E2W and KMC have installed 3 extraction bores and five monitoring wells in proximity to MD-9C to enable extraction and monitoring of the ammonia plume.

Groundwater extraction of the ammonia plume at MD-9C is likely to commence in early 2018.

E2W interpret that several years of groundwater extraction at MD9C area is required to show a consistent improvement in the water quality trends (e.g. ammonia decrease). This interpretation takes in consideration of the coastal sandy aquifer which has high storage and requirement to reduce extraction rates to minimise salt water intrusion.

## 8.1 Recommendations

E2W offer the following recommendations regarding the monitoring at the Minnamurra Waste Disposal Depot:

- Continued groundwater and surface water monitoring and assessment of landfill leachate impacts are required to assess trends in relation to the landfill rehabilitation works.
- Documentation of groundwater remedial works (start date, extraction rates, water quality results) and correlation to EPL monitoring results.

Nitrate analysis is recommended for all sampling in Rocklow Creek (*Note: no nitrate analysis was conducted in the 3 Rocklow Creek samples in 2016/2017*).

### *Sampling Procedures*

- Recording of groundwater purge volumes and any observations (odour, sheen, turbidity) during sampling of monitoring wells,
- Use of calibrated field instruments for measuring field chemistry (pH, EC, DO, Eh, T) prior to sampling (documentation required),
- Sampling of surface water to be timed with a **low ‘run out’ tide**, and documenting tidal and climatic conditions (i.e. sampling at different tides dilutes the groundwater plume).
- Details regarding the well conditions (eg. damaged or dry wells). Any damaged wells should be replaced or substituted with nearby wells.
- Include nitrate analyses for the surface water samples.

The recommended groundwater monitoring program for the prescribed well locations (i.e. EPL conditions) is summarised in Table 8.1. E2W acknowledge that the EPL recommends a half yearly sampling frequency, whilst KMC have continued with quarterly groundwater monitoring and also include surface water sampling (three locations). Increased monitoring frequency facilitates earlier detection of rising trends and decisions regarding potential remedial works.

E2W recommend the current surface water monitoring program is continued on a quarterly basis for the 2016/17 reporting period (exceeds EPL requirements). Frequent review of results from the Rocklow-Mid/Down stream sampling locations is required to address ecosystem risks associated with the elevated ammonia concentrations at well (MD-9C).

Continued monitoring of landfill gas at the gas monitoring wells, trenches (biofilter pads) and buildings (6 monthly) is recommended to comply with the EPL.

## 9. LIMITATIONS

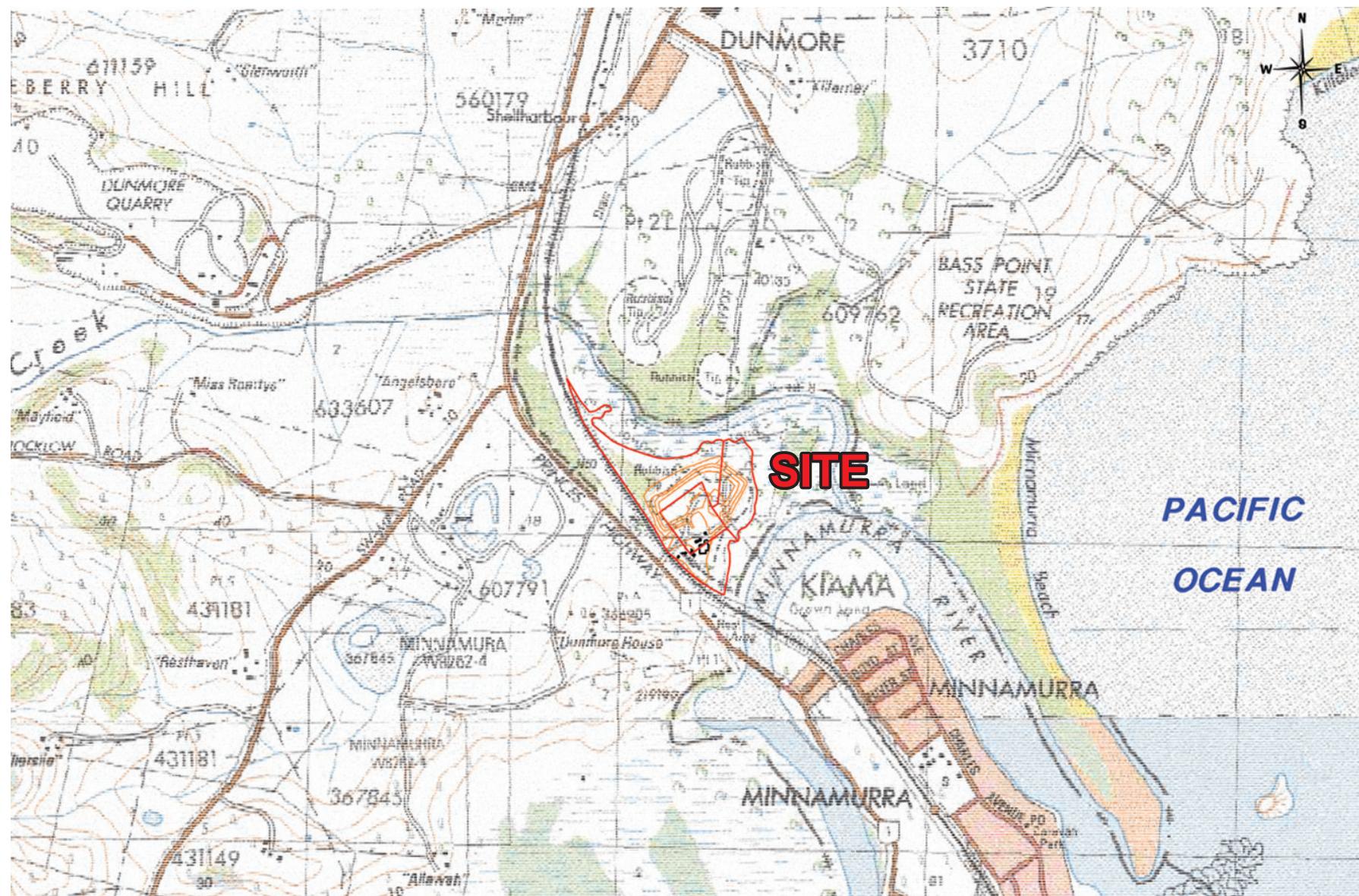
Earth2Water Pty Ltd has prepared this report for the use of Kiama Municipal Council in accordance with the standard terms and conditions of the consulting profession. This report is prepared in accordance with the agreed scope of work. The methodology adopted and sources of information used by E2W are outlined in this report.

This report was prepared during November 2017 and is based on the information reviewed at the time of preparation. This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented by Ecowise and our experience.

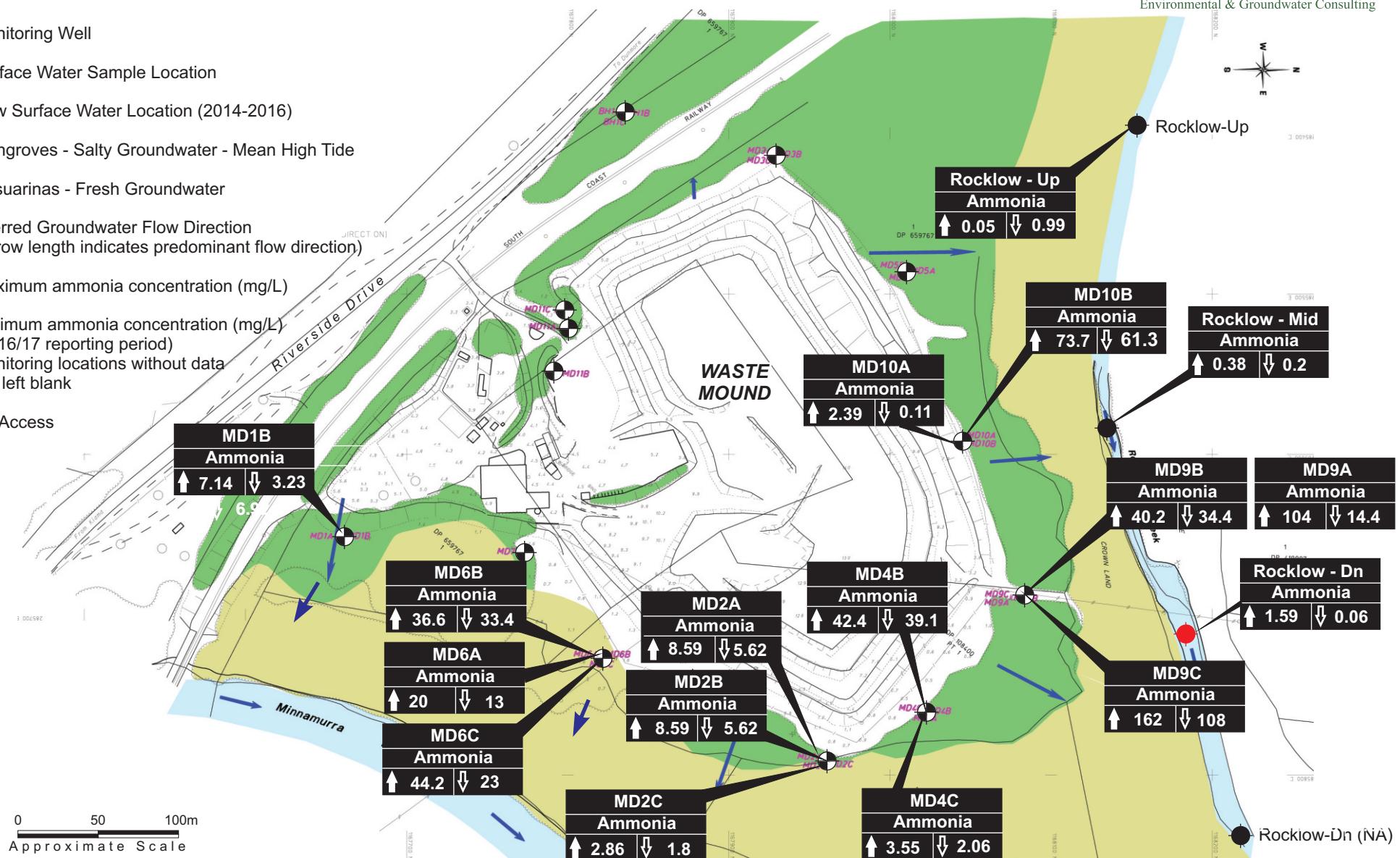
Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, E2W should be notified of any such findings and be provided with an opportunity to review our content and recommendations.

## Figures



**LEGEND**

- Monitoring Well
- Surface Water Sample Location
- New Surface Water Location (2014-2016)
- Mangroves - Salty Groundwater - Mean High Tide
- Casuarinas - Fresh Groundwater
- ← Inferred Groundwater Flow Direction (Arrow length indicates predominant flow direction)
- ↑ 3.2 Maximum ammonia concentration (mg/L)
- ↓ 0.4 Minimum ammonia concentration (mg/L) (2016/17 reporting period)  
Monitoring locations without data are left blank
- NA No Access



Source: Neil Charters Pty Ltd

Date: November 2017

Reference: E2W\_059\_04.cdr

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2016-2017)

## Tables

**Table 5.3: Groundwater and Surface Water Monitoring (2016 to 2017)**

Analytes	Groundwater				Surface Water (Rocklow Creek)				Detection Limits	Method Reference
	9/11/16	20/02/17	19/05/17	17/08/17	9/11/16	20/02/17	19/05/17	17/08/17		
<b>Physical Properties</b>										
pH	X	X	X	X	X	X	X	X	0.01 pH unit	pH meter and probe/ APHA4500-HB
Electrical Conductivity	X	X	X	X	X	X	X	X	0.01 mS/cm	Conductivity meter and probe
Dissolved Oxygen (mg/L)	X	X	X	X	X	X	X	X	0.0001	DO meter and probe
Redox (Orp)									1 mV	Platinum electrode probe - NA
Temperature	X	X	X	X	X	X	X	X	1 °C	Temperature meter and probe
Turbidity									1 NTU	APHA2540D
<b>Nutrients</b>										
Nitrate	X	X	X	X						FIA
Ammonia-nitrogen	X	X	X	X	X	X	X	X	0.01 mg/L	FIA
Total Nitrogen										
Total Phosphorus									2 µg/L	FIA
<b>Hydrochemical</b>										
Calcium	X	X	X	X	X	X	X	X	0.5 mg/L	USEPA 6010 A
Chloride	X	X	X	X	X	X	X	X	0.5 mg/L	diphenol-carbazone/xylene cyanol FF indicator
Fluoride	X	X	X	X	X	X	X	X	0.1 mg/L	APHA4500-FC
Magnesium	X	X	X	X	X	X	X	X	0.02 mg/L	USEPA 6010 A
Sulphate	X	X	X	X	X	X	X	X	1 mg/L	ICID/MS
Sodium	X	X	X	X	X	X	X	X	0.05 mg/L	USEPA 6010 A
Bicarbonate/Alkalinity	X	X	X	X	X	X	X	X	0.5 mg/L	APHA2340C - "Hardness done by error"
Potassium	X	X	X	X	X	X	X	X	0.05 mg/L	USEPA 6010 A
<b>Organic Contaminants</b>										
Dissolved Organic Carbon									0.50 mg/L	APHA 5310C
Total Organic Carbon	X	X	X	X	X	X	X	X	0.1 mg/L	APHA 5310C
<b>Inorganic Contaminants</b>										
Iron	X	X	X	X	X	X	X	X	1 µg/L	USEPA 6010 A
Manganese	X	X	X	X	X	X	X	X	1 µg/L	USEPA 6010
Total Phenolics	X	X	X	X	X	X	X	X	1 µg/L	APHA 5530D

**Table SW-1 Minnamurra Waste Disposal Depot (Rocklow Creek)**

Sample ID	ANZECC, 2000		Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down
Field Measurements	Freshwater	Marine	9/11/16	9/11/16	9/11/16	20/2/17	20/2/17	20/2/17	19/5/17	19/5/17	19/5/17	17/8/17	17/8/17	17/8/17
pH (field)	6.5-8.0	8-8.4	7.6	7	NA	6.9	7.4	7.4	7.5	7.1	7.8	7.7	7.2	7.2
Temperature			21.5	23		20.8	22.1	25.5	18.2	16.9	18.1	15.9	19.4	17
Electrical Conductivity (mS/cm)	0.125-2.2		26500	29600		1790	8030	8930	14500	29100	4730	30000	14800	29100
Dissolved Oxygen (mg/L)	8.5-11.0	9.0-10.0	6.53	5.07		4.57	5.89	6.01	8.17	6.29	10.3	9.09	7.4	7.31
Turbidity (NTU)	6-50 (a)	0.5-10												
<b>Laboratory Analyses (mg/L)</b>														
Sodium (ICP)			4880	5860		268	1450	1520	2340	4270	676	5920	2910	5900
Potassium (ICP)			184	215		15	49	52	103	176	27	222	102	217
Calcium (ICP)			243	243		48	100	106	120	206	52	255	127	245
Magnesium (ICP)			589	680		38	152	160	258	492	84	735	344	704
Chloride			8010	8900		403	2280	2540	4740	8070	1130	9510	4770	8980
Sulphate (SO4)			1120	1360		128	344	366	598	1050	179	1540	695	1570
<b>Water Parameters (mg/L)</b>														
Fluoride			0.6	0.8		0.2	0.6	0.6	0.5	0.6	0.2	0.8	0.8	0.9
Phenols		0.40	0.05	0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
<b>Metals (mg/L)</b>														
Iron (ICP)	0.3 (1)		0.21	0.33		6.74	1.88	1.78	2.05	0.74	0.74	0.17	0.34	0.26
Manganese (ICP)	1.90		0.123	0.145		0.598	0.242	0.239	0.15	0.15	0.113	0.055	0.085	0.058
<b>Nutrients (mg/L)</b>														
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.07	0.18		0.99	0.38	0.58	0.52	0.7	0.06	0.05	0.2	1.59
Ammonia Increment (Upper to Mid Rocklow)				<b>0.11</b>			<b>-0.61</b>			<b>0.18</b>			0.15	
Ammonia Increment (Mid to lower Rocklow)					<b>-0.18</b>			<b>0.20</b>			<b>-0.64</b>			<b>1.39</b>
Total Organic Carbon (TOC)			10	11		29	19	17	11	6	13	7	7	7

**Notes:**

1. Trigger value-indicative interim working level (IIWL).
2. Ammonia trigger value; pH =8, 95% PL,adj to pH=7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.

**Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (1999 - 2017)**

<b>Sample ID</b>	6/05/1999	17/08/1999	2/12/2000	28/02/2000	11/05/2000	10/08/2000	21/11/2000	15/02/2001	17/05/2001	16/08/2001	13/11/2001	22/02/2002	8/04/2002	19/08/2002	14/11/2002	11/02/2003	22/08/2003	20/11/2003	17/02/2004	12/05/2004	11/08/2004	7/12/2004	2/02/2005	4/05/2005	16/08/2005	
<b>Upper Rocklow (mg/L)</b>	0.16	<0.02	0.10	0.16	0.03	0.06	0.04	0.10	0.22	0.35	0.18	0.10	0.07	0.13	0.06	0.01	0.11	1.40	0.38	0.55	0.65	0.92	<0.02	0.31	1.40	
<b>Middle Rocklow (mg/L)</b>																										
<b>Lower Rocklow (mg/L)</b>	1.00	0.65	2.07	1.74	0.57	1.34	0.26	0.56	0.69	0.42	0.24	0.64	1.11	2.00	1.60	0.51	0.13	1.40	1.70	0.38	0.55	0.65	0.92	<0.02	0.31	1.40
<b>Net Increment (mg/L)</b>	0.84	0.64	1.97	1.58	0.54	1.28	0.22	0.46	0.47	0.07	0.06	0.54	1.04	1.87	1.54	0.50	0.02	1.26	1.67	0.21	0.27	0.62	0.70	NA	0.30	1.34

<b>Sample ID</b>	9/11/2005	28/02/2006	30/05/2006	30/08/2006	27/11/2006	26/02/2007	22/05/2007	21/08/2007	20/11/2007	21/02/2008	28/05/2008	26/08/2008	25/11/2008	16/02/2009	18/05/2009	28/08/2009	27/11/2009	26/02/2010	20/05/2010	17/08/2010	29/11/2010	25/02/2011	23/05/2011	23/08/2011	2/11/2011	2/02/2012
<b>Upper Rocklow (mg/L)</b>	<0.02	<0.02	0.22	0.09	0.39	0.66	0.41	0.32	0.39	<0.1	0.27	0.12	<0.1	0.56	0.12	0.15	0.10	0.20	<0.1	0.05	0.30	<0.1	0.01	0.05	0.14	
<b>Middle Rocklow (mg/L)</b>														0.56	0.61	0.38	0.80	<0.1	<0.1	0.27	0.33	5.65	0.56	0.20	0.31	0.58
<b>Lower Rocklow (mg/L)</b>	<0.02	<0.02	0.64	0.90	1.20	0.32	0.62	0.48	1.60	NM	1.60	1.20	0.16	0.66	0.30	0.21	0.60	<0.1	<0.1	0.42	NM	NM	NM	NM	NM	
<b>Net Increment (mg/L)</b>	NA	NA	0.42	0.81	0.81	(0.34)	0.21	0.16	1.21	NA	1.33	1.08	NA	0.10	0.18	0.06	0.50	NA	NA	0.37	0.03	5.55	0.55	0.15	0.28	0.44

<b>Sample ID</b>	30/05/2012	9/08/2012	20/11/2012	18/02/2013	30/05/2013	29/08/2013	26/11/2013	6/02/2014	6/05/2014	18/08/2014	17/11/2014	26/02/2015	27/05/2015	10/08/2015	3/11/2015	15/02/2016	30/05/2016	11/08/2016	9/11/2016	20/02/2017	19/05/2017	17/08/2017			
<b>Upper Rocklow (mg/L)</b>	<0.01	0.04	0.10	0.10	0.12	0.16	0.09	0.16	0.39	0.14	0.14	0.14	0.06	0.09	0.12	0.19	0.17	0.06	0.07	0.99	0.52	0.05			
<b>Middle Rocklow (mg/L)</b>	1.06	1.91	0.44	0.71	0.19	0.40	0.18	1.60	0.29	0.14	0.24	0.13	0.29	0.23	1.08	2.49	0.67	0.17	0.18	0.38	0.70	0.20			
<b>Lower Rocklow (mg/L)</b>	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	0.09	0.28	0.19	2.09	0.58	0.68	0.23		0.58	0.06	1.59			
<b>Net Increment (mg/L) Middle- Lower</b>	1.06	1.87	0.34	0.61	0.07	0.24	0.09	1.44	(0.10)	0.00	0.10	(0.05)	0.01	0.04	1.01	(1.91)	0.01	0.06	0.11	0.20	(0.64)	1.39			

**Legend**

NA = Not Analysed      NM= Not measured

Note: Rocklow Down was inaccessible during the 2010-2014 monitoring periods

Table GW-1: Summary 2015/16 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 1B	MD 1B	No. Samples	MD2A	MD2A	MD2A	MD2A	No. Samples	Min	Mean	Max	MD 2B	MD 2B	MD 2B	MD 2B	No. Sample	Min	Mean	Max			
	Freshwater	Marine																						
Field Measurements			9/11/16	20/2/17		9/11/16	20/2/17	19/5/17	17/8/17					9/11/16	20/2/17	19/5/17	17/8/17							
RL (mAHD at TOC)			2.11	2.11		1.17	1.17	1.17	1.17					1.17	1.17	1.17	1.17							
Standing water level (mTOC)			1.53	1.37	2	0.47	0.39	0.41	0.48	4	0.39	0.44	0.48	0.58	0.60	0.46	0.66	4	0.46	0.58	0.66			
Reduced SWL (mAHD)			0.58	0.74		0.70	0.78	0.76	0.69	4	0.69	0.73	0.78	0.59	0.57	0.71	0.51	4	0.51	0.59	0.71			
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.60	7.40	2	7.20	7.00	7.20	7.00	4	7.0	7.1	7.2	6.90	7.20	7.00	6.90	4	6.9	7.0	7.2			
Temperature			21.90	22.50	2	22.40	21.50	13.70	16.30	4	13.7	18.5	22.4	22.10	20.80	17.70	17.30	4	17.3	19.5	22.1			
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		578	546	2	21200	16100	19700	18400	4	16100	18850	21200	28200	27900	24900	24700	4	24700	26425	28200			
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3.11	3.26	2	3.27	0.99	2.65	0.96	4	0.96	1.97	3.27	2.40	1.38	0.94	0.47	4	0.47	1.30	2.40			
<b>Laboratory Analyses (mg/L)</b>																								
Sodium (ICP)			37	52	2	3750	2570	3330	2990	4	2570	3160	3750	5400	4470	4450	4120	4	4120	4610	5400			
Potassium (ICP)			13	9	2	191	167	187	164	4	164	177	191	210	194	176	173	4	173	188	210			
Calcium (ICP)			55	48	2	268	261	257	230	4	230	254	268	412	456	324	316	4	316	377	456			
Magnesium (ICP)			8	11	2	484	331	431	394	4	331	410	484	708	564	535	516	4	516	581	708			
Chloride			76	41	2	6060	4640	5740	5360	4	4640	5450	6060	8360	8060	7580	7270	4	7270	7818	8360			
Sulphate (SO4)			31	24	2	851	494	701	715	4	494	690	851	1350	1230	1110	1010	4	1010	1175	1350			
<b>Water Parameters (mg/L)</b>																								
Alkalinity (as CaCO3)			178	186	2	810	1040	798	892	4	798	885	1040	807	788	634	694	4	634	731	807			
Fluoride			0.2	0.1	2.0	0.7	0.9	0.8	0.8	4.0	0.7	0.8	0.9	0.7	0.8	0.7	0.8	4	0.7	0.8	0.8			
Phenols			0.40	0.05	0.05	2.00	0.05	0.05	0.05	4.00	ND	ND	ND	0.05	0.05	0.05	0.05	4	ND	ND	ND			
<b>Metals (mg/L)</b>																								
Iron (ICP)	0.3 (1)		0.05	0.05	2	0.33	1.69	1.24	0.48	4	0.33	0.94	1.69	1.38	1.4	1.04	0.49	4	0.49	1.08	1.40			
Manganese (ICP)	1.90		0.019	0.028	2	0.05	0.036	0.053	0.049	4	0.036	0.047	0.053	0.123	0.076	0.094	0.067	4	0.067	0.090	0.123			
<b>Nutrients (mg/L)</b>																								
Nitrate (NO3 as N)	0.7 (7)		5.01	1.58	2	2.63	0.64	3.57	1.24	4	0.64	2.02	3.57	0.01	0.01	0.05	0.07	4	0.01	0.04	0.07			
Ammonia (NH3 as N)	1.88 (2)		2.84 (2)	3.23	7.14	2	9.41	23.10	11.00	15.20	4	9.41	14.68	23.10	8.59	8.31	7.18	5.62	4	5.62	7.43	8.59		
Total Nitrogen	0.5 (3)		0.12 (4)			2																		
Dissolved Organic Carbon (DOC)						2																		
Total Organic Carbon (TOC)						8	7	2	46	71	64	55	4	46	59	71	61	23	44	30	4	23	40	61
Total Phosphorus (TP)	0.05 (5)		0.025 (6)																					

## Notes:

- 1. Trigger value is an indicative interim working level only (IIWL).
- 2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
- 3. Trigger value for total nitrogen for lowland rivers in SE Australia.
- 4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
- 5. Trigger value for total phosphorus in lowland rivers in NSW.
- 6. Trigger value for total phosphorus in marine ecosystems in NSW.
- 7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD 2C	MD 2C	MD 2C	MD 2C	No. Samples	Min	Mean	Max	MD4A	MD4A	MD4A	MD4A	No. of Samples
Field Measurements	Freshwater	Marine	9/11/16	20/2/17	19/5/17	17/8/17					9/11/16	20/2/17	19/5/17	17/8/17	
RL (mAHD at TOC)			1.165	1.165	1.165	1.165					Dry	Dry	Dry	Dry	0
Standing water level (mTOC)			0.62	0.78	0.53	0.74	4	0.53	0.67	0.78	-	-	-	-	0
Reduced SWL (mAHD)			0.55	0.39	0.64	0.43					-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.00	7.20	7.10	7.00	4	7.0	7.1	7.2	-	-	-	-	0
Temperature			22.80	21.60	18.10	17.60	4	17.6	20.0	22.8	-	-	-	-	0
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		43300	22900	44900	45700	4	22900	39200	45700	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3	2	1	1	4	0.68	1.59	2.97	-	-	-	-	0
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			8380	8850	7500	7680	4	7500	8103	8850	-	-	-	-	0
Potassium (ICP)			304	349	293	301	4	293	312	349	-	-	-	-	0
Calcium (ICP)			463	508	416	429	4	416	454	508	-	-	-	-	0
Magnesium (ICP)			1020	1080	874	922	4	874	974	1080	-	-	-	-	0
Chloride			13100	13400	13600	13500	4	13100	13400	13600	-	-	-	-	0
Sulphate (SO4)			2230	2180	2020	1900	4	1900	2083	2230	-	-	-	-	0
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)											-	-	-	-	0
Alkalinity (as CaCO3)			627	575	492	554	4	492	562	627	-	-	-	-	0
Fluoride			0.7	0.8	0.6	0.7	4	0.6	0.7	0.8	-	-	-	-	0
Phenols		0.40	<b>0.05</b>	<b>0.05</b>	<b>0.05</b>	<b>0.05</b>	4	ND	ND	ND	-	-	-	-	0
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)		1.29	1.62	1.27	1.24	4	1.24	1.36	1.62	-	-	-	-	0
Manganese (ICP)	1.90		1020	1080	874	922	4	<0.01	974.000	1080.0	-	-	-	-	0
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		0.01	0.01	0.01	0.01	4	0.01	0.01	0.01	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	<b>2.86</b>	<b>2.58</b>	1.8	1.82	4	1.80	2.27	2.86	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)									-	-	-	-	0
Dissolved Organic Carbon (DOC)											-	-	-	-	0
Total Organic Carbon (TOC)			18	24	12	20	4	12	19	24	-	-	-	-	0
Total Phosphorus (TP)	0.05 (5)	0.025 (6)									-	-	-	-	0
<b>Notes:</b>															

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD6A	MD6A	MD6A	No. Samples	Min	Mean	Max	MD 6B	MD 6B	MD 6B	MD 6B	No. Samples	Min	Mean	Max	
Field Measurements	Freshwater	Marine	9/11/16	20/2/17	19/5/17	17/8/17				9/11/16	20/2/17	19/5/17	17/8/17					
RL (mAHD at TOC)			1.85	1.85	1.85													
Standing water level (mTOC)			1.19	1.15	3.18	1.15	4	1.15	1.67	3.18	1.18	1.16	1.23	1.24	4	1.16	1.20	1.24
Reduced SWL (mAHD)			7.10	7.10	7.10	7.10	4	7.10	7.10	7.10	1.15	1.15	1.15	1.15	4	1.15	1.15	1.15
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.30	7.00	7.10	7.20	4	7.0	7.2	7.3	7.10	6.90	7.00	7.00	4	6.9	7.0	7.1
Temperature			22.9	24.4	20.1	19.8	4	19.8	21.8	24.4	21.90	22.50	20.30	20.00	4	20.0	21.2	22.5
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		3360	3560	3790	2670	4	2670	3345	3790	1550.0	1920.0	1820.0	1620.0	4	1550	1728	1920
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3.27	1.64	1.47	0.95	4	0.95	1.83	3.27	3.1	1.45	0.93	0.87	4	0.87	1.59	3.10
<b>Laboratory Analyses (mg/L)</b>																		
Sodium (ICP)			391	398	442	271	4	271	376	442	84	112	104	84	4	84	96	112
Potassium (ICP)			87	81	96	65	4	65	82	96	41	47	43	39	4	39	43	47
Calcium (ICP)			156	140	169	126	4	126	148	169	130	164	157	140	4	130	148	164
Magnesium (ICP)			78	88	91	63	4	63	80	91	36	52	43	35	4	35	42	52
Chloride			590	552	619	348	4	348	527	619	113	122	113	109	4	109	114	122
Sulphate (SO4)			256	245	256	160	4	160	229	256	61	60	52	47	4	47	55	61
<b>Water Parameters (mg/L)</b>																		
Alkalinity (as CaCO3)			780	806	676	679	4	676	735	806	660	836	694	636	4	636	707	836
Fluoride			0.8	0.8	0.7	0.8	4	0.7	0.8	0.8	0.6	0.5	0.5	0.5	4	0.5	0.5	0.6
Phenols		0.40	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>																		
Iron (ICP)	0.3 (1)		0.44	2.03	1.06	0.20	4	0.20	0.93	2.03	0.17	0.25	0.18	0.10	4	0.10	0.18	0.25
Manganese (ICP)	1.90		0.059	0.061	0.061	0.04	4	0.040	0.055	0.061	0.093	0.11	0.11	0.08	4	0.080	0.098	0.110
<b>Nutrients (mg/L)</b>																		
Nitrate (NO3 as N)	0.7 (7)		0.9	0.24	2.8	6.1	4	0.24	2.49	6.09	0.02	0.65	0.22	0.56	4	0.02	0.36	0.65
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	16.7	20.0	18.0	13.0	4	13.00	16.93	20.00	33.4	33.5	36.6	34.4	4	33.40	34.48	36.60
Total Nitrogen	0.5 (3)	0.12 (4)																
Total Organic Carbon (TOC)			37	52	54	46	4	37	47	54	24	38	29	29	4	24	30	38

**Notes:**

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD 6C	MD 6C	MD 6C	MD 6C	No. Samples	Min	Mean	Max	MD9A	MD9A	MD9A	MD9A	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	9/11/16	20/2/17	19/5/17	17/8/17					9/11/16	20/2/17	19/5/17	17/8/17				
RL (mAHD at TOC)			1.86	1.86	1.86	1.86					1.35	1.35	1.35	1.35				
Standing water level (mTOC)			1.36	1.30	1.33	1.41	4	1.30	1.35	1.41	0.66	0.57			4	0.57	0.62	0.66
Reduced SWL (mAHD)			0.50	0.56	0.53	0.45	4	0.45	0.51	0.56	0.69	0.78			4	0.69	0.74	0.78
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.10	7.40	7.20	7.00	4	7.0	7.2	7.4	7.00	6.50			4	6.5	6.8	7.0
Temperature			22.2	21.4	19.0	19.7	4	19.0	20.6	22.2	22.20	18.20			4	18.2	20.2	22.2
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		23100	32700	26200	23300	4	23100	26325	32700	3100	7170			4	3100	5135	7170
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3.64	1.72	0.74	0.72	4	0.72	1.71	3.64	1.4	0.15			4	0.15	0.78	1.40
<b>Laboratory Analyses (mg/L)</b>																		
Sodium (ICP)			4330	5020	4510	3750	4	3750	4403	5020	452	974			4	452	713	974
Potassium (ICP)			147	189	157	133	4	133	157	189	53	74			4	53	64	74
Calcium (ICP)			356	473	348	310	4	310	372	473	40	109			4	40	75	109
Magnesium (ICP)			541	634	531	461	4	461	542	634	44	138			4	44	91	138
Chloride			7010	9720	7840	6700	4	6700	7818	9720	599	1810			4	599	1205	1810
Sulphate (SO4)			1020	1430	1010	935	4	935	1099	1430	45	115			4	45	80	115
<b>Water Parameters (mg/L)</b>																		
Alkalinity (as CaCO3)			424	451	411	393	4	393	420	451	671	430			4	430	551	671
Fluoride			0.4	0.5	0.4	0.4	4	0.4	0.4	0.5	0.2	0.1			4	0.1	0.2	0.2
Phenols		0.40	0.05	0.05	0.05	0.05	4	0.00	0.00	0.00	0.35	0.05			4	0.00	0.00	0.00
<b>Metals (mg/L)</b>																		
Iron (ICP)	0.3 (1)		0.11	19.70	19.50	0.09	4	0.09	9.85	19.70	0.82	0.11			4	0.11	0.47	0.82
Manganese (ICP)	1.90		0.037	0.06	0.076	0.043	4	0.037	0.054	0.076	0.06	0.019			4	0.019	0.040	0.060
<b>Nutrients (mg/L)</b>																		
Nitrate (NO3 as N)	0.7 (7)		0.96	0.05	0.01	0.93	4	0.01	0.49	0.96	0.04	0.02			4	0.02	0.03	0.04
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	25.0	44.2	37.0	23.0	4	23.00	32.30	44.20	104.0	14.4			4	14.40	59.20	104.00
Total Nitrogen	0.5 (3)	0.12 (4)																
Total Organic Carbon (TOC)			11	15	8	13	4	8	12	15	594	92			4	92	343	594

**Notes:**

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD 9B	MD 9B	MD 9B	MD 9B	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	9/11/16	20/2/17	19/5/17	17/8/17				
RL (mAHD at TOC)			1.35	1.35	1.35	1.35				
Standing water level (mTOC)			0.77	0.66	0.80	0.55	4	0.55	0.70	0.80
Reduced SWL (mAHD)			0.58	0.69	0.55	0.80		0.55	0.66	0.80
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.8	6.9	6.9	7.0	4	6.8	6.9	7.0
Temperature			22.5	19.9	18.9	17.4	4	17.4	19.7	22.5
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		3130	3220	3110	30300	4	3110	9940	30300
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.67	1.23	0.91	1.48	4	0.91	1.32	1.67
Laboratory Analyses (mg/L)										
Sodium (ICP)			277	276	289	272	4	272	279	289
Potassium (ICP)			67	77	84	82	4	67	78	84
Calcium (ICP)			170	196	194	195	4	170	189	196
Magnesium (ICP)			89	97	98	100	4	89	96	100
Chloride			375	398	382	418	4	375	393	418
Sulphate (SO4)			73	3	<10	<10	4	3	38	73
Water Parameters (mg/L)										
Alkalinity (as CaCO3)			1260	1260	1000	1110	4	1000	1158	1260
Fluoride			0.6	0.6	0.6	0.6	4	0.6	0.6	0.6
Phenols		0.40	0.05	0.05	0.05	0.05	4	0.05	0.00	0.05
Metals (mg/L)										
Iron (ICP)	0.3 (1)		4.06	5.26	4.10	2.54	4	2.54	3.99	5.26
Manganese (ICP)	1.90		0.304	0.244	0.249	0.211	4	0.211	0.252	0.304
Nutrients (mg/L)										
Nitrate (NO3 as N)	0.7 (7)		0.02	0.01	0.03	0.01	4	0.01	0.02	0.03
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	34.2	40.2	36.2	39.8	4	34.20	37.60	40.20
Total Nitrogen	0.5 (3)	0.12 (4)								
Total Organic Carbon (TOC)			57	74	60	63	4	57	64	74

**Notes:**

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD 9C	MD 9C	MD 9C	MD 9C	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	9/11/16	20/2/17	19/5/17	17/8/17				
RL (mAHD at TOC)			1.40	1.40	1.40	1.40				
Standing water level (mTOC)			0.76	0.75	0.92	0.78	4	0.75	0.80	0.92
Reduced SWL (mAHD)			0.64	0.65	0.48	0.62	4	0.48	0.60	0.65
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.00	7.10	7.00	7.00	4	7.00	7.03	7.10
Temperature			22.60	18.70	18.90	18.50	4	18.50	19.68	22.60
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		3980	5680	4050	3590	4	3590	4325	5680
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.17	1.13	1.16	0.33	4	0.33	1.20	2.17
<b>Laboratory Analyses (mg/L)</b>										
Sodium (ICP)			362	596	363	294	4	294	404	596
Potassium (ICP)			154	170	150	123	4	123	149	170
Calcium (ICP)			135	148	109	110	4	109	126	148
Magnesium (ICP)			62	84	57	58	4	57	65	84
Chloride			509	942	494	414	4	414	590	942
Sulphate (SO4)			1	10	1	10	4	1	0	10
<b>Water Parameters (mg/L)</b>										
Alkalinity (as CaCO3)			1360	1300	1260	1180	4	1180	1275	1360
Fluoride			0.50	0.50	0.50	0.40	4	0.40	0.48	0.50
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND
<b>Metals (mg/L)</b>										
Iron (ICP)	0.3 (1)		6.88	7.28	6.40	4.51	4	4.51	6.27	7.28
Manganese (ICP)	1.90		0.18	0.21	0.15	0.13	4	0.13	0.17	0.21
<b>Nutrients (mg/L)</b>										
Nitrate (NO3 as N)	0.7 (7)		0.01	0.01	0.03	0.01	4	0.01	0.02	0.03
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	148	162	146	108	4	108	141	162
Total Nitrogen	0.5 (3)	0.12 (4)								
Total Organic Carbon (TOC)			97	117	82	72	4	72	92	117

**Notes:**

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Unsampled well on EPL
Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD 4B	MD 4B	MD 4B	MD 4B	No. Samples	Min	Mean	Max	MD 4C	MD 4C	MD 4C	MD 4C	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	9/11/16	20/2/17	19/5/17	17/8/17					9/11/16	20/2/17	19/5/17	17/8/17				
RL (mAHD at TOC)			1.63	1.63	1.63	1.63					1.59	1.59	1.59	1.59				
Standing water level (mTOC)			1.04	1.04	1.05	1.08	4	1.04	1.05	1.08	1.09	1.10	1.14	1.10	4	1.09	1.11	1.14
Reduced SWL (mAHD)			0.59	0.59	0.58	0.55	4	0.55	0.57	0.59	0.50	0.49	0.45	0.49				
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.00	7.00	6.90	6.80	4	6.8	6.9	7.0	7.20	7.00	6.80	6.80	4	6.8	7.0	7.2
Temperature			22.40	20.40	18.30	17.20	4	17.2	19.6	22.4	22.10	21.00	17.60	17.20	4	17.2	19.5	22.1
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		21200	11800	8830	13200	4	8830	13758	21200	40700	40100	40000	41400	4	40000	40550	41400
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3.27	1.09	0.62	0.65	4	0.62	1.41	3.27	2.40	1.53	0.77	0.50	4	0.50	1.30	2.40
<b>Laboratory Analyses (mg/L)</b>																		
Sodium (ICP)			2110	1620	1240	1800	4	1240	1693	2110	7900	7870	6830	7110	4	6830	7428	7900
Potassium (ICP)			132	117	103	114	4	103	117	132	296	318	263	277	4	263	289	318
Calcium (ICP)			364	342	238	282	4	238	307	364	485	490	416	408	4	408	450	490
Magnesium (ICP)			269	202	145	232	4	145	212	269	977	966	800	842	4	800	896	977
Chloride			3740	3220	2230	3540	4	2230	3183	3740	11800	11900	11900	12700	4	11800	12075	12700
Sulphate (SO4)			410	264	115	304	4	115	273	410	2020	1890	1760	1700	4	1700	1843	2020
<b>Water Parameters (mg/L)</b>																		
Alkalinity (as CaCO3)			999	978	860	883	4	860	930	999	789	713	638	619	4	619	690	789
Fluoride			1	1	1	1	4	0.5	0.6	0.6	1	1	1	1	4	0.8	0.9	1.0
Phenols		0.40	0	0	0	0	4	ND	ND	ND	0	0	0	0	4	ND	ND	ND
<b>Metals (mg/L)</b>																		
Iron (ICP)	0.3 (1)		1.55	1.67	1.11	1.29	4	1.11	1.41	1.67	1.31	1.68	1.48	1.38	4	1.31	1.46	1.68
Manganese (ICP)	1.90		0.098	0.075	0.065	0.077	4	0.065	0.08	0.10	0.172	0.215	0.19	0.18	4	0.172	0.189	0.215
<b>Nutrients (mg/L)</b>																		
Nitrate (NO3 as N)	0.7 (7)		0.15	0.01	0.01	0.14	4	0.01	0.08	0.15	0.01	0.01	0.01	0.01	4	0.01	NA	0.01
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	39.1	40.9	42.4	41.2	4	39.10	40.90	42.40	2.74	3.22	3.55	2.06	4	2.06	2.89	3.55
Total Nitrogen	0.5 (3)	0.12 (4)																
Total Organic Carbon (TOC)			32	42	46	40	4	32	40	46	23	27	27	24	4	23	25	27

**Notes:**

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Table GW-1: Summary 2016/17 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD10A	MD10A	MD10A	MD10A	No. Samples	Min	Mean	Max	MD 10B	MD 10B	MD 10B	MD 10B	No. Sample	Min	Mean	Max
<b>Field Measurements</b>	<b>Freshwater</b>		<b>Marine</b>		<b>9/11/16</b>	<b>20/2/17</b>	<b>19/5/17</b>	<b>17/8/17</b>										
RL (mAHD at TOC)			NM	NM	NM	NM					NM	NM	NM	NM				
Standing water level (mTOC)			0.8	0.47	0.74	0.62	4	0.47	0.66	0.80	0.6	0.57	0.71	0.72	4	0.57	0.65	0.72
Reduced SWL (mAHD)																		
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.7	6.5	6.8	6.9	4	6.5	6.7	6.9	7.1	6.8	7.2	7	4	6.8	7.0	7.2
Temperature			22.1	24	19.3	16.6	4	16.6	20.5	24.0	23.2	23	20.1	19	4	19.0	21.3	23.2
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		37500	58300	4230	33500	4	4230	33383	58300	2070	1990	2030	2030	4	1990	2030	2070
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	6.59	0.96	3.36	5.55	4	0.96	4.12	6.59	1.71	1.21	1.98	0.4	4	0.40	1.33	1.98
<b>Laboratory Analyses (mg/L)</b>																		
Sodium (ICP)			6920	10600	7110	5040	4	5040	7418	10600	121	124	167	144	4	121	139	167
Potassium (ICP)			137	234	144	112	4	112	157	234	70	71	77	68	4	68	72	77
Calcium (ICP)			544	902	615	818	4	544	720	902	97	96	100	87	4	87	95	100
Magnesium (ICP)			984	1610	988	890	4	890	1118	1610	34	40	46	38	4	34	40	46
Chloride			11100	16900	12800	9910	4	9910	12678	16900	236	176	185	172	4	172	192	236
Sulphate (SO4)			1940	2840	1670	1600	4	1600	2013	2840	10	10	1	10	4	1	0	10
<b>Water Parameters (mg/L)</b>																		
Alkalinity (as CaCO3)			486	369	627	384	4	369	467	627	862	793	695	762	4	695	778	862
Fluoride			0.6	0.6	0.6	0.5	4	0.5	0.6	0.6	0.8	0.8	0.7	0.8	4	0.7	0.8	0.8
Phenols		0.40	0.05	0.05	0.05	0.05	4	ND	ND	ND	0.05	0.05	0.05	0.05	4	ND	ND	ND
<b>Metals (mg/L)</b>																		
Iron (ICP)	0.3 (1)		<b>1.64</b>	<b>2.83</b>	<b>2.97</b>	<b>0.16</b>	4	0.16	1.90	2.97	<b>1.27</b>	<b>0.75</b>	<b>0.7</b>	<b>0.69</b>	4	0.69	0.85	1.27
Manganese (ICP)	1.90		0.538	0.577	0.468	0.258	4	0.258	0.460	0.577	0.397	0.306	0.356	0.282	4	0.282	0.335	0.397
<b>Nutrients (mg/L)</b>																		
Nitrate (NO3 as N)	0.7 (7)		0.01	0.01	0.03	0.22	4	0.01	0.07	0.22	0.01	0.01	0.01	0.01	4	0.01	0.01	0.01
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	1.74	2.39	1.78	0.11	4	0.11	1.51	2.39	<b>70.00</b>	<b>61.30</b>	<b>61.90</b>	<b>73.70</b>	4	61.30	66.73	73.70
Total Nitrogen	0.5 (3)	0.12 (4)																
Total Organic Carbon (TOC)			88	121	76	42	4	42	82	121	46	56	56	56	4	46	54	56

**Notes:**

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

**Table 8.1 - Recommended Groundwater Analytical Program for MWDD (2016/17)**

Analytes	Detection Limit	Sampling Frequency	Method Reference
Alkalinity	0.5 mg/L	6 monthly	APHA 2320B
pH/Eh	0.01 pH unit	3 monthly	pH meter and probe/APHA4500-HB
Electrical Conductivity	0.01 mS/cm	3 monthly	Conductivity meter and probe
Dissolved Oxygen	0.01 %	6 monthly	DO meter and probe
Temperature	1 deg	6 monthly	Temperature meter and probe
Ammonia	0.01 mg/L	3 monthly	FIA
Nitrate	10 µg/L	3 monthly	FIA
Calcium	1 mg/L	6 monthly	USEPA 6010 A
Chloride	0.5 mg/L	6 monthly	Titrated with mercuric nitrate using diphenol-carbazone/xylene cyanol FF indicator
Fluoride	0.1 mg/L	6 monthly	APHA4500-FC
Magnesium	0.02 mg/L	6 monthly	USEPA 6010 A
Sulphate	1 mg/L	6 monthly	ICID/MS
Sodium	0.05 mg/L	6 monthly	USEPA 6010 A
Total Alkalinity	0.5 mg/L	6 monthly	APHA 2340C
Potassium	0.05 mg/L	6 monthly	USEPA 6010 A
Dissolved Organic Carbon	0.50 mg/L	6 monthly	APHA 531 OC
Iron	1 µg/L	6 monthly	USEPA 6010 A
Manganese	1 µg/L	6 monthly	USEPA 6010
Phenols	1 µg/L	6 monthly	APHA 5530D
Standing Water Level	m AHD	6 monthly	Water level Probe

*Note:*

*The key landfill indicator (ammonia/nitrate) is proposed on a quarterly basis in groundwater/surface water locations*

*ICP - Inductively Coupled Plasma*

*FIA - Flow Injection Analyser*

*MS - Mass Spectrometry*

*FC - Client Filtered*

*µS/cm - micro Siemens per centimetre*

*µg/L - micrograms per litre*

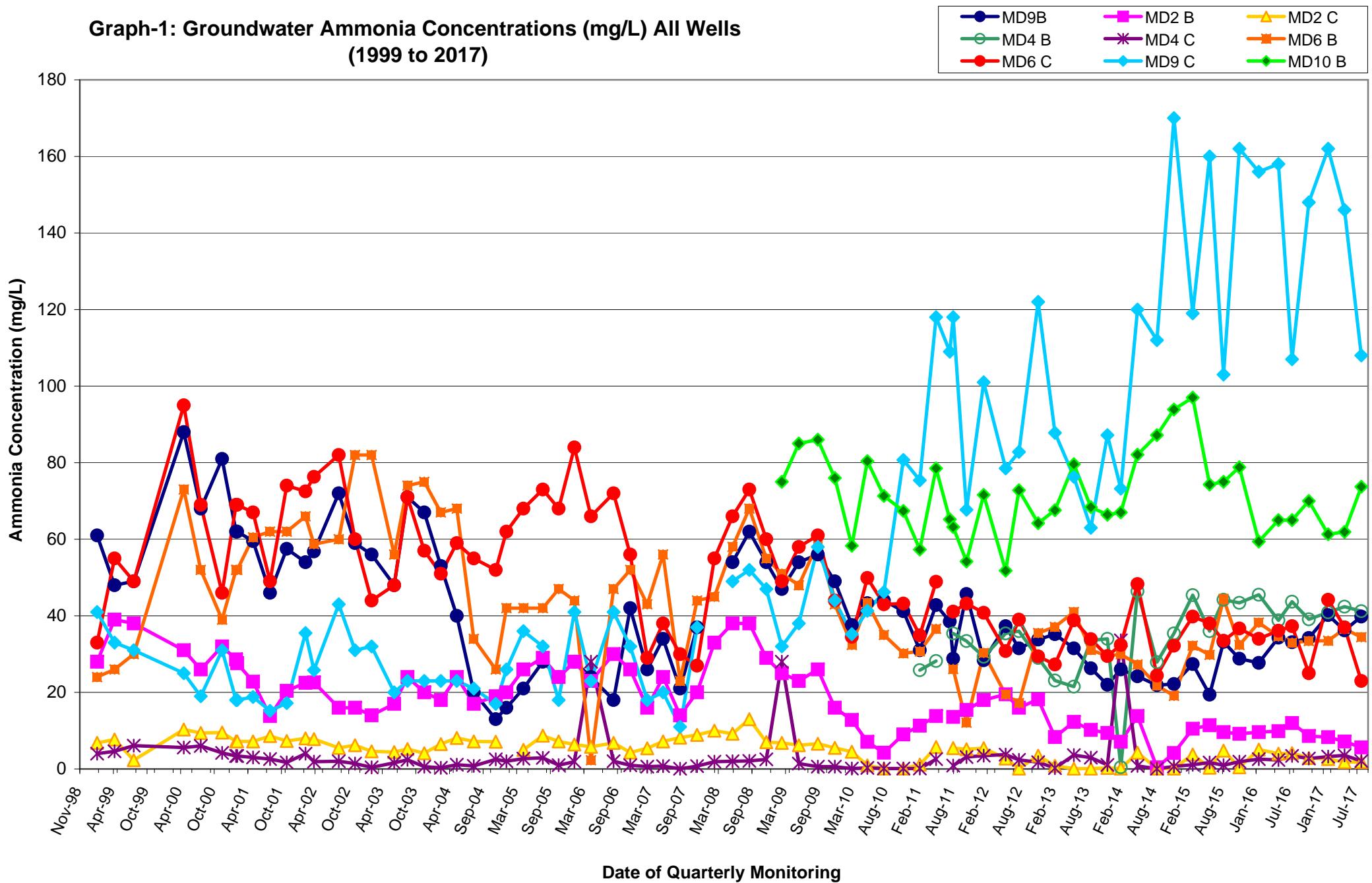
*mg/L - milligrams per litre*

*APHA - American Public Health Association*

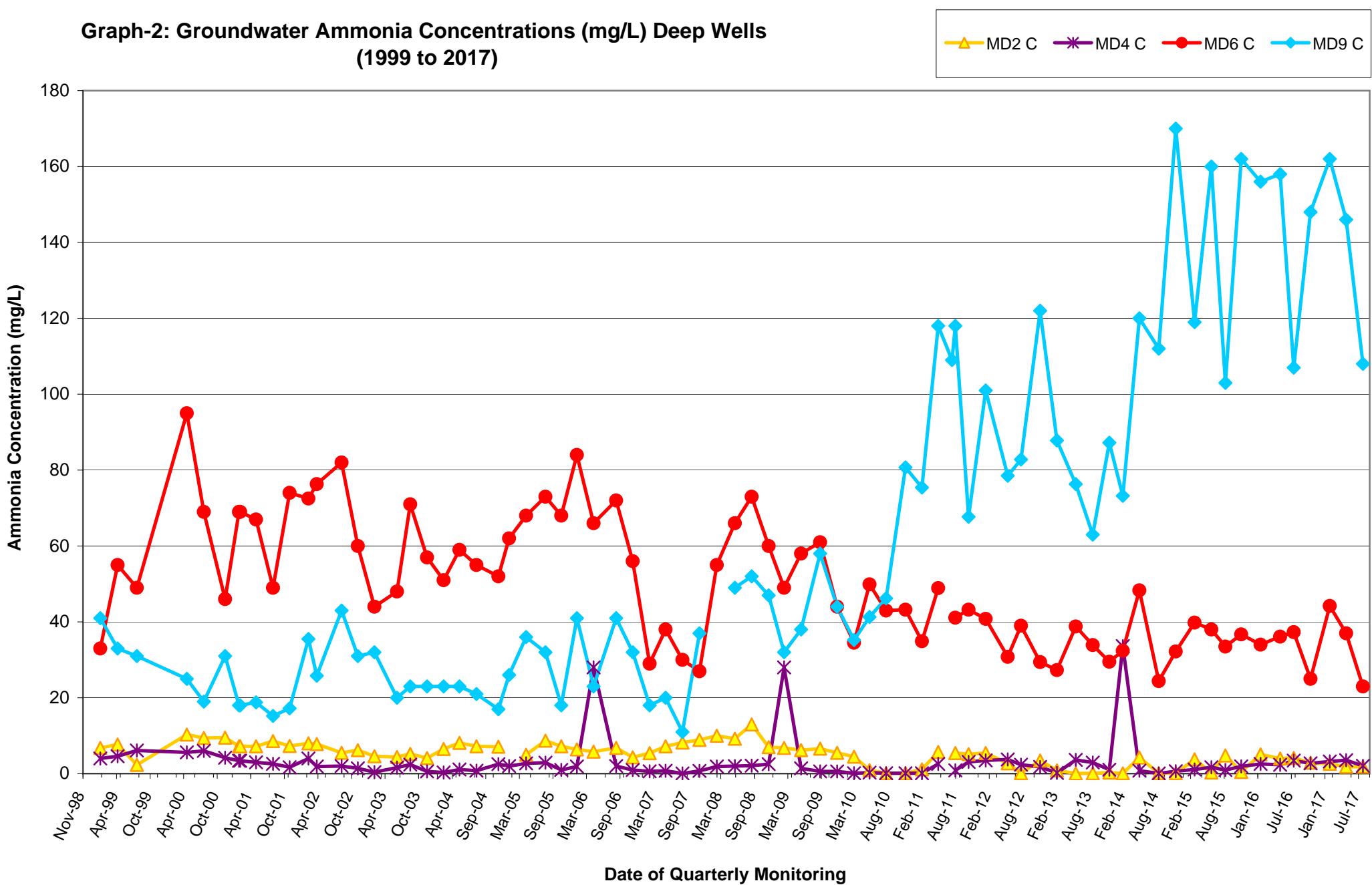
*USEPA - United States Environment Protection Agency*

## Graphs

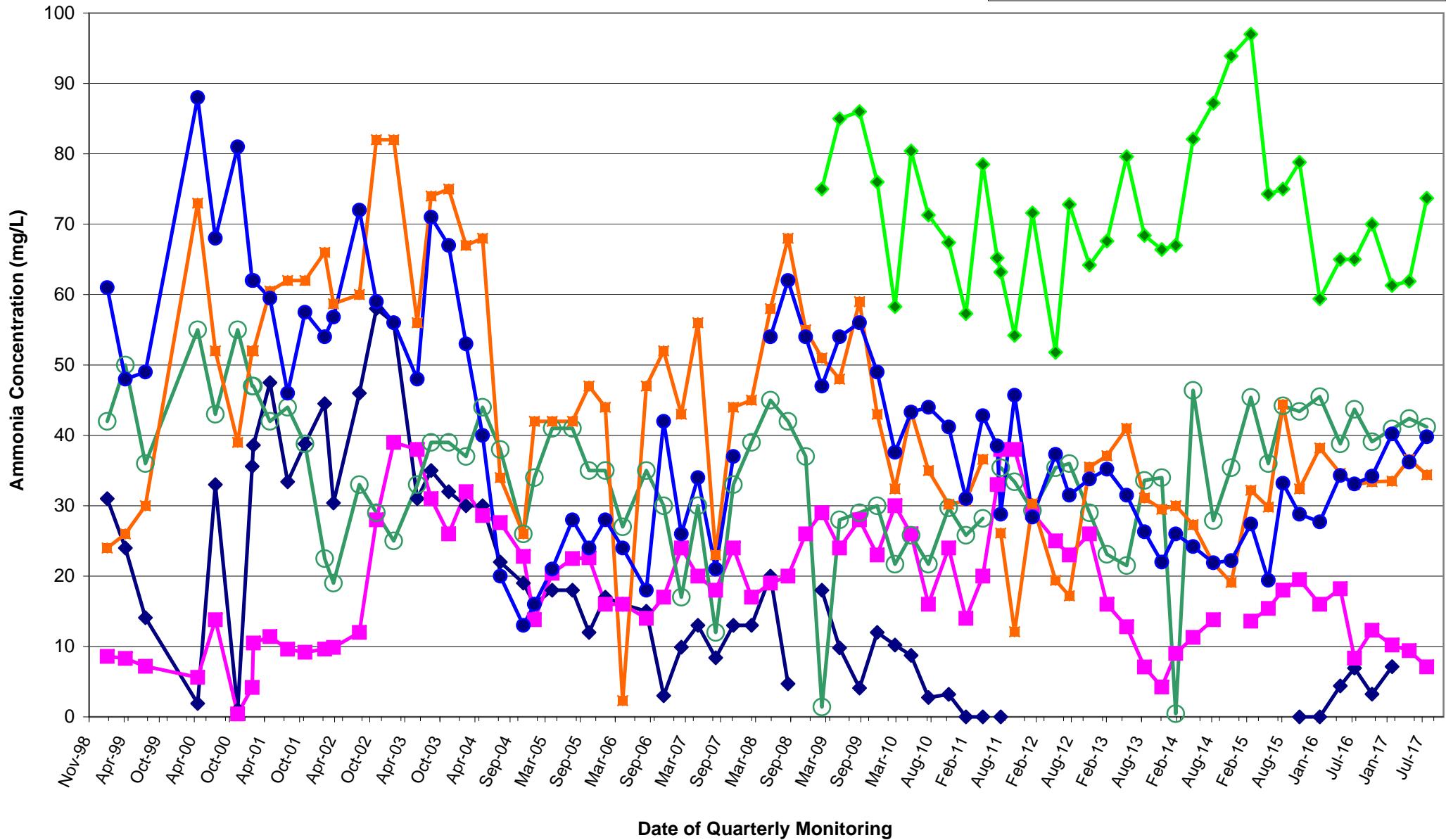
**Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells  
(1999 to 2017)**



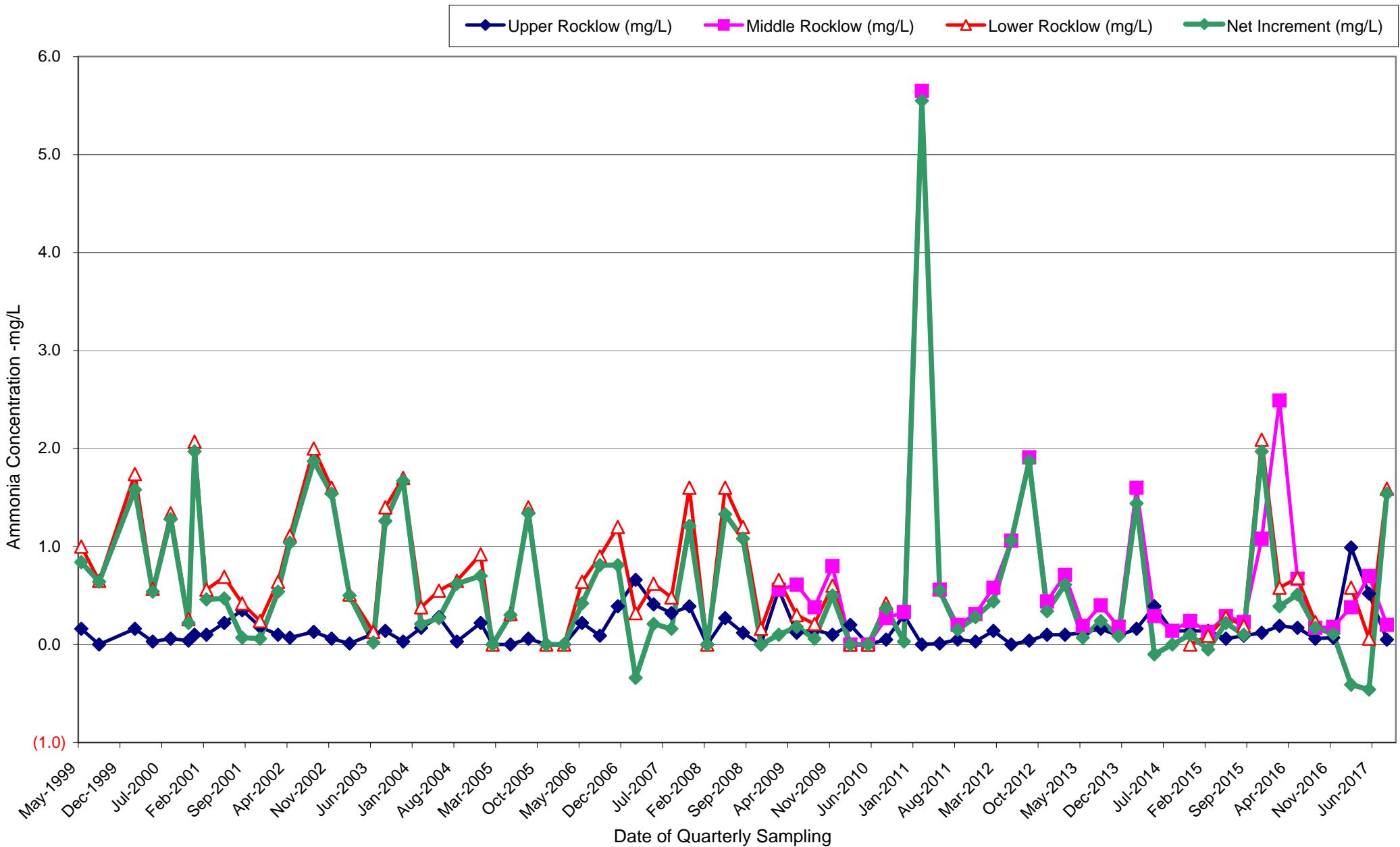
**Graph-2: Groundwater Ammonia Concentrations (mg/L) Deep Wells  
(1999 to 2017)**



**Graph-3: Groundwater Ammonia Concentrations (mg/L) Shallow Wells  
(1999 to 2017)**



**Graph-04: Net Increments of Ammonia Between Up and Down Stream Samples (1999 to 2017)**



## Appendix A





CHAIN OF CUSTODY

ALS Laboratory Please tick →

**Water Container Codes:** P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Calcium Preserved; S = Sodium Hydroxide/Calcium Preserved; VOA = VOA Vial HCl Preserved; VAS = VOA Vial Sulfuric Bisulfite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Affitreat® Unpreserved Vial SG = Sulfuric/Bromine/Sodium Hypochlorite Preserved.

## CERTIFICATE OF ANALYSIS

Work Order	<b>: EW1700714</b>	Page	<b>: 1 of 10</b>
Client	<b>: KIAMA COUNCIL</b>	Laboratory	<b>: Environmental Division NSW South Coast</b>
Contact	<b>: MR PAUL CZULOWSKI</b>	Contact	<b>: Glenn Davies</b>
Address	<b>: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533</b>	Address	<b>: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia</b>
Telephone	<b>: +61 02 4232 0444</b>	Telephone	<b>: 02 42253125</b>
Project	<b>: Minnamurra Landfill</b>	Date Samples Received	<b>: 20-Feb-2017 15:30</b>
Order number	<b>: 87896</b>	Date Analysis Commenced	<b>: 20-Feb-2017</b>
C-O-C number	<b>: ----</b>	Issue Date	<b>: 14-Mar-2017 16:39</b>
Sampler	<b>: Glenn Davies, Robert DaLio</b>		
Site	<b>: Minnamurra Landfill</b>		
Quote number	<b>: WO/026/15 - Minnamurra Landfill</b>		
No. of samples received	<b>: 20</b>		
No. of samples analysed	<b>: 20</b>		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

### Signatures

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW
Robert DaLio	Sampler	Laboratory - Wollongong



Accreditation No. 825  
Accredited for compliance with  
ISO/IEC 17025 - Testing

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ED041G: LOR raised for Sulfate on a few samples due to sample matrix.
- EK057G: LOR raised for Nitrite on sample no:11 due to sample matrix.
- EK059G-EK058G: LOR raised for NOx- Nitrate on sample 11 due to sample matrix.
- EP002 : It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- Ionic Balance out of acceptable limits for sample 2 due to analytes not quantified in this report.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.

## Analytical Results

Client sample ID				MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Compound	CAS Number	LOR	Unit	EW1700714-001	EW1700714-002	EW1700714-003	EW1700714-004	EW1700714-005
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.2	7.4	7.0	7.2	7.2
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	698	546	16100	27900	22900
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	0.4	0.3	10.2	18.9	14.9
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	23.4	22.5	21.5	20.8	21.6
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	250	186	1040	788	575
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	250	186	1040	788	575
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	33	24	494	1230	2180
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	53	41	4640	8060	13400
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	71	48	261	456	508
Magnesium	7439-95-4	1	mg/L	11	11	331	564	1080
Sodium	7440-23-5	1	mg/L	52	66	2570	4470	8850
Potassium	7440-09-7	1	mg/L	9	14	167	194	349
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.069	0.028	0.036	0.076	0.195
Iron	7439-89-6	0.05	mg/L	0.07	<0.05	1.69	1.40	1.62
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	1.0	0.1	0.9	0.8	0.8
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	4.59	7.14	23.1	8.31	2.58
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	0.08	<0.01	<0.01	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	0.56	1.58	0.64	<0.01	<0.01

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
			Client sampling date / time	20-Feb-2017 13:50	20-Feb-2017 13:55	20-Feb-2017 12:35	20-Feb-2017 12:40	20-Feb-2017 12:50
Compound	CAS Number	LOR	Unit	EW1700714-001	EW1700714-002	EW1700714-003	EW1700714-004	EW1700714-005
			Result		Result	Result	Result	Result
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	0.64	1.58	0.64	<0.01	<0.01
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	7.18	5.37	162	269	435
Total Cations	---	0.01	meq/L	6.94	6.53	156	268	508
Ionic Balance	---	0.01	%	1.68	9.72	1.77	0.03	7.77
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	15	8	66	36	23
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	19	7	71	36	24
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	2.77	3.26	0.99	1.38	1.66
Dissolved Oxygen - % Saturation	---	0.1	% saturation	33.1	38.0	11.3	17.0	18.8
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	1.36	1.37	0.39	0.60	0.78

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Compound	CAS Number	LOR	Unit	EW1700714-006	EW1700714-007	EW1700714-008	EW1700714-009	EW1700714-010
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	---	7.0	7.0	7.0	6.9
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	11800	40100	3560	1920
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	---	7.5	28.0	1.9	1.0
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	---	20.4	21.0	24.4	22.5
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	---	978	713	806	836
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	---	978	713	806	836
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	---	264	1890	245	60
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	---	3220	11900	552	122
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	342	490	140	164
Magnesium	7439-95-4	1	mg/L	---	202	966	88	52
Sodium	7440-23-5	1	mg/L	---	1620	7870	398	112
Potassium	7440-09-7	1	mg/L	---	117	318	81	47
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	0.075	0.215	0.061	0.110
Iron	7439-89-6	0.05	mg/L	---	1.67	1.68	2.03	0.25
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	---	0.5	1.0	0.8	0.5
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	---	40.9	3.22	20.0	33.5
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	<0.01	0.04	0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.01	<0.01	0.24	0.65

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)	Client sample ID			MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Client sampling date / time			20-Feb-2017 12:05	20-Feb-2017 12:10	20-Feb-2017 12:20	20-Feb-2017 13:20	20-Feb-2017 13:30	
Compound	CAS Number	LOR	Unit	EW1700714-006	EW1700714-007	EW1700714-008	EW1700714-009	EW1700714-010
Result								
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.01	<0.01	0.28	0.66
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	---	116	389	36.8	21.4
Total Cations	---	0.01	meq/L	---	107	454	33.6	18.5
Ionic Balance	---	0.01	%	---	3.91	7.72	4.49	7.15
<b>EN67 PK: Field Tests</b>								
Field Observations	---	0.01	--	DRY	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	---	43	29	50	39
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	---	42	27	52	38
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	---	1.09	1.53	1.64	1.45
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	12.0	16.9	19.7	16.9
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	---	4.04	1.10	1.15	1.16

## Analytical Results

Client sample ID				MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Compound	CAS Number	LOR	Unit	EW1700714-011	EW1700714-012	EW1700714-013	EW1700714-014	EW1700714-015
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.4	---	6.9	7.1	6.5
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	32700	---	3220	5680	58300
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	22.2	---	1.9	3.5	39.8
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	21.4	---	19.9	18.7	24.0
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	---	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	---	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	451	---	1260	1330	369
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	451	---	1260	1330	369
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	1430	---	<10	<10	2840
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	9720	---	376	942	16900
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	473	---	184	148	902
Magnesium	7439-95-4	1	mg/L	634	---	97	84	1610
Sodium	7440-23-5	1	mg/L	5020	---	288	596	10600
Potassium	7440-09-7	1	mg/L	189	---	96	170	234
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.060	---	0.244	0.212	0.577
Iron	7439-89-6	0.05	mg/L	19.7	---	5.26	7.28	2.83
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.5	---	0.6	0.5	0.6
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	44.2	---	40.2	162	2.39
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.05	---	<0.01	<0.01	0.05
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	<0.05	---	<0.01	<0.01	0.01

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)	Client sample ID			MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Client sampling date / time			20-Feb-2017 13:40	20-Feb-2017 11:35	20-Feb-2017 11:45	20-Feb-2017 11:55	20-Feb-2017 11:10	
Compound	CAS Number	LOR	Unit	EW1700714-011	EW1700714-012	EW1700714-013	EW1700714-014	EW1700714-015
Result								
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.05	---	<0.01	<0.01	0.06
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	313	---	35.8	53.1	543
Total Cations	---	0.01	meq/L	299	---	32.1	44.6	644
Ionic Balance	---	0.01	%	2.29	---	5.35	8.78	8.53
<b>EN67 PK: Field Tests</b>								
Field Observations	---	0.01	--	---	NOT SAMPLED	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	14	---	71	118	90
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	15	---	74	117	121
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	1.72	---	1.23	1.13	0.96
Dissolved Oxygen - % Saturation	---	0.1	% saturation	19.7	---	13.5	12.2	11.2
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	---	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	1.30	---	0.66	0.75	0.47

## Analytical Results

Client sample ID				MD 10B	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK
Compound	CAS Number	LOR	Unit	EW1700714-016	EW1700714-017	EW1700714-018	EW1700714-019	EW1700714-020
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	6.8	7.4	7.4	6.9	---
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	1990	8930	8030	1790	---
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	1.0	4.9	4.7	1.0	---
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	23.0	25.5	22.1	20.8	---
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	---
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	---
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	793	157	154	132	---
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	793	157	154	132	---
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	<10	366	344	128	---
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	176	2540	2280	403	---
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	96	---	---	---	---
Magnesium	7439-95-4	1	mg/L	40	---	---	---	---
Sodium	7440-23-5	1	mg/L	124	---	---	---	---
Potassium	7440-09-7	1	mg/L	71	---	---	---	---
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	106	100	48	---
Magnesium	7439-95-4	1	mg/L	---	160	152	38	---
Sodium	7440-23-5	1	mg/L	---	1520	1450	268	---
Potassium	7440-09-7	1	mg/L	---	52	49	15	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.306	---	---	---	<0.001
Iron	7439-89-6	0.05	mg/L	0.75	---	---	---	<0.05
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	0.239	0.242	0.598	---
Iron	7439-89-6	0.05	mg/L	---	1.78	1.88	6.74	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 10B	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK
Compound	CAS Number	LOR	Unit	20-Feb-2017 11:15	20-Feb-2017 14:30	20-Feb-2017 11:30	20-Feb-2017 10:30	20-Feb-2017 13:50
				Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.8	0.6	0.6	0.2	---
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	61.3	0.58	0.38	0.99	---
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	---	---	---	---
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	---	---	---	---
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	---	---	---	---
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	20.8	---	---	---	---
Total Cations	---	0.01	meq/L	19.7	---	---	---	---
Ionic Balance	---	0.01	%	2.85	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	57	8	15	26	<1
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	56	17	19	29	---
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	1.21	6.01	5.89	4.57	---
Dissolved Oxygen - % Saturation	---	0.1	% saturation	14.0	73.7	67.9	51.3	---
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	---
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	0.57	---	---	---	---



## CHAIN OF CUSTODY

ALS Laboratory: Please tick →

**CLIENT:** Kialma Municipal Council  
**OFFICE:** PO Box 75 Kialma NSW 2533  
**PROJECT:** Minamurra Landfill  
**ORDER NUMBER:** 87896

**PROJECT MANAGER:** Paul Czulowski  
**SAMPLER:** Craig Wilson  
**CONTACT PH:** 4232 0418  
**SAMPLER MOBILE:** 0408 251 560  
**COC emailed to ALS? ( YES / NO )**

**EDD FORMAT (or default):**  
**Email Reports to (will default to PM if no other addresses are listed):** paulc@kialma.nsw.gov.au, juliem@kialma.nsw.gov.au  
**Email Invoice to (will default to PM if no other addressees are listed):** paulc@kialma.nsw.gov.au, juliem@kialma.nsw.gov.au

**TURNAROUND REQUIREMENTS:**  Standard TAT (List due date):  
 Non Standard or urgent TAT (List due date):  
**(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)**

**AL'S QUOTE NO.:** **Delivery W/0/026/15**

**RELINQUISHED BY:**  
**Craig Green**

**RECEIVED BY:**  
**Aneta**

**DATE/TIME:** **9/11/16**

**RELINQUISHED BY:**  
**Aneta**

**DATE/TIME:** **9/11/16 16:50**

**RELINQUISHED BY:**  
**Aneta**

**DATE/TIME:** **9/11/16 16:50**

**RELINQUISHED BY:**  
**Aneta**

**DATE/TIME:** **9/11/16 16:50**

**COMMENT/SPECIAL HANDLING/STORAGE OR DISPOSAL:**

AL'S USE ONLY		SAMPLE DETAILS		CONTAINER INFORMATION		ANALYSIS REQUIRED Including SUITES (NB. Suite Codes must be listed to attract suite price)		Additional Information <small>Where Matrix are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).</small>				
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	Dissolved Filtered) Fe, Mn, NT-01 (Mg, Ca, Na, K)	(Total) Fe, Mn, Mg, Ca, Na, K	
1	MD 1B	9. 11. 16	W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
2	MD 2A		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
2	MD 2B		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
4	MD 2C		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
5	MD 4A		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
6	MD 4B		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
7	MD 4C		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
8	MD6A		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
9	MD 6B		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
10	MD 6C		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
11	MD 9A		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
12	MD 9B		W	500ml., SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth



## **CHAIN OF CUSTODY**

ALS Laboratory: please tick →

**Sydney:** 277 Woodpark Rd Smithfield NSW 2176  
Ph: 02 8784 8535 E: samples.sydney@afserviro.com.au  
**Newcastle:** 5 Roseglen Rd Warabrook NSW 2304  
Ph: 02 4986 3433 E: samples.newcastle@afserviro.com.au

**Melbourne**: 24 Westall Rd, Sunshine VIC 3171  
Ph: 03 8559 3600; E: samples.melb@one4usenviro.com.au

**Adelaide**: 21 Birrae Rd, Pocock SA 5035  
Ph: 08 8263 4500; E: samples.adel@one4usenviro.com.au

**Perth**: 10 Head Hwy, Matilda WA 6000  
Ph: 08 9279 7855; E: samples.pert@one4usenviro.com.au

**Lauanester**: 27 Wallington St, Lauanester TAS 7250  
Ph: 03 6222 2222; E: samples.lau@one4usenviro.com.au

**V-0A Vial Container Codes:** P = Unpreserved Plastic; ORC = Nutrc Preserved ORC; SHA = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Anfright Unpreserved Plastic; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Spurts; B = Unpreserved Bag.

## CERTIFICATE OF ANALYSIS

Work Order	<b>: EW1604242</b>	Page	<b>: 1 of 10</b>
Client	<b>: KIAMA COUNCIL</b>	Laboratory	<b>: Environmental Division NSW South Coast</b>
Contact	<b>: MS JULIE MILEVSKI</b>	Contact	<b>: Glenn Davies</b>
Address	<b>: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533</b>	Address	<b>: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia</b>
Telephone	<b>: +61 02 4232 0557</b>	Telephone	<b>: 02 42253125</b>
Project	<b>: Minnamurra Landfill</b>	Date Samples Received	<b>: 09-Nov-2016 16:50</b>
Order number	<b>: 87896</b>	Date Analysis Commenced	<b>: 09-Nov-2016</b>
C-O-C number	<b>: ----</b>	Issue Date	<b>: 20-Dec-2016 16:52</b>
Sampler	<b>: Glenn Davies</b>		
Site	<b>: Minnamurra Landfill</b>		
Quote number	<b>: WO/026/15 - Minnamurra Landfill</b>		
No. of samples received	<b>: 20</b>		
No. of samples analysed	<b>: 20</b>		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

### Signatures

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong



Accreditation No. 825  
Accredited for compliance with  
ISO/IEC 17025 - Testing

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

∅ = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ED041G: LOR raised for Sulfate analysis on sample no:15, due to matrix interferences.
- It has been noted that Nitrite is greater than NOx for sample 13,14, however this difference is within the limits of experimental variation.
- It has been noted that Nitrite is greater than NOx for sample 15, however this difference is within the limits of experimental variation.
- EP002: It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.

## Analytical Results

Client sample ID				MD 1B	MD 4A	MD 2B	MD 2C	MD 2A
Compound	CAS Number	LOR	Unit	09-Nov-2016 14:00	09-Nov-2016 11:40	09-Nov-2016 11:45	09-Nov-2016 11:55	09-Nov-2016 12:30
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.6	---	6.9	7.0	7.2
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	578	---	28200	43300	21200
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	0.3	---	18.5	29.3	13.4
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	21.9	---	22.1	22.8	22.4
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	---	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	---	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	178	---	807	627	810
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	178	---	807	627	810
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	31	---	1350	2230	851
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	76	---	8360	13100	6060
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	55	---	412	463	268
Magnesium	7439-95-4	1	mg/L	8	---	708	1020	484
Sodium	7440-23-5	1	mg/L	37	---	5400	8380	3750
Potassium	7440-09-7	1	mg/L	13	---	210	304	191
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	---	---	---
Magnesium	7439-95-4	1	mg/L	---	---	---	---	---
Sodium	7440-23-5	1	mg/L	---	---	---	---	---
Potassium	7440-09-7	1	mg/L	---	---	---	---	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.019	---	0.123	0.133	0.050
Iron	7439-89-6	0.05	mg/L	<0.05	---	1.38	1.29	0.33
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	---	---	---
Iron	7439-89-6	0.05	mg/L	---	---	---	---	---

## Analytical Results

Client sample ID				MD 1B	MD 4A	MD 2B	MD 2C	MD 2A
Compound	CAS Number	LOR	Unit	09-Nov-2016 14:00	09-Nov-2016 11:40	09-Nov-2016 11:45	09-Nov-2016 11:55	09-Nov-2016 12:30
				Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.2	---	0.7	0.7	0.7
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	3.23	---	8.59	2.86	9.41
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	0.03	---	<0.01	<0.01	0.04
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	5.01	---	<0.01	<0.01	2.63
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	5.04	---	<0.01	<0.01	2.67
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	6.34	---	280	428	205
Total Cations	---	0.01	meq/L	5.58	---	---	---	---
Total Cations	---	0.01	meq/L	----	----	319	479	221
Ionic Balance	---	0.01	%	6.49	----	----	----	----
Ionic Balance	---	0.01	%	----	----	6.51	5.60	3.84
<b>EN67 PK: Field Tests</b>								
Field Observations	---	0.01	--	---	BLOCKED	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	8	---	26	18	42
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	8	---	28	18	46
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	3.11	---	2.40	2.97	3.27
Dissolved Oxygen - % Saturation	---	0.1	% saturation	35.4	---	27.6	34.4	37.7
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	---	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	1.53	---	0.58	0.62	0.47

## Analytical Results

Client sample ID				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Compound	CAS Number	LOR	Unit	09-Nov-2016 12:35	09-Nov-2016 12:45	09-Nov-2016 13:00	09-Nov-2016 13:10	09-Nov-2016 13:20
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.0	7.2	7.3	7.1	7.1
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	21200	40700	3360	1550	23100
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	13.6	27.6	1.8	0.8	14.8
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	22.4	22.1	22.9	21.9	22.2
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	999	789	780	660	424
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	999	789	780	660	424
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	410	2020	256	61	1020
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	3740	11800	590	113	7010
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	364	485	156	130	356
Magnesium	7439-95-4	1	mg/L	269	977	78	36	541
Sodium	7440-23-5	1	mg/L	2110	7900	391	84	4330
Potassium	7440-09-7	1	mg/L	132	296	87	41	147
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	---	---	---
Magnesium	7439-95-4	1	mg/L	---	---	---	---	---
Sodium	7440-23-5	1	mg/L	---	---	---	---	---
Potassium	7440-09-7	1	mg/L	---	---	---	---	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.098	0.172	0.059	0.093	0.037
Iron	7439-89-6	0.05	mg/L	1.55	1.31	0.44	0.17	0.11
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	---	---	---
Iron	7439-89-6	0.05	mg/L	---	---	---	---	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Compound	CAS Number	LOR	Unit	09-Nov-2016 12:35	09-Nov-2016 12:45	09-Nov-2016 13:00	09-Nov-2016 13:10	09-Nov-2016 13:20
				Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.6	0.8	0.8	0.6	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	39.1	2.74	16.7	33.4	25.0
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.03	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	0.15	<0.01	0.88	0.02	0.96
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	0.15	<0.01	0.91	0.02	0.96
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	134	391	37.6	17.6	227
Total Cations	---	0.01	meq/L	---	---	---	16.5	---
Total Cations	---	0.01	meq/L	135	456	33.4	---	254
Ionic Balance	---	0.01	%	---	---	---	3.27	---
Ionic Balance	---	0.01	%	0.54	7.69	5.80	---	5.59
<b>EN67 PK: Field Tests</b>								
Field Observations	---	0.01	--	---	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	32	28	34	24	12
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	32	23	37	24	11
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	3.27	2.40	3.27	3.10	3.64
Dissolved Oxygen - % Saturation	---	0.1	% saturation	37.7	27.6	37.7	35.4	41.7
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	1.04	1.09	1.19	1.18	1.36

## Analytical Results

Client sample ID				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Compound	CAS Number	LOR	Unit	09-Nov-2016 10:55	09-Nov-2016 11:15	09-Nov-2016 11:25	09-Nov-2016 10:05	09-Nov-2016 10:15
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.0	6.8	7.0	6.7	7.1
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	3100	3130	3980	37500	2070
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	1.7	1.7	2.2	25.4	1.1
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	22.2	22.5	22.6	22.1	23.2
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	671	1260	1360	486	862
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	671	1260	1360	486	862
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	45	2	<1	1940	<10
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	599	387	509	11100	236
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	40	199	135	544	97
Magnesium	7439-95-4	1	mg/L	44	95	62	984	34
Sodium	7440-23-5	1	mg/L	452	287	362	6920	121
Potassium	7440-09-7	1	mg/L	53	83	154	137	70
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	---	---	---
Magnesium	7439-95-4	1	mg/L	---	---	---	---	---
Sodium	7440-23-5	1	mg/L	---	---	---	---	---
Potassium	7440-09-7	1	mg/L	---	---	---	---	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.060	0.304	0.184	0.538	0.397
Iron	7439-89-6	0.05	mg/L	0.82	4.06	6.88	1.64	1.27
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	---	---	---
Iron	7439-89-6	0.05	mg/L	---	---	---	---	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Compound	CAS Number	LOR	Unit	09-Nov-2016 10:55	09-Nov-2016 11:15	09-Nov-2016 11:25	09-Nov-2016 10:05	09-Nov-2016 10:15
				Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.2	0.6	0.5	0.6	0.8
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	104	34.2	148	1.74	70.0
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	0.02	0.03	0.01	0.02	0.02
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	0.04	0.02	<0.01	<0.01	<0.01
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	0.06	0.05	<0.01	<0.01	<0.01
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	31.2	36.1	41.5	363	23.9
Total Cations	---	0.01	meq/L	34.1	34.8	42.1	---	19.7
Total Cations	---	0.01	meq/L	---	---	---	413	---
Ionic Balance	---	0.01	%	4.30	1.92	0.64	---	9.65
Ionic Balance	---	0.01	%	---	---	---	6.37	---
<b>EN67 PK: Field Tests</b>								
Field Observations	---	0.01	--	---	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	418	62	99	77	47
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	594	57	97	88	46
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	1.40	1.67	2.17	6.59	1.71
Dissolved Oxygen - % Saturation	---	0.1	% saturation	0.1	18.6	22.4	77.0	19.8
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	0.35	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	0.66	0.77	0.76	0.80	0.60

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 1A
Compound	CAS Number	LOR	Unit	09-Nov-2016 14:30	09-Nov-2016 10:35	09-Nov-2016 14:15	09-Nov-2016 13:45	09-Nov-2016 13:45
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	---	7.0	7.6	---	7.4
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	29600	26500	---	743
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	---	19.1	17.5	---	0.4
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	---	23.0	21.5	---	21.5
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	---	<1	<1	---	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	---	<1	<1	---	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	---	132	200	---	253
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	---	132	200	---	253
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	---	1360	1120	---	46
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	---	8900	8010	---	35
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	---	---	89
Magnesium	7439-95-4	1	mg/L	---	---	---	---	12
Sodium	7440-23-5	1	mg/L	---	---	---	---	47
Potassium	7440-09-7	1	mg/L	---	---	---	---	8
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	243	243	---	---
Magnesium	7439-95-4	1	mg/L	---	680	589	---	---
Sodium	7440-23-5	1	mg/L	---	5860	4880	---	---
Potassium	7440-09-7	1	mg/L	---	215	184	---	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	---	<0.001	0.064
Iron	7439-89-6	0.05	mg/L	---	---	---	<0.05	<0.05
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	0.145	0.123	---	---
Iron	7439-89-6	0.05	mg/L	---	0.33	0.21	---	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)	Client sample ID			ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 1A
Client sampling date / time				09-Nov-2016 14:30	09-Nov-2016 10:35	09-Nov-2016 14:15	09-Nov-2016 13:45	09-Nov-2016 13:45
Compound	CAS Number	LOR	Unit	EW1604242-016	EW1604242-017	EW1604242-018	EW1604242-019	EW1604242-020
Result								
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	---	0.8	0.6	---	1.0
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	---	0.18	0.07	---	1.18
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	---	---	---	---	0.38
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	---	---	---	---	7.19
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	---	---	---	---	7.57
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	---	---	---	---	7.00
Total Cations	---	0.01	meq/L	---	---	---	---	---
Total Cations	---	0.01	meq/L	---	---	---	---	7.68
Ionic Balance	---	0.01	%	---	---	---	---	---
Ionic Balance	---	0.01	%	---	---	---	---	4.62
<b>EN67 PK: Field Tests</b>								
Field Observations	---	0.01	--	NO ACCESS	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	---	12	10	<1	12
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	---	11	10	---	14
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	---	5.07	6.53	---	3.10
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	59.3	73.9	---	35.1
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	---	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	---	<0.01	<0.01	---	1.55



## CHAIN OF CUSTODY

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 Newcastle: 14-15 Dunes Ct, Belgrave Hill NSW 2314  
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Launceston: 27 Wellington St, Launceston TAS 7250  
Ph: 03 6231 2150 E: launceston@alsinternational.com.au

CLIENT: Klama Municipal Council

OFFICE: PO Box 75 Klama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER: 87896

PROJECT MANAGER: Paul Czulowski

SAMPLER: Craig Wilson

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 251 560

EDD FORMAT (or default):

COC emailed to ALS? ( YES / NO )

Email Reports to (will default to PM if no other addresses are listed): paulc@klama.nsw.gov.au, juliem@klama.nsw.gov.au

Email Invoice to (will default to PM if no other addresses are listed): paulc@klama.nsw.gov.au, juliem@klama.nsw.gov.au

### COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALB USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)	CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price)				Additional Information
				Where Matrix are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).				
		LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	
1	MD 1A	19.5.17	W	500mL, SP, 2 X VS, N	5	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	DOC (Filtered)	(Dissolved Filtered) Fe, Mn, NT-01 (Mg, Ca, Na, K)
2	MD 1B	19.5.17	W	500mL, SP, 2 X VS, N	5	Nitrate, Ammonia, Total Phenolics	TOC	(Total) Fe, Mn, Mg, Ca, Na, K
3	MD 2A	19.5.17	W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
4	MD 2B		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
20	MD 2C		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
5	MD 4A	18.5.17	W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
6	MD 4B		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
7	MD 4C		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
8	MD6A		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
9	MD 6B		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
10	MD 6C		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
11	MD 9A		W	1L, SP, 2 X VS, N	5	YSI (Field Tests)	YSI (Field Tests)	pH, Temp, EC, Sal, DO, Depth
TOTAL:								

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; OHC = Nitric Preserved Plastic; SH = Sodium Hydroxide Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic; V = Vial HCl Preserved; VB = VOA Vial Sulfuric Preserved; VS = VOA Vial Sulfuric Preserved; AV = Air freight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottles; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division  
Wollongong  
Work Order Reference  
**EW1702210**



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Environmental Seal/Label  
See reverse for instructions  
Date/Time: *18/05/17 16:00*

Relinquished Sample Tag  
Date/Time: *18/05/17 16:00*

Relinquished BY:  
Signature: *Alison*  
Date/Time: *18/05/17 16:00*

Received BY:  
Signature: *Annet*  
Date/Time: *18/05/17 16:00*

FOR LABORATORIES  
Environmental Seal/Label  
Work Order Reference  
**EW1702210**

Relinquished BY:  
Signature: *Alison*  
Date/Time: *18/05/17 16:00*

Received BY:  
Signature: *Annet*  
Date/Time: *18/05/17 16:00*



## CHAIN OF CUSTODY

REJ Lannan, please click >

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## CERTIFICATE OF ANALYSIS

Work Order	<b>: EW1702210</b>	Page	<b>: 1 of 10</b>
Client	<b>: KIAMA COUNCIL</b>	Laboratory	<b>: Environmental Division NSW South Coast</b>
Contact	<b>: MR PAUL CZULOWSKI</b>	Contact	<b>: Glenn Davies</b>
Address	<b>: 175 FERN STREET GERRINGONG NSW, AUSTRALIA 2534</b>	Address	<b>: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW</b>
Telephone	<b>: +61 02 4232 0444</b>	Telephone	<b>: 02 42253125</b>
Project	<b>: Minnamurra Landfill</b>	Date Samples Received	<b>: 18-May-2017 13:37</b>
Order number	<b>: 87896</b>	Date Analysis Commenced	<b>: 18-May-2017</b>
C-O-C number	<b>: ----</b>	Issue Date	<b>: 26-May-2017 09:47</b>
Sampler	<b>: Glenn Davies, Robert DaLio</b>		
Site	<b>: MINNAMURRA LANDFILL</b>		
Quote number	<b>: WO/026/15 - Minnamurra Landfill</b>		
No. of samples received	<b>: 20</b>		
No. of samples analysed	<b>: 20</b>		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

### Signatures

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Robert DaLio	Sampler	Laboratory - Wollongong, NSW



Accreditation No. 825  
Accredited for compliance with  
ISO/IEC 17025 - Testing

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- It has been noted that Nitrite is greater than NOx for sample 15, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.

## Analytical Results

Client sample ID				MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Compound	CAS Number	LOR	Unit	19-May-2017 00:00	19-May-2017 00:00	19-May-2017 12:50	19-May-2017 13:10	18-May-2017 14:20
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	---	---	7.2	7.0	---
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	---	19700	24900	---
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	---	---	13.7	17.7	---
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	---	---	18.2	18.3	---
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	---	---	<1	<1	---
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	---	---	<1	<1	---
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	---	---	798	634	---
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	---	---	798	634	---
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	---	---	701	1110	---
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	---	---	5740	7580	---
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	257	324	---
Magnesium	7439-95-4	1	mg/L	---	---	431	535	---
Sodium	7440-23-5	1	mg/L	---	---	3330	4450	---
Potassium	7440-09-7	1	mg/L	---	---	187	176	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	0.053	0.094	---
Iron	7439-89-6	0.05	mg/L	---	---	1.24	1.04	---
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	---	---	0.8	0.7	---
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	---	---	11.0	7.18	---
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	---	---	0.03	<0.01	---
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	---	---	3.57	0.05	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A	
Compound	CAS Number	LOR	Unit	Client sampling date / time	19-May-2017 00:00	19-May-2017 00:00	19-May-2017 12:50	19-May-2017 13:10	18-May-2017 14:20
				Result	Result	Result	Result	Result	Result
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	---	0.01	mg/L	---	---	3.60	0.05	---	---
<b>EN055: Ionic Balance</b>									
Total Anions	---	0.01	meq/L	---	---	192	250	---	---
Total Cations	---	0.01	meq/L	---	---	198	258	---	---
Ionic Balance	---	0.01	%	---	---	1.40	1.70	---	---
<b>EN67 PK: Field Tests</b>									
Field Observations	---	0.01	--	NOT FOUND	NOT FOUND	---	---	---	BLOCKED
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	---	1	mg/L	---	---	60	31	---	---
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	---	1	mg/L	---	---	64	33	---	---
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	---	0.01	mg/L	---	---	2.65	0.94	---	---
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	---	23.0	9.8	---	---
<b>EP035G: Total Phenol by Discrete Analyser</b>									
Phenols (Total)	---	0.05	mg/L	---	---	<0.05	<0.05	---	---
<b>FWI-EN/001: Groundwater Sampling - Depth</b>									
Depth	---	0.01	m	---	---	0.41	0.46	---	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Compound	CAS Number	LOR	Unit	18-May-2017 14:25	18-May-2017 14:30	18-May-2017 15:10	18-May-2017 15:15	18-May-2017 15:20
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	6.9	6.8	7.1	7.0	7.2
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	8830	40000	3790	1820	26200
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	5.7	30.3	2.2	1.0	18.4
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	18.3	17.6	20.1	20.3	19.0
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	860	638	676	694	411
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	860	638	676	694	411
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	115	1760	256	52	1010
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	2230	11900	619	113	7840
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	238	416	169	157	348
Magnesium	7439-95-4	1	mg/L	145	800	91	43	531
Sodium	7440-23-5	1	mg/L	1240	6830	442	104	4510
Potassium	7440-09-7	1	mg/L	103	263	96	43	157
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.065	0.190	0.061	0.110	0.076
Iron	7439-89-6	0.05	mg/L	1.11	1.48	1.06	0.18	19.5
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.8	0.7	0.5	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	42.4	3.55	18.0	36.6	37.0
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.05	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	2.76	0.22	<0.01

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
		Client sampling date / time		18-May-2017 14:25	18-May-2017 14:30	18-May-2017 15:10	18-May-2017 15:15	18-May-2017 15:20
Compound	CAS Number	LOR	Unit	EW1702210-006	EW1702210-007	EW1702210-008	EW1702210-009	EW1702210-010
			Result		Result	Result	Result	Result
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	<0.01	2.81	0.22	<0.01
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	82.5	385	36.3	18.1	250
Total Cations	---	0.01	meq/L	80.4	390	37.6	17.0	261
Ionic Balance	---	0.01	%	1.29	0.69	1.77	3.24	2.12
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	47	29	54	30	7
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	46	27	54	29	8
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	0.62	0.77	1.47	0.93	0.74
Dissolved Oxygen - % Saturation	---	0.1	% saturation	6.5	8.0	16.0	10.1	7.8
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	1.05	1.14	3.18	1.23	1.33

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Compound	CAS Number	LOR	Unit	18-May-2017 14:07	18-May-2017 13:40	18-May-2017 13:50	18-May-2017 13:00	18-May-2017 13:15
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	6.5	6.9	7.0	6.8	7.2
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	7170	3110	4050	4230	2030
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	4.6	1.9	2.5	2.6	1.2
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	18.2	18.9	18.9	19.3	20.1
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	430	1000	1170	627	695
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	430	1000	1170	627	695
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	115	<1	<1	1670	<1
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	1810	352	494	12800	185
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	109	179	109	615	100
Magnesium	7439-95-4	1	mg/L	138	93	57	988	46
Sodium	7440-23-5	1	mg/L	974	292	363	7110	167
Potassium	7440-09-7	1	mg/L	74	86	150	144	77
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.019	0.249	0.150	0.468	0.356
Iron	7439-89-6	0.05	mg/L	0.11	4.10	6.40	2.97	0.70
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	<0.1	0.6	0.5	0.6	0.7
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	14.4	36.2	146	1.78	61.9
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.03
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	0.02	0.03	0.03	0.03	<0.01

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
		Client sampling date / time		18-May-2017 14:07	18-May-2017 13:40	18-May-2017 13:50	18-May-2017 13:00	18-May-2017 13:15
Compound	CAS Number	LOR	Unit	EW1702210-011	EW1702210-012	EW1702210-013	EW1702210-014	EW1702210-015
Result								
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	0.02	0.03	0.03	0.03	0.02
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	62.0	29.9	37.3	408	19.1
Total Cations	---	0.01	meq/L	---	---	40.2	---	---
Total Cations	---	0.01	meq/L	61.0	31.5	---	425	18.0
Ionic Balance	---	0.01	%	---	---	3.24	---	---
Ionic Balance	---	0.01	%	0.80	2.57	---	1.99	2.95
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	110	59	84	71	54
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	92	60	82	76	56
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	0.15	0.91	1.16	3.36	1.98
Dissolved Oxygen - % Saturation	---	0.1	% saturation	1.6	9.7	12.3	36.0	21.7
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	0.57	0.80	0.92	0.74	0.71

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Compound	CAS Number	LOR	Unit	19-May-2017 14:00	18-May-2017 13:30	19-May-2017 12:30	19-May-2017 13:25	19-May-2017 13:20
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.5	7.1	7.8	---	7.1
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	14500	29100	4730	---	44900
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	9.8	21.7	3.0	---	34.1
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	18.2	16.9	18.1	---	18.1
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	---	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	---	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	120	158	113	---	492
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	120	158	113	---	492
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	598	1050	179	---	2020
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	4740	8070	1130	---	13600
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	---	---	416
Magnesium	7439-95-4	1	mg/L	---	---	---	---	874
Sodium	7440-23-5	1	mg/L	---	---	---	---	7500
Potassium	7440-09-7	1	mg/L	---	---	---	---	293
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	120	206	52	---	---
Magnesium	7439-95-4	1	mg/L	258	492	84	---	---
Sodium	7440-23-5	1	mg/L	2340	4270	676	---	---
Potassium	7440-09-7	1	mg/L	103	176	27	---	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	---	<0.001	0.130
Iron	7439-89-6	0.05	mg/L	---	---	---	<0.05	1.27
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.150	0.150	0.113	---	---
Iron	7439-89-6	0.05	mg/L	2.05	0.74	0.74	---	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Compound	CAS Number	LOR	Unit	19-May-2017 14:00	18-May-2017 13:30	19-May-2017 12:30	19-May-2017 13:25	19-May-2017 13:20
				Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.6	0.2	---	0.6
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	0.52	0.70	0.06	---	1.80
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	---	---	---	---	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	---	---	---	---	<0.01
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	---	---	---	---	<0.01
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	---	---	---	---	436
Total Cations	---	0.01	meq/L	---	---	---	---	426
Ionic Balance	---	0.01	%	---	---	---	---	1.06
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	11	6	14	<1	12
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	11	6	13	---	12
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	8.17	6.29	10.3	---	1.06
Dissolved Oxygen - % Saturation	---	0.1	% saturation	85.8	64.3	107	---	11.1
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	---	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	---	---	---	---	0.53



## CHAIN OF CUSTODY

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Tasmania: 100 Pittwater Rd, Port Macquarie NSW 2444  
Ph: 03 6531 2785 E:taunton@alsenviro.com

Work Order Preference  
Environmental Division

EV1703509

CLIENT: Kiama Municipal Council		PROJECT: PO Box 75 Kiama NSW 2533		OFFICE: Minnamurra Landfill		PROJECT NUMBER: 87896		TURNAROUND REQUIREMENTS:  (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)		ALS QUOTE NO.: SY-146-10		TICK ONE: <input type="checkbox"/> Standard TAT (List due date): <input type="checkbox"/> Non Standard or urgent TAT (List due date):	
SAMPLER: Craig Wilson		SAMPLE MOBILE: 0408 251 560		CONTACT PH: 4232 0418		RELINQUISHED BY: Graig Clemin		RECEIVED BY: Aneta		FOR DISPOSE: Landfill			
COC emailed to ALS? ( YES / NO)		EDD FORMAT (or default):		DATE/TIME: 17-8-17 14:45		RELINQUISHED BY: Aneta		DATE/TIME: 17-8-17 14:45		Comments:			
Email Reports to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, julien@kiama.nsw.gov.au													
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:													

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price)						Additional Information		
				TYPE & PRESERVATIVE (Refer to codes below)		TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn, NT-01 (Mg, Ca, Na, K)		(Total) Fe, Mn, Mg, Ca, Na, K	YSI (Field Results) pH, Temp, EC, Sal, DO, Depth
1	MD 1A	17-8-17 14:45	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	Destroy	✓	YSI (Field Results) pH, Temp, EC, Sal, DO, Depth
2	MD 1B	17-8-17 14:45	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	Destroy	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
3	MD 2A	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
4	MD 2B	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
5	MD 2C	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
6	MD 4A	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	Block	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
7	MD 4B	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
8	MD 4C	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
9	MD 6A	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
10	MD 6B	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
11	MD 6C	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
12	MD 9A	17-8-17 14:45	W	1L, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	Not Sampled		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; G = Amber Glass Unpreserved Plastic; AP = Airfreight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sulfuric Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Plastic; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.



#### CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT:		Kiama Municipal Council		TURNAROUND REQUIREMENTS:		<input type="checkbox"/> Standard TAT (List due date: _____)		<input type="checkbox"/> Non Standard or urgent TAT (List due date: _____)	
OFFICE:		PO Box 75 Kiama NSW 2533		(Standard TAT may be longer for some tests e.g., Ultra Trace Organics)					
PROJECT:		Minamurra Landfill		ALS QUOTE NO.:		SY-14-10			
ORDER NUMBER:				COC SEQUENCE NUMBER (Circle)					
PROJECT MANAGER:		Paul Czulowski		COC: 1    2    3    4    5    6    7					
SAMPLER:		Craig Wilson		OF: 1    2    3    4    5    6    7					
COC emailed to ALS? ( YES / NO)				RELIQUISHESED BY:		RECEIVED BY:		RELIQUISHESED BY:	
Email Reports to (will default to PM if no other addressees are listed):				Craig		RECEIVED BY:			
Email Invoice to (will default to PM if no other addresses are listed):				DATETIME:		DATETIME:		DATETIME:	
COMMENTS/SPECIAL INSTRUCTIONS OR DISCUSSION									
<input type="checkbox"/> Sydney 277 Myrtle Rd, Sutherland NSW 2176 <input type="checkbox"/> Newcastle: 5 Roseglen Rd, Wattlebank NSW 2304 <input type="checkbox"/> PO Box 4800 94-33 E samples.nsw@alsenviro.com.au <input type="checkbox"/> Ph: 02 8599 9433 E samples.nsw@alsenviro.com <input type="checkbox"/> Ph: 02 8599 0890 E. alsales@alsenviro.com <input type="checkbox"/> Ph: 02 4766 0600 E. townsville.environmetals@alsenviro.com <input type="checkbox"/> Ph: 08 8599 0890 E. alsales@alsenviro.com <input type="checkbox"/> Ph: 03 6519 5909 E. samples.melbourne@alsenviro.com <input type="checkbox"/> Ph: 03 6519 5710 E. samples.melbourne@alsenviro.com <input type="checkbox"/> Ph: 03 9217 7155 E. samples.perth@alsenviro.com <input type="checkbox"/> Ph: 03 9217 7155 E. launceston@alsenviro.com <input type="checkbox"/> Ph: 13 Hock Way, Nillahora WA 63360 <input type="checkbox"/> Ph: 03 9217 7155 E. samples.perth@alsenviro.com <input type="checkbox"/> Ph: 03 6519 2155 E. launceston@alsenviro.com									

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	SAMPLE DETAILS		CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Matrix is required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).	Additional Information
				MATRIX: Solid(S) Water(W)	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES		
13	MD 9B	17807 1240 W	500mL, SP, 2X VS, N	5	✓	✓	(Dissolved Filtered) Fe, Mn, NT-01 (Mg, Ca, Na, K)	YSI(Field Results) pH, Temp, EC, Sal, DO.
14	MD 9C	1250 W	500mL, SP, 2X VS, N	5	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10A	1205 W	500mL, SP, 2X VS, N	5	✓	✓	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth
16	MD 10B	1210 W	500mL, SP, 2X VS, N	5	✓	✓	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth	pH, Temp, EC, Sal, DO, Depth
17	Rocklow Down	1415 W	500mL, SP, 2X VS, N	5	✓	✓	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Middle	1202 W	500mL, SP, 2X VS, N	5	✓	✓	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth	pH, Temp, EC, Sal, DO, Depth
19	Rocklow Up	1140 W	500mL, SP, 2X VS, N	5	✓	✓	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth
20	Blank	1240 W	VS, N	2	✓	✓	YSI(Field Tests) pH, Temp, EC, Sal, DO, Depth	pH, Temp, EC, Sal, DO, Depth
TOTAL:								Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.

**Water Container Codes:** P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/CE Preserved; S = Sodium Hypochlorite Preserved Plastic; AG = Amber Glass Unpreserved; AS = Airfreight Unpreserved Plastic; V = VOA Vial HCl Preserved; Z = Zinc Acetate Preserved; B = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphuric Acid; SG = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SF = Sulfuric Preserved Plastic; SP = Speciation bottle.

## CERTIFICATE OF ANALYSIS

Work Order	<b>: EW1703509</b>	Page	<b>: 1 of 10</b>
Client	<b>: KIAMA COUNCIL</b>	Laboratory	<b>: Environmental Division NSW South Coast</b>
Contact	<b>: MR PAUL CZULOWSKI</b>	Contact	<b>: Glenn Davies</b>
Address	<b>: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533</b>	Address	<b>: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW</b>
Telephone	<b>: +61 02 4232 0444</b>	Telephone	<b>: 02 42253125</b>
Project	<b>: Minnamurra Landfill</b>	Date Samples Received	<b>: 17-Aug-2017 15:00</b>
Order number	<b>: 87896</b>	Date Analysis Commenced	<b>: 17-Aug-2017</b>
C-O-C number	<b>: ----</b>	Issue Date	<b>: 31-Aug-2017 11:21</b>
Sampler	<b>: Glenn Davies, Robert DaLio</b>		
Site	<b>: MINNAMURRA LANDFILL</b>		
Quote number	<b>: WO/026/15 - Minnamurra Landfill</b>		
No. of samples received	<b>: 20</b>		
No. of samples analysed	<b>: 20</b>		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

### Signatures

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW



Accreditation No. 825  
Accredited for compliance with  
ISO/IEC 17025 - Testing

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

∅ = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ED041G: LOR raised for Sulfate on sample nos: 13, 14 and 16 due to sample matrix.
- EP002: It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- EN055: Ionic Balance out of acceptable limits for samples 14 and 16 due to analytes not quantified in this report.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.

## Analytical Results

Client sample ID				MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Compound	CAS Number	LOR	Unit	17-Aug-2017 14:00	17-Aug-2017 14:05	17-Aug-2017 13:35	17-Aug-2017 13:45	17-Aug-2017 13:55
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	---	---	7.0	6.9	7.0
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	---	18400	24700	45700
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	---	---	13.3	17.9	35.2
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	---	---	16.3	17.3	17.6
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	---	---	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	---	---	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	---	---	892	694	554
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	---	---	892	694	554
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	---	---	715	1010	1900
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	---	---	5360	7270	13500
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	---	230	316	429
Magnesium	7439-95-4	1	mg/L	---	---	394	516	922
Sodium	7440-23-5	1	mg/L	---	---	2990	4120	7680
Potassium	7440-09-7	1	mg/L	---	---	164	173	301
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	---	0.049	0.067	0.139
Iron	7439-89-6	0.05	mg/L	---	---	0.48	0.49	1.24
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	---	---	0.8	0.8	0.7
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	---	---	15.2	5.62	1.82
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	---	---	0.03	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	---	---	1.24	0.07	<0.01

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 2C	
Compound	CAS Number	LOR	Unit	Client sampling date / time	17-Aug-2017 14:00	17-Aug-2017 14:05	17-Aug-2017 13:35	17-Aug-2017 13:45	17-Aug-2017 13:55
				Result	Result	Result	Result	Result	Result
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	---	0.01	mg/L	---	---	1.27	0.07	<0.01	
<b>EN055: Ionic Balance</b>									
Total Anions	---	0.01	meq/L	---	---	184	240	431	
Total Cations	---	0.01	meq/L	---	---	178	242	439	
Ionic Balance	---	0.01	%	---	---	1.59	0.39	0.87	
<b>EN67 PK: Field Tests</b>									
Field Observations	---	0.01	--	DESTROYED	DESTROYED	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	---	1	mg/L	---	---	54	30	16	
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	---	1	mg/L	---	---	55	30	20	
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	---	0.01	mg/L	---	---	0.96	0.47	0.68	
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	---	9.9	5.4	7.2	
<b>EP035G: Total Phenol by Discrete Analyser</b>									
Phenols (Total)	---	0.05	mg/L	---	---	<0.05	<0.05	<0.05	
<b>FWI-EN/001: Groundwater Sampling - Depth</b>									
Depth	---	0.01	m	---	---	0.48	0.66	0.74	

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Compound	CAS Number	LOR	Unit	Client sampling date / time	17-Aug-2017 13:00	17-Aug-2017 13:00	17-Aug-2017 13:15	17-Aug-2017 13:00	17-Aug-2017 13:10
				Result	EW1703509-006	EW1703509-007	EW1703509-008	EW1703509-009	EW1703509-010
<b>EA005FD: Field pH</b>									
pH	---	0.1	pH Unit	---	6.8	6.8	7.2	7.0	
<b>EA010FD: Field Conductivity</b>									
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	13200	41400	2670	1620	
<b>EA020FD: Field Salinity</b>									
Salinity	---	0.2	g/L	---	9.1	31.8	1.6	0.9	
<b>EA116: Temperature</b>									
Temperature	---	0.1	°C	---	17.2	17.2	19.8	20.0	
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	---	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	---	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	---	883	619	679	636	
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	---	883	619	679	636	
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>									
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	---	304	1700	160	47	
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L	---	3540	12700	348	109	
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L	---	282	408	126	140	
Magnesium	7439-95-4	1	mg/L	---	232	842	63	35	
Sodium	7440-23-5	1	mg/L	---	1800	7110	271	84	
Potassium	7440-09-7	1	mg/L	---	114	277	65	39	
<b>EG020F: Dissolved Metals by ICP-MS</b>									
Manganese	7439-96-5	0.001	mg/L	---	0.077	0.180	0.040	0.080	
Iron	7439-89-6	0.05	mg/L	---	1.29	1.38	0.20	0.10	
<b>EK040P: Fluoride by PC Titrator</b>									
Fluoride	16984-48-8	0.1	mg/L	---	0.6	0.9	0.8	0.5	
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L	---	41.2	2.06	13.0	34.4	
<b>EK057G: Nitrite as N by Discrete Analyser</b>									
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	<0.01	0.11	0.04	
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
Nitrate as N	14797-55-8	0.01	mg/L	---	0.14	<0.01	6.09	0.56	

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B	
Compound	CAS Number	LOR	Unit	Client sampling date / time	17-Aug-2017 13:00	17-Aug-2017 13:00	17-Aug-2017 13:15	17-Aug-2017 13:00	17-Aug-2017 13:10
				Result	Result	Result	Result	Result	Result
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.14	<0.01	6.20	0.60	
<b>EN055: Ionic Balance</b>									
Total Anions	---	0.01	meq/L	---	124	406	26.7	16.8	
Total Cations	---	0.01	meq/L	---	114	406	24.9	14.5	
Ionic Balance	---	0.01	%	---	3.97	<0.01	3.47	7.17	
<b>EN67 PK: Field Tests</b>									
Field Observations	---	0.01	--	BLOCKED	---	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	---	1	mg/L	---	41	24	43	29	
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	---	1	mg/L	---	40	24	46	29	
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	---	0.01	mg/L	---	0.65	0.50	0.95	0.87	
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	7.1	6.1	10.4	9.7	
<b>EP035G: Total Phenol by Discrete Analyser</b>									
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>									
Depth	---	0.01	m	---	1.08	1.10	1.15	1.24	

## Analytical Results

Client sample ID				MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Compound	CAS Number	LOR	Unit	17-Aug-2017 13:20	17-Aug-2017 12:30	17-Aug-2017 12:40	17-Aug-2017 12:50	17-Aug-2017 12:05
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.0	---	7.0	7.0	6.9
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	23300	---	30300	3590	33500
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	15.9	---	22.4	2.2	25.5
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	19.7	---	17.4	18.5	16.6
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	---	<1	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	---	<1	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	393	---	1110	1200	384
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	393	---	1110	1200	384
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	935	---	<10	<10	1600
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	6700	---	346	414	9910
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	310	---	157	110	818
Magnesium	7439-95-4	1	mg/L	461	---	79	58	890
Sodium	7440-23-5	1	mg/L	3750	---	261	294	5040
Potassium	7440-09-7	1	mg/L	133	---	75	123	112
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.043	---	0.211	0.127	0.258
Iron	7439-89-6	0.05	mg/L	0.09	---	2.54	4.51	0.16
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.4	---	0.6	0.4	0.5
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	23.0	---	39.8	108	0.11
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	---	<0.01	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	0.93	---	<0.01	0.24	0.22

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 6C	MD 9A	MD 9B	MD 9C	MD 10A	
Compound	CAS Number	LOR	Unit	Client sampling date / time	17-Aug-2017 13:20	17-Aug-2017 12:30	17-Aug-2017 12:40	17-Aug-2017 12:50	17-Aug-2017 12:05
				Result	Result	Result	Result	Result	Result
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	---	0.01	mg/L	0.93	---	<0.01	0.24	0.22	
<b>EN055: Ionic Balance</b>									
Total Anions	---	0.01	meq/L	216	---	31.9	35.6	320	
Total Cations	---	0.01	meq/L	220	---	27.6	26.2	336	
Ionic Balance	---	0.01	%	0.83	---	7.27	15.3	2.38	
<b>EN67 PK: Field Tests</b>									
Field Observations	---	0.01	--	---	NOT SAMPLED	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	---	1	mg/L	13	---	62	70	40	
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	---	1	mg/L	13	---	63	72	42	
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	---	0.01	mg/L	0.72	---	1.48	0.33	5.55	
Dissolved Oxygen - % Saturation	---	0.1	% saturation	8.0	---	15.6	3.5	57.4	
<b>EP035G: Total Phenol by Discrete Analyser</b>									
Phenols (Total)	---	0.05	mg/L	<0.05	---	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>									
Depth	---	0.01	m	1.41	---	0.55	0.78	0.62	

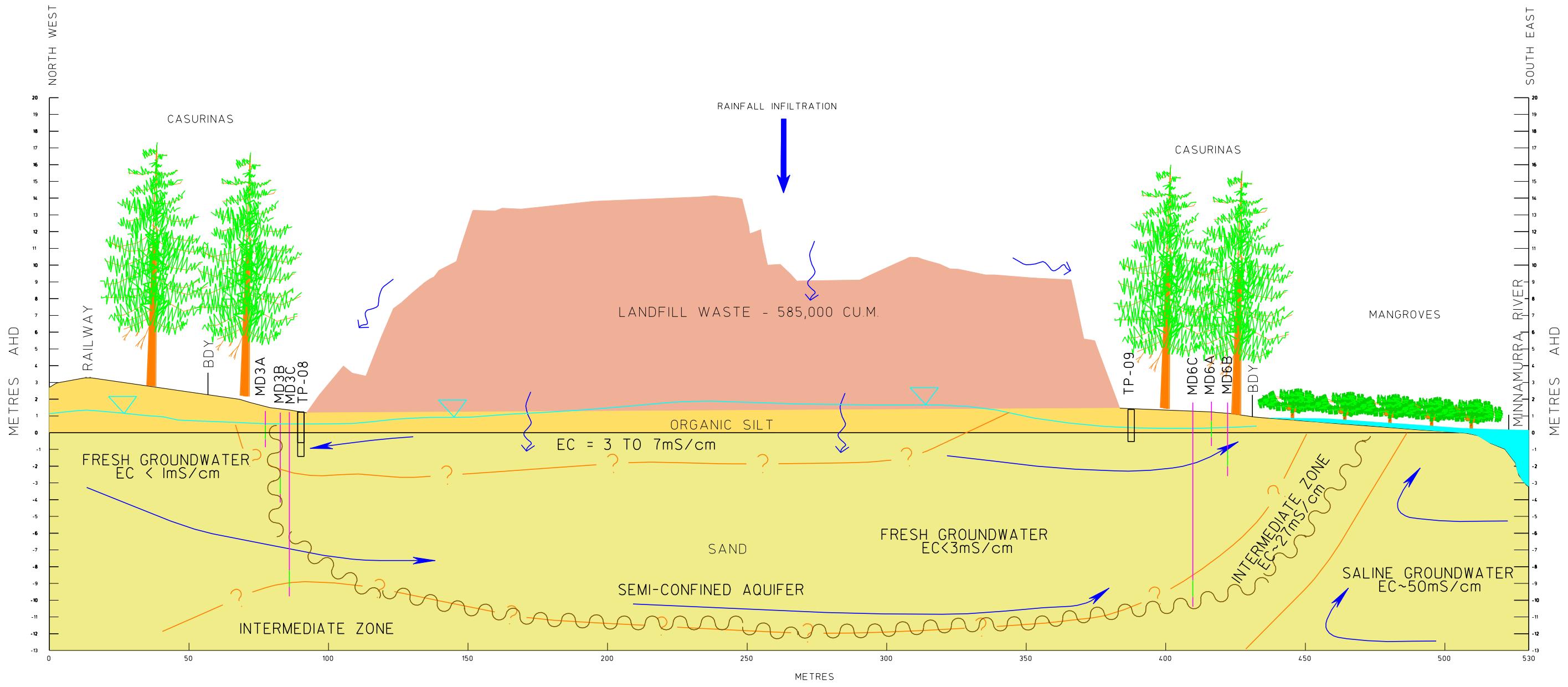
## Analytical Results

Client sample ID				MD 10B	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK
Compound	CAS Number	LOR	Unit	17-Aug-2017 12:10	17-Aug-2017 11:15	17-Aug-2017 12:00	17-Aug-2017 11:40	17-Aug-2017 12:40
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	---	0.1	pH Unit	7.0	7.2	7.2	7.7	---
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	2030	29100	14800	30000	---
<b>EA020FD: Field Salinity</b>								
Salinity	---	0.2	g/L	1.2	23.6	9.8	23.0	---
<b>EA116: Temperature</b>								
Temperature	---	0.1	°C	19.0	17.0	19.4	15.9	---
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	<1	<1	---
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	<1	<1	---
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	762	152	123	127	---
Total Alkalinity as CaCO <sub>3</sub>	---	1	mg/L	762	152	123	127	---
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	<10	1570	695	1540	---
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	172	8980	4770	9510	---
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	87	---	---	---	---
Magnesium	7439-95-4	1	mg/L	38	---	---	---	---
Sodium	7440-23-5	1	mg/L	144	---	---	---	---
Potassium	7440-09-7	1	mg/L	68	---	---	---	---
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	---	245	127	255	---
Magnesium	7439-95-4	1	mg/L	---	704	344	735	---
Sodium	7440-23-5	1	mg/L	---	5900	2910	5920	---
Potassium	7440-09-7	1	mg/L	---	217	102	222	---
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.282	---	---	---	<0.001
Iron	7439-89-6	0.05	mg/L	0.69	---	---	---	<0.05
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	---	0.058	0.085	0.055	---
Iron	7439-89-6	0.05	mg/L	---	0.26	0.34	0.17	---

## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 10B	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK
Compound	CAS Number	LOR	Unit	17-Aug-2017 12:10	17-Aug-2017 11:15	17-Aug-2017 12:00	17-Aug-2017 11:40	17-Aug-2017 12:40
				Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.8	0.9	0.8	0.8	---
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	73.7	1.59	0.20	0.05	---
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	---	---	---	---
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	---	---	---	---
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	---	---	---	---
<b>EN055: Ionic Balance</b>								
Total Anions	---	0.01	meq/L	20.1	---	---	---	---
Total Cations	---	0.01	meq/L	15.5	---	---	---	---
Ionic Balance	---	0.01	%	13.0	---	---	---	---
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	---	1	mg/L	56	6	7	8	<1
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	---	1	mg/L	56	7	7	7	---
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	---	0.01	mg/L	0.40	7.31	7.40	9.09	---
Dissolved Oxygen - % Saturation	---	0.1	% saturation	5.3	76.7	74.5	92.9	---
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	---
<b>FWI-EN/001: Groundwater Sampling - Depth</b>								
Depth	---	0.01	m	0.72	---	---	0.70	---

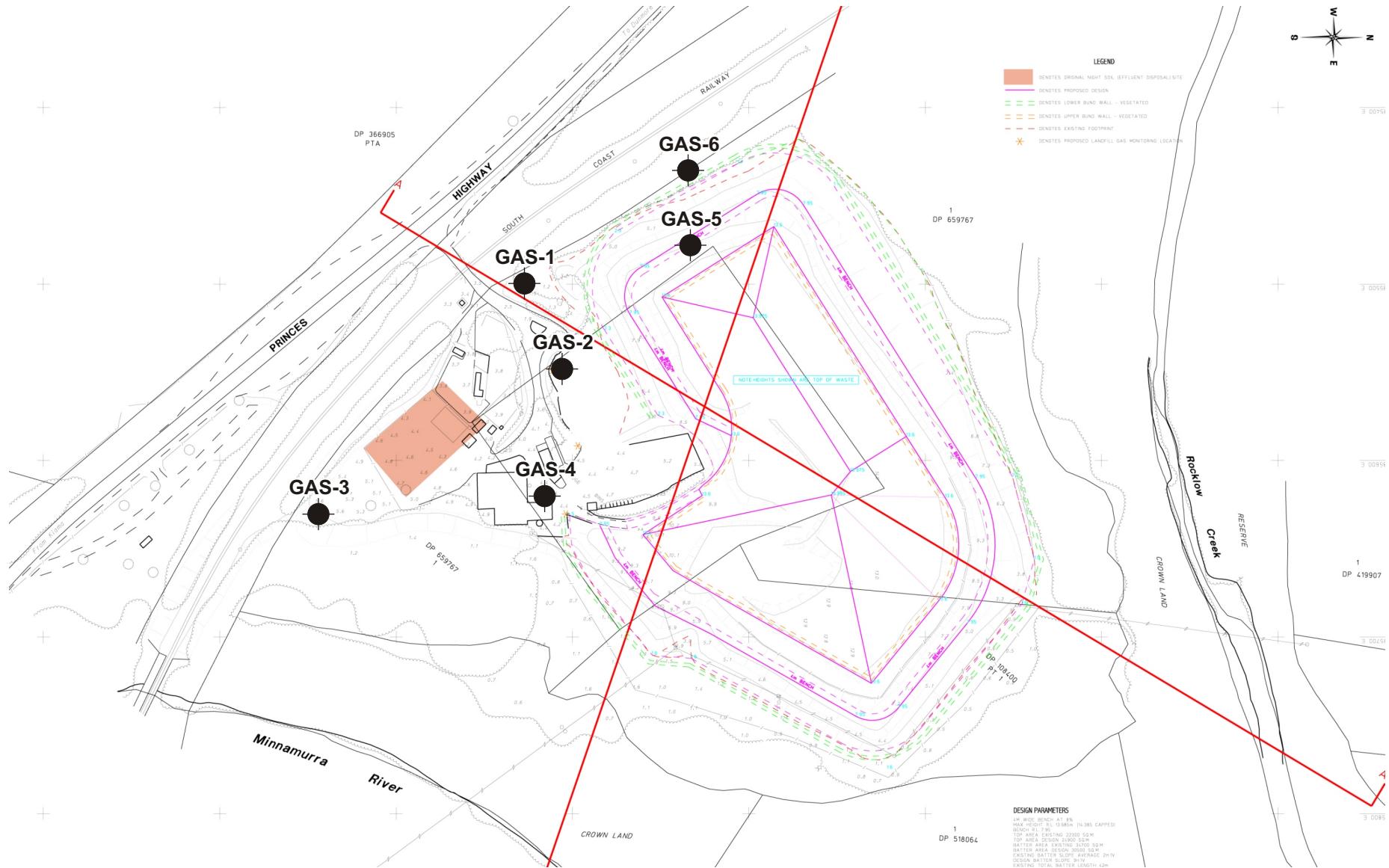
## Appendix B



SECTION B - B1

- LEGEND**
- Wavy line: INFERRED EXTENT OF LEACHATE PLUME
  - Blue arrow: INFERRED LEACHATE MOVEMENT
  - Cyan line: INFERRED GROUNDWATER LEVEL
  - Blue arrow: INFERRED LOCAL REGIONAL GROUNDWATER FLOW
  - Cyan line: EXTENT OF HIGH TIDE LEVEL (& SALINE LEVEL)
  - Pink line: MONITORING WELL
  - Green line: WELL SCREEN INTERVAL

## Appendix C



## GAS WELL MONITORING LOCATIONS

KIAMA MUNICIPAL COUNCIL - MINNAMURRA LANDFILL

Date: 7 August 2006

Reference: E2W\_047\_10.cdr

Figure 1

# LANDFILL GAS MONITORING

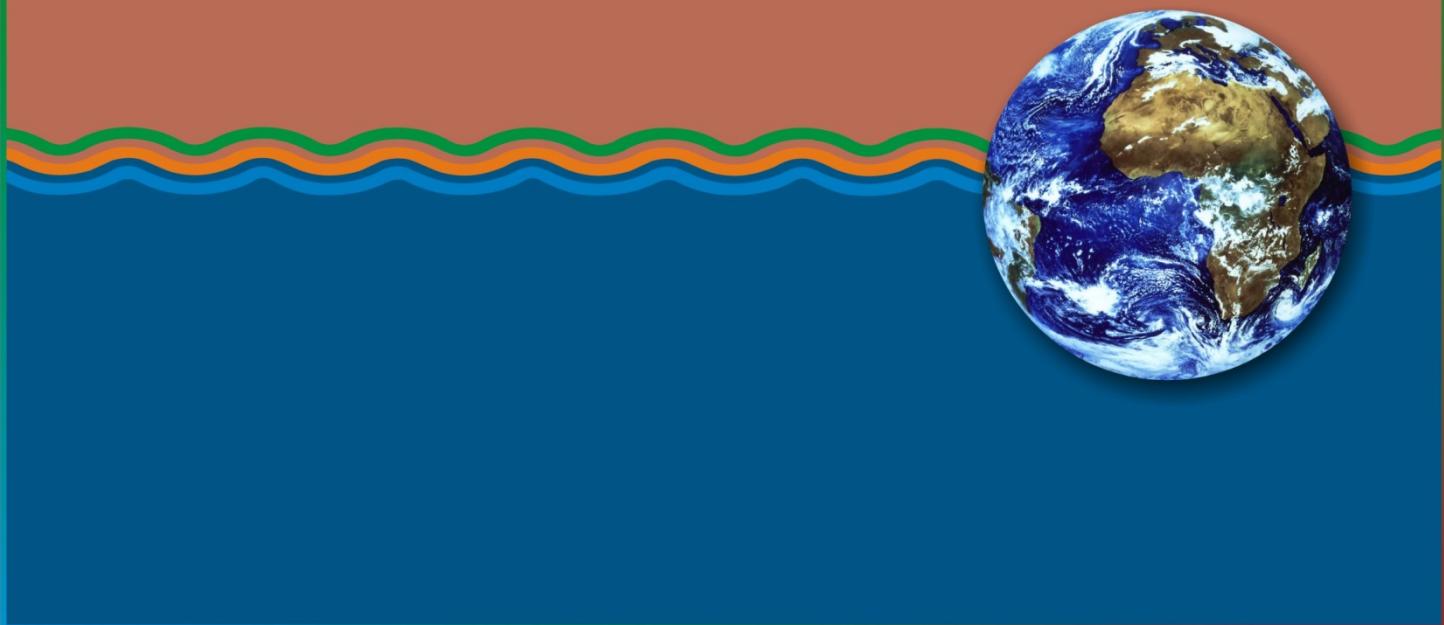
GAS 1	Site Entrance		TRENCH	North Bank Middle
GAS 2	40m South of Landfill (Removed)		TRENCH	South Bank Side
GAS 3	Carpark South of Landfill		TRENCH	East Bank Side
GAS 4	Next to Secondhand Shop		TRENCH	North Bank East Side
TRENCH 1	West Bank		TRENCH	Lower Level South Side
TRENCH 2	North Bank West Side			

WELL ID	DATE	TIME	LEL PPM				COMMENTS	
			MAX		STABLE			
			LEL%	PPM	LEL%	PPM		
Trench 4	24-Jan-17	1315		1,100		500	Good Readings	
Trench 1	24-Jan-17	1320	95	700		230	*****	
Trench 2	24-Jan-17	1325		450		110	*****	
Trench 3	24-Jan-17	1330	100	1,000		200	*****	
Trench 6	24-Jan-17	1335		700		140	*****	
Trench 5	24-Jan-17	1340	100	750		150	*****	
Trench 7	24-Jan-17	1345	90	1,100		190	*****	
Gas 1	24-Jan-17	1350		200		100	*****	
Gas 2							Removed due to new CRC site	
Gas 3	24-Jan-17	1355		350		130	Good Readings	
Gas 4	24-Jan-17	1400		350		110	*****	
Weighbridge	24-Jan-17	1245		0		0	All Building with clear readings	
Cleaning Shed	24-Jan-17	1250		0		0	*****	
MRF	24-Jan-17	1300		0		0	*****	
Lunchroom	24-Jan-17	1305		0		0	*****	
Ute Shed	24-Jan-17	1310		0		0	*****	
Trench 4	15-Jun-17	945		900		420	Good Readings Slight Wind Blowing	
Trench 1	15-Jun-17	950	98	700		180	*****	
Trench 2	15-Jun-17	955		430		100	*****	
Trench 3	15-Jun-17	1000	100	1,100		180	*****	
Trench 6	15-Jun-17	1005		680		150	*****	
Trench 5	15-Jun-17	1010	100	600		120	*****	
Trench 7	15-Jun-17	1015	100	1,000		170	*****	
Gas 1	15-Jun-17	1020		300		120	*****	
Gas 2							Removed due to new CRC site	
Gas 3	15-Jun-17	1025		350		120	Good Readings Slight Wind Blowing	
Gas 4	15-Jun-17	1030		300		100	*****	
Weighbridge	15-Jun-17	910		0		0	All Building with clear readings	
Cleaning Shed	15-Jun-17	915		0		0	*****	
MRF	15-Jun-17	920		0		0	*****	
Lunchroom	15-Jun-17	925		0		0	*****	
Ute Shed	15-Jun-17	930		0		0	*****	
Trench 4	6-Oct-17	1030		1,100		400	Good Readings	
Trench 1	6-Oct-17	1035	100	740		160	Good Readings	
Trench 2	6-Oct-17	1040		440		150	*****	
Trench 3	6-Oct-17	1045	100	1,200		210	*****	
Trench 6	6-Oct-17	1050		680		220	*****	
Trench 5	6-Oct-17	1055	100	740		340	*****	
Trench 7	6-Oct-17	1100	95	1,250		320	*****	
Gas 1	6-Oct-17	1110		200		180	*****	
Gas 2							Removed due to new CRC site	
Gas 3	6-Oct-17	1120		350		100	Good Readings	
Gas 4	6-Oct-17	1125		350		100	Good Readings	
Weighbridge	6-Oct-17	1130		0		0	All Building with clear readings	
Cleaning Shed	6-Oct-17	1135		0		0	*****	
MRF	6-Oct-17	1140		0		0	*****	
Lunchroom	6-Oct-17	1145		0		0	*****	
Ute Shed	6-Oct-17	1150		0		0	*****	

CALIBRATED WITH SPAN GAS:

Note: LEL % from inside trench pipe cap (not needed, but recorded)

## LAST PAGE OF REPORT



***Thank you for the opportunity to work with  
Council.***

Feedback is welcomed at Earth2Water  
(dino@earth2water.com.au)

