



Kiama Municipal Council

# Minnamurra Waste Disposal Depot Annual Groundwater & Surface Water Monitoring Report – 2014 to 2015

Report E2W-059 (R001a)

9 November 2015



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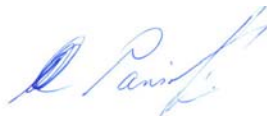
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Minnamurra Waste Disposal Depot  
(EPL 2014 to 2015)

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## 1. INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Kiama Municipal Council (KMC) to provide the 2014 to 2015 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 (formerly Ecowise) and previous monitoring reports by E2W (2004 - 2014), Eco-engineers Pty Ltd and Forbes Rigby Pty Ltd (pre 2004).

This monitoring report for the MWDD is based on quarterly monitoring results (17 November 2014, 26 February 2015, 27 May 2015, and 10 August 2015) 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 (i.e. food waste trial), 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 2014 to 2015 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 DECCW with a summary of the monitoring results obtained in the 2014-2015 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 (Ecowise) during 2014 and 2015. The annual reporting period covers four quarterly monitoring events in November 2014, February 2015, May 2015 and August 2015 (Figures 1 & 2).

Each monitoring event comprised the following:

- Sampling of onsite and offsite groundwater wells 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<sup>2</sup>).

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 2013 to August 2014) 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.

### 3. ENVIRONMENTAL SETTING

The Minnamurra Waste Disposal and Recycling Depot (MWDD) is located 1 km north of the Minnamurra township (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> MD1B was not accessible. The shallow well was consistently dry MD4A. Several wells were dry (50%) on occasions: MD2A MD6A, MD9A, MD10A.

<sup>2</sup> No sample from Rocklow-down due to access restrictions

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 receipt & 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 2014 to July 2015 was 1269<sup>3</sup> mm which is higher than the previous monitoring periods. (i.e. August 2013 to July 2014 = 873.0 mm<sup>4</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). The higher rainfall in 2014-2015 is interpreted to be reflected in higher water levels and ammonia spikes at two wells (MD9C and MD10B).

### 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).

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<sup>3</sup> Bombo Headland

<sup>4</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 (~0.02), and potentially reverses at high tide.

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, 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 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 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 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 marine environment.

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 is to be re-established once access is made available by Council).

#### **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 (MD1B<sup>5</sup>, 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 2014, February 2015, May 2015 and August 2015 of each reporting period) to establish water quality trends post landfill rehabilitation works.

Some of the groundwater monitoring locations (i.e. MD2A, MD4A, MD6A, MD9A, MD10A) are sampled (50%) of the occasions (i.e. shallow wells are commonly dry or don't not 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 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).

<sup>5</sup> No access available to MD-1B



## 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, and 2012-2013). Quarterly sampling in the 2014 to 2014 reporting period was undertaken on the following dates:

- 17 November 2014,
- 26 February 2015,
- 27 May 2015; and
- 10 August 2015.

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 (September 2014, January 2015, May 2015 and September 2015) during the 2014/15 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 (2014/2015) from the trenches (biofilter pads, Trench 1 to Trench 7) and gas monitoring wells (Gas 1 to Gas 3, Gas 4) showed similar concentrations to previous years (2010/2011/2012/2013/2014). Methane gas readings were consistent at each sampling event through the monitoring period. The maximum methane (stable) gas reading was 600 ppm at Trench 4 (Jan 2015). The lowest readings were 100 ppm at several locations: Trench 2,3,4, in Sept 2015, Trench -2, 6 in Sept 2014. Several gas well locations reported low concentrations of 100ppm at Gas-1,2,4 on several occasions in 2014 and 2015. The highest readings at each sampling event were recorded at either Trench 4, Trench 1 & 7. Buildings were sampled for landfill gas in 2014 and 2015, 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, no change to the landfill and nature of onsite buildings (well vented or air conditioned office).

## 5.2 Surface and Groundwater Monitoring Locations

Groundwater monitoring was undertaken from up to 13 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 2014 and 2015 reporting period are outlined below:

- 26 November 2013. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 6 February 2014. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down.
- 6 May 2014. Groundwater wells: MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down;
- 18 August 2014. Groundwater wells: MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, & Rocklow-Down.

Out of the 13 wells that were “not” tested in the 2014 and 2015 reporting period, but are part of the EPL include:

- MD1B. No access in all 4 rounds
- MD4A. Dry/damaged well in all 4 rounds
- MD2A, MD6A, MD9A, MD10A. Shallow wells were sampled in 2 out of the 4 rounds due to absence of water.

It is noted that shallow wells tend to be dry at time of sampling. 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 Quality 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 2014 to 2015 Reporting Period**

Sample ID	Screen Interval (m AHD) - or Sample Location	Nov 2014	Feb 2015	May 2015	Aug 2015
(MD1A)	0.5 to -0.5				
MD1B	-4.7 to -5.7	No Access	No Access	No Access	No Access
MD2A	0.525 to -0.475	Dry	Dry	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
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	Dry	Dry	X	X
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	Dry	X	Dry	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 (no sample)	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 2014/15 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 2015) for ammonia (mg/L) is presented in Graph-1, Graph-2 and Graph-3. The graphs highlight ammonia groundwater quality trends

over the past ~ 15 years (January 1999 to August 2015). 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 waters in and around landfills, 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 2014/15 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 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 2014/15 reporting period are similar to previous years and reflect changes in rainfall and tide levels.

The reduced groundwater levels (m AHD) from the 13 wells sampled in 2014/15<sup>6</sup> indicate a relatively low water table elevation (<1 m AHD), which is characteristic of the swamp/estuarine environment. The annual rainfall from August 2014 to July 2015 was 1269 mm (Albion Park Airport), which was lower than the previous monitoring period (August 2013 to July 2014=873 mm, August 2012 to July 2013=1201.8 mm)<sup>7</sup>.

Recharge to the aquifer system beneath and surrounding the waste disposal facility mainly occurs from rainfall infiltration and storm water runoff around the footprint. Some minor recharge may be occurring through the landfill mound (<5% of annual rainfall). It is likely infiltration of rainfall is moderate-high around the footprint area (uncapped areas, silty/sandy soils) due to the low elevation and accumulated run-off from the batter slopes and spillways.

### 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).

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<sup>6</sup> Note: MD2A, MD7 and MD10B have no RL measurement.

<sup>7</sup> Note: data from Kiama (Bombo Headland) (Station ID 068242), ~4.5 km SSE of MWDD.

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).

#### **6.1.2.1 Field pH**

The pH from the 13 wells (MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) ranged from pH 6.4 to 7.4 in the 2014-15 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 ranged from approximately 1.38 to 44.10 mS/cm in the 2014/15 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 13 wells recorded field dissolved oxygen (DO) concentrations ranging between 0.76 to 5.95 mg/L in the 2014/15 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 2014/15 reporting period (note: Total nitrogen is not an EPL requirement).

Four (MD2A, 2C, 4B, 6A) out of the 13 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 2014/2015 concentrations ranged from <0.01 (non-detected/below LOR) to 4.02 mg/L (MD-4B), which is lower than previous years. Nitrate has been detected in more wells in the 2013/2014 monitoring round (nine wells above ANZECC 2000) in comparison to the 2012/2013 monitoring round (eight wells above ANZECC 2000) and the 2011/2012 monitoring round (five wells above ANZECC 2000).

The “average” nitrate concentrations for 2014/15 were lowest at MD10B (at LOR) whilst highest at MD2B (1.46 mg/L) and MD4B (1.19 mg/L).

The “average” nitrate concentrations for 2013/14 were lowest at MD9B (0.38 mg/L) whilst highest at MD2B (3.20 mg/L) and MD4B (2.18 mg/L). During 2012/13, wells MD9C (0.01 mg/L) and MD4B (6.68 mg/L) were reported as the lowest and highest average (nitrate) 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). Five of the wells (MD6B, MD6C, MD9B, MD9C, MD10B) 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 all 4 rounds of sampling.

Groundwater from the wells 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). Well (**MD9C**) reported the maximum ammonia of **170** mg/L (November 2014), which is higher than the maximum in 2012/13 (ammonia=122 mg/L) and in 2010/2011 (ammonia= 118 mg/L). Ammonia trends over time are presented in Graphs 1 to 3. Highest ammonia correlates with the main downgradient area (plume centreline) of the waste mound and above average rainfall conditions.

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 2015 change to a possible declining ammonia trend).



#### 6.1.4 Ammonia Trends

The groundwater ammonia trends from 1999 to 2015 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 2014)**

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	Overall Decreasing, but variable
MD2B	Overall Decreasing, but variable	MD4C	Overall Decreasing
MD2C	Overall Decreasing, but variable	MD9B	Overall Decreasing, but variable
MD6B	Overall Decreasing, but variable	MD9C	<b>Rising trend</b> & peaks in late 2011, late 2012 and again in mid & late 2014 and 2015.
MD6C	Overall Decreasing, but variable	MD10B	Variable- 2015 has possible decreasing trend

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

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

Monitoring reports (e.g. E2W, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2013-2014) 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>8</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)<sup>7</sup>. Rainfall of 289 mm in February and 213.2mm in March (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 2015 are interpreted to be associated with high recharge rainfall events.

<sup>8</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 2014/15 ammonia generally continues to decrease (variably) in wells compared with previous monitoring periods, but with continued variability (Graph-1 to Graph-3) likely due to rainfall spikes. During the 2014/15 reporting period, 6 wells (MD4B, MD9C and MD10B) showed a temporary rise in ammonia concentrations in during late 2014 and in 2015. Two wells with elevated concentrations of ammonia show variable and increasing trends (MD9C and MD10B). Recent results (2015) indicate possible reversal of the increasing ammonia trend.

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 a high tide) around the landfill footprint.

Results from the 2014/2015 monitoring period and 2013/14 monitoring period are similar to the 2013/14 and 2012/13 monitoring periods (i.e. some variable, but generally decreasing ammonia trend and leachate impact). Future monitoring is required to assess ammonia trends and characteristics (declines, variations etc), especially at MD9C and MD10B 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 2014/15 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 Hydrogeochemical 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)**

Total iron (filtered at the laboratory) ranges from the 0.11 mg/L at MD2C to 16.3 mg/L (MD6C). With the exception of MD6B all the groundwater wells reported ANZECC (2000) exceedances (freshwater ecosystems, 0.3 mg/L) in at least one in 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 0.016 mg/L (MD2C) to 0.581 mg/L (MD10A). 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 0.2 mg/L (MD9A) to 1.1 (MD4C). 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 dissolved organic carbon (DOC) ranged from 8 to 551 mg/L in the 2014/15 reporting period (MD6C & MD9A, respectively). Concentrations of total organic carbon (TOC) ranged from 7 mg/L (MD6C) to 523 mg/L (MD9A) in the 2014/15 reporting period. ANZECC (2000) guidelines do not exist for DOC or TOC. The DOC/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) and were below marine water trigger values (ANZECC 2000, 0.4 mg/L) at all wells in all monitoring rounds. Future groundwater monitoring will determine if phenol concentrations warrant further assessment (i.e. not required based on current data).

### **6.2 Surface Water**

Surface water sampling was undertaken quarterly during the 2014/15 reporting period (EPL requirement is only six-monthly sampling). Samples were collected from two locations along the estuarine reach of Rocklow Creek on November 2014, whilst three locations (including Rocklow

down) on February, May and August 2015 (Figure 2). ALS previous attempts to sample at Rocklow-down were impeded due to thick vegetation, and was subsequently relocated for accessibility (commencing February 2015).

The surface water locations are considered limited to assess water quality impacts from the MWDD (i.e. additional mid-stream sample location is presented in Figure 2). It is noted that impacts to Rocklow Creek water quality may be occurring from Shellharbour Waste Disposal Depot, which is situated on the northern side of Rocklow Creek and from runoff from agricultural and residential land in the catchment.

The three surface water locations are not sampled according to tidal levels (i.e. Rocklow Creek has marine water influences which is a mixture of groundwater discharge and tidal water), therefore nutrients concentrations are likely to vary due to tidal water influence.

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 (6.8 to 7.6) in 2014/15, 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 (0.436 to 10.3 mS/cm). EC values are generally lower than previous results, however may relate to timing of sampling (tidal range). Sampling at low tide would result in decreased salinity due to an increased baseflow (fresh groundwater) contribution.

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

### **6.2.2.1 Nitrogen**

Rocklow Creek surface water samples collected in the 2014/15 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). Concentrations of nitrate were all at or

below 0.40 mg/L (ANZECC (2000), lower than the trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level).

Water samples collected from Rocklow Creek during 2014/15 reporting period generally show an increase (of up to 0.23 mg/L) in ammonia in the midstream sample compared to the upstream sample. 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 and MD-10B which have elevated and irregular ammonia trends).

Ammonia concentrations in Rocklow Creek (2014/15) are generally comparable and slightly lower than previous results (2013/2014, 2012/13 and 2011/12, Table SW-2).

Increases in ammonia from upstream to downstream of the landfill have been observed over 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 cannot be 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-Down show a declining 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).

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

Total phosphorus (TP) is not an EPL requirement and were not analysed during the 2014/15 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 (DOC and Phenols)**

Concentrations of dissolved organic carbon (DOC) ranged from 7 to 14 mg/L in the 2014/15 reporting period (Rocklow-Middle & Down locations). No recommended ANZECC (2000) guidelines exist for DOC (concentrations could be related to natural waters or leachate).

Concentrations of phenols were below LOR (0.05 mg/L) in all other surface water samples in all monitoring rounds.

The source and nature (possible sample bottles, gloves used for sampling, laboratory contamination) of phenols is not well known (concentrations are below guidelines).

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

The results of 2014/15 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 2015) confirm that ammonia concentrations are elevated above background levels. Improvement in groundwater quality (i.e. a decreasing ammonia trend) is evident in six wells (MD2B, MD2C, MD4B, MD4C, MD6B, 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 and March-April 2014 and late 2014).

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 and de-nitrification 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 reporting period (Table SW-2). This net increment is lower than 2013/2014, 2012/13, however increments are also dependant on tidal flows during sampling.

The ammonia in groundwater (MD-9C and MD-10B) during 2014/15 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). Downstream ammonia concentrations have declined 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.

Ammonia and nitrate concentrations in all surface water samples collected in the 2014/15 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>9</sup> from November 2014 to August 2015 (EPL reporting period). Monitoring data collected during the 2014/2015 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 site. Ammonia levels reported by the laboratory exceed the ANZECC (2000) guidelines for the protection of fresh and marine water ecosystems at all monitoring wells sampled.
- 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 (13.8 mg/L), MD4B (45.4 mg/L), MD4C (1.68 mg/L), MD6B (44.4 mg/L), MD6C (39.8 mg/L), MD9B (33.2 mg/L), MD10B (97 mg/L) and the maximum at MD9C

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<sup>9</sup> Council has conducted additional monitoring at the site as the EPL only requires 6 monthly sampling.



(170 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 during the 2014/15 reporting period ranged from not detected to 4.02 mg/L (MD2B). All 13 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). Nitrate concentrations are comparable and lower with those previously reported in 2013/2014 and those reported in 2011/12 (MD9C = 8.17 mg/L).
- Ammonia concentrations in the 2014/15 monitoring period continue to be elevated and variable, however show a clear overall decreasing trend, with two exceptions (MD9C and MD10B). 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 2014/15 monitoring period Rocklow-Down (downstream) was sampled three times in 2015 due to sample relocation (previously un-accessible). Low concentrations of ammonia and nitrate (i.e. below ANZECC 2000 trigger values) were reported from the upstream, mid and down stream locations on Rocklow Creek during the 2014/15 reporting period. A minor increase occurs in the downstream sample locations (or Rocklow-Mid). The actual difference between upstream and downstream concentrations has reduced since 1999 (Graph 4, reflecting reduced leachate migration from the capped waste mound).
- The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in the 2014/15 reporting period (Table SW-2). This "net incremental average" is lower than previous years (2012/13 averaged net incremental increase = 0.315 and 2011/12 averaged net incremental increase = 0.91 mg/L). The elevated ammonia in nearby groundwater (MD-9C and MD-10B) may be contributing to the nutrient concentrations in the surface water (Rocklow-Mid/downstream), however further monitoring is required to verify this interpretation (possible other sources such as the 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.
- Bimonthly testing of the gas monitoring wells (Gas 1 to 3, Gas 4) and trenches (Trench 1 to Trench 7 -the biofilter pads) indicated that gas levels are comparable with previous years. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings on September 2014, January 2015, May 2015 and September 2015 (annual monitoring).
- KMC (& E2W) are unaware of any complaints from the community arising from rehabilitation works at the MWDD during the 2014/15 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 2014/15 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 area 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 (& remedial works- as necessary). The landfill closure and capping of the landfill mound would improve the local surface water and groundwater quality.

Close monitoring of the elevated ammonia at wells (MD-9C, MD-10B at centreline of plume) and Rocklow Creek (mid-downstream creek) is recommended to address any remedial requirements (e.g. groundwater extraction and irrigation of the mound). E2W consider that ongoing monitoring (re-sampling with ammonia spikes/increasing trends over 100 mg/L) to assess ammonia trends and any remedial actions (MD-9C/MD-10B) to minimise impact to the creek (*note: the down stream samples indicate minimal impacts from the ammonia in the groundwater*). The scale of the landfill mound (6 ha) and generally slow movement of the deeper groundwater is likely to be influencing results at MD-9C (i.e. the residual core leachate plume is still migrating slowly under the capped part of the mound).

E2W interpret that additional time (3 + years) is required to show a more consistent and widespread improvement in the water quality trends (eg. ammonia) due to landfill rehabilitation works. This interpretation takes in consideration the dilution effects of rainfall recharge, clean water runoff from the mound and subsequent attenuation of the landfill leachate around the landfill footprint. It is noted that the majority of the monitoring wells are situated immediately off the landfill perimeter and readily influenced from the leachate plume migrating under the waste mound.

## 8.1 Recommendations

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

- Continued water monitoring and assessment of the ammonia is required to assess trends in relation to the landfill rehabilitation works.

E2W have initiated concept design of potential groundwater remedial works to address the rising ammonia trend identified at well (MD-9C). Currently, extraction wells and a holding dam are proposed to extract the ammonia enriched groundwater, facilitate biological treatment (via wetland plants) and irrigation to reduce the amount of ammonia from the groundwater. Groundwater remedial works are recommended if ammonia concentrations continue to exceed 100 mg/L in successive monitoring rounds in 2015 and 2016 (i.e. MD-9C or MD-10B).

### ***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). Any damaged wells should be replaced or substituted with nearby wells.

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 2014/15 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 rising ammonia trend 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.

**Table 8.1 - Recommended Groundwater Analytical Program for MWDD (2014/15)**

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-nitrogen	0.01 mg/L	3 monthly	FIA
Nitrate-nitrogen	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
Total 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

Notes: 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

## 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 October/November 2015 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.

## 10. REFERENCES

Hazelton (1992). *Soil Landscapes of the Kiama 1:1,000,000 Sheet*, Department of Conservation and Land Management.

NSW EPA (1996). *Environmental Guidelines: Solid Waste Landfills*.

DUAP (1996). *EIS Practise Guideline: Landfilling*

NSW EPA (1999). *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes*. May 1999.

Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

Earth2Water Pty Ltd (October, 2005). *Landfill Closure Plan for the Minnamurra Waste Disposal Facility*.

## Tables

**Table 5.3: Groundwater and Surface Water Monitoring (2014 to 2015)**

Analytes	Groundwater				Surface Water (Rocklow Creek)				Detection Limits	Method Reference
	17/11/14	26/02/15	27/05/15	10/08/15	17/11/14	26/02/15	27/05/15	10/08/15		
Physical Properties										
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	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
Nutrients										
Ammonia-nitrogen	X	X	X	X	X	X	X	X	0.01 mg/L	FIA
Total Nitrogen										
Total Phosphorus									2 µg/L	FIA
Hydrochemical										
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/xylylene 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
Organic Contaminants										
Dissolved Organic Carbon	X	X	X	X	X	X	X	X	0.50 mg/L	APHA 5310C
Total Organic Carbon	X	X	X	X	X	X	X	X	0.1 mg/L	APHA 5310C
Inorganic Contaminants										
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



Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 1B	MD 1B	MD 1B	MD 1B	No. Samples	MD2A	MD2A	MD2A	MD2A	No. Samples	MD 2B	MD 2B	MD 2B	MD 2B	No. Sample	Min	Mean	Max
Field Measurements	Freshwater	Marine	17/11/14	26/2/15	27/5/15	10/8/15		17/11/14	26/2/15	27/5/15	10/8/15		17/11/14	26/2/15	27/5/15	10/8/15				
RL (mAHD at TOC)			No Access	No Access	No Access	No Access	0	Dry	Dry	NM	NM	2	1.17	1.17	1.17	1.17	0	NA	NA	NA
Standing water level (mTOC)			-	-	-	-	0	-	-	0.50	0.60	2	0.80	0.63	0.72	0.75	4	0.63	0.73	0.80
Reduced SWL (mAHD)			-	-	-	-	0	-	-				0.37	0.54	0.45	0.42	0	0.37	0.44	0.54
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	-	-	-	0	-	-	7.10	7.30	2	7.20	6.90	7.10	7.10	4	6.9	7.1	7.2
Temperature			-	-	-	-	0	-	-	16.90	14.90	2	16.80	18.40	17.90	17.40	4	16.8	17.6	18.4
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	-	-	-	0	-	-	13300	21800	2	19900	21600	19200	25700	4	19200	21600	25700
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	-	-	-	0	-	-	5.40	1.91	2	3.50	5.20	3.10	1.22	4	1.22	3.26	5.20
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	-	-	-	-	0	-	-	NM	NM	0	NM	NM	NM	NM	0	NA	NA	NA
Laboratory Analyses (mg/L)																				
Sodium (ICP)			-	-	-	-	0	-	-	2940	3830	2	3980	4520	4160	4610	4	3980	4318	4610
Potassium (ICP)			-	-	-	-	0	-	-	168	173	2	185	191	175	171	4	171	181	191
Calcium (ICP)			-	-	-	-	0	-	-	241	276	2	341	344	358	351	4	341	349	358
Magnesium (ICP)			-	-	-	-	0	-	-	381	511	2	488	580	519	589	4	488	544	589
Chloride			-	-	-	-	0	-	-	4420	5280	2	7980	7810	6310	6190	4	6190	7073	7980
Sulphate (SO4)			-	-	-	-	0	-	-	690	976	2	1200	1130	1020	1160	4	1020	1128	1200
Water Parameters (mg/L)																				
Total Suspended Solids (TSS)			-	-	-	-	0	-	-	NM	NM	0	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	-	-	-	0	-	-	828	776	2	588	704	632	660	4	588	646	704
Fluoride			-	-	-	-	0	-	-	1	1	2	1	1	1	1	4	0.8	0.8	0.9
Phenols		0.40	-	-	-	-	0	-	-	<0.05	<0.05	2	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND
Metals (mg/L)																				
Iron (ICP)	0.3 (1)		-	-	-	-	0	-	-	1.44	0.34	2	0.25	0.9	2.54	0.83	4	0.25	1.13	2.54
Manganese (ICP)	1.90		-	-	-	-	0	-	-	0.041	0.046	2	0.036	0.082	0.149	0.082	4	0.036	0.087	0.149
Nutrients (mg/L)																				
Nitrate (NO3 as N)	0.7 (7)		-	-	-	-	0	-	-	1.07	1.98	2	4.02	0.06	<0.01	0.29	4	0.06	1.46	4.02
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	-	-	-	0	-	-	22.00	11.80	2	4.17	10.50	11.40	9.61	4	4.17	8.92	11.40
Total Nitrogen	0.5 (3)	0.12 (4)	-	-	-	-	0	-	-	NM	NM	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	-	-	-	0	-	-	53.00	42.00	2	34.00	23.00	33.00	26.00	4	23	29	34
Total Organic Carbon (TOC)			-	-	-	-	0	-	-	56.00	42.00	2	37.00	21.00	34.00	27.00	4	21	30	37
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	-	-	-	-	0	-	-	NM	NM	0	NM	NM	NM	NM	0	NA	NA	NA

- 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 2014/15 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	17/11/14	26/2/15	27/5/15	10/8/15					17/11/14	26/2/15	27/5/15	10/8/15	
RL (mAHD at TOC)			1.17	1.17	1.17	1.17	0	NA	NA	NA	Dry	Dry	Dry	Dry	0
Standing water level (mTOC)			0.84	0.66	0.80	0.82	4	0.66	0.78	0.84	-	-	-	-	0
Reduced SWL (mAHD)							0	NA	NA	NA	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.10	6.90	7.30	7.00	4	6.9	7.1	7.3	-	-	-	-	0
Temperature			16.7	18.0	17.9	17.5	4	16.7	17.5	18.0	-	-	-	-	0
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		36800	37800	37800	44100	4	36800	39125	44100	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.20	2.70	2.80	1.11	4	1.11	2.20	2.80	-	-	-	-	0
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			9550	9340	7960	8180	4	7960	8758	9550	-	-	-	-	0
Potassium (ICP)			315	350	320	267	4	267	313	350	-	-	-	-	0
Calcium (ICP)			456	505	420	463	4	420	461	505	-	-	-	-	0
Magnesium (ICP)			1120	1140	1060	915	4	915	1059	1140	-	-	-	-	0
Chloride			15600	14500	12800	10700	4	10700	13400	15600	-	-	-	-	0
Sulphate (SO4)			2270	2180	2070	2120	4	2070	2160	2270	-	-	-	-	0
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Alkalinity (as CaCO3)			443	543	484	517	4	443	497	543	-	-	-	-	0
Fluoride			0.80	0.70	0.90	0.80	4	0.7	0.8	0.9	-	-	-	-	0
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND	-	-	-	-	0
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)		<0.50	1.40	0.11	1.10	4	0.11	0.87	1.40	-	-	-	-	0
Manganese (ICP)	1.90		<0.010	0.16	0.02	0.13	4	<0.01	0.100	0.160	-	-	-	-	0
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		0.74	<0.01	0.87	0.04	4	0.04	0.55	0.87	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.11	3.77	0.32	4.80	4	0.11	2.25	4.80	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Dissolved Organic Carbon (DOC)			22	14	20	22	4	14	20	22	-	-	-	-	0
Total Organic Carbon (TOC)			20	12	19	18	4	12	17	20	-	-	-	-	0
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0

**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.

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	17/11/14	26/2/15	27/5/15	10/8/15					26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			1.63	1.63	1.63	1.63	0	NA	NA	NA	1.59	1.59	1.59	1.59	0	NA	NA	NA
Standing water level (mTOC)			1.22	1.05	1.16	1.18	4	1.05	1.15	1.22	1.24	1.10	1.20	1.21	4	1.10	1.19	1.24
Reduced SWL (mAHD)			0.41	0.58	0.47	0.45	0	0.41	0.47	0.58	0.35	0.49	0.39	0.38	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.1	6.8	7.1	7.0	4	6.8	7.0	7.1	7.10	6.90	7.00	7.00	4	6.9	7.0	7.1
Temperature			16.9	18.9	17.5	16.9	4	16.9	17.6	18.9	16.7	18.1	17.4	16.8	4	16.7	17.3	18.1
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		8880	11000	9170	10500	4	8880	9888	11000	29600	36100	32500	43200	4	29600	35350	43200
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.50	2.90	2.60	1.50	4	1.50	2.38	2.90	2.2	2.2	2.2	0.96	4	0.96	1.89	2.20
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
Laboratory Analyses (mg/L)																		
Sodium (ICP)			1670	1960	1670	1690	4	1670	1748	1960	7300	8890	6590	7910	4	6590	7673	8890
Potassium (ICP)			129	136	125	109	4	109	125	136	251	340	262	263	4	251	279	340
Calcium (ICP)			388	379	390	321	4	321	370	390	372	478	357	462	4	357	417	478
Magnesium (ICP)			241	272	238	199	4	199	238	272	761	1100	882	877	4	761	905	1100
Chloride			3060	3680	2810	2680	4	2680	3058	3680	12500	13600	10800	10500	4	10500	11850	13600
Sulphate (SO4)			414	501	440	390	4	390	436	501	1800	2030	1810	2130	4	1800	1943	2130
Water Parameters (mg/L)																		
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			765	889	833	827	4	765	829	889	490	542	600	570	4	490	551	600
Fluoride			0.5	0.7	0.5	0.6	4	0.5	0.6	0.7	0.8	1.0	0.9	1.1	4	0.8	1.0	1.1
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
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		0.22	1.77	0.68	1.13	4	0.22	0.95	1.77	0.69	1.41	2.18	1.16	4	0.69	1.36	2.18
Manganese (ICP)	1.90		0.084	0.094	0.091	0.081	4	0.081	0.09	0.09	0.10	0.19	0.20	0.17	4	0.103	0.165	0.197
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		2.62	<0.01	0.88	0.07	4	0.07	1.19	2.62	0.42	0.02	0.01	<0.01	4	0.01	0.15	0.42
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	35.40	45.40	36.00	44.20	4	35.40	40.25	45.40	0.66	1.11	1.68	0.96	4	0.66	1.10	1.68
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			49	29	51	35	4	29	41	51	25	14	27	19	4	14	21	27
Total Organic Carbon (TOC)			44	25	49	35	4	25	38	49	24	14	28	21	4	14	22	28
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
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.

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

Table GW-1: Summary 2014/15 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD6A	MD6A	MD6A	MD6A	No. Samples	MD 6B	MD 6B	MD 6B	MD 6B	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	17/11/14	26/2/15	27/5/15	10/8/15		17/11/14	26/2/15	27/5/15	10/8/15				
RL (mAHD at TOC)			Dry	Dry	NM	NM		1.85	1.85	1.85	1.85				
Standing water level (mTOC)			-	-	1.23	1.33	2	1.37	1.16	1.23	1.29	4	1.16	1.26	1.37
Reduced SWL (mAHD)			-	-				0.48	0.69	0.62	0.56	4	0.48	0.59	0.69
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	-	7.20	7.40	2	7.00	6.70	7.10	7.20	4	6.7	7.0	7.2
Temperature			-	-	19.2	17.9	2	17.9	19.9	19.9	18.4	4	17.9	19.0	19.9
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	-	5420	4190	2	1560	1400	1380	1550	4	1380	1473	1560
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	-	3.3	2.13	2	4.6	3.4	3.4	1.19	4	1.19	3.15	4.60
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	-	-	NM	NM		NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			-	-	948	596	2	106	97	106	75	4	75	96	106
Potassium (ICP)			-	-	198	122	2	44	49	43	40	4	40	44	49
Calcium (ICP)			-	-	191	148	2	168	133	123	135	4	123	140	168
Magnesium (ICP)			-	-	147	106	2	53	45	41	37	4	37	44	53
Chloride			-	-	1050	648	2	112	96	71	55	4	55	84	112
Sulphate (SO4)			-	-	619	403	2	<1	94	92	91	4	91	92	94
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			-	-	-	-		NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	-	775	647	2	628	616	550	589	4	550	596	628
Fluoride			-	-	0.9	0.8	2	0.5	0.5	0.6	0.6	4	0.5	0.6	0.6
Phenols		0.40	-	-	<0.05	<0.05	2	<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)		-	-	0.34	0.18	2	0.41	0.19	0.16	0.16	4	0.16	0.23	0.41
Manganese (ICP)	1.90		-	-	0.075	0.062	2	0.139	0.102	0.09	0.089	4	0.089	0.105	0.139
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		-	-	0.49	2.92	2	0.08	0.01	0.22	0.04	4	0.01	0.09	0.22
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	-	10.40	5.98	2	19.10	32.20	29.80	44.40	4	19.10	31.38	44.40
Total Nitrogen	0.5 (3)	0.12 (4)	-	-	NM	NM	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	-	72	48	2	37	22	29	25	4	22	28	37
Total Organic Carbon (TOC)			-	-	74	43	2	36	20	30	28	4	20	29	36
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	-	-	NM	NM	0	NM	NM	NM	NM	0	NA	NA	NA
<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.

Unsampled well on EPL

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

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
Field Measurements	Freshwater	Marine	17/11/14	26/2/15	27/5/15	10/8/15					17/11/14	26/2/15	27/5/15	10/8/15	
RL (mAHD at TOC)			1.86	1.86	1.86	1.86					Dry	Dry	NM	NM	0
Standing water level (mTOC)			1.45	1.40	1.37	1.50	4	1.37	1.43	1.50	-	-	0.53	0.62	2
Reduced SWL (mAHD)			0.41	0.46	0.49	0.36	4	0.36	0.43	0.49	-	-	NA	NA	
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.90	7.00	7.20	7.10	4	6.9	7.1	7.2	-	-	6.4	6.8	2
Temperature			17.70	19.30	19.60	18.60	4	17.7	18.8	19.6	-	-	18	14	2
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		21900	22700	23400	25300	4	21900	23325	25300	-	-	10200	5910	2
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3.20	3.40	2.70	1.14	4	1.14	2.61	3.40	-	-	3.00	2.89	2
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NM	NM	NM	-	-	NM	NM	0
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			4380	4770	4830	4340	4	4340	4580	4830	-	-	2190	1120	2
Potassium (ICP)			159	174	161	138	4	138	158	174	-	-	83	44	2
Calcium (ICP)			361	380	364	356	4	356	365	380	-	-	78	48	2
Magnesium (ICP)			552	600	572	536	4	536	565	600	-	-	265	102	2
Chloride			8800	8080	7530	6220	4	6220	7658	8800	-	-	3480	1370	2
Sulphate (SO4)			1240	1190	1200	1210	4	1190	1210	1240	-	-	452	275	2
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Alkalinity (as CaCO3)			342	402	391	365	4	342	375	402	-	-	123	172	2
Fluoride			0.40	0.40	0.40	0.40	4	0.4	0.4	0.4	-	-	<0.1	0.2	2
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.00	0.00	0.00	-	-	<0.05	<0.25	2
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)		0.16	8.17	16.30	0.83	4	0.16	6.37	16.30	-	-	0.22	0.52	2
Manganese (ICP)	1.90		0.06	0.07	0.07	0.05	4	0.045	0.061	0.072	-	-	0.021	0.017	2
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		0.29	<0.01	0.02	0.27	4	0.02	0.19	0.29	-	-	0.56	<0.10	2
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	32.20	39.80	38.00	33.50	4	32.20	35.88	39.80	-	-	0.40	<0.10	2
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	-	-			
Dissolved Organic Carbon (DOC)			14	8	15	8	4	8	11	15	-	-	147	551	2
Total Organic Carbon (TOC)			15	7	16	12	4	7	13	16	-	-	137	523	2
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	-	-	NM	NM	0

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 2014/15 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	17/11/14	26/2/15	27/5/15	10/8/15				
RL (mAHD at TOC)			1.35	1.35	1.35	1.35	0	NA	NA	NA
Standing water level (mTOC)			0.88	0.75	0.83	0.88	4	0.75	0.84	0.88
Reduced SWL (mAHD)			0.47	0.60	0.52	0.47	0	0.47	0.52	0.60
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7	7	7	7	4	6.8	6.9	7.1
Temperature			19	20	20	16	4	16.2	18.6	19.8
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		2600	2680	2740	2950	4	2600	2743	2950
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	5	3	3	2	4	1.89	3.25	4.70
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>										
Sodium (ICP)			261	274	284	285	4	261	276	285
Potassium (ICP)			62	74	68	70	4	62	69	74
Calcium (ICP)			213	197	182	202	4	182	199	213
Magnesium (ICP)			95	105	99	96	4	95	99	105
Chloride			405	398	403	342	4	342	387	405
Sulphate (SO4)			<1	<10	19	4	4	4	12	19
<b>Water Parameters (mg/L)</b>										
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			944	1080	942	982	4	942	987	1080
Fluoride			0.6	0.5	0.6	0.5	4	0.5	0.6	0.6
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.00	0.00	0.00
<b>Metals (mg/L)</b>										
Iron (ICP)	0.3 (1)		7.44	5.95	0.38	3.46	4	0.38	4.31	7.44
Manganese (ICP)	1.90		0.28	0.274	0.156	0.244	4	0.156	0.239	0.280
<b>Nutrients (mg/L)</b>										
Nitrate (NO3 as N)	0.7 (7)		0.24	<0.01	0.02	0.02	4	0.02	0.09	0.24
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	22.20	27.40	19.40	33.20	4	19.40	25.55	33.20
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			55	26	45	37	4	26	41	55
Total Organic Carbon (TOC)			56	24	49	52	4	24	45	56
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA

**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.

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

Exceedance of IIWL values or fresh water not highlighted.



Table GW-1: Summary 2014/15 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	17/11/14	26/2/15	27/5/15	10/8/15				
RL (mAHD at TOC)			1.40	1.40	1.40	1.40	0	NA	NA	NA
Standing water level (mTOC)			0.84	0.92	0.78	0.88	4	0.78	0.86	0.92
Reduced SWL (mAHD)			0.56	0.48	0.62	0.52	4	0.48	0.55	0.62
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.1	6.8	6.9	7.3	4	6.80	7.03	7.30
Temperature			17.8	17.8	19.7	19.5	4	17.80	18.70	19.70
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		3940	3540	3580	3420	4	3420	3620	3940
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	0.76	2.4	3.3	3.1	4	0.76	2.39	3.30
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0			
<b>Laboratory Analyses (mg/L)</b>										
Sodium (ICP)			402	377	361	367	4	361	377	402
Potassium (ICP)			165	150	166	160	4	150	160	166
Calcium (ICP)			137	187	156	168	4	137	162	187
Magnesium (ICP)			57	86	74	78	4	57	74	86
Chloride			451	580	506	447	4	447	496	580
Sulphate (SO4)			<10	<1	2	<1	4	2	2	2
<b>Water Parameters (mg/L)</b>										
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			1290	1220	1400	1210	4	1210	1280	1400
Fluoride			0.5	0.4	0.4	0.4	4	0.40	0.43	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)		6.07	7.99	7.36	1.8	4	1.80	5.81	7.99
Manganese (ICP)	1.90		0.19	0.366	0.24	0.222	4	0.19	0.25	0.37
<b>Nutrients (mg/L)</b>										
Nitrate (NO3 as N)	0.7 (7)		0.04	0.26	<0.01	0.02	4	0.02	0.11	0.26
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	170	119	160	103	4	103	138	170
Total Nitrogen	0.5 (3)	0.12 (4)					0			
Dissolved Organic Carbon (DOC)			143	76	83	100	4	76	101	143
Total Organic Carbon (TOC)			140	124	71	90	4	71	106	140
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NM	NM	NM
<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.

Unsampled well on EPL

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2014/15 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD10A	MD10A	MD10A	MD10A	No. Samples	MD 10B	MD 10B	MD 10B	MD 10B	No. Sample	Min	Mean	Max
Field Measurements	Freshwater	Marine	17/11/14	26/2/15	27/5/15	10/8/15		17/11/14	26/2/15	27/5/15	10/8/15				
RL (mAHD at TOC)			Dry	NM	Dry	NM	0	NM	NM	NM	NM				
Standing water level (mTOC)				0.5		0.78	2	0.7	0.62	0.72	0.7	4	0.62	0.69	0.72
Reduced SWL (mAHD)							0					0			
pH (field)	6.5-8.0 (a)	8-8.4 (a)		6.7		7.3	2	7.3	7.1	7.3	7.4	4	7.1	7.3	7.4
Temperature				17.8		14.2	2	19.6	22.1	18.9	16.9	4	16.9	19.4	22.1
Electrical Conductivity (mS/cm)	0.125-2.2 (a)			30900		32000	2	2040	2050	2060	2040	4	2040	2048	2060
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)		3.5		5.95	2	3.2	3.6	2.9	1.16	4	1.16	2.72	3.60
Turbidity (NTU)	6-50 (a)	0.5-10 (a)		NM		NM	0	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)				5770		5390	2	146	144	158	147	4	144	149	158
Potassium (ICP)				156		111	2	95	90	88	73	4	73	87	95
Calcium (ICP)				680		614	2	131	102	117	113	4	102	116	131
Magnesium (ICP)				924		716	2	49	47	51	42	4	42	47	51
Chloride				10400		8040	2	227	196	222	160	4	160	201	227
Sulphate (SO4)				1690		1390	2	<10	<1	21	<10	4	21	21	21
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)				NM		NM	0	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)				348		424	2	743	815	743	750	4	743	763	815
Fluoride				0.5		0.5	2	0.7	0.8	0.8	0.8	4	0.7	0.8	0.8
Phenols		0.40		<0.05		<0.05	0	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)			4.78		<0.50	2	1.26	0.63	0.44	0.48	4	0.44	0.70	1.26
Manganese (ICP)	1.90			0.581		0.287	2	0.46	0.313	0.372	0.341	4	0.313	0.372	0.460
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)			<0.01		0.37	2	<0.50	<0.01	<0.01	0.01	4	0.01	0.01	0.01
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)		1.45		0.2	2	93.9	97.0	74.3	75.0	4	74.30	85.05	97.00
Total Nitrogen	0.5 (3)	0.12 (4)		NM		NM	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)				64		59	2	59	50	54	57	4	50	55	59
Total Organic Carbon (TOC)				63		61	2	58	46	57	52	4	46	53	58
Total Phosphorus (TP)	0.05 (5)	0.025 (6)		NM		NM	0	NM	NM	NM	NM	0	NA	NA	NA

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

Sample ID	ANZECC, 2000		Rocklow Up	Rocklow Middle	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down
Field Measurements	Freshwater	Marine	17/11/14	17/11/14	26/02/15	26/02/15	26/02/15	27/05/15	27/05/15	27/05/15	10/08/15	10/08/15	10/08/15
pH (field)	6.5-8.0	8-8.4	7	7.4	6.8	7.4	7	7.2	7.6	6.8	7.5	7.5	7.6
Temperature			17.6	18.3	21.4	21	20.1	13.1	13.8	13.2	10.8	11.3	12.2
Electrical Conductivity (mS/cm)	0.125-2.2		8920	10300	686	3170	6610	436	3480	3960	1710	7000	6680
Dissolved Oxygen (mg/L)	8.5-11.0	9.0-10.0	7.80	4.30	5.50	5.00	6.90	7.20	7.70	7.30	9.18	9.13	9.82
Turbidity (NTU)	6-50 (a)	0.5-10	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
<b>Laboratory Analyses (mg/L)</b>													
Sodium (ICP)			1860	2000	80	522	1190	61	662	828	272	1290	1230
Potassium (ICP)			74	84	5	22	54	7	27	34	12	48	44
Calcium (ICP)			121	125	30	43	64	20	55	60	38	80	72
Magnesium (ICP)			222	233	16	61	137	14	89	105	35	141	131
Chloride			3550	3850	133	850	2270	76	999	1240	347	1600	1500
Sulphate (SO4)			466	554	35	124	312	28	181	221	86	357	342
<b>Water Parameters (mg/L)</b>													
Hardness (as CaCO3)			155	155	136	152	152	78	116	117	97	133	130
Fluoride			0.4	0.8	0.1	0.4	0.3	0.1	0.3	0.3	0.2	0.5	0.5
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)		0.06	0.18	3.09	1.60	1.52	1.56	1.00	0.95	1.70	1.01	0.99
Manganese (ICP)	1.90		0.18	0.23	1.00	0.32	0.24	0.06	0.10	0.08	0.18	0.07	0.06
<b>Nutrients (mg/L)</b>													
Total Phosphorus (TP)	0.05 (5)	0.025 (6)											
Total Nitrogen	0.5 (3)	0.12 (4)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (NO3 as N)	0.7 (7)		0.04	0.07	<0.01	0.03	0.02	0.03	0.10	0.13	0.12	0.34	0.34
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.14	0.24	0.14	0.13	0.09	0.06	0.29	0.28	0.09	0.23	0.19
Ammonia Increment (Upper to Mid Rocklow)				<b>0.10</b>		-0.01			<b>0.23</b>			<b>0.14</b>	
Ammonia Increment (Mid to lower Rocklow)							<b>-0.05</b>			<b>-0.01</b>			<b>-0.04</b>
Dissolved Organic Carbon (DOC)			14	14	10	11	12	10	10	10	9	7	10
Total Organic Carbon (TOC)			14	13	10	10	12	11	10	10	8	7	7

**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.

Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (1999 - 2015)

Sample ID	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	12/06/2003	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
Upper Rocklow (mg/L)	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	0.14	0.03	0.17	0.28	0.03	0.22	<0.02	<0.02	0.06
Middle Rocklow (mg/L)																										
Lower Rocklow (mg/L)	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
Net Increment (mg/L)	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

Sample ID	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
Upper Rocklow (mg/L)	<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	0.03	0.14
Middle Rocklow (mg/L)														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
Lower Rocklow (mg/L)	<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	NM
Net Increment (mg/L)	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

Sample ID	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
Upper Rocklow (mg/L)	<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
Middle Rocklow (mg/L)	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
Lower Rocklow (mg/L)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	0.09	0.28	0.19
Net Increment (mg/L)	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

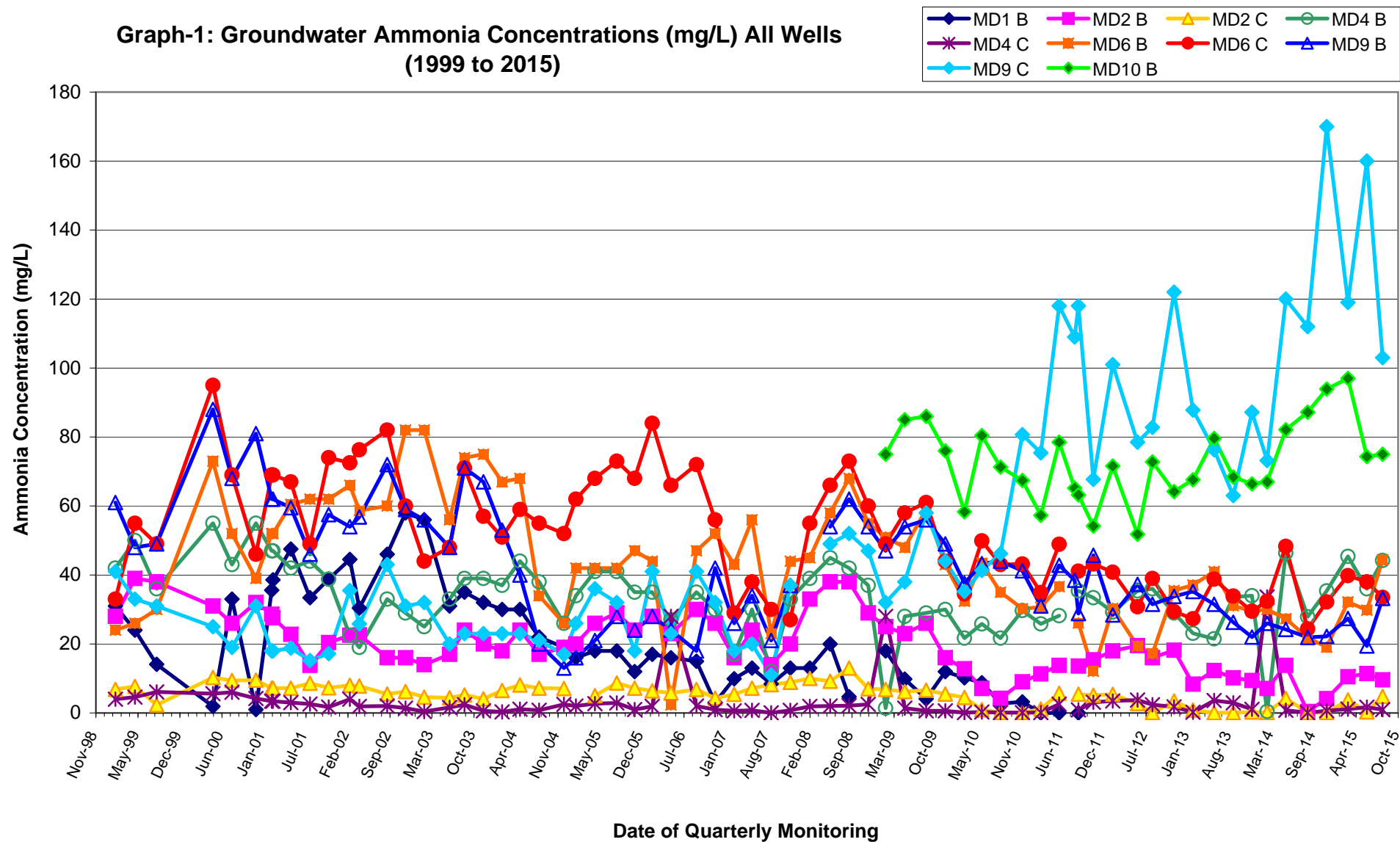
**Legend**

NA = Not Analysed    NM= Not measured

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

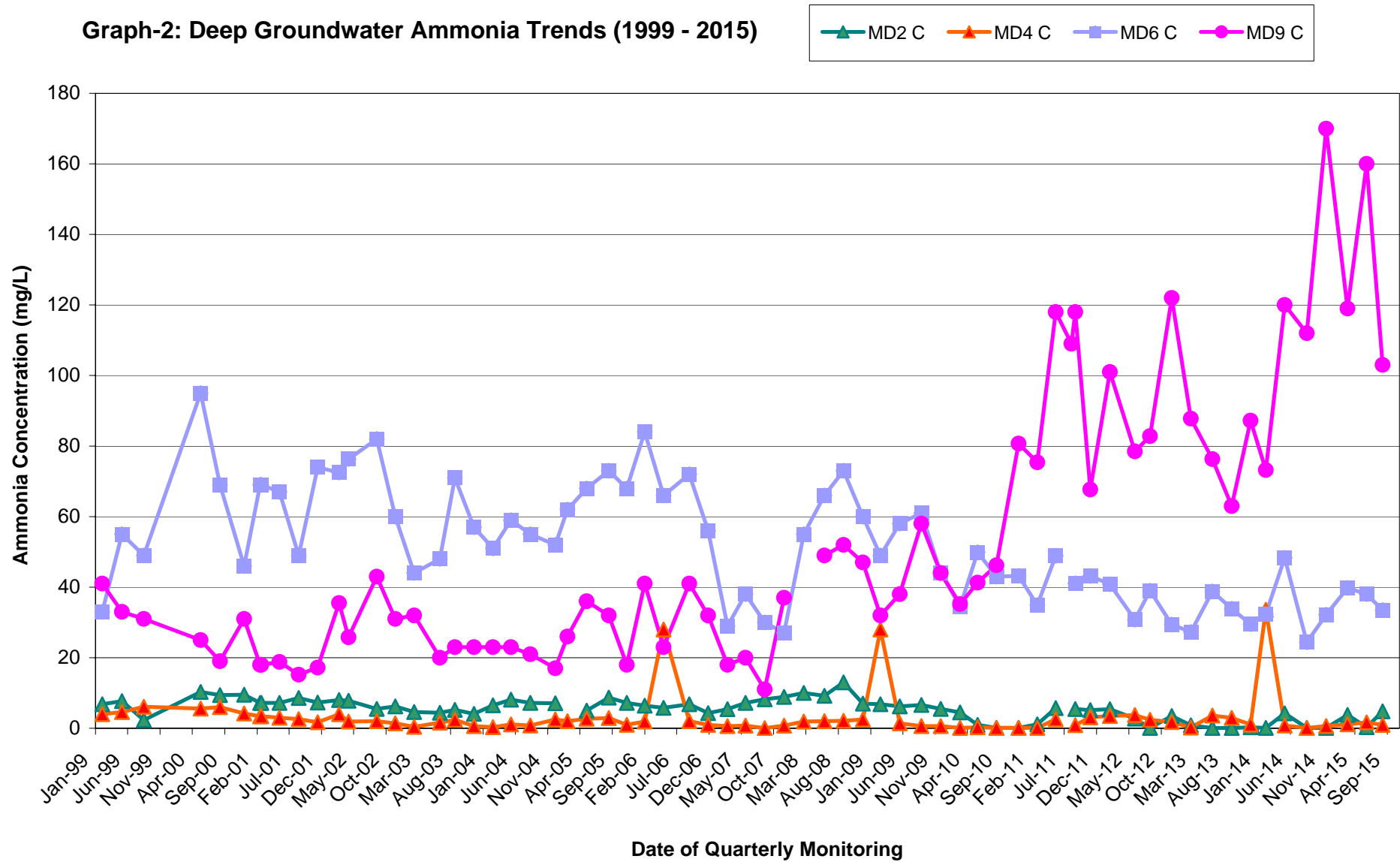
## Graphs

**Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999 to 2015)**

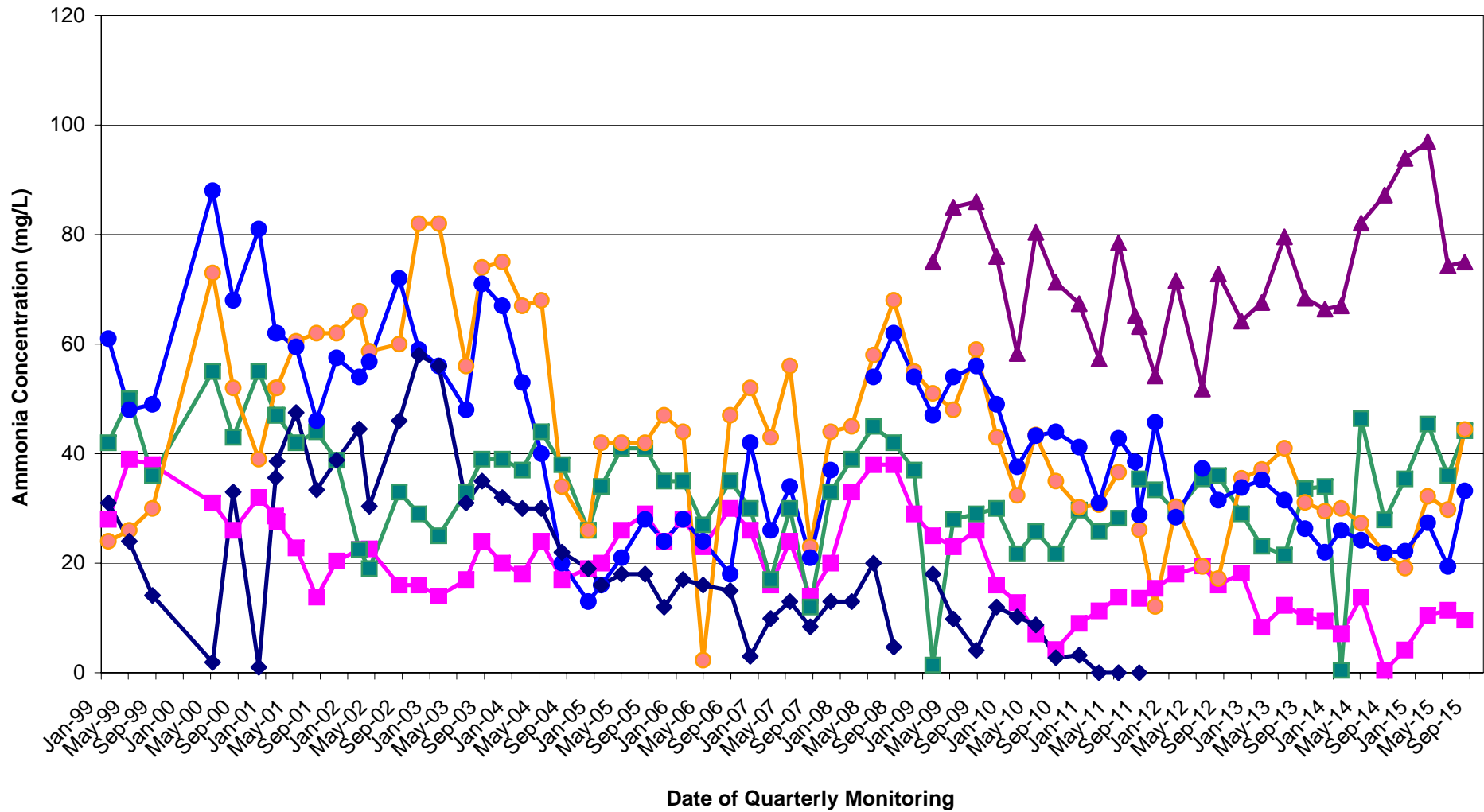




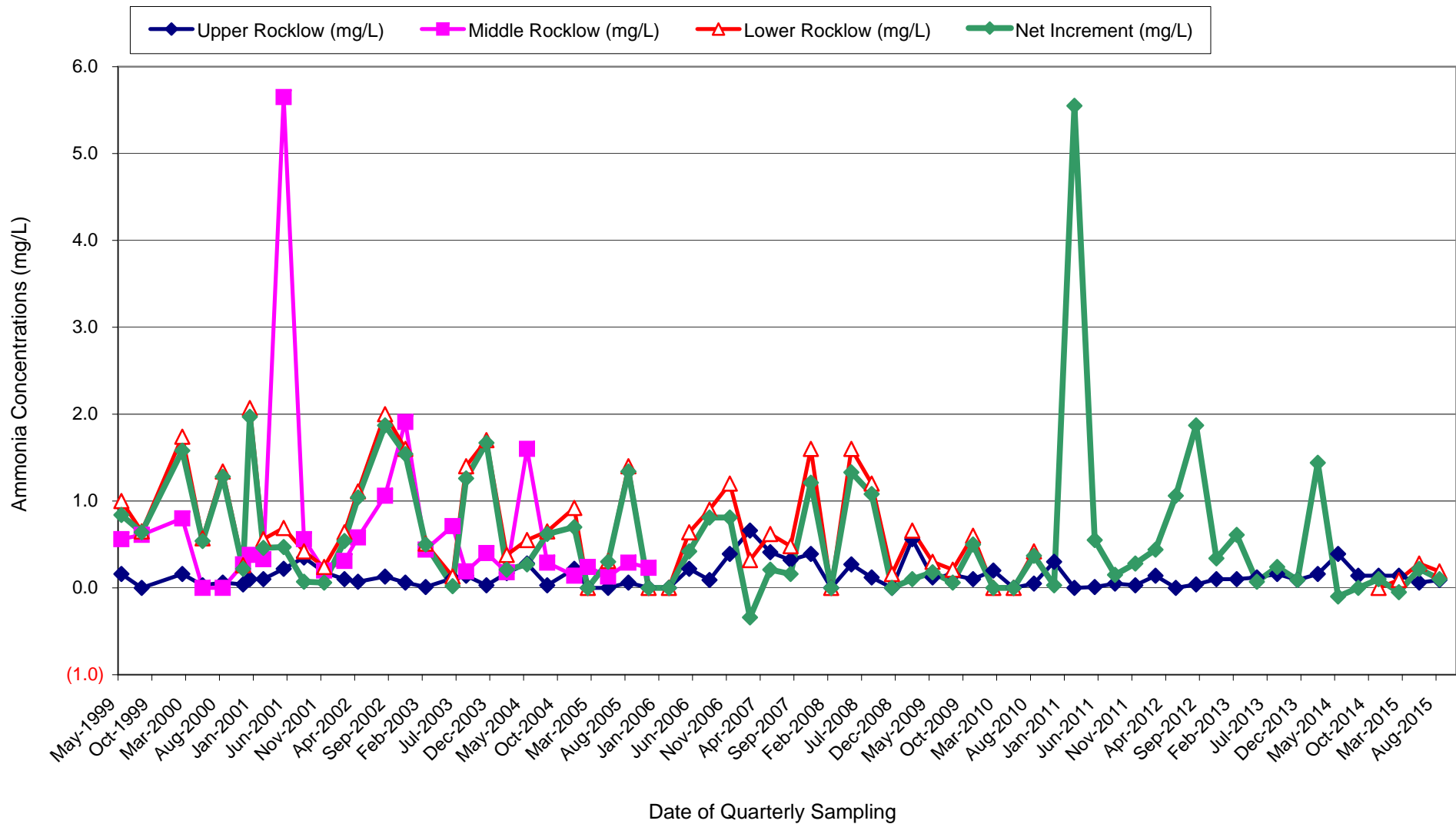
**Graph-2: Deep Groundwater Ammonia Trends (1999 - 2015)**



**Graph-3: Shallow Groundwater Ammonia Trends  
(1999 - 2015)**

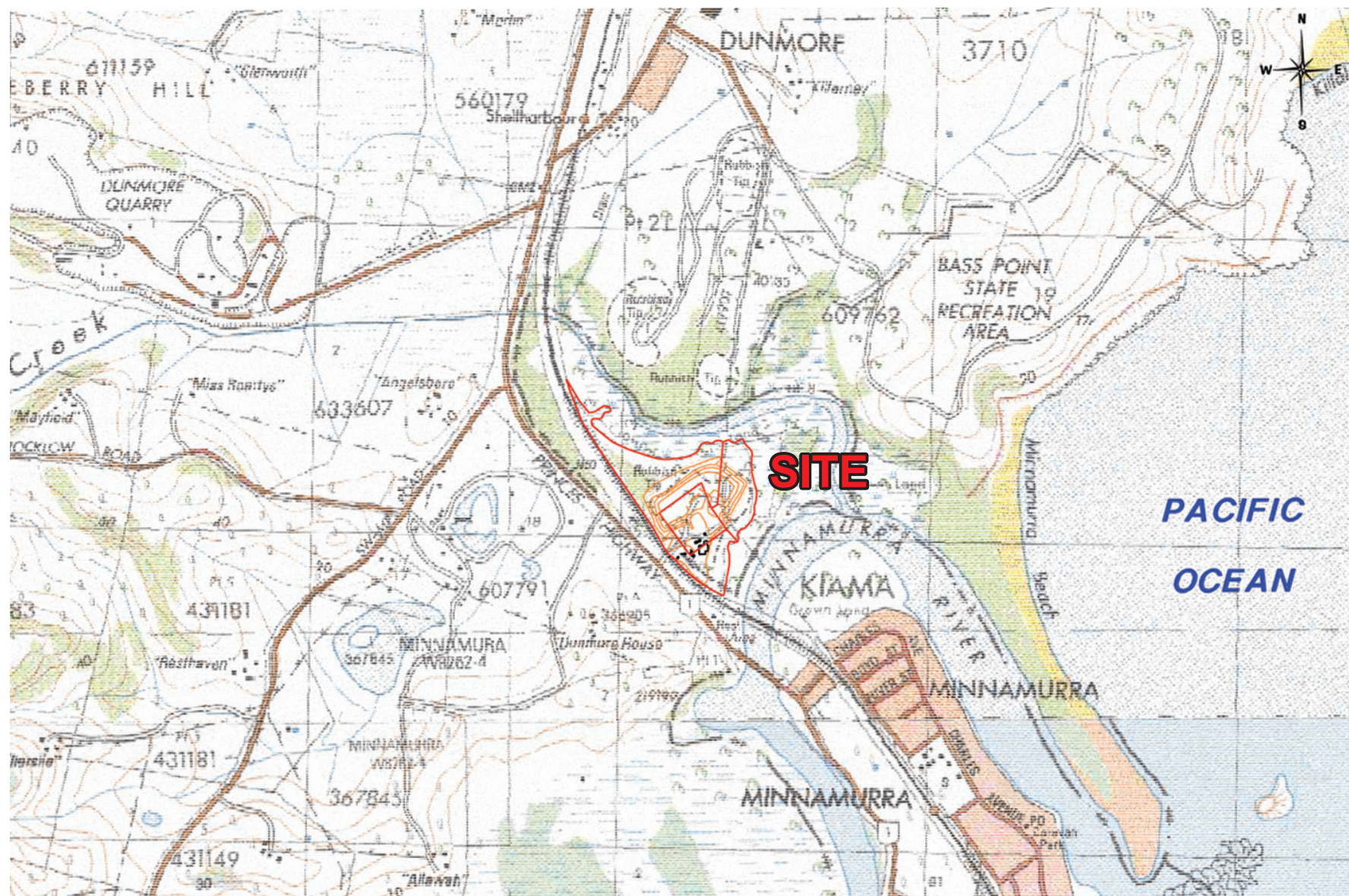


**Graph-04: Net Increments of Ammonia Between Up and Down Stream Samples (1999 to 2015)**



## Figures











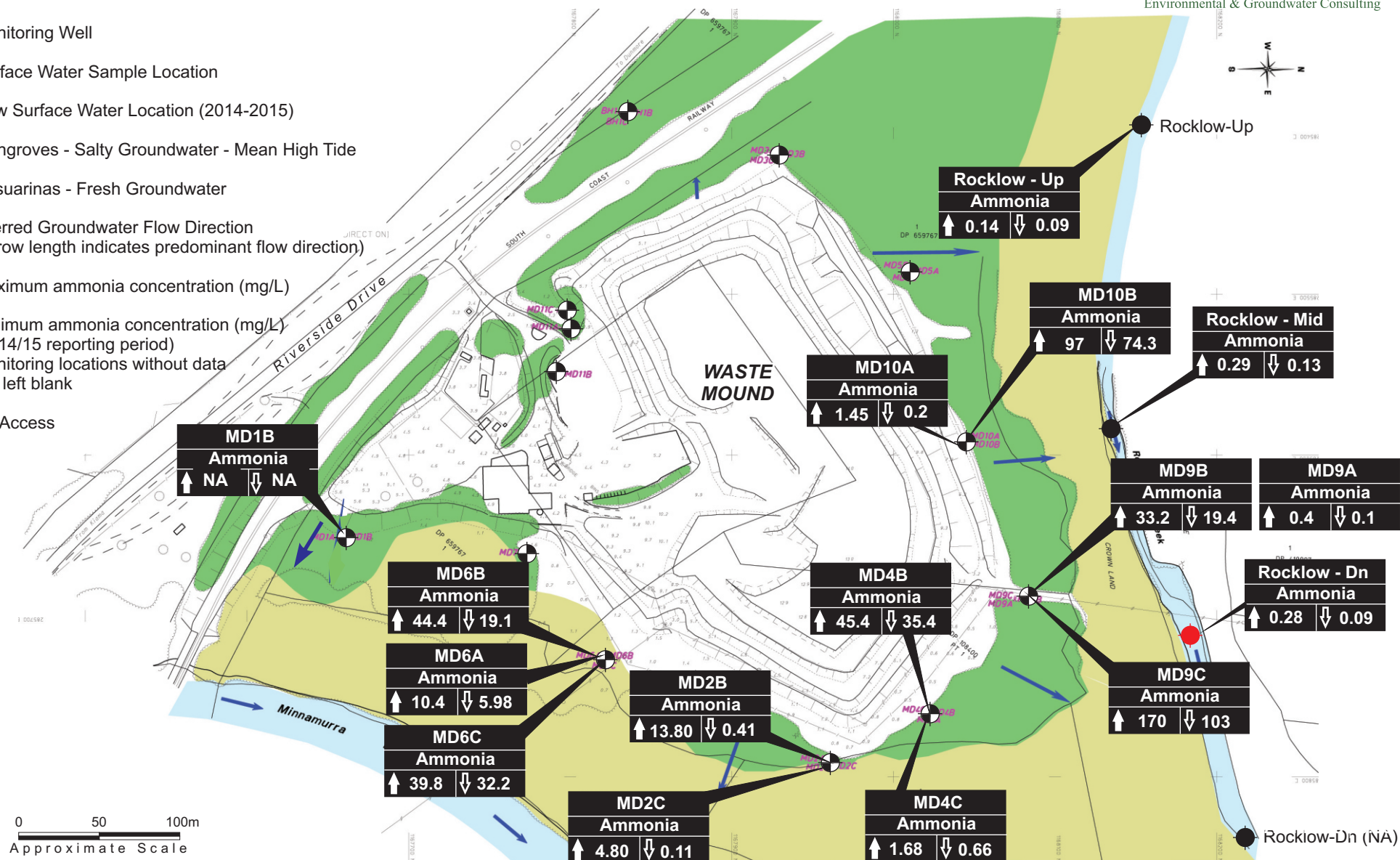


**SITE LOCATION**



# LEGEND

-  Monitoring Well
-  Surface Water Sample Location
-  New Surface Water Location (2014-2015)
-  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)  
(2014/15 reporting period)  
Monitoring locations without data are left blank
- NA** No Access



Source: Neil Charters Pty Ltd

## MONITORING WELL LOCATIONS & MAXIMUM & MINIMUM AMMONIA CONCENTRATION (2014-2015)

Date: 16 October 2015

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2014-2015)

Reference: E2W\_059\_04.cdr

Figure 2



## Appendix A



# CHAIN OF CUSTODY

ALS Laboratory, please tick →

☐ Sydney 271 Woodpark Rd, Smithfield NSW 2178  
Ph: 02 8784 8555 E: samples.syd@alsenviro.com  
☐ Newcastle 5 Peasgum Rd, Waratook NSW 2304  
Ph: 02 4868 5433 E: samples.newcastle@alsenviro.com

☐ Brisbane 32 Strand St, Stafford QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
☐ Townsville 14-15 Darna Ct, Bohle QLD 4818  
Ph: 07 4756 0800 E: townsville.environment@alsenviro.com

☐ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 5600 E: samples.melbourne@alsenviro.com  
☐ Adelaide 2-1 Burma Rd, Pooraka SA 5095  
Ph: 08 8355 0890 E: adelaide@alsenviro.com

☐ Perth 10 Hod Way, Malaga WA 6060  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
☐ Lancaster 27 Wellington St, Lancaster TAS 7250  
Ph: 03 6331 2158 E: lancaster@alsenviro.com

Environmental Division  
NSW South Coast  
Work Order  
**EW1403462**

## FOR LABORATORY

Custody Seal Intact  
Free Ice / Frozen /  
Receipt?

Random Sample 1  
Other comment:

COC SEQUENCE NUMBER (Circle)  
COC: 1 2 3 4 5 6 7  
OF: 1 2 3 4 5 6 7

RECEIVED BY: *Aneta*  
DATE/TIME: 17/11/14 15:30

RELINQUISHED BY: *Craig*  
DATE/TIME: 17/11/14 15:30



Telephone : 02 42253125

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):	FOR LABORATORY
OFFICE:	PO Box 75 Kiama NSW 2533	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)		
PROJECT:	Minnamurra Landfill	ALS QUOTE NO.:	SY-146-10	
ORDER NUMBER:		CONTACT PH: 4232 0418		
PROJECT MANAGER:	Paul Czulkowski	SAMPLER MOBILE: 0408 261 560		
SAMPLER:	Craig Wilson	RELINQUISHED BY: <i>Craig</i>		
COC emailed to ALS? (YES / NO)	YES	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed)	pauc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au	DATE/TIME:		
Email Invoice to (will default to PM if no other addresses are listed)	pauc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au	DATE/TIME:		
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:				

ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION			ANALYSIS REQUIRED including SUITES (NB Suite Codes must be listed to attract charges - Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required))						Additional Information	
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			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.	
1	MD 1B	17/11 1010	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	NO ACCESS			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
2	MD 2A	825	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	Insufficient Sample			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
3	MD 2B	829	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
4	MD 2C	833	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
5	MD 4A	850	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	Insufficient Sample			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
6	MD 4B	855	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
7	MD 4C	900	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
8	MD 6A	807	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	Insufficient Sample			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
9	MD 6B	805	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
10	MD 6C	800	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
11	MD 9A	950	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	Insufficient Sample			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
12	MD 9B	982	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
TOTAL															

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

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Air-tight Unpreserved Plastic  
V = VOA Via HCl Preserved; VB = VOA Via Sodium Bisulfate Preserved; VS = VOA Via Sulfuric Preserved; AV = Air-tight Unpreserved Via 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 Bottle; E = EDTA Preserved Bottle; ST = Sterile Bottle; ASS = Plastic Bag for Acid Suphate Solis; B = Unpreserved Bag.



## CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1403462</b>	Page	: 1 of 10
Client	: <b>KIAMA COUNCIL</b>	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 99 Kenny Street, Wollongong 2500 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541 AUSTRALIA
E-mail	: paulc@kiama.nsw.gov.au	E-mail	: glenn.davies@alsglobal.com
Telephone	: +61 02 4232 0444	Telephone	: 02 4225 3125
Facsimile	: +61 02 4232 0555	Facsimile	: 02 4225 3128
Project	: Minnamurra Landfill	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-NOV-2014
Sampler	: Craig Wilson	Issue Date	: 26-NOV-2014
Site	: ----		
Quote number	: Minnamurra Landfill WL/083/11	No. of samples received	: 19
		No. of samples analysed	: 19

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

Address 99 Kenny Street, Wollongong 2500

Environmental Division NSW South Coast, PO Box 3105, North Nowra 2541, Australia. An ALS Limited Company



## 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 sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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

- ED041G:LOR raised for Sulfate analysis on various samples due to sample matrix.
- EG020: LOR's have been raised due to matrix interference (High Total Dissolved Solids)
- EK059-EK058G-EK057G: LOR raised for NOx-Nitrate-Nitrite on sample ID (MD 10B) due to sample matrix.
- Field tests completed on day of sampling/receipt.
- Ionic Balance out of acceptable limits for sample 9 due to analytes not quantified in this report.
- It has been noted that DOC is greater than TOC, however this difference is within the limits of experimental variation.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Sites MD1B & Rocklow Down - No access at time of sampling.
- Sites MD2A, MD4A, MD6A, MD9A and MD10A - Insufficient water at time of sampling.



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				17-NOV-2014 10:10	17-NOV-2014 08:25	17-NOV-2014 08:29	17-NOV-2014 08:33	17-NOV-2014 08:50
Compound	CAS Number	LOR	Unit	EW1403462-001	EW1403462-002	EW1403462-003	EW1403462-004	EW1403462-005
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	----	----	7.2	7.1	----
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	19900	36800	----
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	----	----	14.4	28.3	----
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	----	----	16.8	16.7	----
<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	----	----	588	443	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	588	443	----
<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	----	----	1200	2270	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	7980	15600	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	341	456	----
Magnesium	7439-95-4	1	mg/L	----	----	488	1120	----
Sodium	7440-23-5	1	mg/L	----	----	3980	9550	----
Potassium	7440-09-7	1	mg/L	----	----	185	315	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.036	<0.010	----
Iron	7439-89-6	0.05	mg/L	----	----	0.25	<0.50	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.8	0.8	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	4.17	0.11	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	0.12	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	4.02	0.74	----





## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				17-NOV-2014 10:10	17-NOV-2014 08:25	17-NOV-2014 08:29	17-NOV-2014 08:33	17-NOV-2014 08:50
Compound	CAS Number	LOR	Unit	EW1403462-001	EW1403462-002	EW1403462-003	EW1403462-004	EW1403462-005
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	4.14	0.74	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	262	496	----
Total Cations	----	0.01	meq/L	----	----	235	538	----
Ionic Balance	----	0.01	%	----	----	5.41	4.07	----
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	NO ACCESS	INSUFFICIENT WATER	----	----	INSUFFICIENT WATER
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	34	22	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	37	20	----
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	----	----	3.50	2.20	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	39.6	27.0	----
<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	----	----	0.80	0.84	----



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				17-NOV-2014 08:55	17-NOV-2014 09:00	17-NOV-2014 08:07	17-NOV-2014 08:05	17-NOV-2014 08:00
Compound	CAS Number	LOR	Unit	EW1403462-006	EW1403462-007	EW1403462-008	EW1403462-009	EW1403462-010
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	7.1	7.1	----	7.0	6.9
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	8880	29600	----	1560	21900
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	6.0	22.2	----	0.9	15.6
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	16.9	16.7	----	17.9	17.7
<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	765	490	----	628	342
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	765	490	----	628	342
<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	414	1800	----	<1	1240
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	3060	12500	----	112	8800
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	388	372	----	168	361
Magnesium	7439-95-4	1	mg/L	241	761	----	53	552
Sodium	7440-23-5	1	mg/L	1670	7300	----	106	4380
Potassium	7440-09-7	1	mg/L	129	251	----	44	159
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.084	0.103	----	0.139	0.057
Iron	7439-89-6	0.05	mg/L	0.22	0.69	----	0.41	0.16
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.8	----	0.5	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	35.4	0.66	----	19.1	32.2
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	0.06	0.02	----	0.08	0.04
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	2.62	0.42	----	0.08	0.29



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				17-NOV-2014 08:55	17-NOV-2014 09:00	17-NOV-2014 08:07	17-NOV-2014 08:05	17-NOV-2014 08:00
Compound	CAS Number	LOR	Unit	EW1403462-006	EW1403462-007	EW1403462-008	EW1403462-009	EW1403462-010
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	2.68	0.44	----	0.16	0.33
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	110	400	----	15.7	281
Total Cations	----	0.01	meq/L	115	405	----	18.5	258
Ionic Balance	----	0.01	%	2.18	0.64	----	8.12	4.25
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	----	----	INSUFFICIENT WATER	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	49	25	----	37	14
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	44	24	----	36	15
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	2.50	2.20	----	4.60	3.20
Dissolved Oxygen - % Saturation	----	0.1	% saturation	26.6	25.9	----	48.5	36.5
<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	1.22	1.24	----	1.37	1.45



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				17-NOV-2014 09:40	17-NOV-2014 09:42	17-NOV-2014 09:48	17-NOV-2014 09:30	17-NOV-2014 09:25
Compound	CAS Number	LOR	Unit	EW1403462-011	EW1403462-012	EW1403462-013	EW1403462-014	EW1403462-015
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	----	6.8	6.8	----	7.3
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2600	3540	----	2040
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	----	1.6	2.2	----	1.2
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	----	18.5	17.8	----	19.6
<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	----	944	1220	----	743
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	944	1220	----	743
<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	----	<1	<1	----	<10
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	405	580	----	227
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	213	187	----	131
Magnesium	7439-95-4	1	mg/L	----	95	86	----	49
Sodium	7440-23-5	1	mg/L	----	261	377	----	146
Potassium	7440-09-7	1	mg/L	----	62	150	----	95
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.280	0.366	----	0.460
Iron	7439-89-6	0.05	mg/L	----	7.44	7.99	----	1.26
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.6	0.4	----	0.7
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	22.2	119	----	93.9
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	0.02	0.02	----	<0.50
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	0.24	0.26	----	<0.50



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				17-NOV-2014 09:40	17-NOV-2014 09:42	17-NOV-2014 09:48	17-NOV-2014 09:30	17-NOV-2014 09:25
Compound	CAS Number	LOR	Unit	EW1403462-011	EW1403462-012	EW1403462-013	EW1403462-014	EW1403462-015
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.26	0.28	----	<0.50
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	30.3	40.7	----	21.2
Total Cations	----	0.01	meq/L	----	31.4	36.6	----	19.4
Ionic Balance	----	0.01	%	----	1.78	5.29	----	4.67
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	INSUFFICIENT WATER	----	----	INSUFFICIENT WATER	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	55	76	----	59
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	56	124	----	58
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	----	4.70	2.40	----	3.20
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	50.3	26.0	----	34.8
<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	----	0.88	0.92	----	0.70



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				17-NOV-2014 09:55	17-NOV-2014 09:20	17-NOV-2014 07:40	17-NOV-2014 07:43	----
Compound	CAS Number	LOR	Unit	EW1403462-016	EW1403462-017	EW1403462-018	EW1403462-019	----
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	----	7.4	7.0	----	----
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	10300	8920	----	----
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	----	6.8	5.9	----	----
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	----	18.3	17.6	----	----
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	<1	<1	----	----
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	----	155	155	----	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	155	155	----	----
<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	----	554	466	----	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	3850	3550	----	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	----	<1	----
Magnesium	7439-95-4	1	mg/L	----	----	----	<1	----
Sodium	7440-23-5	1	mg/L	----	----	----	<1	----
Potassium	7440-09-7	1	mg/L	----	----	----	<1	----
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	125	121	----	----
Magnesium	7439-95-4	1	mg/L	----	233	222	----	----
Sodium	7440-23-5	1	mg/L	----	2000	1860	----	----
Potassium	7440-09-7	1	mg/L	----	84	74	----	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	----
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	----
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.225	0.181	----	----
Iron	7439-89-6	0.05	mg/L	----	0.18	0.06	----	----





## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				17-NOV-2014 09:55	17-NOV-2014 09:20	17-NOV-2014 07:40	17-NOV-2014 07:43	----
Compound	CAS Number	LOR	Unit	EW1403462-016	EW1403462-017	EW1403462-018	EW1403462-019	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.8	0.4	----	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	0.24	0.14	----	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	<0.01	<0.01	----	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	0.07	0.04	----	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.07	0.04	----	----
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	INSUFFICIENT WATER	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	14	14	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	13	14	----	----
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	----	4.30	7.80	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----





# CHAIN OF CUSTODY

ALS Laboratory, please tick →

□ Sydney 277 Wyndham Rd, Smithfield NSW 2178  
Ph: 02 8784 8555 E: samples.syd@alsenviro.com  
□ Newcastle 5 Rosegum Rd, Warabrook NSW 2250  
Ph: 02 4968 9433 E: samples.newcastle@alsenviro.com

□ Brisbane 32 Strand St, St Albans QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
□ Townsville 14-15 Desma Ct, Bohle QLD 4818  
Ph: 07 4796 0600 E: samples.townsville@alsenviro.com

□ Melbourne 24 Watral Rd, Springvale VIC 3171  
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com  
□ Adelaide 21 Burns Rd, Poonake SA 5095  
Ph: 08 8359 0690 E: samples.adelaide@alsenviro.com

□ Perth 10 Hed Way,  
Ph: 08 9209 7655 E: 84  
□ Lancaster 27 Wd  
Ph: 03 6331 2158 E: 14

## TURNAROUND REQUIREMENTS:

Standard TAT may be longer for some tests  
e.g. Ultra Trace Organics

□ Standard TAT (List due date)  
□ Non Standard or urgent TAT (List due date)

ALS QUOTE NO.:

SY-146-10

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 261 560

EDD FORMAT (or default):

RELINQUISHED BY:

DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

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DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

DATE/TIME:

## Environmental Division

NSW South Coast

Work Order

EW1500670



Telephone : 02 42253125

## COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

### ALS USE ONLY

### SAMPLE DETAILS

### CONTAINER INFORMATION

### ANALYSIS REQUIRED INCLUDING SUITES (NB Suite Codes must be listed to attract suite price)

### Additional Information

Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.

YSI (Field Results)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

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pH, Temp, EC, Sal, DO, Depth



# CHAIN OF CUSTODY

ALS Laboratory, please tick →

☐ Sydney 2711 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8555 E: samples.syd@alsenviro.com  
☐ Newcastle 5 Rosegum Rd, Waratah NSW 2304  
Ph: 02 4568 9433 E: samples.newcastle@alsenviro.com  
☐ Brisbane 32 Strand St, St Albans QLD 4103  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
☐ Townsville 14.15 Desma Ct, Bohia QLD 4818  
Ph: 07 4796 0800 E: townsville.environment@alsenviro.com  
☐ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com  
☐ Adelaide 2-1 Burma Rd, Poracola SA 5095  
Ph: 08 8359 0890 E: adelaide@alsenviro.com  
☐ Perth 110 Hood Way, Malaga WA 6100  
Ph: 08 9209 7665 E: samples.perth@alsenviro.com  
☐ Lancaster 27 Wellington St, Lancaster TAS 7250  
Ph: 03 6331 2158 E: lancaster@alsenviro.com

CLIENT: Kiama Municipal Council

OFFICE: PO Box 76 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER:

PROJECT MANAGER: Paul Czulkowski

SAMPLER: Craig Wilson

COC emailed to ALS? ( YES / NO )

Email Reports to (will default to PM if no other addresses are listed):

Email Invoice to (will default to PM if no other addresses are listed):

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

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

ALS QUOTE NO.: SY-146-10

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 261 660

EDD FORMAT (or default):

RELINQUISHED BY:

DATE/TIME:

RECEIVED BY:

DATE/TIME:

RELINQUISHED BY:

DATE/TIME:

RECEIVED BY:

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## SAMPLE DETAILS

MATRIX: Solid(S) Water(W)

## CONTAINER INFORMATION

Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required)

## ANALYSIS REQUIRED INCLUDING SUITES (NB: Suite Codes must be listed to attract suite price)

Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required)

## Additional Information

Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.

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

YSI (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)

pH, Temp, EC, Sal, DO, Depth

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pH, Temp, EC, Sal, DO, Depth

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## CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1500670</b>	Page	: 1 of 10
Client	: <b>KIAMA COUNCIL</b>	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 99 Kenny Street, Wollongong 2500 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541 AUSTRALIA
E-mail	: paulc@kiama.nsw.gov.au	E-mail	: glenn.davies@alsglobal.com
Telephone	: +61 02 4232 0444	Telephone	: 02 4225 3125
Facsimile	: +61 02 4232 0555	Facsimile	: 02 4225 3128
Project	: Minnamurra Landfill	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-FEB-2015
Sampler	: Craig Wilson	Issue Date	: 10-MAR-2015
Site	: ----		
Quote number	: Minnamurra Landfill WL/083/11	No. of samples received	: 19
		No. of samples analysed	: 19

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong
Shobhna Chandra	Metals Coordinator	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics



## 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 sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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

- **ED041G: LOR raised for Sulfate analysis on sample ID: MD 9B due to matrix interferences.**
- **EP002: It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.**
- **Field tests completed on day of sampling/receipt.**
- **Ionic Balance out of acceptable limits 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.**
- **Site MD1B - No Access at time of sampling.**
- **Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.**



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				26-FEB-2015 10:15	26-FEB-2015 08:55	26-FEB-2015 08:56	26-FEB-2015 09:01	26-FEB-2015 09:10
Compound	CAS Number	LOR	Unit	EW1500670-001	EW1500670-002	EW1500670-003	EW1500670-004	EW1500670-005
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	----	----	6.9	6.9	----
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	21600	37800	----
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	----	----	15.1	28.1	----
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	----	----	18.4	18.0	----
<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	----	----	704	543	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	704	543	----
<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	----	----	1130	2180	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	7810	14500	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	344	505	----
Magnesium	7439-95-4	1	mg/L	----	----	580	1140	----
Sodium	7440-23-5	1	mg/L	----	----	4520	9340	----
Potassium	7440-09-7	1	mg/L	----	----	191	350	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.082	0.160	----
Iron	7439-89-6	0.05	mg/L	----	----	0.90	1.40	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.9	0.7	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	10.5	3.77	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	<0.01	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	0.06	<0.01	----



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				26-FEB-2015 10:15	26-FEB-2015 08:55	26-FEB-2015 08:56	26-FEB-2015 09:01	26-FEB-2015 09:10
Compound	CAS Number	LOR	Unit	EW1500670-001	EW1500670-002	EW1500670-003	EW1500670-004	EW1500670-005
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	0.06	<0.01	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	258	465	----
Total Cations	----	0.01	meq/L	----	----	266	534	----
Ionic Balance	----	0.01	%	----	----	1.61	6.89	----
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	0	0	----	----	0
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	23	14	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	21	12	----
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	----	----	5.20	2.70	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	60.0	34.1	----
<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	----	----	0.63	0.66	----





## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				26-FEB-2015 09:14	26-FEB-2015 09:18	26-FEB-2015 08:35	26-FEB-2015 08:36	26-FEB-2015 08:45
Compound	CAS Number	LOR	Unit	EW1500670-006	EW1500670-007	EW1500670-008	EW1500670-009	EW1500670-010
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	6.8	6.9	----	6.7	7.0
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	11000	36100	----	1400	22700
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	7.2	26.7	----	0.8	15.6
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	18.9	18.1	----	19.9	19.3
<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	889	542	----	616	402
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	889	542	----	616	402
<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	501	2030	----	94	1190
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	3680	13600	----	96	8080
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	379	478	----	133	380
Magnesium	7439-95-4	1	mg/L	272	1100	----	45	600
Sodium	7440-23-5	1	mg/L	1960	8890	----	97	4770
Potassium	7440-09-7	1	mg/L	136	340	----	49	174
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.094	0.194	----	0.102	0.069
Iron	7439-89-6	0.05	mg/L	1.77	1.41	----	0.19	8.17
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.7	1.0	----	0.5	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	45.4	1.11	----	32.2	39.8
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	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	<0.01	0.02	----	0.01	<0.01





## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				26-FEB-2015 09:14	26-FEB-2015 09:18	26-FEB-2015 08:35	26-FEB-2015 08:36	26-FEB-2015 08:45
Compound	CAS Number	LOR	Unit	EW1500670-006	EW1500670-007	EW1500670-008	EW1500670-009	EW1500670-010
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	----	0.01	<0.01
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	132	437	----	17.0	261
Total Cations	----	0.01	meq/L	130	510	----	15.8	280
Ionic Balance	----	0.01	%	0.76	7.70	----	3.53	3.60
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	----	----	0	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	29	14	----	22	8
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	25	14	----	20	7
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	2.90	2.20	----	3.40	3.40
Dissolved Oxygen - % Saturation	----	0.1	% saturation	32.9	27.9	----	37.9	40.7
<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	1.05	1.10	----	1.16	1.40



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				26-FEB-2015 09:45	26-FEB-2015 09:49	26-FEB-2015 09:55	26-FEB-2015 09:35	26-FEB-2015 09:39
Compound	CAS Number	LOR	Unit	EW1500670-011	EW1500670-012	EW1500670-013	EW1500670-014	EW1500670-015
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	----	6.8	6.9	----	7.1
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2680	3580	----	2050
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	----	1.6	2.1	----	1.1
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	----	19.8	19.7	----	22.1
<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	----	1080	1400	----	815
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	1080	1400	----	815
<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	2	----	<1
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	398	506	----	196
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	197	156	----	102
Magnesium	7439-95-4	1	mg/L	----	105	74	----	47
Sodium	7440-23-5	1	mg/L	----	274	361	----	144
Potassium	7440-09-7	1	mg/L	----	74	166	----	90
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.274	0.240	----	0.313
Iron	7439-89-6	0.05	mg/L	----	5.95	7.36	----	0.63
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.5	0.4	----	0.8
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	27.4	160	----	97.0
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	<0.01	<0.01	----	0.08
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	<0.01	<0.01	----	<0.01



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				26-FEB-2015 09:45	26-FEB-2015 09:49	26-FEB-2015 09:55	26-FEB-2015 09:35	26-FEB-2015 09:39
Compound	CAS Number	LOR	Unit	EW1500670-011	EW1500670-012	EW1500670-013	EW1500670-014	EW1500670-015
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	<0.01	<0.01	----	0.08
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	32.8	42.3	----	21.8
Total Cations	----	0.01	meq/L	----	32.3	----	----	----
Total Cations	----	0.01	meq/L	----	----	45.2	----	24.4
Ionic Balance	----	0.01	%	----	0.80	----	----	----
Ionic Balance	----	0.01	%	----	----	3.35	----	5.67
<b>EN67 PK: Field Tests</b>								
Field Observations	----	0.01	--	0	----	----	0	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	26	83	----	50
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	24	71	----	46
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	----	3.00	3.30	----	3.60
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	33.0	36.5	----	41.7
<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	----	0.75	0.78	----	0.62



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				26-FEB-2015 08:00	26-FEB-2015 09:34	26-FEB-2015 08:18	26-FEB-2015 08:03	----
Compound	CAS Number	LOR	Unit	EW1500670-016	EW1500670-017	EW1500670-018	EW1500670-019	----
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	7.0	7.4	6.8	----	----
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	6610	3170	686	----	----
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	4.0	1.8	0.4	----	----
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	20.1	21.0	21.4	----	----
<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	152	152	136	----	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	152	152	136	----	----
<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	312	124	35	----	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	2270	850	133	----	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	----	<1	----
Magnesium	7439-95-4	1	mg/L	----	----	----	<1	----
Sodium	7440-23-5	1	mg/L	----	----	----	<1	----
Potassium	7440-09-7	1	mg/L	----	----	----	<1	----
<b>ED093T: Total Major Cations</b>								
Calcium	7440-70-2	1	mg/L	64	43	30	----	----
Magnesium	7439-95-4	1	mg/L	137	61	16	----	----
Sodium	7440-23-5	1	mg/L	1190	522	80	----	----
Potassium	7440-09-7	1	mg/L	54	22	5	----	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	----
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	----
<b>EG020T: Total Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.244	0.320	0.999	----	----
Iron	7439-89-6	0.05	mg/L	1.52	1.60	3.09	----	----



## Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				26-FEB-2015 08:00	26-FEB-2015 09:34	26-FEB-2015 08:18	26-FEB-2015 08:03	----
Compound	CAS Number	LOR	Unit	EW1500670-016	EW1500670-017	EW1500670-018	EW1500670-019	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.3	0.4	0.1	----	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	0.09	0.13	0.14	----	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	<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	0.02	0.03	<0.01	----	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.03	<0.01	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	12	11	10	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	12	10	10	----	----
<b>EP025FD: Field Dissolved Oxygen</b>								
Dissolved Oxygen	----	0.01	mg/L	6.90	5.00	5.50	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	77.4	56.4	62.4	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	----	----



# CHAIN OF CUSTODY

ALS Laboratory please tick →

□ Sydney 271 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8555 E: samples.syd@alsenviro.com  
□ Newcastle 5 Rossignol Rd, Waratah NSW 2254  
Ph: 02 4586 5403 E: samples.newcastle@alsenviro.com

□ Brisbane 32 Strand St, Stafford QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
□ Townsville 14-15 Desma Ct, Bohle QLD 4818  
Ph: 07 4786 0800 E: townsville@alsenviro.com

□ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 0600 E: samples.melbourne@alsenviro.com  
□ Adelaide 2-1 Burma Rd, Pooraka SA 5095  
Ph: 08 8359 0890 E: adelaide@alsenviro.com

□ Perth 10 Hood Way, Malaga WA 6060  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
□ Launceston 27 Melville St, Launceston TAS 7250  
Ph: 03 6331 2158 E: laur

Environmental Division

Wollongong  
Work Order Reference

EW1510399

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):	FOR LABOUR:
OFFICE:	PO Box 76 Kiama NSW 2533	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)		Custody Seal in Free Ice / frozen receipt?
PROJECT:	Minnamurra Landfill	ALS QUOTE NO.:	SV-146-10	Random Sample
ORDER NUMBER:				Other comment
PROJECT MANAGER:	Paul Czulkowski	CONTACT PH:	4232 0418	
SAMPLER:	Craig Wilson	SAMPLER MOBILE:	0408 261 660	
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RELINQUISHED BY:	Craig	RECEIVED BY:
Email Reports to (will default to PM if no other addresses are listed):	paucic@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au	DATE/TIME:	27/5/15 16:50	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):	paucic@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au			DATE/TIME:

Telephone : 02 42253125



ALS 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) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required)						Additional Information	
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	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.		
1	MD 1B	27/5 1320	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	YSI (Field Results) pH, Temp, EC, Sal, DO, Depth	
2	MD 2A	1121	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
3	MD 2B	1107	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
4	MD 2C	1114	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
5	MD 4A	1138	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
6	MD 4B	1142	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
7	MD 4C	1151	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
8	MD 6A	1023	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
9	MD 6B	1033	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
10	MD 6C	1040	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
11	MD 9A	1249	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
12	MD 9B	1306	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
TOTAL														

Notes/Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cl Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airtight Unpreserved Plastic  
= VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulfate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airtight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;  
= Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solis; B = Unpreserved Bag





# CHAIN OF CUSTODY

ALS Laboratory, please tick →

☐ Sydney 2777 Woodpark Rd, Smithfield NSW 2176  
Ph 02 8724 5555 E [samples.syd@alsenviro.com](mailto:samples.syd@alsenviro.com)  
☐ Newcastle 5 Rossgum Rd, Waratah NSW 2224  
Ph 02 4568 5433 E [samples.newcastle@alsenviro.com](mailto:samples.newcastle@alsenviro.com)

☐ Brisbane 32 Shand St, St Albans QLD 4053  
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☐ Townsville 14-15 Dasma Ct, Borne QLD 4818  
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☐ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
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☐ Adelaide 2-1 Burns Rd, Poonake SA 5095  
Ph 08 8359 0800 E [adelaide@alsenviro.com](mailto:adelaide@alsenviro.com)

☐ Perth 110 Hod Way, Maga WA 6190  
Ph 08 9209 7655 E [samples.perth@alsenviro.com](mailto:samples.perth@alsenviro.com)  
☐ Launceston 27 Wellington St, Launceston TAS 7250  
Ph 03 6331 2158 E [launceston@alsenviro.com](mailto:launceston@alsenviro.com)

CLIENT:	Kiama Municipal Council	TURNAROUND REQUIREMENTS:	<input type="checkbox"/> Standard TAT (Last due date): <input type="checkbox"/> Non Standard or urgent TAT (Last due date):	FOR LABORATORY USE ONLY (Circle)	
OFFICE:	PO Box 76 Kiama NSW 2533	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)		Custody Seal intact?	Yes No N/A
PROJECT:	Mimamurra Landfill	ALS QUOTE NO.:	SY-146-10	Free ice / frozen ice bricks present upon receipt?	Yes No N/A
ORDER NUMBER:				Random Sample Temperature on Receipt:	°C
PROJECT MANAGER:	Paul Czulowski	CONTACT PH:	4232 0418	Other comment:	
SAMPLER:	Craig Wilson	SAMPLER MOBILE:	0408 251 660	RECEIVED BY:	
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RELINQUISHED BY:	Craig	DATE/TIME:	
Email Reports to (will default to PM if no other addressees are listed):		DATE/TIME:	27/5/15	DATE/TIME:	
Email Invoice to (will default to PM if no other addressees are listed):		DATE/TIME:		DATE/TIME:	

## COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS 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) <small>Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required)</small>						Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE <small>(refer to codes below)</small>	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			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
13	MD 9C	27/5 1311	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth  YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth  YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth  YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth  YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth  YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
14	MD 10A	1221	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				
15	MD 10B	1230	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓				
16	Rocklow Down	940	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓		✓			
17	Rocklow Middle	1211	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓		✓			
18	Rocklow Up	1000	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓		✓			
19	Blank	1006	W	VS, N	2			✓		✓				
TOTAL														
Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cl Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulphuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulphuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfu Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag														

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic  
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulfate 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 = Sulfu  
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

## CERTIFICATE OF ANALYSIS

<b>Work Order</b>	<b>: EW1510399</b>	<b>Page</b>	<b>: 1 of 10</b>
<b>Client</b>	<b>: KIAMA COUNCIL</b>	<b>Laboratory</b>	<b>: Environmental Division NSW South Coast</b>
<b>Contact</b>	<b>: MR PAUL CZULOWSKI</b>	<b>Contact</b>	<b>: Glenn Davies</b>
<b>Address</b>	<b>: 11 MANNING STREET</b>	<b>Address</b>	<b>: 99 Kenny Street, Wollongong 2500</b>
	<b>KIAMA NSW, AUSTRALIA 2533</b>		<b>Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541</b>
			<b>AUSTRALIA</b>
<b>E-mail</b>	<b>: paulc@kiama.nsw.gov.au</b>	<b>E-mail</b>	<b>: glenn.davies@alsglobal.com</b>
<b>Telephone</b>	<b>: +61 02 4232 0444</b>	<b>Telephone</b>	<b>: 02 42253125</b>
<b>Facsimile</b>	<b>: +61 02 4232 0555</b>	<b>Facsimile</b>	<b>: W 02 42253128 N 02 44232083</b>
<b>Project</b>	<b>: Minnamurra Landfill</b>	<b>QC Level</b>	<b>: NEPM 2013 Schedule B(3) and ALS QCS3 requirement</b>
<b>Order number</b>	<b>: ----</b>	<b>Date Samples Received</b>	<b>: 27-May-2015 17:30</b>
<b>C-O-C number</b>	<b>: ----</b>	<b>Date Analysis Commenced</b>	<b>: 27-May-2015</b>
<b>Sampler</b>	<b>: Craig Wilson</b>	<b>Issue Date</b>	<b>: 12-Jun-2015 10:50</b>
<b>Site</b>	<b>: ----</b>		
<b>Quote number</b>	<b>: ----</b>	<b>No. of samples received</b>	<b>: 19</b>
		<b>No. of samples analysed</b>	<b>: 19</b>

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### *Signatories*

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong



## 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 sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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.

- Site MD1B - Not found at time of sampling.
- Site MD4A - Dry at time of sampling.
- EP002: It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- It has been noted that Nitrite is greater than NOx for sample ID (EW1510399-3,15) , 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.

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD1B	MD2A	MD2B	MD2C	MD4A
Client sampling date / time				27-May-2015 13:20	27-May-2015 11:21	27-May-2015 11:07	27-May-2015 11:14	27-May-2015 11:38	
Compound	CAS Number	LOR	Unit	EW1510399-001	EW1510399-002	EW1510399-003	EW1510399-004	EW1510399-005	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	7.1	7.1	7.3	----	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	13300	19200	37800	----	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	9.3	13.4	28.3	----	
EA116: Temperature									
Temperature	----	0.1	°C	----	16.9	17.9	17.9	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	<1	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	<1	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	828	632	484	----	
Total Alkalinity as CaCO3	----	1	mg/L	----	828	632	484	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	690	1020	2070	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	4420	6310	12800	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	241	358	420	----	
Magnesium	7439-95-4	1	mg/L	----	381	519	1060	----	
Sodium	7440-23-5	1	mg/L	----	2940	4160	7960	----	
Potassium	7440-09-7	1	mg/L	----	168	175	320	----	
ED093T: Total Major Cations									
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	----	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.041	0.149	0.016	----	
Iron	7439-89-6	0.05	mg/L	----	1.44	2.54	0.11	----	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	----	----	----	----	----	
EK040P: Fluoride by PC Titrator									



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD1B	MD2A	MD2B	MD2C	MD4A
Client sampling date / time					27-May-2015 13:20	27-May-2015 11:21	27-May-2015 11:07	27-May-2015 11:14	27-May-2015 11:38
Compound	CAS Number	LOR	Unit		EW1510399-001	EW1510399-002	EW1510399-003	EW1510399-004	EW1510399-005
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator - Continued</b>									
Fluoride	16984-48-8	0.1	mg/L		----	0.8	0.8	0.9	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		----	22.0	11.4	0.32	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>									
Nitrite as N	----	0.01	mg/L		----	0.13	0.01	0.02	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
^ Nitrate as N	14797-55-8	0.01	mg/L		----	1.07	<0.01	0.87	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		----	1.20	<0.01	0.89	----
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		----	156	212	414	----
^ Total Cations	----	0.01	meq/L		----	176	246	463	----
^ Ionic Balance	----	0.01	%		----	6.02	7.44	5.55	----
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		Not Found	----	----	----	Dry
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		----	53	33	20	----
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		----	56	34	19	----
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		----	5.40	3.10	2.80	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation		----	59.2	35.6	35.2	----
<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		----	0.50	0.72	0.80	----

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD4B	MD4C	MD6A	MD6B	MD6C
Client sampling date / time				27-May-2015 11:42	27-May-2015 11:51	27-May-2015 10:23	27-May-2015 10:33	27-May-2015 10:40	
Compound	CAS Number	LOR	Unit	EW1510399-006	EW1510399-007	EW1510399-008	EW1510399-009	EW1510399-010	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.1	7.0	7.2	7.1	7.2	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	9170	32500	5420	1380	23400	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	6.1	24.2	3.3	0.8	16.0	
EA116: Temperature									
Temperature	----	0.1	°C	17.5	17.4	19.2	19.9	19.6	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	833	600	775	550	391	
Total Alkalinity as CaCO3	----	1	mg/L	833	600	775	550	391	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	440	1810	619	92	1200	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	2810	10800	1050	71	7530	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	390	357	191	123	364	
Magnesium	7439-95-4	1	mg/L	238	882	147	41	572	
Sodium	7440-23-5	1	mg/L	1670	6590	948	106	4830	
Potassium	7440-09-7	1	mg/L	125	262	198	43	161	
ED093T: Total Major Cations									
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	----	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.091	0.197	0.075	0.090	0.072	
Iron	7439-89-6	0.05	mg/L	0.68	2.18	0.34	0.16	16.3	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	----	----	----	----	----	
EK040P: Fluoride by PC Titrator									





## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD4B	MD4C	MD6A	MD6B	MD6C
Client sampling date / time					27-May-2015 11:42	27-May-2015 11:51	27-May-2015 10:23	27-May-2015 10:33	27-May-2015 10:40
Compound	CAS Number	LOR	Unit		EW1510399-006	EW1510399-007	EW1510399-008	EW1510399-009	EW1510399-010
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator - Continued</b>									
Fluoride	16984-48-8	0.1	mg/L		0.5	0.9	0.9	0.6	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		36.0	1.68	10.4	29.8	38.0
<b>EK057G: Nitrite as N by Discrete Analyser</b>									
Nitrite as N	----	0.01	mg/L		0.12	<0.01	0.14	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
^ Nitrate as N	14797-55-8	0.01	mg/L		0.88	0.01	0.49	0.22	0.02
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		1.00	0.01	0.63	0.22	0.02
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		105	354	58.0	14.9	245
^ Total Cations	----	0.01	meq/L		115	384	67.9	15.2	279
^ Ionic Balance	----	0.01	%		4.46	3.97	7.88	1.05	6.51
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		----	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		51	27	72	29	15
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		49	28	74	30	16
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		2.60	2.20	3.30	3.40	2.70
Dissolved Oxygen - % Saturation	----	0.1	% saturation		28.2	26.4	36.5	37.4	31.8
<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		1.16	1.20	1.23	1.23	1.37



Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD9A	MD9B	MD9C	MD10A	MD10B
Client sampling date / time				27-May-2015 12:49	27-May-2015 13:06	27-May-2015 13:11	27-May-2015 12:21	27-May-2015 12:30	
Compound	CAS Number	LOR	Unit	EW1510399-011	EW1510399-012	EW1510399-013	EW1510399-014	EW1510399-015	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	6.4	7.1	7.3	6.7	7.3	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	10200	2740	3420	30900	2060	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	6.7	1.6	2.0	22.7	1.2	
EA116: Temperature									
Temperature	----	0.1	°C	18.1	19.8	19.5	17.8	18.9	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	123	942	1210	348	743	
Total Alkalinity as CaCO3	----	1	mg/L	123	942	1210	348	743	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	452	19	<1	1690	21	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	3480	403	447	10400	222	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	78	182	168	680	117	
Magnesium	7439-95-4	1	mg/L	265	99	78	924	51	
Sodium	7440-23-5	1	mg/L	2190	284	367	5770	158	
Potassium	7440-09-7	1	mg/L	83	68	160	156	88	
ED093T: Total Major Cations									
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	----	----	----	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.021	0.156	0.222	0.581	0.372	
Iron	7439-89-6	0.05	mg/L	0.22	0.38	1.80	4.78	0.44	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	----	----	
Iron	7439-89-6	0.05	mg/L	----	----	----	----	----	
EK040P: Fluoride by PC Titrator									



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD9A	MD9B	MD9C	MD10A	MD10B
Client sampling date / time					27-May-2015 12:49	27-May-2015 13:06	27-May-2015 13:11	27-May-2015 12:21	27-May-2015 12:30
Compound	CAS Number	LOR	Unit		EW1510399-011	EW1510399-012	EW1510399-013	EW1510399-014	EW1510399-015
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator - Continued</b>									
Fluoride	16984-48-8	0.1	mg/L		<0.1	0.6	0.4	0.5	0.8
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		0.40	19.4	103	1.45	74.3
<b>EK057G: Nitrite as N by Discrete Analyser</b>									
Nitrite as N	----	0.01	mg/L		<0.01	0.02	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		0.56	0.02	0.02	<0.01	<0.01
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		0.56	0.04	0.03	<0.01	0.01
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		110	30.6	36.8	336	21.5
^ Total Cations	----	0.01	meq/L		123	31.3	34.8	365	19.2
^ Ionic Balance	----	0.01	%		5.58	1.19	2.69	4.19	5.86
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		----	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		147	45	100	64	54
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		137	49	90	63	57
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		3.00	3.40	3.10	3.50	2.90
Dissolved Oxygen - % Saturation	----	0.1	% saturation		32.7	37.3	34.4	42.4	31.4
<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		0.53	0.83	0.88	0.50	0.72

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time				27-May-2015 09:40	27-May-2015 12:10	27-May-2015 10:00	27-May-2015 10:05	----	
Compound	CAS Number	LOR	Unit	EW1510399-016	EW1510399-017	EW1510399-018	EW1510399-019	-----	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	6.8	7.6	7.2	----	----	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	3960	3480	436	----	----	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	2.8	2.4	0.3	----	----	
EA116: Temperature									
Temperature	----	0.1	°C	13.2	13.8	13.1	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	117	116	78	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	117	116	78	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	221	181	28	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	1240	999	76	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	<1	----	
Magnesium	7439-95-4	1	mg/L	----	----	----	<1	----	
Sodium	7440-23-5	1	mg/L	----	----	----	<1	----	
Potassium	7440-09-7	1	mg/L	----	----	----	<1	----	
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	60	55	20	----	----	
Magnesium	7439-95-4	1	mg/L	105	89	14	----	----	
Sodium	7440-23-5	1	mg/L	828	662	61	----	----	
Potassium	7440-09-7	1	mg/L	34	27	7	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	----	
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	----	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.078	0.096	0.063	----	----	
Iron	7439-89-6	0.05	mg/L	0.95	1.00	1.56	----	----	
EK040P: Fluoride by PC Titrator									



## Analytical Results

Sub-Matrix: <b>WATER</b> (Matrix: <b>WATER</b> )				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time					27-May-2015 09:40	27-May-2015 12:10	27-May-2015 10:00	27-May-2015 10:05	----
Compound	CAS Number	LOR	Unit		EW1510399-016	EW1510399-017	EW1510399-018	EW1510399-019	-----
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator - Continued</b>									
Fluoride	16984-48-8	0.1	mg/L		0.3	0.3	0.1	----	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		0.28	0.29	0.06	----	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>									
Nitrite as N	----	0.01	mg/L		<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		0.13	0.10	0.03	----	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		0.13	0.10	0.03	----	----
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		----	----	----	----	----
^ Total Cations	----	0.01	meq/L		----	----	----	----	----
^ Ionic Balance	----	0.01	%		----	----	----	----	----
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		----	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		10	10	10	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		10	10	11	----	----
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		7.30	7.70	7.20	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation		70.6	75.5	68.9	----	----
<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		----	----	----	----	----

# CHAIN OF CUSTODY

ALS Laboratory: please tick →

- ☐ Sydney 277 Wyndham Rd. Smithfield NSW 2176
- ☐ Brisbane 32 Sharn St. Stalford QLD 4053
- ☐ Melbourne 2-4 Westall Rd. Springvale VIC 3171
- ☐ Perth 10 Hot Way, Malaga WA 6090
- ☐ Ph. 02 8784 8555 E. samples.syd@alsenviro.com
- ☐ Ph. 07 3243 7222 E. samples.bris@alsenviro.com
- ☐ Ph. 03 8549 9500 E. samples.mel@alsenviro.com
- ☐ Ph. 08 9209 7655 E. samples.perth@alsenviro.com
- ☐ Newcastle 5 Peasegum Rd. Waratah NSW 2204
- ☐ Townsville 14-15 Dharma Ct. Bolle QLD 4818
- ☐ Adelaide 2-1 Burma Rd. Poraka SA 5095
- ☐ Launceston 27 Vellingdon St. Launceston TAS 7250
- ☐ Ph. 02 4988 3453 E. samples.newcastle@alsenviro.com
- ☐ Ph. 07 4736 0600 E. townsville@alsenviro.com
- ☐ Ph. 08 8359 0890 E. adelaide@alsenviro.com
- ☐ Ph. 03 6331 2158 E. launceston@alsenviro.com

## FOR LABORATORY USE ONLY (GIVE)

Custody Seal Intact? ☐ Yes ☐ No ☐ N/A

Free ice / frozen ice bricks present upon receipt? ☐ Yes ☐ No ☐ N/A

Random Sample Temperature on Receipt: \_\_\_\_\_

Other comment: \_\_\_\_\_

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)

ALS QUOTE NO.: SY-146-10

PROJECT: Mimamurra Landfill

ORDER NUMBER: 87896

PROJECT MANAGER: Paul Czulowski

CONTACT PH: 4232 0418

SAMPLER: Craig Wilson


SAMPLER MOBILE: 0408 261 660

COG emailed to ALS? (YES / NO) EDD FORMAT (or default):

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

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

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

RELINQUISHED BY: 

DATE/TIME: 10/8/15 1530

RECEIVED BY: 

DATE/TIME: 10/11/15 1530

RELINQUISHED BY:

DATE/TIME:

RECEIVED BY:

DATE/TIME:

RELINQUISHED BY:

DATE/TIME:

RECEIVED BY:

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DATE/TIME:

RECEIVED BY:

DATE/TIME:

ANALYSIS REQUIRED INCLUDING SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (filtered bottle required).

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

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

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YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

## Additional Information

Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.

YSL (Field Results)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

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YSL (Field Tests)

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YSL (Field Tests)

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YSL (Field Tests)

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YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

YSL (Field Tests)

pH, Temp, EC, Sal, DO, Depth

Environmental Division  
Wollongong  
Work Order Reference  
EW1511234



Telephone: 02 42253125

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; S = Sodium Hydroxide/Cd Preserved; SH = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airtight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AM = Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speculation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag.



# CHAIN OF CUSTODY

ALS Laboratory, please tick →

☐ Sydney: 277 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 9764 5555 E: samples.sydney@alsenviro.com  
☐ Newcastle: 5 Rosslyn Rd, Warabrook NSW 2204  
Ph: 02 4988 9433 E: samples.newcastle@alsenviro.com  
☐ Brisbane: 32 Strand St, Stafford QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
☐ Townsville: 14-15 Derna Ct, Baithe QLD 4818  
Ph: 07 4736 0600 E: townsville.environmental@alsenviro.com  
☐ Melbourne: 2-4 Vineshall Rd, Springvale VIC 3171  
Ph: 03 8540 9600 E: samples.melbourne@alsenviro.com  
☐ Adelaide: 2-1 Dalrym Rd, Prospect SA 5095  
Ph: 08 8359 0990 E: adelaide@alsenviro.com  
☐ Perth: 10 Hod Way, Malaga WA 6090  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
☐ Lancaster: 27 Wellington St, Lancaster TAS 7250  
Ph: 03 9331 2158 E: lancaster@alsenviro.com

CLIENT: Kiama Municipal Council

OFFICE: PO Box 76 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER: CONTACT PH: 4232 0418

SAMPLER: Craig Wilson

COC emailed to ALS? (YES / NO)

Email Reports to (will default to PM if no other addresses are listed):

Email Invoice to (will default to PM if no other addresses are listed):

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

FOR LABORATORY USE ONLY (circle)

Custody Seal intact? Yes No N/A

Leaks / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

Other comment:

COC SEQUENCE NUMBER (circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

RECEIVED BY: Ma H J.

DATE/TIME: 10/8/15 1530

REINQUISHED BY:

DATE/TIME: 10/8/15 1530

ALS 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) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).	Additional Information
--------------	---	-----------------------	--	------------------------

Comments on likely contaminant levels, dilutions or samples requiring specific QC analysis etc.												
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	
13	MD 9C	10/8 1125	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
14	MD 10A	1065	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10B	1025	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
16	Rocklow Down	855	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
17	Rocklow Middle	955	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Up	920	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓		✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
19	Blank	955	W	VS, N	2			✓		✓		
TOTAL												
Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic V = VOA Via HCl Preserved; VB = VOA Via Sodium Bisulphate Preserved; VS = VOA Via Sulfuric Preserved; AV = Airfreight Unpreserved Vial; SQ = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfu V = Zinc Aerialia Preserved Bottle; F = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solis; B = Unpreserved Bag												

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



## CERTIFICATE OF ANALYSIS

**Work Order** : **EW1511234**  
**Client** : **KIAMA COUNCIL**  
**Contact** : MR PAUL CZULOWSKI  
**Address** : 11 MANNING STREET  
 KIAMA NSW, AUSTRALIA 2533

**E-mail** : paulc@kiama.nsw.gov.au  
**Telephone** : +61 02 4232 0444  
**Facsimile** : +61 02 4232 0555  
**Project** : Minnamurra Landfill  
**Order number** : 87896  
**C-O-C number** : ----  
**Sampler** : Craig Wilson  
**Site** : ----

**Quote number** : ----

**Page** : 1 of 10  
**Laboratory** : Environmental Division NSW South Coast  
**Contact** : Glenn Davies  
**Address** : 99 Kenny Street, Wollongong 2500  
 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541  
 AUSTRALIA  
**E-mail** : glenn.davies@alsglobal.com  
**Telephone** : 02 42253125  
**Facsimile** : W 02 42253128 N 02 44232083  
**QC Level** : NEPM 2013 Schedule B(3) and ALS QCS3 requirement  
**Date Samples Received** : 10-Aug-2015 15:30  
**Date Analysis Commenced** : 10-Aug-2015  
**Issue Date** : 17-Aug-2015 17:05

**No. of samples received** : 19  
**No. of samples analysed** : 19

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### *Signatories*

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

#### *Signatories*

Ankit Joshi  
 Celine Conceicao  
 Glenn Davies  
 Raymond Commodore

#### *Position*

Inorganic Chemist  
 Senior Spectroscopist  
 Environmental Services Representative  
 Instrument Chemist

#### *Accreditation Category*

Sydney Inorganics  
 Sydney Inorganics  
 Laboratory - Wollongong  
 Sydney Inorganics



## 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 sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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.

- EG020: LOR's have been raised due to matrix interference (High Total Dissolved Solids)
- Site MD1B - Site not found at time of sampling.
- EK055G-EK059G: LOR raised for Ammonia- NOx on sample ID (EW1511234-10) due to sample matrix.
- EP035G: LOR raised for Phenol analysis on sample ID: MD9A, due to matrix interferences.
- ED041G: LOR raised for Sulfate analysis on a few samples due to matrix interferences.
- EK055G: LOR raised for Ammonia on sample ID (EW1511234-11) due to sample matrix.
- EK059G-EK058G: LOR raised for NOx-Nitrate on sample ID (EW1511234-11) 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 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

Sub-Matrix: **WATER**  
 (Matrix: **WATER**)

Client sample ID

				MD1B	MD2A	MD2B	MD2C	MD4A
Client sampling date / time				10-Aug-2015 14:00	10-Aug-2015 12:30	10-Aug-2015 12:45	10-Aug-2015 13:00	10-Aug-2015 11:40
Compound	CAS Number	LOR	Unit	EW1511234-001	EW1511234-002	EW1511234-003	EW1511234-004	EW1511234-005
				Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>								
pH	----	0.1	pH Unit	----	7.3	7.1	7.0	----
<b>EA010FD: Field Conductivity</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	21800	25700	44100	----
<b>EA020FD: Field Salinity</b>								
Salinity	----	0.2	g/L	----	16.6	18.7	33.9	----
<b>EA116: Temperature</b>								
Temperature	----	0.1	°C	----	14.9	17.4	17.5	----
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	776	660	517	----
Total Alkalinity as CaCO3	----	1	mg/L	----	776	660	517	----
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	976	1160	2120	----
<b>ED045G: Chloride by Discrete Analyser</b>								
Chloride	16887-00-6	1	mg/L	----	5280	6190	10700	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	276	351	463	----
Magnesium	7439-95-4	1	mg/L	----	511	589	915	----
Sodium	7440-23-5	1	mg/L	----	3830	4610	8180	----
Potassium	7440-09-7	1	mg/L	----	173	171	267	----
<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	----	0.046	0.082	0.125	----
Iron	7439-89-6	0.05	mg/L	----	0.34	0.83	1.10	----
<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	MD1B	MD2A	MD2B	MD2C	MD4A
Client sampling date / time					10-Aug-2015 14:00	10-Aug-2015 12:30	10-Aug-2015 12:45	10-Aug-2015 13:00	10-Aug-2015 11:40
Compound	CAS Number	LOR	Unit		EW1511234-001	EW1511234-002	EW1511234-003	EW1511234-004	EW1511234-005
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>									
Fluoride	16984-48-8	0.1	mg/L		----	0.8	0.8	0.8	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		----	11.8	9.61	4.80	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>									
Nitrite as N	14797-65-0	0.01	mg/L		----	0.02	<0.01	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
^ Nitrate as N	14797-55-8	0.01	mg/L		----	1.98	0.29	0.04	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		----	2.00	0.29	0.04	----
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		----	185	212	356	----
^ Total Cations	----	0.01	meq/L		----	227	271	461	----
^ Ionic Balance	----	0.01	%		----	10.2	12.2	12.8	----
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		NOT FOUND	----	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		----	42	26	22	----
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		----	42	27	18	----
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		----	1.91	1.22	1.11	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation		----	19.5	12.7	11.7	----
<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		----	0.60	0.75	0.82	----



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD4B	MD4C	MD6A	MD6B	MD6C
Client sampling date / time					10-Aug-2015 11:55	10-Aug-2015 12:10	10-Aug-2015 13:15	10-Aug-2015 13:35	10-Aug-2015 13:45
Compound	CAS Number	LOR	Unit		EW1511234-006	EW1511234-007	EW1511234-008	EW1511234-009	EW1511234-010
					Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>									
pH	----	0.1	pH Unit		7.0	7.0	7.4	7.2	7.1
<b>EA010FD: Field Conductivity</b>									
Electrical Conductivity (Non Compensated)	----	1	µS/cm		10500	43200	4190	1550	25300
<b>EA020FD: Field Salinity</b>									
Salinity	----	0.2	g/L		7.2	33.7	2.6	0.9	17.8
<b>EA116: Temperature</b>									
Temperature	----	0.1	°C		16.9	16.8	17.9	18.4	18.6
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		827	570	647	589	365
Total Alkalinity as CaCO3	----	1	mg/L		827	570	647	589	365
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		390	2130	403	91	1210
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		2680	10500	648	55	6220
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		321	462	148	135	356
Magnesium	7439-95-4	1	mg/L		199	877	106	37	536
Sodium	7440-23-5	1	mg/L		1690	7910	596	75	4340
Potassium	7440-09-7	1	mg/L		109	263	122	40	138
<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		0.081	0.165	0.062	0.089	0.045
Iron	7439-89-6	0.05	mg/L		1.13	1.16	0.18	0.16	0.83
<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	MD4B	MD4C	MD6A	MD6B	MD6C
Client sampling date / time					10-Aug-2015 11:55	10-Aug-2015 12:10	10-Aug-2015 13:15	10-Aug-2015 13:35	10-Aug-2015 13:45
Compound	CAS Number	LOR	Unit		EW1511234-006	EW1511234-007	EW1511234-008	EW1511234-009	EW1511234-010
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>									
Fluoride	16984-48-8	0.1	mg/L		0.6	1.1	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		44.2	0.96	5.98	44.4	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	0.06	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
^ Nitrate as N	14797-55-8	0.01	mg/L		0.07	<0.01	2.92	0.04	0.27
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		0.07	<0.01	2.98	0.04	0.27
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		100	352	39.6	15.2	208
^ Total Cations	----	0.01	meq/L		109	446	45.2	14.1	254
^ Ionic Balance	----	0.01	%		4.04	11.8	6.55	3.91	9.99
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		----	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		35	19	48	25	8
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		35	21	43	28	12
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		1.50	0.96	2.13	1.19	1.14
Dissolved Oxygen - % Saturation	----	0.1	% saturation		15.5	10.0	22.8	12.7	12.2
<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		1.18	1.21	1.33	1.29	1.50





## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD9A	MD9B	MD9C	MD10A	MD10B
Client sampling date / time					10-Aug-2015 10:55	10-Aug-2015 11:10	10-Aug-2015 11:25	10-Aug-2015 10:05	10-Aug-2015 10:25
Compound	CAS Number	LOR	Unit		EW1511234-011	EW1511234-012	EW1511234-013	EW1511234-014	EW1511234-015
					Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>									
pH	----	0.1	pH Unit		6.8	7.0	7.1	7.3	7.4
<b>EA010FD: Field Conductivity</b>									
Electrical Conductivity (Non Compensated)	----	1	µS/cm		5910	2950	3940	32000	2040
<b>EA020FD: Field Salinity</b>									
Salinity	----	0.2	g/L		4.2	1.9	2.4	25.8	1.2
<b>EA116: Temperature</b>									
Temperature	----	0.1	°C		13.8	16.2	17.8	14.2	16.9
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L		<1	<1	<1	<1	<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		172	982	1290	424	750
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L		172	982	1290	424	750
<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		275	4	<10	1390	<10
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L		1370	342	451	8040	160
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L		48	202	137	614	113
Magnesium	7439-95-4	1	mg/L		102	96	57	716	42
Sodium	7440-23-5	1	mg/L		1120	285	402	5390	147
Potassium	7440-09-7	1	mg/L		44	70	165	111	73
<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		0.017	0.244	0.190	0.287	0.341
Iron	7439-89-6	0.05	mg/L		0.52	3.46	6.07	<0.50	0.48
<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	MD9A	MD9B	MD9C	MD10A	MD10B
Client sampling date / time					10-Aug-2015 10:55	10-Aug-2015 11:10	10-Aug-2015 11:25	10-Aug-2015 10:05	10-Aug-2015 10:25
Compound	CAS Number	LOR	Unit		EW1511234-011	EW1511234-012	EW1511234-013	EW1511234-014	EW1511234-015
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>									
Fluoride	16984-48-8	0.1	mg/L		0.2	0.5	0.5	0.5	0.8
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		<0.10	33.2	170	0.20	75.0
<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	0.02	0.02
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
^ Nitrate as N	14797-55-8	0.01	mg/L		<0.10	0.02	0.04	0.37	0.01
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.10	0.02	0.04	0.39	0.03
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		47.8	29.4	38.5	264	19.5
^ Total Cations	----	0.01	meq/L		60.6	32.2	33.2	327	17.4
^ Ionic Balance	----	0.01	%		11.8	4.58	7.34	10.6	5.81
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		----	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		551	37	143	59	57
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		523	52	140	61	52
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		2.89	1.89	0.76	5.95	1.16
Dissolved Oxygen - % Saturation	----	0.1	% saturation		27.9	19.1	7.9	58.9	12.0
<b>EP035G: Total Phenol by Discrete Analyser</b>									
Phenols (Total)	----	0.05	mg/L		<0.25	<0.05	<0.05	<0.05	<0.05
<b>FWI-EN/001: Groundwater Sampling - Depth</b>									
Depth	----	0.01	m		0.62	0.88	0.84	0.78	0.70



## Analytical Results

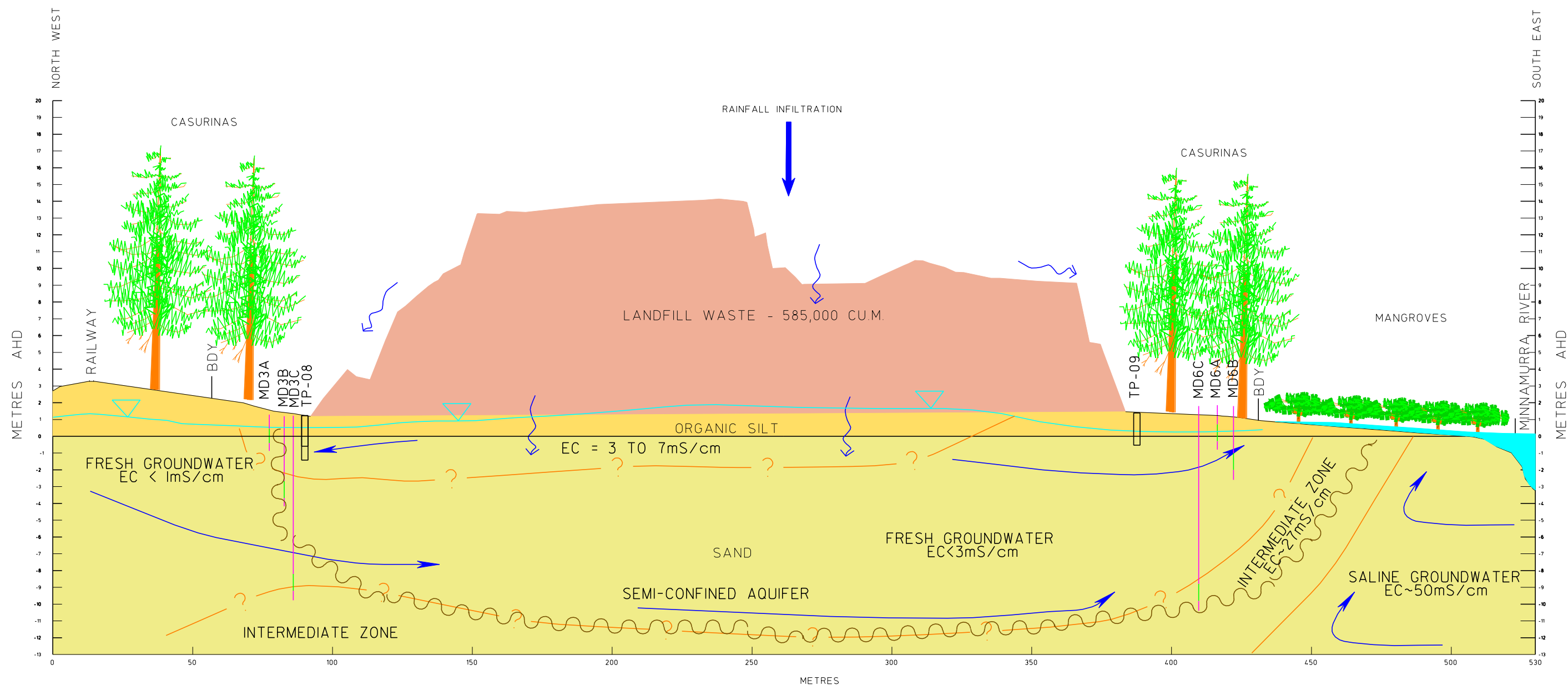
Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time					10-Aug-2015 08:55	10-Aug-2015 09:45	10-Aug-2015 09:20	10-Aug-2015 09:55	----
Compound	CAS Number	LOR	Unit	EW1511234-016	EW1511234-017	EW1511234-018	EW1511234-019	-----	
				Result	Result	Result	Result	Result	Result
<b>EA005FD: Field pH</b>									
pH	----	0.1	pH Unit	7.6	7.5	7.5	----	----	----
<b>EA010FD: Field Conductivity</b>									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	6680	7000	1710	----	----	----
<b>EA020FD: Field Salinity</b>									
Salinity	----	0.2	g/L	5.0	5.3	1.2	----	----	----
<b>EA116: Temperature</b>									
Temperature	----	0.1	°C	12.2	11.3	10.8	----	----	----
<b>ED037P: Alkalinity by PC Titrator</b>									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	130	133	97	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	130	133	97	----	----	----
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	342	357	86	----	----	----
<b>ED045G: Chloride by Discrete Analyser</b>									
Chloride	16887-00-6	1	mg/L	1500	1600	347	----	----	----
<b>ED093F: Dissolved Major Cations</b>									
Calcium	7440-70-2	1	mg/L	----	----	----	<1	----	----
Magnesium	7439-95-4	1	mg/L	----	----	----	<1	----	----
Sodium	7440-23-5	1	mg/L	----	----	----	<1	----	----
Potassium	7440-09-7	1	mg/L	----	----	----	<1	----	----
<b>ED093T: Total Major Cations</b>									
Calcium	7440-70-2	1	mg/L	72	80	38	----	----	----
Magnesium	7439-95-4	1	mg/L	131	141	35	----	----	----
Sodium	7440-23-5	1	mg/L	1230	1290	272	----	----	----
Potassium	7440-09-7	1	mg/L	44	48	12	----	----	----
<b>EG020F: Dissolved Metals by ICP-MS</b>									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	----	----
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	----	----
<b>EG020T: Total Metals by ICP-MS</b>									
Manganese	7439-96-5	0.001	mg/L	0.059	0.070	0.184	----	----	----
Iron	7439-89-6	0.05	mg/L	0.99	1.01	1.70	----	----	----



## Analytical Results

Sub-Matrix: <b>WATER</b> (Matrix: <b>WATER</b> )				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time					10-Aug-2015 08:55	10-Aug-2015 09:45	10-Aug-2015 09:20	10-Aug-2015 09:55	----
Compound	CAS Number	LOR	Unit		EW1511234-016	EW1511234-017	EW1511234-018	EW1511234-019	-----
					Result	Result	Result	Result	Result
<b>EK040P: Fluoride by PC Titrator</b>									
Fluoride	16984-48-8	0.1	mg/L		0.5	0.5	0.2	----	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>									
Ammonia as N	7664-41-7	0.01	mg/L		0.19	0.23	0.09	----	----
<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	----	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>									
^ Nitrate as N	14797-55-8	0.01	mg/L		0.34	0.34	0.12	----	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>									
Nitrite + Nitrate as N	----	0.01	mg/L		0.34	0.34	0.12	----	----
<b>EN055: Ionic Balance</b>									
^ Total Anions	----	0.01	meq/L		----	----	----	----	----
^ Total Cations	----	0.01	meq/L		----	----	----	----	----
^ Ionic Balance	----	0.01	%		----	----	----	----	----
<b>EN67 PK: Field Tests</b>									
Field Observations	----	0.01	--		----	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>									
Dissolved Organic Carbon	----	1	mg/L		10	7	9	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>									
Total Organic Carbon	----	1	mg/L		7	7	8	----	----
<b>EP025FD: Field Dissolved Oxygen</b>									
Dissolved Oxygen	----	0.01	mg/L		9.82	9.13	9.18	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation		----	----	----	----	----
<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		----	----	----	----	----

## Appendix B



SECTION B - B1

LEGEND

- INFERRED EXTENT OF LEACHATE PLUME
- INFERRED LEACHATE MOVEMENT
- INFERRED GROUNDWATER LEVEL
- INFERRED LOCAL REGIONAL GROUNDWATER FLOW
- EXTENT OF HIGH TIDE LEVEL (& SALINE LEVEL)
- MONITORING WELL
- WELL SCREEN INTERVAL



## Appendix C

## LANDFILL GAS MONITORING

GAS 1	Site Entrance
GAS 2	40m South of Landfill
GAS 3	Carpark South of Landfill
GAS 4	Next to Secondhand Shop
GAS 5	Landfill West Bank, Bench
GAS 6	Landfill West Bank, Bund Wall
TRENCH 1	West Bank
TRENCH 2	North Bank West Side
TRENCH 3	North Bank Middle
TRENCH 4	South Bank Side
TRENCH 5	East Bank Side
TRENCH 6	North Bank East Side
TRENCH 7	Lower Level South Side

LEL % from inside trench pipe cap. This is normally not needed, but wanted to keep a record.

WELL ID	DATE	TIME	LEL PPM				COMMENTS
			MAX		STABLE		
			LEL%	PPM	LEL%	PPM	
Trench 4	16-Jan-15	1030	100	2,500		600	Good Readings
Trench 1	16-Jan-15	1035	100	900		400	*****
Trench 2	16-Jan-15	1040		780		240	*****
Trench 3	16-Jan-15	1045	100	1,600		300	*****
Trench 6	16-Jan-15	1050		800		210	*****
Trench 5	16-Jan-15	1055	100	890		310	*****
Trench 7	16-Jan-15	1100	100	1,000		410	*****
Gas 1	16-Jan-15	1115		220		100	*****
Gas 2	16-Jan-15						Removed due to new CRC site
Gas 3	16-Jan-15	1125		260		140	*****
Gas 4	16-Jan-15	1130		400		210	*****
Weighbridge	16-Jan-15	1000		0		0	All Building with clear readings
Cleaning Shed	16-Jan-15	1005		0		0	*****
MRF	16-Jan-15	1010		0		0	*****
Lunchroom	16-Jan-15	1015		0		0	*****
Ute Shed	16-Jan-15	1020		0		0	*****
Trench 4	28-May-15	900	100	1,900		300	Wet ground
Trench 1	28-May-15	905		500		160	*****
Trench 2	28-May-15	910		490		170	*****
Trench 3	28-May-15	910	100	900		220	*****
Trench 6	28-May-15	915		550		210	*****
Trench 5	28-May-15	920		490		390	*****
Trench 7	28-May-15	925	80	900		390	*****
Gas 1	28-May-15	930		200		190	*****
Gas 2	28-May-15			0		0	Removed due to new CRC site
Gas 3	28-May-15	940		180		120	*****
Gas 4	28-May-15	945		140		100	*****
Weighbridge	28-May-15	950		0		0	All Building with clear readings
Cleaning Shed	28-May-15	955		0		0	*****
MRF	28-May-15	955		0		0	*****
Lunchroom	28-May-15	1000		0		0	*****
Ute Shed	28-May-15	1005		0		0	*****
Trench 4	3-Sep-15	1100		1,000		440	Pipe cracked, so no pipe reading
Trench 1	3-Sep-15	1105	100	600		230	Good Readings
Trench 2	3-Sep-15	1110		450		100	*****
Trench 3	3-Sep-15	1115	100	1,100		100	*****
Trench 6	3-Sep-15	1120		690		100	*****
Trench 5	3-Sep-15	1125	100	700		140	*****
Trench 7	3-Sep-15	1130	80	1,000		180	*****
Gas 1	3-Sep-15	1135		160		100	*****
Gas 2	3-Sep-15			0		0	Removed due to new CRC site
Gas 3	3-Sep-15	1145		360		110	*****
Gas 4	3-Sep-15	1150		350		120	*****
Weighbridge	3-Sep-15	1155		0		0	All Building with clear readings
Cleaning Shed	3-Sep-15	1200		0		0	*****
MRF	3-Sep-15	1200		0		0	*****
Lunchroom	3-Sep-15	1205		0		0	*****
Ute Shed	3-Sep-15	1210		0		0	*****

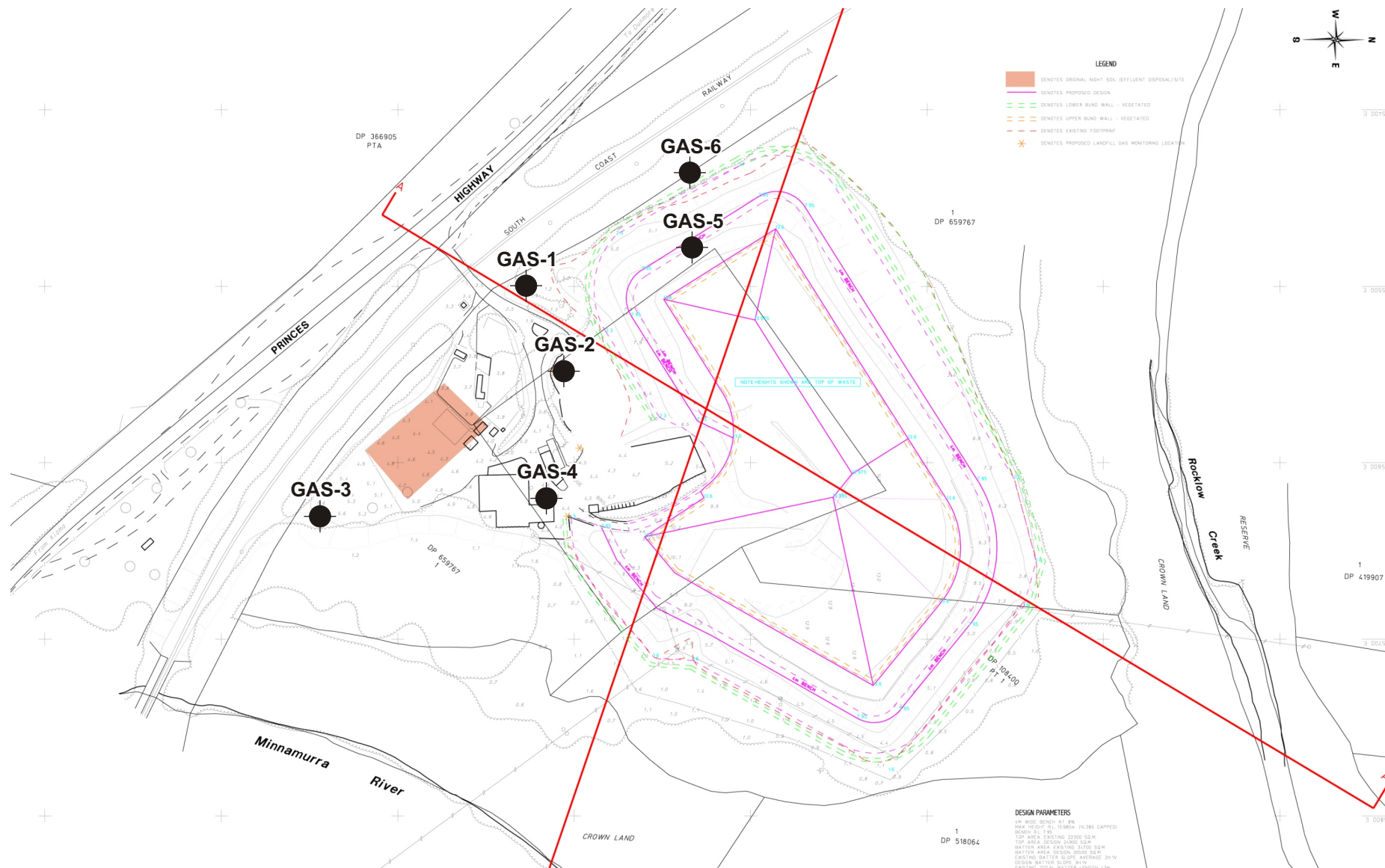
**CALIBRATED WITH SPAN GAS:**

# LANDFILL GAS MONITORING

GAS 1	Site Entrance
GAS 2	40m South of Landfill
GAS 3	Carpark South of Landfill
GAS 4	Next to Secondhand Shop
GAS 5	Landfill West Bank, Bench
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TRENCH 1	West Bank
TRENCH 2	North Bank West Side
TRENCH 3	North Bank Middle
TRENCH 4	South Bank Side
TRENCH 5	East Bank Side
TRENCH 6	North Bank East Side
TRENCH 7	Lower Level South Side

WELL ID	DATE	TIME	LEL PPM				COMMENTS
			MAX		STABLE		
			LEL%	PPM	LEL%	PPM	
Trench 4	21-Jan-14	1030	100	4,000		750	Good Readings
Trench 1	21-Jan-14	1035	100	1,100		400	
Trench 2	21-Jan-14	1040		900		250	
Trench 3	21-Jan-14	1045	100	2,000		500	
Trench 6	21-Jan-14	1050		750		200	
Trench 5	21-Jan-14	1055	100	990		340	
Trench 7	21-Jan-14	1100	100	1,200		480	
Gas 1	21-Jan-14	1115		340		200	
Gas 2	21-Jan-14	1120		250		120	
Gas 3	21-Jan-14	1125		260		150	
Gas 5	21-Jan-14						
Gas 4	21-Jan-14	1130		400		200	
Gas 6	21-Jan-14						
Trench 4	2-Jun-14	930	100	2,600		400	Slightly windy
Trench 1	2-Jun-14	935		900		170	
Trench 2	2-Jun-14	940		370		170	
Trench 3	2-Jun-14	945	100	1,000		200	
Trench 6	2-Jun-14	950		410		230	
Trench 5	2-Jun-14	955		700		420	
Trench 7	2-Jun-14	1000	100	900		800	
Gas 1	2-Jun-14	1010		370		220	
Gas 2	2-Jun-14	1015		350		130	
Gas 3	2-Jun-14	1020		290		100	
Gas 5	2-Jun-14						
Gas 4	2-Jun-14	1025		140		100	
Gas 6	2-Jun-14						
Weighbridge	2-Jun-14	1310		0		0	All Building with clear readings
Cleaning Shed	2-Jun-14	1315		0		0	
MRF	2-Jun-14	1320		0		0	
Lunchroom	2-Jun-14	1325		0		0	
Ute Shed	2-Jun-14	1330		0		0	
Trench 4	19-Sep-14	1230	100	2,800		500	Good Readings
Trench 1	19-Sep-14	1235		600		210	
Trench 2	19-Sep-14	1240		450		100	
Trench 3	19-Sep-14	1245	100	900		110	
Trench 6	19-Sep-14	1250		400		100	
Trench 5	19-Sep-14	1300		380		180	
Trench 7	19-Sep-14	1305	90	900		220	
Gas 1	19-Sep-14	1310		180		0	
Gas 2	19-Sep-14	1315		250		100	
Gas 3	19-Sep-14	1320		480		110	
Gas 5	19-Sep-14						
Gas 4	19-Sep-14	1325		350		130	
Gas 6	19-Sep-14						

**CALIBRATED WITH SPAN GAS:**



Source: Neil Charters Pty Ltd

Date: 7 August 2006

Reference: E2W\_047\_10.cdr

**Figure 1**

LAST PAGE OF REPORT



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

Feedback is welcomed at Earth2Water  
([dino@earth2water.com.au](mailto:dino@earth2water.com.au))



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