



Kiama Municipal Council

Minnamurra Waste Disposal Depot Annual Groundwater & Surface Water Monitoring Report – 2017 to 2018

Report E2W-059 (R001 v1)

26 November 2018



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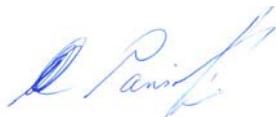
**Project: Annual Surface and Groundwater Monitoring Report Minnamurra
Waste Disposal Depot
(EPL 2017 to 2018)**

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1. INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Kiama Municipal Council (KMC) to provide the 2017 to 2018 annual surface and groundwater monitoring report for the Minnamurra Waste Disposal Depot (MWDD).

This report is based on information provided in field and laboratory reports provided by ALS Environmental Pty Ltd, and previous monitoring reports by E2W (2004 - 2017), Eco-Engineers Pty Ltd and Forbes Rigby Pty Ltd (pre 2004).

This monitoring report for the MWDD is based on quarterly monitoring results (9 November 2017, 9 February 2018, 24 May 2018, and 29 August 2018) and NSW EPA Environmental Protection Licence (EPL) conditions (R1.10). E2W completed the landfill closure plan (LCP in October 2005) and construction quality assurance (April 2008) for the landfill rehabilitation works completed by KMC in January 2008.

1.1 Background

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

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

1.2 Objectives

The objective of surface and groundwater monitoring in the 2017 to 2018 reporting period was to assess actual or potential impacts associated with the MWDD on the surrounding aquatic environment. Gas monitoring is undertaken by KMC to measure the performance of landfill rehabilitation works.

The objective of this annual report is to provide KMC and the NSW EPA with a summary of the monitoring results obtained in the 2017-2018 reporting period (i.e. EPL 5958 conditions).

2. SCOPE OF WORK

E2W was commissioned by KMC to collate and assess surface and groundwater monitoring data provided by ALS during 2017 and 2018. The annual reporting period covers four quarterly monitoring events in November 2017, February 2018, May 2018 and August 2018 (Figures 1 & 2).

Each monitoring event comprised the following:

- Sampling of onsite and offsite groundwater wells MD1B, MD1A, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, and MD10B¹.
- Sampling of surface water at three locations along Rocklow Creek (Rocklow-Up, Rocklow-Middle and Rocklow-Down).

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

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

- Provide advice to KMC (in relation to monitoring results- as required).
- Prepare this annual report for monitoring period (November 2017 to August 2018) and comply with Section R1.10 of the EPL (No. 5958). The annual report is to include the following:
 1. Tabulation of the monitoring data obtained for the period.
 2. Graphical representation of the current and previous monitoring data (minimum - last three years). Statistically significant variations or anomalies will be highlighted.
 3. Analyses and interpretation of monitoring data.
 4. Analyses and response to any complaints received.
 5. Identification of any deficiencies in the environmental performance of the MWDD, as highlighted by the monitoring data, trends and/or accidents.
 6. Recommendations to address the above identified deficiencies.
 7. Recommendations on improving the overall environmental performance of the facility.

Rehabilitation of the landfill commenced in August 2006 and was completed by KMC in January 2008. The work included reshaping, cut/fill of waste materials and capping with clays and soil/compost mix (i.e. evapotranspiration layer). The rehabilitation works may have temporarily degraded the runoff and shallow groundwater (2007) due to exposure and leaching of buried putrescible waste which was redistributed during the reshaping.

In early to mid 2016, E2W and Council commenced testing of new extraction bores near MD-9C to assess yields, water quality and the potential for reducing the leachate impact (i.e. ammonia >100 mg/L) by irrigation on the mound. Groundwater remedial works are progressing and include the installation of three extraction bores, and five monitoring wells in proximity to the MD-9C. Groundwater pumps and infrastructure has been installed and commissioned (i.e. extraction works planned for end of 2018).

3. ENVIRONMENTAL SETTING

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

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

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

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

3.1 Climate

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

The annual rainfall from August 2017 to July 2018 was 663mm (drought), whilst August 2016 to July 2017 was 923 mm which is also substantially less than previous years (August 2015 to July 2016 was 1260 mm, August 2014 to July 2015 was 1269² mm).

The annual rainfall in previous years are as follows; August 2013 to July 2014 = 873.0 mm³, 1201.8 mm =August 2012 to July 2013, 1282.8 mm =August 2011 to July 2012, 1308 mm =August 2010 to July 2011, 1054.4 mm =August 2009 to July 2010.

Periods of high monthly rainfall occurred in November 2017 (116.8 mm) and February 2018 (111.6 mm) are reflected in higher water levels in the following month.

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).

² Bombo Headland

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

3.3 Geology

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

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

3.4 Hydrogeology and Groundwater Flow Regime

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

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

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

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

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

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

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

3.5 Hydrology

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

The Minnamurra River drains a catchment of approximately 142 km². 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 km² and occupies the northern most portion of the Minnamurra River catchment. Rocklow Creek flows into the main arm of the Minnamurra River downstream of the MWDD, approximately 2 km upstream of the river entrance. Potential up-gradient sources of contamination may include the Shellharbour landfill, Princes Highway, Riverside Drive and nearby sand mining operations.

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

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

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

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

4. LICENCE CRITERIA AND RELEVANT GUIDELINES

Under the NSW EPA requirements for Licence No. 5958, the criteria for surface and groundwater quality are based on the ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. E2W note that the ANZECC (2000) guidelines have been superseded by ANZECC (2018), however ANZECC (2000) are referenced for this EPL report.

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 20 monitoring points for the MWDD (two for landfill gas and fifteen for groundwater monitoring and three for surface water). The landfill gas monitoring points are required to be analysed for methane every 6 months (i.e. twice in the reporting period). Landfill gas monitoring was conducted on a quarterly basis by KMC (Appendix C) at gas wells and trenches, however annually for inside buildings.

The frequency of testing of the groundwater monitoring points (MD1A, MD1B, MD2A, MD2B, MD2C, MD4A, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) is also half yearly (EPL requirement). However, KMC conducts the groundwater monitoring on a quarterly basis (November 2017, February 2018, May 2018 and August 2018 of each reporting period) to establish water quality trends post landfill rehabilitation works.

Some of the groundwater monitoring locations (i.e. MD4A, and previously MD2A, MD6A, MD9A, MD10A) are sampled on some occasions (i.e. shallow wells are commonly dry or do not have enough water for sampling). Other available wells onsite including MD3B, MD3C,

MD7, MD5A/B/C and MD8 however are not part of the EPL (previously tested prior to landfill closure for characterising the local groundwater).

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

Table 4.1: Groundwater analytical suite (as per the EPL)

Alkalinity (as CaCO ₃)	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 required to be undertaken twice a year to comply with the EPL, however they are also undertaken quarterly by KMC in conjunction with groundwater monitoring. Surface water samples are collected and analysed from an up-stream (Rocklow-Up) and mid-gradient (Rocklow-Middle) locations. An alternative sample location was established in May and August 2015 for the down-gradient location (Rocklow-Down, Figure 2).

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

4.2 Previous Monitoring Results

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

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

5. ENVIRONMENTAL MONITORING

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

- 9 November 2017,
- 20 February 2018,
- 19 May 2018; and

- 17 August 2018.

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

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

5.1 Landfill Gas Monitoring

The landfill gas testing locations (areas where intermediate or final cover has been placed and inside all buildings within 250 m of the deposited waste) were tested by KMC (24 January 2016, 15 June 2017, 6 October 2017, February 2018, June 2018, and October 2018). The three rounds of landfill gas testing (2017/18) are presented in Appendix C.

All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings in January 2017, June 2017, October 2017, February 2018, June 2018, and October 2018. KMC (& E2W) are unaware of any reportable pollution incidences or complaints from the community related to the MWDD during the 2017/18 reporting period.

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 (2017/2018) from the trenches (biofilter pads, Trench 1 to Trench 7) and gas monitoring wells (Gas 1, Gas 3 & Gas 4) showed similar concentrations to previous years (i.e. 2010/2011/2012/2013/2014/2015/2016/2017). Methane gas readings were consistent at each sampling event through the monitoring period. The maximum methane (stable) gas reading was 420 ppm at Trench (4) on 17 October 2018. The lowest readings were 100 ppm at trench2 in 17 October 2017. Gas well locations (Gas; 1, 2, 3) in 2017/2018 also reported low landfill gas concentration (i.e. less than 140 ppm).

Buildings were sampled for landfill gas in 2017/2018, with all locations recording no methane gas readings (non-detectable and compliant with EPL conditions).

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

5.2 Surface and Groundwater Monitoring Locations

Groundwater monitoring was undertaken from up to 16 existing groundwater wells (shallow, intermediate and deep) located on the landfill mound perimeter and surface water monitoring at two locations along Rocklow Creek (up, middle and down-gradient of the landfill mound,

whilst access was re-established at Rocklow-down in May 2015). Monitoring locations are shown on Figure 2.

The wells and surface water locations sampled in the 2017 and 2018 reporting period are outlined below:

- 9 November 2017. Groundwater wells: MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle (no access to Rocklow-dn);
- 9 February 2018. Groundwater wells: MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down.
- 24 May 2018. Groundwater wells: MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down;
- 29 November 2018. Groundwater wells: MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, & Rocklow-Down.

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

Table 5.2.1: Summary of Groundwater Salinity Changes with Depth

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

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

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

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

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

Table 5.2.2: Monitoring Summary for the 2017 to 2018 Reporting Period

Sample ID	Screen Interval (m AHD) - or Sample Location	Nov 2017	Feb 2018	May 2018	Aug 2018
(MD1A)	0.5 to -0.5	No Access/dry	No Access/dry	No Access/dry	No Access/dry
MD1B	-4.7 to -5.7	No Access/dry	No Access/dry	X	No Access/dry
MD2A	0.525 to -0.475	X	X	X	X
MD2B	-2.93 to -3.93	X	X	X	X
MD2C	-5.2 to -6.2	X	X	X	X
(MD3B)	-3.22 to -4.22*				
(MD3C)	-5.55 to -6.55*				
MD4A	1.2 to 0.2	Dry	Dry	Dry	Dry
MD4B	-3.22 to -4.22	X	X	X	X
MD4C	-5.55 to -6.55	X	X	X	X
MD6A	0.71 to -0.30	X	X	X	X
MD6B	-1.05 to -2.05	X	X	X	X
MD6C	-8.8 to -9.8	X	X	X	X
(MD7)	0.5 to -0.5 *				
(MD8)	0.5 to -0.5*				
MD9A	0.58 to -0.42	Dry	Dry	X	X
MD9B	-2.3 to -3.3	X	X	X	X
MD9C	-4.75 to -5.75	X	Dry	X	X
MD10A	0.68 to -0.32	X	X	X	X
MD10B	-2.85 to -3.85	X	X	X	X
Rocklow-Up	Upstream of landfill	X	X	X	X
Rocklow-Middle	Midstream of landfill	X	X	X	X
Rocklow-Down	Downstream and opposite landfill	No Access	X (new location)	X (new location)	X (new location)

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

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

= Not enough water for sampling

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

6. MONITORING RESULTS

All surface and groundwater analytical results for the 2017/18 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 2018) for ammonia (mg/L) is presented in Graph-1, Graph-2 and Graph-3. The graphs highlight ammonia groundwater quality trends over the past ~ 17 years (January 1999 to August 2018). Ammonia is considered to be a key landfill leachate indicator for the site.

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

6.1 Groundwater Data

Groundwater for the 2017/18 reporting period was collected from a network of seventeen monitoring wells (mostly downgradient locations) at the MWDD (Figure 2). The results of the groundwater testing are summarised in Table GW-1, Graphs-1 to 3, Figure 2 and in the following subsections.

6.1.1 Groundwater Depth

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

The groundwater levels recorded from the 2017/18 reporting period are similar to previous years and reflect changes in rainfall and tide levels.

The reduced groundwater levels (m AHD) from the 16 wells sampled in 2017/18⁴ indicate a relatively low water table elevation (<1 m AHD), which is characteristic of the swamp/estuarine environment. The annual rainfall from August 2017 to July 2018 was 663 which is substantially less than previous years (e.g. 2016-2017 was 923 mm at Bombo Headland).

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

6.1.2 Field Parameters

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

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

⁴ Note: MD2A, MD4A, MD10A, MD10B have no RL measurement.

6.1.2.1 Field pH

The pH from the 15 wells (MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) ranged from pH 6.2 to 7.7 (average =7.01) in the 2017-18 reporting period, indicating relatively neutral groundwater.

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

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

6.1.2.2 Electrical Conductivity (EC)

The EC in groundwater collected from the site vary and range from approximately 627 to 54,600 uS/cm (average=20768 uS/cm) in the 2017/18 reporting period. The salinity reflects the transgression/regression of fresh and marine groundwater and presence of saline groundwater at depth (Figure 2 & Appendix B).

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

6.1.2.3 Dissolved Oxygen (DO)

The 15 wells recorded field dissolved oxygen (DO) concentrations ranging between 0.53 to 8.38 mg/L (average=1.49 mg/L) in the 2017/18 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 2017/18 reporting period (note: Total nitrogen is not an EPL requirement).

Four (MD1B, MD2A, MD2C, MD6A) out of the 15 wells reported one or more samples with nitrate concentrations above the ANZECC (2000) trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level). In 2017/2018 concentrations ranged from <0.01 (non-detected/below LOR) to 8.75 mg/L (average=0.79 mg/L) which is similar to previous years.

Nitrate has been detected in fewer wells (MD2A, MD6A, MD10A) in the 2017/2018 monitoring round (2016/2017 had nine wells above ANZECC 2000) in comparison to the 2012/2013 monitoring round (eight wells above ANZECC 2000). The majority of nitrate concentrations in groundwater in 2017/2018 are generally low and below ANZECC (2000), except for the 3 wells (MD2A, MD6A, MD10A). Nitrate is associated with the shallow wells due to oxidation of the ammonia concentrations.

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

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

Fourteen (14) out of 15 wells (excluding MD4A) reported ammonia concentrations in excess of the ANZECC (2000) trigger value for marine ecosystems (2.84 mg/L, based on a pH of 7.3) in the 4 rounds of sampling. Concentration of ammonia range from 0.05 to 134 mg/L, with an average of 32.65 mg/L (2017/2018).

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

The Well (**MD9C**) reported the maximum ammonia of **134** mg/L in August 2018. The results are similar to May 2016 (160 mg/L) and November 2014 (170 mg/L). The recent monitoring results are higher than the ammonia (maximum of 122 mg/L) in 2012/13. Ammonia trends are presented in the time series Graphs 1 to 3.

Highest ammonia concentrations correlate with the main downgradient area (plume centreline) of the waste mound and above average rainfall events. The ammonia concentrations from 2015 to 2018 are variable and elevated reflecting leachate spikes which are interpreted to reflect the variable and heavy rainfall events in late summer/autumn (e.g. March 2017 @309 mm).

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

Groundwater extraction works are in progress for the rising ammonia trend (above 100 mg/L) at MD9C. A series of extraction and monitoring wells have been installed by E2W and KMC together to enable irrigation of the leachate on the batter slopes.

6.1.4 Ammonia Trends

The groundwater ammonia trends from 1999 to 2018 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 2018)

South-east of Landfill (Across-gradient)		North of Landfill (Down-gradient, plume centreline)	
Well ID	Trend	Well ID	Trend
MD1B	Overall Decreasing, but variable	MD4B	Variable trend, recently decreasing (2018)
MD2B	Overall Decreasing, but variable	MD4C	Overall Decreasing
MD2C	Overall Decreasing, but variable	MD9B	Variable and Recently increasing
MD6B	variable to a slightly increasing trend (2018)	MD9C	Rising trend & peaks in late 2011, late 2012, mid & late 2014. Elevated and ammonia spikes late 2015, 2016 to 2018
MD6C	Overall decreasing, & recently stable	MD10B	Variable trend- 2015 to 2018

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

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

Monitoring reports (e.g. E2W, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2013-2014, 2014-2015, 2016-2017, 2017-2018) have identified spikes in ammonia concentrations that are interpreted to result from high rainfall and plume migration. 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)⁵. Over the 2011/12 period, a combined 176.2mm rainfall from 20 to 23 July was followed by an increase in ammonia (November 2011, Graph 1-3). Rainfall of 289 mm in February and 213.2mm in March 2012 (502.2mm combined in 2 months) was followed by rises in ammonia (May 2012, Graph 1-3)⁷.

During the 2012/13 period, high rainfall was experienced in January 2013 (170.8 mm) and February 2013 (153.2 mm) resulting in elevated ammonia during the February monitoring. In addition, high rainfall in April 2013 (183.6 mm) was followed by a rise in ammonia in May 2013. This occurred again in the 2013/14 period with high rainfall in November 2013 followed by a rise in Ammonia in the November 2013 samples and high rainfall again in March and April 2014 followed by an increase in Ammonia in the May 2014 samples. The ammonia peak in November 2014 (170 mg/L) and November 2015 are interpreted to be associated with high recharge rainfall events.

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

Heavy rain occurred in February (158.8 mm) and March (309 mm) 2017, however rainfall during the 2016 -2017 (923 mm) and 2017-2018 (663mm) monitoring period are below the annual average.

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

During 2014 to 2018 ammonia concentrations are generally variable at MD9C and MD9B (hotspot area). An increase in ammonia occurs in 2015 where concentrations exceed 100 mg/L and range between 100 and 170 mg/L. The elevated ammonia concentrations are reported at the north east corner of the landfill as measured by wells at MD10B/MD9C/MD9B. This area has been further investigated and targeted for groundwater remedial works (in progress) to minimise impacts to aquatic ecosystems.

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.

Groundwater remedial works are being implemented at the site (MD9 Area) to reduce risk to aquatic ecosystems.

Results from 2012 to 2018 monitoring periods show cyclical seasonal trends (i.e. a variable, but generally decreasing ammonia trend). Future monitoring is required to assess ammonia trends and characteristics (nature of trends and variations), especially at MD9C/MD9B, MD10B, and MD4B well locations, representing the centreline and core of leachate plume.

6.1.4.1 Total Phosphorus (TP, groundwater)

The total phosphorus (TP) is not an EPL requirement, and was not sampled during the 2016-2018 monitoring period. In the 2007/08 monitoring period the majority of TP results from twelve wells exceeded the ANZECC (2000) trigger values for the protection of marine ecosystems.

6.1.5 Hydrochemical Indicators

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

In wells with freshwater, (MD6B and MD10B) calcium concentrations are similar to, and sometimes greater than sodium concentrations.

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

6.1.6 Inorganic Contaminants (Iron, Manganese and Fluoride)

Dissolved iron (filtered at the laboratory) ranges from the 0.06 mg/L to 19.5 mg/L (average=3.21 mg/L). 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 0.023 mg/L to 1.12 mg/L (average=0.188 mg/L). The ANZECC (2000) guideline for manganese in fresh water is 1.9 mg/L. All results were reported below the ANZECC fresh water guidelines.

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

Concentrations of fluoride ranged from 0.1 mg/L to 1.2 mg/L (average=0.65 mg/L). No recommended reliable ANZECC (2000) guidelines exist for fluoride in fresh or marine waters. The data ranges between the minimum and maximum values are similar to previous levels. The results indicate that fluoride levels are generally associated with landfill leachate.

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

Concentrations of total and dissolved organic carbon (TOC/DOC) ranged from 6/6 to 107/101 mg/L in the 2017/18 reporting period. ANZECC (2000) guidelines do not exist for TOC. The TOC may relate to landfill leachate and/or naturally occurring organic matter/content associated with lowland/estuary.

Concentrations of phenols were all reported below the LOR (0.05 mg/L). Phenols have been previously detected at MD9A in February 2016 (0.6 mg/L) and August 2016 (0.33 mg/L).

The November 2016 (0.35 mg/L) results from MD9A indicate phenol concentrations are likely to relate to the landfill leachate.

6.2 Surface Water

Surface water sampling was undertaken quarterly during the 2017/18 reporting period (EPL requirement is only six-monthly sampling).

The three surface water locations provide a general indication of water quality impacts from the MWDD (Figure 2). Impacts to the water quality in Rocklow Creek may also occur from the neighbouring Shellharbour Waste Disposal Depot situated on the northern side of Rocklow Creek.

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

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 (7 to 7.6) in 2017/18, 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 saline (1.37 to 53.6 mS/cm). Sampling at low tide would result in decreased salinity due to an increased baseflow (fresh groundwater) contribution.

6.2.1.3 Dissolved Oxygen (DO)

The DO of waters ranged from 2.03 to 7.8 mg/L. Higher DO values are associated with upstream section of Rocklow Creek.

6.2.2 Nutrients (surface water)

6.2.2.1 Nitrogen

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

Nitrate concentrations for the 2017-2018 ranged from 0.01 to 0.12 mg/L (average 0.05 mg/L) and were below the ANZECC (2000) guidelines. Ammonia concentrations for the 2017-2018 ranged from 0.08 to 1.39 mg/L (average 0.55 mg/L) and were below the ANZECC (2000) guidelines.

Water samples collected from Rocklow Creek during 2017/18 reporting period generally show variable concentrations of ammonia an upstream to downstream locations. The greatest increase in ammonia from upstream to midstream location occurs on 9 February 2018 (<0.05 mg/L to 1.39 mg/L). The midstream location corresponds to the area of MD-9.

The previous greatest increase in ammonia from upstream to downstream location occurs on 17 August 2017 (0.05 mg/L to 1.59 mg/L). The ammonia increments between the upper, mid and down stream samples are presented in Table SW-2 and Graph-4 (note: mid-stream

location is downgradient to MD-9C, MD4B and MD-10B which have elevated and irregular ammonia trends).

Ammonia concentrations in Rocklow Creek (2017/18) are generally comparable to previous results (2016-2017, 2014/2015, 2013/2014, 2012/13 and 2011/12, Table SW-2). However, the ammonia increments, and seasonal variability in the Rocklow-Mid and Rocklow-Low is evident from 2011 to 2018 (spiking of ammonia), which is interpreted to reflect tidal influences, climate and potentially the groundwater (MD9C) discharges.

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

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

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

6.2.2.2 Total Phosphorous (surface water)

Total phosphorus (TP) is not an EPL requirement and were not analysed during the 2017/18 monitoring period.

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

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

Concentrations of total organic carbon (TOC) ranged from 4 to 14 mg/L in the 2017/18 reporting period. No recommended ANZECC (2000) guidelines exist for DOC (concentrations could be related to natural waters or leachate).

Concentrations of phenols were reported all below LOR (0.05 mg/L) in all other surface water samples in all monitoring rounds. Concentrations of fluoride ranged from 0.2 mg/L to 1.2 mg/L, with concentrations showing a general increase in the Rocklow-Mid & Rocklow-Low sampling locations relative to the upstream sample.

7. CHEMICALS OF CONCERN AND CONTAMINANT PLUMES

The results of 2017/18 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 2018) confirm that ammonia concentrations are elevated above background levels. Improvement in groundwater quality (i.e. a decreasing ammonia trend) is evident in several wells (MD2B, MD2C, MD4C, MD6C) since landfill rehabilitation works commenced (2006).

High rainfall periods since landfill rehabilitation completion are interpreted to have resulted in periodic ammonia increases (e.g. February 2008, March 2011, July 2011, February/March 2012, January/February 2013, April 2013, November 2013, March-April & late 2014, August 2015, June 2016, March 2017). Some wells (MD-6B, MD-10B) show variable trends, whilst three wells show an increasing trend (MD-9C, MD-9B, MD-6B) in 2017/2018.

It is likely the leachate plume arising from the landfill mound would migrate radially (local system) and with the regional flow regime towards the north-east and east (MD9 centreline). Landfill leachate infiltrates into the sandy aquifer and migrates towards Rocklow Creek and Minnamurra River.

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

7.1 Ecological Issues

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

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

Discharges of landfill leachate to Rocklow Creek would be at a maximum when the tide is low and groundwater gradients are steeper. The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in the 2014/15, ~0.96 mg/L the 2015/16, ~0.146 mg/L in the 2016/2017, and 0.605 mg/L in the 2017-2018 reporting period (Table SW-2). This net increment in 2017-2018 is also dependant on tidal regime during sampling. The reduced net increment of ammonia may also reflect the below average climate (663 mm) during the 2017-2018 monitoring period.

The ammonia in groundwater (MD-9C, MD-10B, MD-4B) during 2017/18 may be contributing to the nutrient concentrations in the surface water (Rocklow-Middle & Down), however this is not clear given other potential sources (Dunmore landfill) and variables (climate, tide). Downstream ammonia concentrations have generally declined, but show significant variability since monitoring commenced in 1999 (Graph-4).

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

Since early 2016, Council and E2W have investigated groundwater near MD9C and installed test bores (3) and pumping infrastructure to progress remedial works to reduce the elevated ammonia concentrations. Leachate management is proposed to include extraction of groundwater at MD9C and irrigation of the landfill mound (work is in progress with Council, E2W, and the DPI, NSW EPA).

Ammonia and nitrate concentrations in all surface water samples collected in the 2017/18 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 from November 2017 to August 2018 (EPL reporting period). Monitoring data collected during the 2017/2018 period was assessed by E2W (Dino Parisotto) to determine the impact of the landfill facility on local groundwater and aquatic ecosystems.

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

- Elevated concentrations of nutrients, in particular ammonia, continue to be detected in groundwater at the former landfill site. Ammonia levels reported by the laboratory exceed the ANZECC (2000) guidelines for the protection of fresh and marine water ecosystems in 14 out of 15 monitoring wells sampled (i.e. MD-1A & MD-4A dry, MD10A ammonia below guidelines).
- The impacted wells are located on the footprint (downgradient) of the landfill mound, indicating contaminant migration towards Rocklow Creek and Minnamurra River (north-east and east).
- Elevated ammonia concentrations (above ANZECC 2000) were reported at majority of wells (Figure 2), with highest concentrations exceeding 100 mg/L (i.e. MD9B= 106 mg/L, and MD9C =134 mg/L). Elevated ammonia in the groundwater is located on the north and eastern landfill perimeters coinciding with the predominant groundwater flow direction.
- The majority of nitrate concentrations in groundwater in 2017/2018 are generally low and below ANZECC (2000), except for the 3 wells (MD2A, MD6A, MD10A), which were

above the ANZECC (2000) trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level). Nitrate concentrations in 2017/2018 are comparable to previous years.

- Ammonia concentrations in the 2017/18 monitoring period continue to be elevated and variable, however show an overall decreasing trend in most wells. Some exceptions include MD-6B, MD9C, and MD9B have rising trends. Variations in ammonia are inferred to reflect seasonal trends and plume migration.
- Generally low concentrations of ammonia (below ANZECC 2000) were reported from the upstream, mid and down stream locations during 2017/18 reporting period. A general increase in ammonia is evident in the downstream or Rocklow-Mid surface water locations relative to upstream. The net increment of ammonia between upstream, mid stream and downstream concentrations is variable since 1999, however a potential decrease is evident in the 2017/2018 results (Graph 4).
- The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in the 2014/15, ~0.96 mg/L the 2015/16, ~0.146 mg/L in the 2016/2017, and 0.605 mg/L in the 2017-2018 reporting period (Table SW-2). This net increment in 2017-2018 is also dependant on tidal regime during sampling. The elevated ammonia in nearby groundwater (MD-9C, MD-9B) may be contributing ammonia concentrations in the surface water (Rocklow-Mid/downstream). Further monitoring is required to verify this interpretation, as tidal dilution and multiple sources are situated around the creek (e.g. Dunmore landfill).
- While downstream ammonia concentration increases could be attributable to the discharge of groundwater impacted by ammonia from the MWDD, contribution from other sources of nitrogen input such as polluted runoff from the catchment (Dunmore Landfill, agricultural areas) is not discounted.
- All other water quality indicators were consistent with the results of previous monitoring periods.
- The testing of the gas monitoring wells (Gas 1, Gas 3, Gas 4) and trenches (Trench 1 to Trench 7 -the biofilter pads) indicated that gas levels are comparable or lower than previous years. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings in January 2017, June 2017, October 2017, February 2018, June 2018, and October 2018. KMC (& E2W) are unaware of any reportable pollution incidences or complaints from the community related to the MWDD during the 2017/18 reporting period.

The nutrients in the local surface and groundwater are likely to decrease over time due to the landfill closure and rehabilitation works. Leachate generation has decreased due to the landfill capping from August 2006 to January 2008. Monitoring data in 2017/18 supports this interpretation and improvement in the local water quality.

The elevated ammonia concentrations reported at MD-9C, MD9B and MD-10B is interpreted to relate to the remnant deeper centre/core plume migrating from under the landfill mound to the site boundary. Other areas are showing a decrease in leachate strength associated with landfill closure works.

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

Groundwater remediation and monitoring of elevated ammonia at wells (MD-9C, MD-10B) and Rocklow Creek (mid-downstream creek) is required to assess water quality trends. Remedial works are progressing and include groundwater extraction (MD-9C) and irrigation

of the landfill mound. In early 2017, E2W and KMC have installed 3 extraction bores and five monitoring wells in proximity to MD-9C to enable extraction and monitoring of the ammonia plume. Groundwater extraction of the ammonia plume at MD-9C is likely to commence in late 2018.

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

8.1 Recommendations

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

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

Sampling Procedures

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

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 2018/19 reporting period (exceeds EPL requirements). Quarterly review of results from the Rocklow-Mid/Down stream sampling locations is required to address ecosystem risks associated with the elevated ammonia concentrations at well (MD-9C) and the remedial/extraction works.

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

9. LIMITATIONS

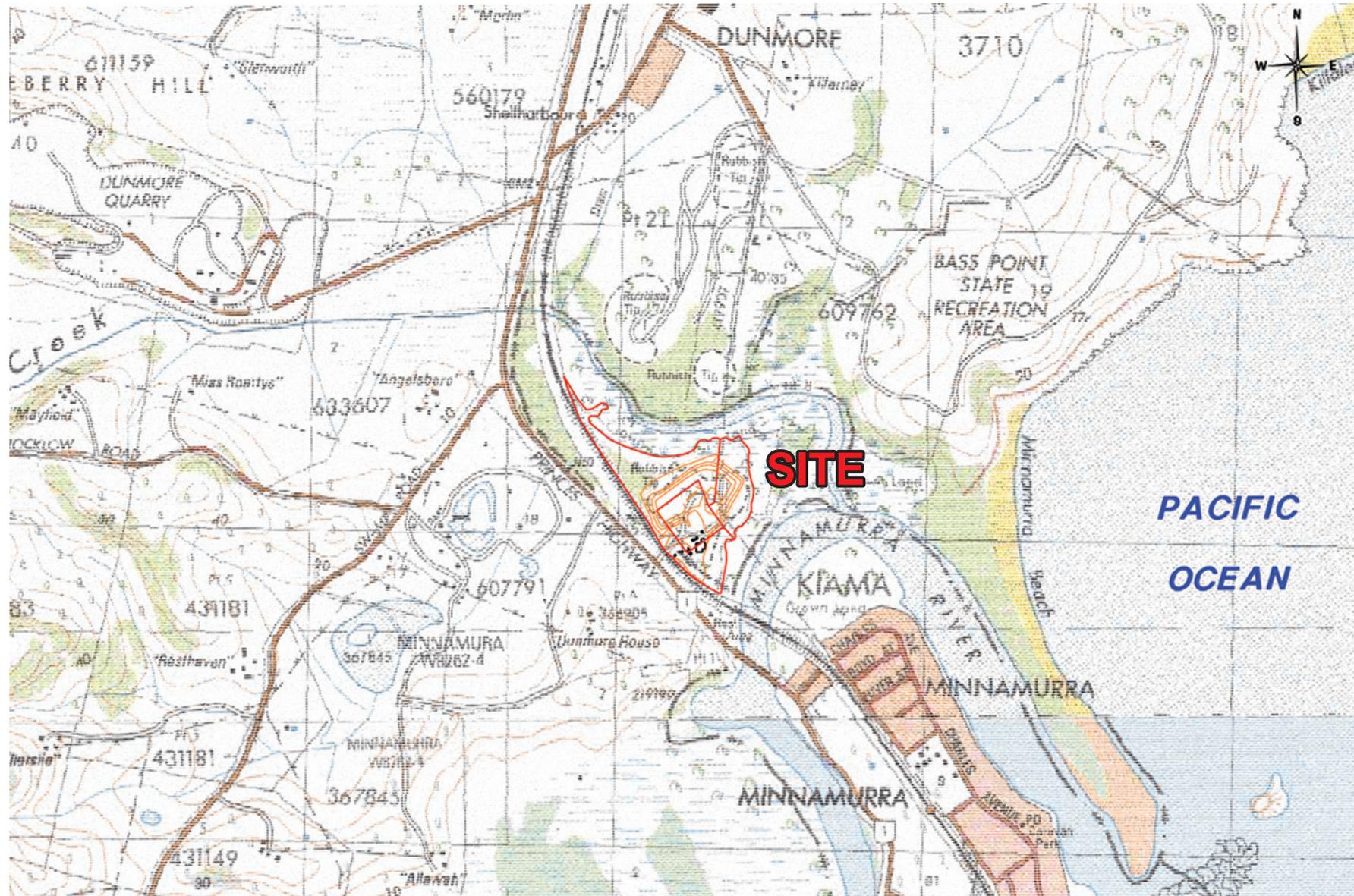
Earth2Water Pty Ltd has prepared this report for the use of Kiama Municipal Council in accordance with the standard terms and conditions of the consulting profession. This report is prepared in accordance with the agreed scope of work. The methodology adopted and sources of information used by E2W are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

This report was prepared during November 2018 and is based on the information reviewed at the time of preparation. This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

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

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

Figures



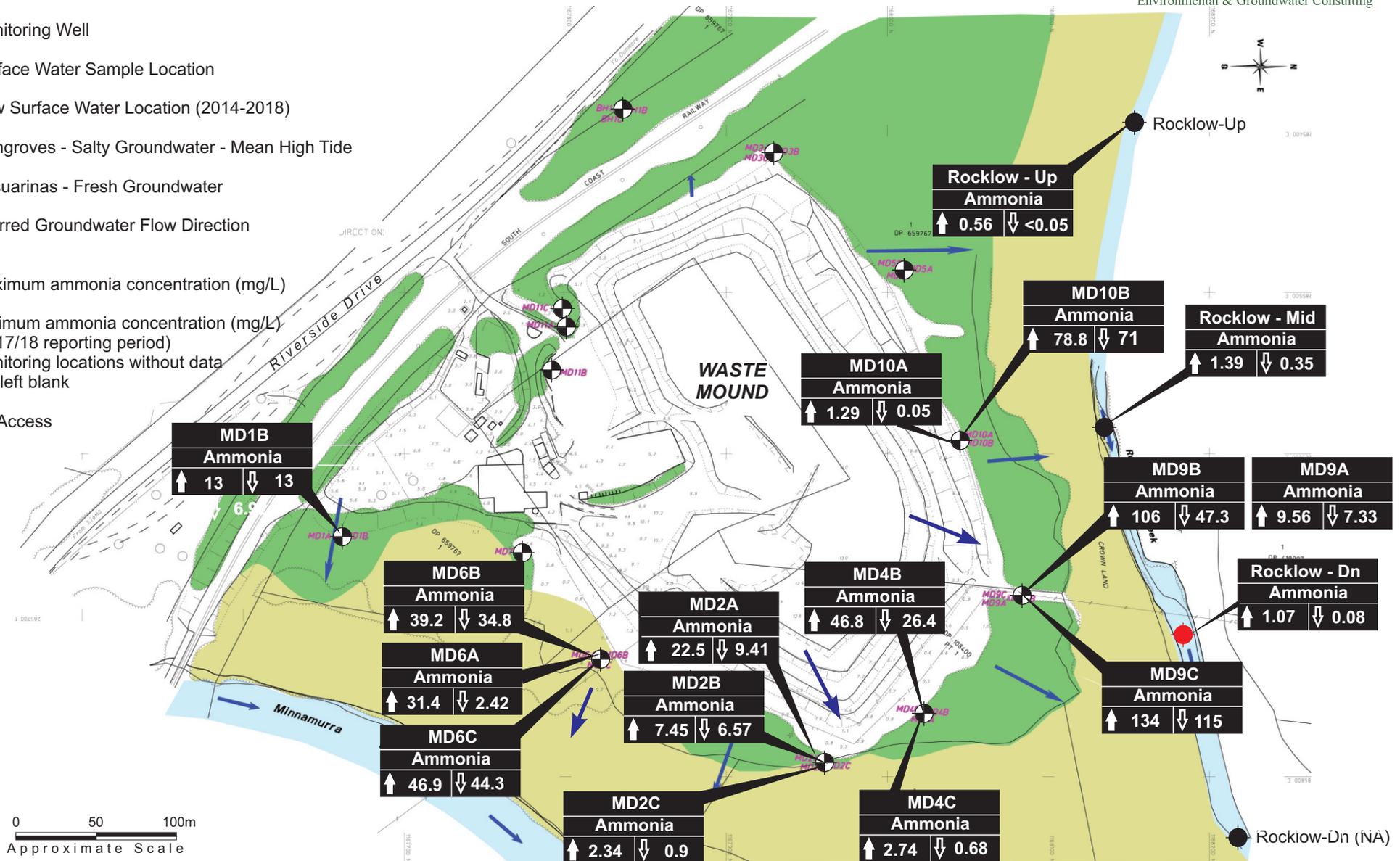
SITE LOCATION

Date: November 2018

Reference: E2W_059_01.cdr

LEGEND

-  Monitoring Well
-  Surface Water Sample Location
-  New Surface Water Location (2014-2018)
-  Mangroves - Salty Groundwater - Mean High Tide
-  Casuarinas - Fresh Groundwater
-  Inferred Groundwater Flow Direction
-  **↑ 3.2** Maximum ammonia concentration (mg/L)
-  **↓ 0.4** Minimum ammonia concentration (mg/L) (2017/18 reporting period)
Monitoring locations without data are left blank
-  **NA** No Access



Source: Neil Charters Pty Ltd

MONITORING WELL LOCATIONS & MAXIMUM & MINIMUM AMMONIA CONCENTRATIONS (2017- 2018)

Date: November 2018

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2017-2018)

Reference: E2W_059_04.cdr

Figure 2

Tables

Table 8.1 - Recommended Groundwater Analytical Program for MWDD (2017/18)

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

Note:

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

ICP - Inductively Coupled Plasma

FIA - Flow Injection Analyser

MS - Mass Spectrometry

FC - Client Filtered

µS/cm - micro Siemens per centimetre

µg/L - micrograms per litre

mg/L - milligrams per litre

APHA - American Public Health Association

USEPA - United States Environment Protection Agency

Table GW-1: Summary 2017/18 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 1B	No. Sample	MD2A	MD2A	MD2A	MD2A	No. Sample	Min	Mean	Max	MD 2B	MD 2B	MD 2B	MD 2B	No. Sample	Min	Mean	Max
	Freshwater	Marine																		
Field Measurements																				
RL (mAHD at TOC)			NA		1.17	1.17	1.17	1.17					1.17	1.17	1.17	1.17				
Standing water level (mTOC)			1.50	2	0.63	0.57	0.42	0.54	4	0.42	0.54	0.63	0.75	0.78	0.55	0.72	4	0.55	0.70	0.78
Reduced SWL (mAHD)					0.54	0.60	0.75	0.63	4	0.54	0.63	0.75	0.42	0.39	0.62	0.45	4	0.39	0.47	0.62
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.70	2	7.10	6.80	7.10	7.40	4	6.8	7.1	7.4	7.00	7.10	6.80	6.90	4	6.8	7.0	7.1
Temperature			20.00	2	20.10	21.90	17.00	17.10	4	17.0	19.0	21.9	18.30	19.50	17.90	17.50	4	17.5	18.3	19.5
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		627	2	12100	26200	25700	19900	4	12100	20975	26200	23600	25400	32900	32300	4	23600	28550	32900
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9-10 (a)	1.09	2	1.54	3.49	1.70	1.68	4	1.54	2.10	3.49	0.80	0.91	0.90	1.13	4	0.80	0.94	1.13
Laboratory Analyses (mg/L)																				
Sodium (ICP)			36	2	3750	2570	3330	2990	4	2570	3160	3750	4230	4560	5600	5840	4	4230	5058	5840
Potassium (ICP)			13	2	191	167	187	164	4	164	177	191	180	192	227	229	4	180	207	229
Calcium (ICP)			45	2	268	261	257	230	4	230	254	268	330	347	406	403	4	330	372	406
Magnesium (ICP)			7	2	484	331	431	394	4	331	410	484	551	576	717	719	4	551	641	719
Chloride			46	2	6060	4640	5740	5360	4	4640	5450	6060	8070	7960	9910	10000	4	7960	8985	10000
Sulphate (SO4)			20	2	851	494	701	715	4	494	690	851	660	1120	1640	1530	4	660	1238	1640
Water Parameters (mg/L)																				
Alkalinity (as CaCO3)			209	2	1080	912	935	828	4	828	939	1080	764	762	778	665	4	665	742	778
Fluoride			0.2	2.0	0.8	1.2	0.9	1.0	4	0.8	1.0	1.2	0.6	1.0	0.6	0.8	4	0.6	0.8	1.0
Phenols		0.40	<0.05	2.00	<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)		0.44	2	0.75	7.94	0.68	0.39	4	0.39	2.44	7.94	0.88	0.91	1.23	1.12	4	0.88	1.04	1.23
Manganese (ICP)	1.90		0.042	2	0.047	0.091	0.073	0.06	4	0.047	0.068	0.091	0.08	0.085	0.116	0.108	4	0.080	0.097	0.116
Nutrients (mg/L)																				
Nitrate (NO3 as N)	0.7 (7)		0.18	2	0.15	1.45	1.81	4.37	4	0.15	1.95	4.37	0.02	<0.01	<0.01	0.1	4	0.02	0.06	0.10
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	13.00	2	22.50	21.80	9.41	12.10	4	9.41	16.45	22.50	7.45	6.66	6.58	6.57	4	6.57	6.82	7.45
Total Nitrogen	0.5 (3)	0.12 (4)																		
Dissolved Organic Carbon (DOC)			6	2	6	59	51	54	4	6.00	42.50	59.00	30	----	32	31	3	30.00	31.00	32.00
Total Organic Carbon (TOC)			6	2	6	61	53	55	4	6.00	43.75	61.00	32	26	34	31	4	26.00	30.75	34.00

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 |
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
 - a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2017/18 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
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18					9/11/17	9/2/18	24/5/18	23/8/18	
Field Measurements															
RL (mAHD at TOC)			1.165	1.165	1.165	1.165					Dry	Dry	Dry	Dry	0
Standing water level (mTOC)			0.8	0.82	0.66	0.76	4	0.66	0.76	0.82	-	-	-	-	0
Reduced SWL (mAHD)			0.37	0.35	0.51	0.41	4	0.35	0.41	0.51	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7	7	6.9	7	4	6.9	7.0	7.0	-	-	-	-	0
Temperature			19	18.6	17.4	17.9	4	17.4	18.2	19.0	-	-	-	-	0
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		44300	43600	45300	45200	4	43600	44600	45300	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.67	0.8	0.9	0.92	4	0.80	1.07	1.67	-	-	-	-	0
Laboratory Analyses (mg/L)															
Sodium (ICP)			8380	8850	7500	7680	4	7500	8103	8850	-	-	-	-	0
Potassium (ICP)			304	349	293	301	4	293	312	349	-	-	-	-	0
Calcium (ICP)			463	508	416	429	4	416	454	508	-	-	-	-	0
Magnesium (ICP)			1020	1080	874	922	4	874	974	1080	-	-	-	-	0
Chloride			13100	13400	13600	13500	4	13100	13400	13600	-	-	-	-	0
Sulphate (SO4)			2230	2180	2020	1900	4	1900	2083	2230	-	-	-	-	0
Water Parameters (mg/L)															
Total Suspended Solids (TSS)											-	-	-	-	0
Alkalinity (as CaCO3)			588	589	686	566	4	566	607	686	-	-	-	-	0
Fluoride			0.5	0.7	0.7	0.8	4	0.5	0.7	0.8	-	-	-	-	0
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND	-	-	-	-	0
Metals (mg/L)															
Iron (ICP)	0.3 (1)		1.6	1.55	1.5	1.48	4	1.48	1.53	1.60	-	-	-	-	0
Manganese (ICP)	1.90		0.176	0.161	0.148	0.143	4	<0.01	0.157	0.2	-	-	-	-	0
Nutrients (mg/L)															
Nitrate (NO3 as N)	0.7 (7)		<0.01	<0.01	<0.01	<0.01	4	0.00		0.00	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	2.34	1.58	1.20	0.90	4	0.90	1.51	2.34	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)													
Dissolved Organic Carbon (DOC)			20	18	34	22	4	18.00	23.50	34.00	-	-	-	-	0
Total Organic Carbon (TOC)			20	18	34	20	4	18.00	23.00	34.00	-	-	-	-	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 2017/18 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 4B	MD 4B	MD 4B	MD 4B	No. Samples	Min	Mean	Max	MD 4C	MD 4C	MD 4C	MD 4C	No. Samples	Min	Mean	Max
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18					9/11/17	9/2/18	24/5/18	23/8/18				
Field Measurements																		
RL (mAHD at TOC)			1.63	1.63	1.63	1.63					1.59	1.59	1.59	1.59				
Standing water level (mTOC)			1.19	1.24	1.02	1.16	4	1.02	1.15	1.24	1.19	1.22	0.98	1.15	4	0.98	1.14	1.22
Reduced SWL (mAHD)			0.44	0.39	0.61	0.47	4	0.39	0.47	0.61	0.40	0.37	0.61	0.44	4	0.37	0.45	0.61
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.00	7.00	6.90	6.90	4	6.9	7.0	7.0	6.90	7.00	6.90	7.00	4	6.9	7.0	7.0
Temperature			19.20	18.70	17.90	18.00	4	17.9	18.5	19.2	18.60	18.60	17.50	17.50	4	17.5	18.1	18.6
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		11300	13100	19000	18300	4	11300	15425	19000	37400	40800	43800	44600	4	37400	41650	44600
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.36	1.16	1.61	0.76	4	0.76	1.22	1.61	1.87	1.00	1.82	0.95	4	0.95	1.41	1.87
Laboratory Analyses (mg/L)																		
Sodium (ICP)			1750	2040	2870	2880	4	1750	2385	2880	7900	7870	6830	7110	4	6830	7428	7900
Potassium (ICP)			121	131	152	147	4	121	138	152	296	318	263	277	4	263	289	318
Calcium (ICP)			304	315	424	370	4	304	353	424	485	490	416	408	4	408	450	490
Magnesium (ICP)			239	261	399	373	4	239	318	399	977	966	800	842	4	800	896	977
Chloride			3650	3860	5860	5950	4	3650	4830	5950	11800	11900	11900	12700	4	11800	12075	12700
Sulphate (SO4)			315	396	753	770	4	315	559	770	2020	1890	1760	1700	4	1700	1843	2020
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			986	964	796	769	4	769	879	986	691	553	483	441	4	441	542	691
Fluoride			1	1	0	1	4	0.4	0.5	0.6	1	1	1	1	4	0.7	0.9	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)		1.55	1.54	2.23	1.64	4	1.54	1.74	2.23	1.51	1.64	1.36	1.41	4	1.36	1.48	1.64
Manganese (ICP)	1.90		0.091	0.095	0.14	0.108	4	0.091	0.11	0.14	0.182	0.192	0.172	0.18	4	0.172	0.182	0.192
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		0.24	0.01	<0.01	0.11	4	0.01	0.12	0.24	<0.01	0.16	<0.01	<0.01	4	0.16	NA	0.16
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	46.8	44.9	28.7	26.4	4	26.40	36.70	46.80	2.74	1.45	0.82	0.68	4	0.68	1.42	2.74
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			41	38	40	38	4	38.00	39.25	41.00	23	18	19	16	4	16.00	19.00	23.00
Total Organic Carbon (TOC)			44	38	41	39	4	38.00	40.50	44.00	23	18	16	15	4	15.00	18.00	23.00

Notes:

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

Exceeds ANZECC (2000) marine trigger value

Table GW-1: Summary 2017/18 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD6A	MD6A	MD6A	MD6A	No. Samples	Min	Mean	Max	MD 6B	MD 6B	MD 6B	MD 6B	No. Samples	Min	Mean	Max
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18					9/11/17	9/2/18	24/5/18	23/8/18				
Field Measurements	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18					9/11/17	9/2/18	24/5/18	23/8/18				
RL (mAHD at TOC)			1.85	1.85	1.85	1.85					1.85	1.85	1.85	1.85				
Standing water level (mTOC)			1.32	1.26	1.14	1.27	4	1.14	1.25	1.32	1.32	1.32	1.16	1.25	4	1.16	1.26	1.32
Reduced SWL (mAHD)			0.53	0.59	0.71	0.58	4	0.53	0.60	0.71	0.53	0.53	0.69	0.60	4	0.53	0.59	0.69
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.30	6.80	7.20	7.60	4	6.8	7.2	7.6	7.10	6.80	7.10	7.20	4	6.8	7.1	7.2
Temperature			20.40	22.90	19.40	18.70	4	18.7	20.4	22.9	19.5	21.4	19.8	19.0	4	19.0	19.9	21.4
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		2780.0	2040.0	1790.0	2250.0	4	1790	2215	2780	1800	1580	1760	1610	4	1580	1688	1800
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.98	1.13	3.13	1.96	4	1.13	2.30	3.13	0.99	0.69	0.93	0.79	4	0.69	0.85	0.99
Laboratory Analyses (mg/L)																		
Sodium (ICP)			151	190	108	210	4	108	165	210	84	112	104	84	4	84	96	112
Potassium (ICP)			50	53	40	44	4	40	47	53	41	47	43	39	4	39	43	47
Calcium (ICP)			140	148	128	128	4	128	136	148	130	164	157	140	4	130	148	164
Magnesium (ICP)			56	60	42	58	4	42	54	60	36	52	43	35	4	35	42	52
Chloride			146	150	154	327	4	146	194	327	113	122	113	109	4	109	114	122
Sulphate (SO4)			47	63	49	65	4	47	56	65	61	60	52	47	4	47	55	61
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			758	756	741	574	4	574	707	758	873	706	772	608	4	608	740	873
Fluoride			0.6	1	0.7	0.8	4	0.6	0.8	1.0	0.4	0.6	0.5	0.5	4	0.4	0.5	0.6
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	4	0.05	0.05	0.05
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		1.40	1.09	0.21	0.12	4	0.12	0.71	1.40	0.30	0.19	0.20	0.17	4	0.17	0.22	0.30
Manganese (ICP)	1.90		0.053	0.053	0.036	0.032	4	0.032	0.044	0.053	0.126	0.105	0.102	0.092	4	0.092	0.106	0.126
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		0.59	0.2	1.6	8.8	4	0.20	2.78	8.75	<0.01	<0.01	0.02	0.02	4	0.02	0.02	0.02
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	24.2	27.1	31.4	18.7	4	18.70	25.35	31.40	34.8	35.3	36.7	39.2	4	34.80	36.50	39.20
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			24	32	31	27	4	24.00	28.50	32.00	37	28	38	27	4	27.00	32.50	38.00
Total Organic Carbon (TOC)			28	33	33	27	4	27.00	30.25	33.00	38	28	38	26	4	26.00	32.50	38.00

Notes:

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

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2017/18 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 6C	MD 6C	MD 6C	MD 6C	No. Samples	Min	Mean	Max	MD9A	MD9A	MD9A	MD9A	No. Samples	Min	Mean	Max
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18					9/11/17	9/2/18	24/5/18	23/8/18				
Field Measurements	Freshwater	Marine																
RL (mAHD at TOC)			1.86	1.86	1.86	1.86					1.35	1.35	1.35	1.35				
Standing water level (mTOC)			1.47	1.52	1.34	1.51	4	1.34	1.46	1.52	----	----	0.51	0.53	2	0.51	0.52	0.53
Reduced SWL (mAHD)			0.39	0.34	0.52	0.35	4	0.34	0.40	0.52			0.84	0.82	2	0.82	0.83	0.84
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.40	7.40	7.20	7.30	4	7.2	7.3	7.4	----	----	6.40	7.20	2	6.4	6.8	7.2
Temperature			19.90	20.80	19.00	19.30	4	19.0	19.8	20.8	----	----	17.80	15.10	2	15.1	16.5	17.8
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		29700	31400	35800	35700	4	29700	33150	35800	----	----	10500	14400	2	10500	12450	14400
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.1	0.6	1.3	0.9	4	0.58	0.96	1.29	----	----	1.0	2.7	2	1.00	1.84	2.68
Laboratory Analyses (mg/L)																		
Sodium (ICP)			5440	5680	6020	6510	4	5440	5913	6510	----	----	1580	2420	2	1580	2000	2420
Potassium (ICP)			201	201	215	225	4	201	211	225	----	----	77	106	2	77	92	106
Calcium (ICP)			376	383	367	375	4	367	375	383	----	----	89	117	2	89	103	117
Magnesium (ICP)			709	726	775	787	4	709	749	787	----	----	219	297	2	219	258	297
Chloride			10300	9800	10700	11000	4	9800	10450	11000	----	----	3250	4720	2	3250	3985	4720
Sulphate (SO4)			752	1480	1790	1740	4	752	1441	1790	----	----	357	467	2	357	412	467
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			452	453	467	393	4	393	441	467	----	----	388	296	2	296	342	388
Fluoride			0.4	0.5	0.5	0.6	4	0.4	0.5	0.6	----	----	0.1	<0.1	2	0.1	0.1	0.1
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.00	0.00	0.00	----	----	<0.05	<0.05	2	0.00	0.00	0.00
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		19.40	19.50	18.40	17.30	4	17.30	18.65	19.50	----	----	0.08	0.06	2	0.06	0.07	0.08
Manganese (ICP)	1.90		0.066	0.066	0.063	0.061	4	0.061	0.064	0.066	----	----	0.023	0.035	2	0.023	0.029	0.035
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		<0.01	<0.01	<0.01	0.01	4	0.01	0.01	0.01	----	----	0.28	0.06	2	0.06	0.17	0.28
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	46.9	45.9	45.2	44.3	4	44.30	45.58	46.90	----	----	7.3	9.6	2	7.33	8.45	9.56
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			13	11	13	12	4	11.00	12.25	13.00	----	----	101	53	2	53.0	77.0	101.0
Total Organic Carbon (TOC)			13	14	13	12	4	12.00	13.00	14.00	----	----	107	60	2	60.0	83.5	107.0

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.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2017/18 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
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18				
Field Measurements										
RL (mAHD at TOC)			1.35	1.35	1.35	1.35				
Standing water level (mTOC)			0.84	----	0.67	0.78	3	0.67	0.76	0.84
Reduced SWL (mAHD)			0.51	----	0.68	0.57	3	0.51	0.59	0.68
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7	----	7	7.1	3	7.0	7.0	7.1
Temperature			19.8	----	18.7	17.8	3	17.8	18.8	19.8
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		2860	----	3250	3400	3	2860	3170	3400
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	0.99	----	1.51	0.81	3	0.81	1.10	1.51
Laboratory Analyses (mg/L)										
Sodium (ICP)			293	----	266	288	3	266	282	293
Potassium (ICP)			87	----	96	112	3	87	98	112
Calcium (ICP)			172	----	146	126	3	126	148	172
Magnesium (ICP)			86	----	69	63	3	63	73	86
Chloride			371	----	438	434	3	371	414	438
Sulphate (SO4)			<10	----	<5	<1	3			
Water Parameters (mg/L)										
Alkalinity (as CaCO3)			1190	----	1200	1070	3	1070	1153	1200
Fluoride			0.5	----	0.6	0.7	3	0.5	0.6	0.7
Phenols		0.40	<0.05	----	<0.05	<0.05	3	0.00	0.00	0.00
Metals (mg/L)										
Iron (ICP)	0.3 (1)		4.6	----	3.59	2.45	3	2.45	3.55	4.60
Manganese (ICP)	1.90		0.26	----	0.201	0.172	3	0.172	0.211	0.260
Nutrients (mg/L)										
Nitrate (NO3 as N)	0.7 (7)		0.06	----	<0.01	<0.01	3	0.06	0.06	0.06
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	47.3	----	68.5	106.0	3	47.30	73.93	106.00
Total Nitrogen	0.5 (3)	0.12 (4)								
Dissolved Organic Carbon (DOC)			57	----	75	72	3	57	68	75
Total Organic Carbon (TOC)			57	----	76	73	3	57	69	76

Notes:

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

Exceeds ANZECC (2000) marine trigger value
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Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2017/18 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
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18				
Field Measurements										
RL (mAHD at TOC)			1.40	1.40	1.40	1.40				
Standing water level (mTOC)			0.87		0.71	0.83	3	0.71	0.80	0.87
Reduced SWL (mAHD)			0.53		0.69	0.57		0.53	0.60	0.69
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.10	----	7.00	7.10	3	7.00	7.07	7.10
Temperature			18.7	----	18.5	18.5	3	18.50	18.57	18.70
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		4400	----	5770	6730	3	4400	5633	6730
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	0.71	----	0.88	1.04	3	0.71	0.88	1.04
Laboratory Analyses (mg/L)										
Sodium (ICP)			470	----	622	740	3	470	611	740
Potassium (ICP)			134	----	130	143	3	130	136	143
Calcium (ICP)			148	----	137	172	3	137	152	172
Magnesium (ICP)			83	----	81	109	3	81	91	109
Chloride			816	----	1110	1330	3	816	1085	1330
Sulphate (SO4)			<10	----	<1	95	3	95	0	95
Water Parameters (mg/L)										
Alkalinity (as CaCO3)			1220	----	1220	980	3	980	1140	1220
Fluoride			0.5	----	0.5	0.6	3	0.50	0.53	0.60
Phenols		0.40	<0.05	----	<0.05	<0.05	3	ND	ND	ND
Metals (mg/L)										
Iron (ICP)	0.3 (1)		7.35	----	5.48	5.5	3	5.48	6.11	7.35
Manganese (ICP)	1.90		0.25	----	0.147	0.168	3	0.15	0.19	0.25
Nutrients (mg/L)										
Nitrate (NO3 as N)	0.7 (7)		<0.01	----	<0.01	0.58	3	0.58	0.58	0.58
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	115.0	----	120.0	134.0	3	115	123	134
Total Nitrogen	0.5 (3)	0.12 (4)								
Dissolved Organic Carbon (DOC)			80	----	88	62	3	62	77	88
Total Organic Carbon (TOC)			81	----	86	64	3	64	77	86

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 2017/18 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD10A	MD10A	MD10A	MD10A	No. Samples	Min	Mean	Max	MD 10B	MD 10B	MD 10B	MD 10B	No. Sample	Min	Mean	Max
	Freshwater	Marine	9/11/17	9/2/18	24/5/18	23/8/18					9/11/17	9/2/18	24/5/18	23/8/18				
Field Measurements																		
RL (mAHD at TOC)			NM	NM	NM	NM					NM	NM	NM	NM				
Standing water level (mTOC)			0.65	0.63	0.62	0.63	4	0.62	0.63	0.65	0.72	0.83	1.34	0.7	4	0.70	0.90	1.34
Reduced SWL (mAHD)																		
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.3	6.2	7.1	6.4	4	6.2	6.5	7.1	7.2	6.7	7	7.1	4	6.7	7.0	7.2
Temperature			23.6	23.3	20.7	15	4	15.0	20.7	23.6	21.6	21.7	18.8	18.6	4	18.6	20.2	21.7
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		54600	53600	1930	44900	4	1930	38758	54600	2020	2000	51800	1850	4	1850	14418	51800
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	4.14	1.39	0.77	1.87	4	0.77	2.04	4.14	1.04	0.53	8.38	0.97	4	0.53	2.73	8.38
Laboratory Analyses (mg/L)																		
Sodium (ICP)			10000	8360	7860	6700	4	6700	8230	10000	134	152	104	110	4	104	125	152
Potassium (ICP)			227	189	178	154	4	154	187	227	75	77	70	65	4	65	72	77
Calcium (ICP)			1470	1880	1660	1360	4	1360	1593	1880	99	94	80	80	4	80	88	99
Magnesium (ICP)			1690	1410	1430	1110	4	1110	1410	1690	45	42	33	35	4	33	39	45
Chloride			18800	16100	14700	14200	4	14200	15950	18800	222	181	187	180	4	180	193	222
Sulphate (SO4)			2960	2480	2800	2600	4	2480	2710	2960	<10	<10	<10	<10	4	0	0	0
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			222	289	333	240	4	222	271	333	801	762	716	619	4	619	725	801
Fluoride			0.3	0.4	0.4	0.4	4	0.3	0.4	0.4	0.8	1	0.9	1	4	0.8	0.9	1.0
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)		1.64	2.83	2.97	0.16	4	0.16	1.90	2.97	1.06	0.65	0.51	0.55	4	0.51	0.69	1.06
Manganese (ICP)	1.90		0.538	0.577	0.468	0.258	4	0.258	0.460	0.577	0.346	0.301	0.278	0.281	4	0.278	0.302	0.346
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		<0.01	0.33	0.32	0.88	4	0.32	0.51	0.88	0.33	0.02	0.32	0.06	4	0.02	0.18	0.33
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	1.02	1.29	0.05	0.45	4	0.05	0.70	1.29	73.50	78.80	71.00	72.00	4	71.00	73.83	78.80
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			30	30	46	30	4	30.00	34.00	46.00	52	----	58	43	3	43.00	51.00	58.00
Total Organic Carbon (TOC)			30	30	60	31	4	30	38	60	54	43	57	40	4	40	49	57

Notes:

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

Exceeds ANZECC (2000) marine trigger value
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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 Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down
	Freshwater	Marine	9/11/17	9/11/17	9/11/17	20/2/18	20/2/18	20/2/18	19/5/18	19/5/18	19/5/18	17/8/18	17/8/18	17/8/18
Field Measurements														
pH (field)	6.5-8.0	8-8.4	7	7.2	7.1	7.2	7.1	7.3	7.4	7.3	7.4	7.2	7	7.6
Temperature			24.5	22.9	22.4	22.8	24.3	23.3	13.6	14.4	13.4	10.9	12.5	12.2
Electrical Conductivity (mS/cm)	0.125-2.2		1370	14200	30000	53600	48700	52000	41600	43100	52800	37200	38700	34400
Dissolved Oxygen (mg/L)	8.5-11.0	9.0-10.0	5.69	4.96	4.19	3.5	2.03	4.68	7.17	5.85	6.93	5.05	4.37	7.8
Turbidity (NTU)	6-50 (a)	0.5-10												
Laboratory Analyses (mg/L)														
Sodium (ICP)			258	2600	5550	11200	9630	10400	8250	8370	10300	6800	7110	6310
Potassium (ICP)			16	97	210	396	344	376	292	306	378	244	254	228
Calcium (ICP)			51	139	254	476	440	470	341	359	424	313	325	287
Magnesium (ICP)			40	317	687	1360	1170	1270	984	989	1210	825	851	757
Chloride			314	5090	10500	15600	14100	15100	10000	14600	14900	11700	12100	10800
Sulphate (SO4)			194	480	796	2380	2160	2320	1670	2220	2670	1920	1770	1620
Water Parameters (mg/L)														
Fluoride			0.2	0.6	0.6	0.9	0.9	1	1	1.1	1.2	1.1	1	1
Phenols		0.40	<0.05	<0.05	<0.05				<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Metals (mg/L)														
Iron (ICP)	0.3 (1)		2.13	1.53	0.89	0.57	0.9	1.16	0.2	<0.10	<0.10	0.25	0.22	0.28
Manganese (ICP)	1.90		0.33	0.259	0.206	0.178	0.493	0.211	0.049	0.043	0.02	0.071	0.094	0.077
Nutrients (mg/L)														
Total Phosphorus (TP)	0.05 (5)	0.025 (6)												
Total Nitrogen	0.5 (3)	0.12 (4)												
Nitrate (NO3 as N)	0.7 (7)		<0.01	0.03	<0.01	0.02	0.05	0.12	0.01	0.03	0.02	0.10	0.08	0.04
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.2	0.56	0.44	<0.05	1.39	1.07	0.16	0.35	0.2	0.56	1.09	0.08
Ammonia Increment (Upper to Mid Rocklow)				0.36			1.34			0.19			0.53	
Ammonia Increment (Mid to lower Rocklow)					-0.12			-0.32			-0.15			-1.01
Total Organic Carbon (TOC)			14	12	9	4	8	7	6	7	4	7	7	6

Notes:

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

Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (1999 - 2018)

Sample ID	6/05/1999	17/08/1999	2/12/2000	28/02/2000	1/05/2000	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	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	3/11/2015	15/02/2016	30/05/2016	11/08/2016	9/11/2016	20/02/2017	19/05/2017	17/08/2017	9/11/2017	20/02/2018	19/05/2018	17/08/2018
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	0.12	0.19	0.17	0.06	0.07	0.99	0.52	0.05	0.20	<0.05	0.16	0.56
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	1.08	2.49	0.67	0.17	0.18	0.38	0.70	0.20	0.56	1.39	0.35	1.09
Lower Rocklow (mg/L)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	0.09	0.28	0.19	2.09	0.58	0.68	0.23		0.58	0.06	1.59	0.44	1.07	0.20	0.08
Net Increment (mg/L) Middle- Lower	1.06	1.87	0.34	0.61	0.07	0.24	0.09	1.44	(0.10)	0.00	0.10	(0.05)	0.01	0.04	1.01	(1.91)	0.01	0.06	0.11	0.20	(0.64)	1.39	(0.12)	(0.32)	(0.15)	(1.01)

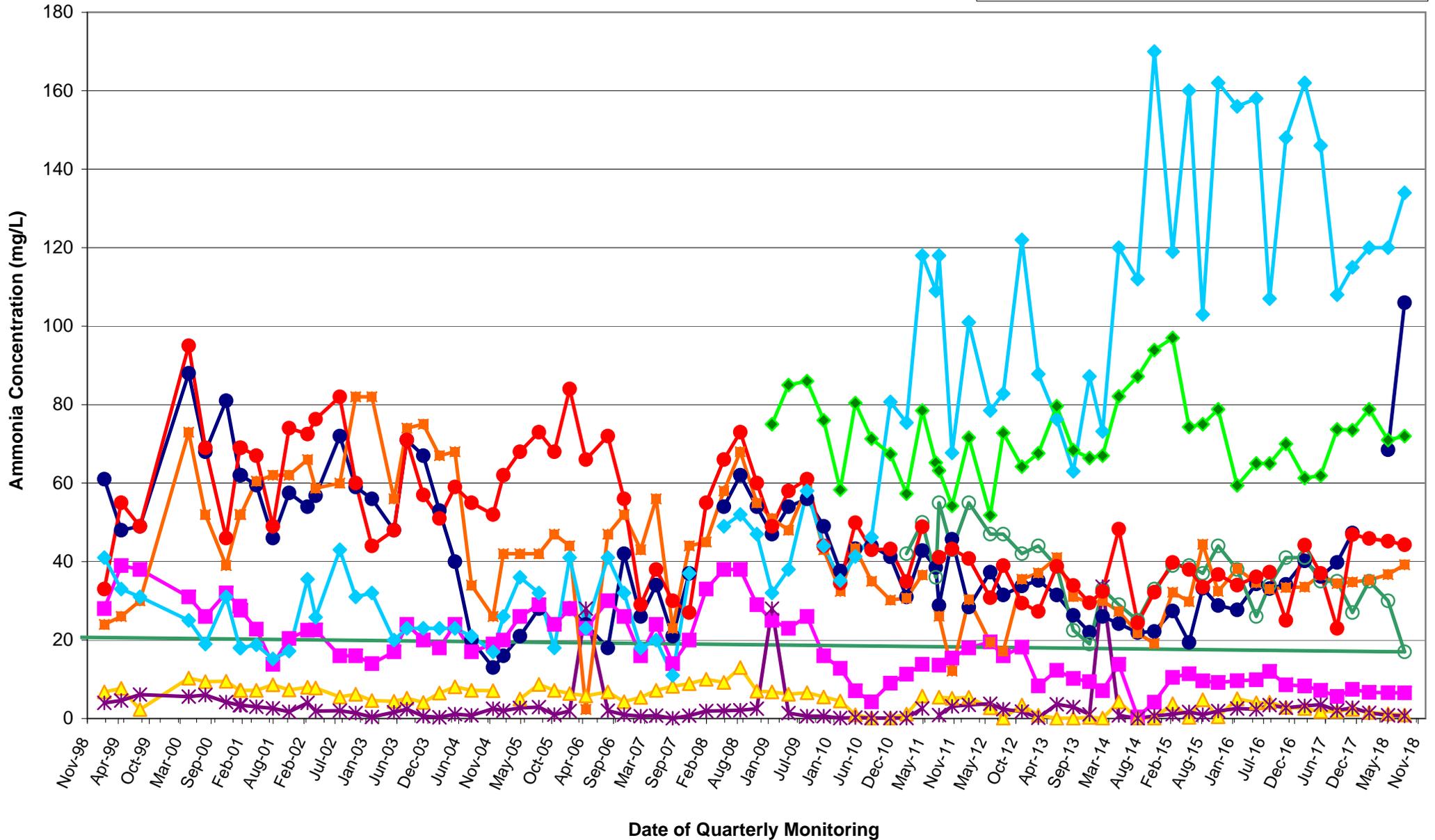
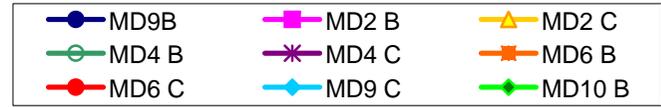
Legend

NA = Not Analysed NM= Not measured

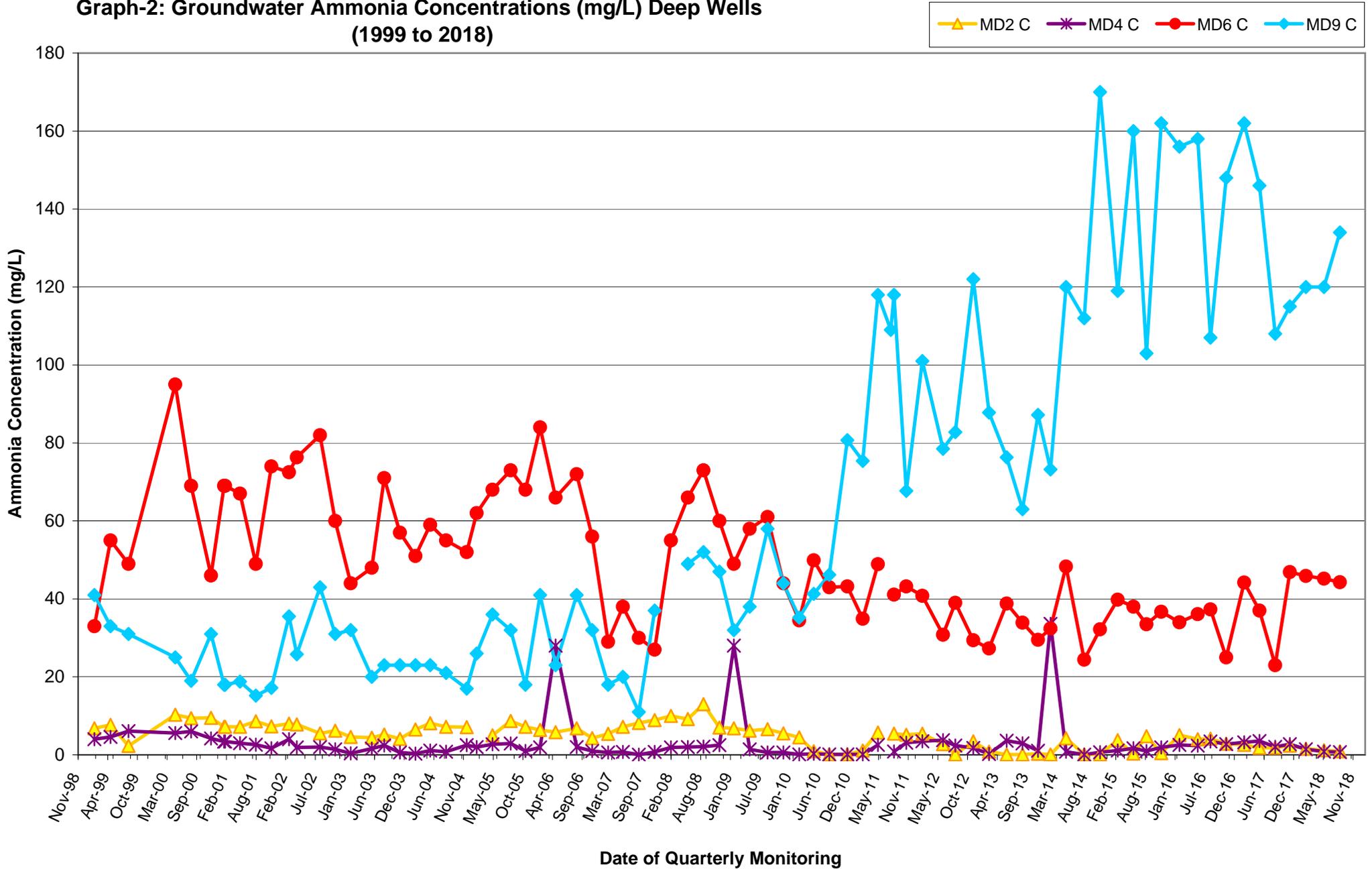
Note: Rocklow Down was inaccessible during the 2010-2014 monitoring periods

Graphs

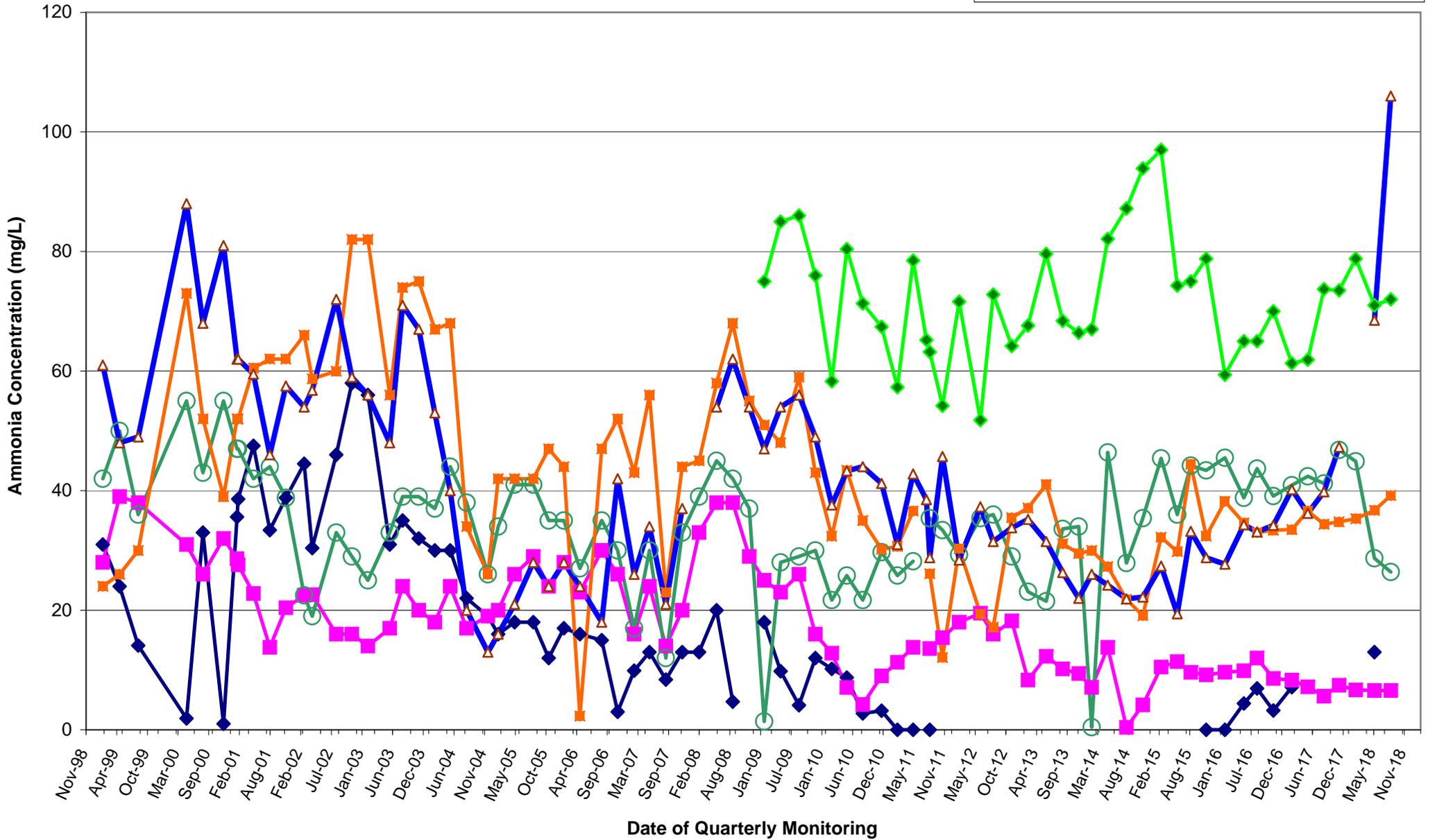
Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999 to 2018)



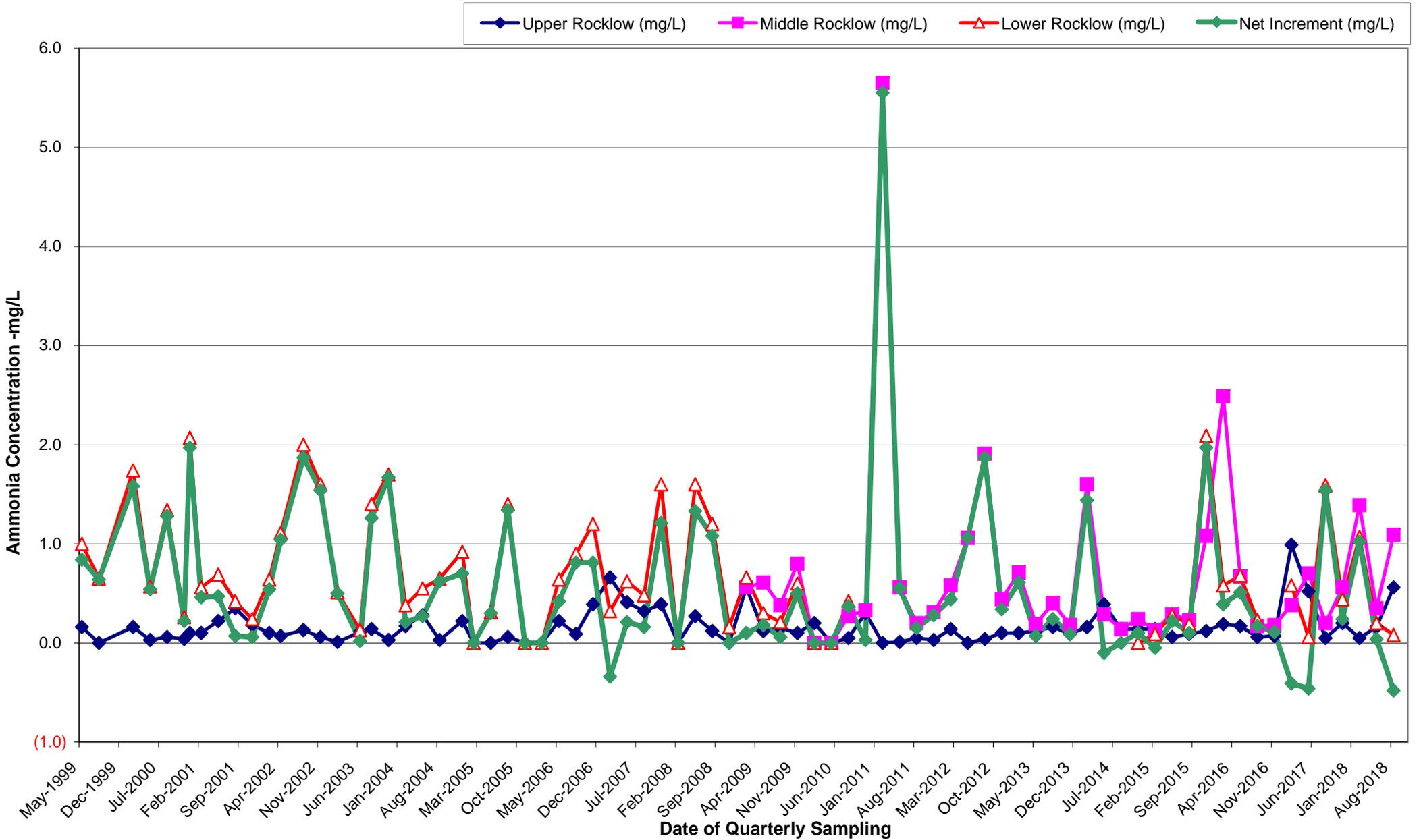
Graph-2: Groundwater Ammonia Concentrations (mg/L) Deep Wells (1999 to 2018)



Graph-3: Groundwater Ammonia Concentrations (mg/L) Shallow Wells (1999 to 2018)



Graph-04: Net Increments of Ammonia Between Up and Down Stream Samples (1999 to 2018)



Appendix A

CERTIFICATE OF ANALYSIS

Work Order : **EW1704933**
Client : **KIAMA COUNCIL**
Contact : **MR PAUL CZULOWSKI**
Address : **11 MANNING STREET**
KIAMA NSW, AUSTRALIA 2533

Telephone : **+61 02 4232 0444**
Project : **Minnamurra Landfill**
Order number : **87896**
C-O-C number : **----**
Sampler : **Robert DaLio**
Site : **MINNAMURRA LANDFILL**
Quote number : **WO/026/15 - Minnamurra Landfill**
No. of samples received : **20**
No. of samples analysed : **20**

Page : 1 of 10
Laboratory : Environmental Division NSW South Coast
Contact : Glenn Davies
Address : 1/19 Ralph Black Dr, North Wollongong 2500
4/13 Geary Pl, North Nowra 2541
Australia NSW
Telephone : 02 42253125
Date Samples Received : 29-Nov-2017 15:00
Date Analysis Commenced : 29-Nov-2017
Issue Date : 19-Dec-2017 14:12



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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW



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
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: LOR's have been raised due to matrix interference. (High Total Dissolved Solids)
- ED041G: LOR raised for Sulfate on sample no: 12, 13 & 15 due to sample matrix.
- 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	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Client sampling date / time				29-Nov-2017 00:00	29-Nov-2017 00:00	29-Nov-2017 11:45	29-Nov-2017 11:55	29-Nov-2017 11:10	
Compound	CAS Number	LOR	Unit	EW1704933-001	EW1704933-002	EW1704933-003	EW1704933-004	EW1704933-005	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	----	7.1	7.0	----	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	12100	23600	----	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	----	7.7	16.6	----	
EA116: Temperature									
Temperature	----	0.1	°C	----	----	20.1	18.3	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	----	<1	<1	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	----	<1	<1	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	----	1080	764	----	
Total Alkalinity as CaCO3	----	1	mg/L	----	----	1080	764	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	----	371	660	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	----	3740	8070	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	178	330	----	
Magnesium	7439-95-4	1	mg/L	----	----	285	551	----	
Sodium	7440-23-5	1	mg/L	----	----	2020	4230	----	
Potassium	7440-09-7	1	mg/L	----	----	146	180	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	0.047	0.080	----	
Iron	7439-89-6	0.05	mg/L	----	----	0.75	0.88	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	----	0.8	0.6	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	----	22.5	7.45	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	----	0.02	<0.01	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	----	0.15	0.02	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Client sampling date / time				29-Nov-2017 00:00	29-Nov-2017 00:00	29-Nov-2017 11:45	29-Nov-2017 11:55	29-Nov-2017 11:10	
Compound	CAS Number	LOR	Unit	EW1704933-001	EW1704933-002	EW1704933-003	EW1704933-004	EW1704933-005	
				Result	Result	Result	Result	Result	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	0.17	0.02	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	----	135	257	----	
Total Cations	----	0.01	meq/L	----	----	124	250	----	
Ionic Balance	----	0.01	%	----	----	4.20	1.23	----	
EN67 PK: Field Tests									
Field Observations	----	0.01	--	DESTROYED	DESTROYED	----	----	DRY	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	----	----	59	30	----	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	----	----	61	32	----	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	----	----	1.54	0.80	----	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	17.0	8.6	----	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	----	----	<0.05	<0.05	----	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	----	0.63	0.75	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				29-Nov-2017 11:15	29-Nov-2017 11:30	29-Nov-2017 12:45	29-Nov-2017 12:55	29-Nov-2017 13:05	
Compound	CAS Number	LOR	Unit	EW1704933-006	EW1704933-007	EW1704933-008	EW1704933-009	EW1704933-010	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.0	6.9	7.3	7.1	7.4	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	11300	37400	2780	1800	29700	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	7.3	27.4	1.6	1.0	20.6	
EA116: Temperature									
Temperature	----	0.1	°C	19.2	18.6	20.4	19.5	19.9	
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	986	691	758	873	452	
Total Alkalinity as CaCO3	----	1	mg/L	986	691	758	873	452	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	315	960	47	40	752	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	3650	13100	146	111	10300	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	304	439	140	152	376	
Magnesium	7439-95-4	1	mg/L	239	875	56	47	709	
Sodium	7440-23-5	1	mg/L	1750	7250	151	135	5440	
Potassium	7440-09-7	1	mg/L	121	280	50	44	201	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.091	0.182	0.053	0.126	0.066	
Iron	7439-89-6	0.05	mg/L	1.55	1.51	1.40	0.30	19.4	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.5	0.7	0.6	0.4	0.4	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	46.8	2.74	24.2	34.8	46.9	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.04	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.24	<0.01	0.59	<0.01	<0.01	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				29-Nov-2017 11:15	29-Nov-2017 11:30	29-Nov-2017 12:45	29-Nov-2017 12:55	29-Nov-2017 13:05	
Compound	CAS Number	LOR	Unit	EW1704933-006	EW1704933-007	EW1704933-008	EW1704933-009	EW1704933-010	
				Result	Result	Result	Result	Result	
EPK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.24	<0.01	0.63	<0.01	<0.01	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	129	403	20.2	21.4	315	
Total Cations	----	0.01	meq/L	114	416	19.4	18.4	319	
Ionic Balance	----	0.01	%	6.23	1.60	2.02	7.42	0.57	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	41	23	24	37	13	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	44	23	28	38	13	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	1.36	1.87	2.98	0.99	1.11	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	14.8	20.2	33.1	10.8	12.3	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	1.19	1.19	1.32	1.32	1.47	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10b
Client sampling date / time				29-Nov-2017 10:40	29-Nov-2017 10:45	29-Nov-2017 10:55	29-Nov-2017 10:10	29-Nov-2017 10:15	
Compound	CAS Number	LOR	Unit	EW1704933-011	EW1704933-012	EW1704933-013	EW1704933-014	EW1704933-015	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	7.0	7.1	6.3	7.2	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2860	4400	54600	2020	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	1.7	2.7	37.3	1.1	
EA116: Temperature									
Temperature	----	0.1	°C	----	19.8	18.7	23.6	21.6	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	1190	1220	222	801	
Total Alkalinity as CaCO3	----	1	mg/L	----	1190	1220	222	801	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	<10	<10	2960	<10	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	371	816	18800	222	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	172	148	1470	99	
Magnesium	7439-95-4	1	mg/L	----	86	83	1690	45	
Sodium	7440-23-5	1	mg/L	----	293	470	10000	134	
Potassium	7440-09-7	1	mg/L	----	87	134	227	75	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.260	0.250	1.12	0.346	
Iron	7439-89-6	0.05	mg/L	----	4.60	7.35	3.39	1.06	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.5	0.5	0.3	0.8	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	47.3	115	1.02	73.5	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	<0.01	<0.01	0.02	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.06	<0.01	<0.01	0.33	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10b
Client sampling date / time				29-Nov-2017 10:40	29-Nov-2017 10:45	29-Nov-2017 10:55	29-Nov-2017 10:10	29-Nov-2017 10:15	
Compound	CAS Number	LOR	Unit	EW1704933-011	EW1704933-012	EW1704933-013	EW1704933-014	EW1704933-015	
				Result	Result	Result	Result	Result	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.06	<0.01	0.02	0.33	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	34.2	47.4	596	22.3	
Total Cations	----	0.01	meq/L	----	----	46.3	----	21.6	
Total Cations	----	0.01	meq/L	----	30.6	----	653	----	
Ionic Balance	----	0.01	%	----	----	1.19	----	1.64	
Ionic Balance	----	0.01	%	----	5.57	----	4.55	----	
EN67 PK: Field Tests									
Field Observations	----	0.01	--	INSUFFICIENT SAMPLE	----	----	----	----	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	----	57	80	30	52	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	----	57	81	30	54	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	----	0.99	0.71	4.14	1.04	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	10.6	7.6	48.3	11.8	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	0.84	0.87	0.65	0.72	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Client sampling date / time				29-Nov-2017 08:45	29-Nov-2017 09:45	29-Nov-2017 09:20	29-Nov-2017 08:35	29-Nov-2017 12:10	
Compound	CAS Number	LOR	Unit	EW1704933-016	EW1704933-017	EW1704933-018	EW1704933-019	EW1704933-020	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.1	7.2	7.0	----	7.0	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	30000	14200	1370	----	44300	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	19.7	8.6	0.7	----	32.8	
EA116: Temperature									
Temperature	----	0.1	°C	22.4	22.9	24.5	----	19.0	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	187	167	56	----	588	
Total Alkalinity as CaCO3	----	1	mg/L	187	167	56	----	588	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	796	480	194	----	2150	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	10500	5090	314	----	15000	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	----	508	
Magnesium	7439-95-4	1	mg/L	----	----	----	----	1160	
Sodium	7440-23-5	1	mg/L	----	----	----	----	9200	
Potassium	7440-09-7	1	mg/L	----	----	----	----	355	
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	254	139	51	----	----	
Magnesium	7439-95-4	1	mg/L	687	317	40	----	----	
Sodium	7440-23-5	1	mg/L	5550	2600	258	----	----	
Potassium	7440-09-7	1	mg/L	210	97	16	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	0.176	
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	1.60	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.206	0.259	0.330	----	----	
Iron	7439-89-6	0.05	mg/L	0.89	1.53	2.13	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Client sampling date / time				29-Nov-2017 08:45	29-Nov-2017 09:45	29-Nov-2017 09:20	29-Nov-2017 08:35	29-Nov-2017 12:10	
Compound	CAS Number	LOR	Unit	EW1704933-016	EW1704933-017	EW1704933-018	EW1704933-019	EW1704933-020	
				Result	Result	Result	Result	Result	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.6	0.6	0.2	----	0.5	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.44	0.56	0.20	----	2.34	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.01	<0.01	----	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.03	<0.01	----	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.04	<0.01	----	<0.01	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	----	----	----	480	
Total Cations	----	0.01	meq/L	----	----	----	----	530	
Ionic Balance	----	0.01	%	----	----	----	----	4.99	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	9	10	13	<1	20	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	9	12	14	----	20	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	4.19	4.96	5.69	----	1.67	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	48.7	57.4	68.3	----	17.4	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	----	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	----	----	----	0.80	



CHAIN OF CUSTODY

ALS Laboratory, please tick →

- Sydney 277 Westdunbar Rd, Smithfield NSW 2178
- Brisbane 32 Grand St, Sefton QLD 4653
- Melbourne 2-4 Westall Rd, Springvale VIC 3177
- Perth 10 Hazel Wy, Malaga WA 6030
- Adelaide 5 Rosebery St, Adelaide SA 5005
- Darwin 14-15 Darwin Ct, Raine QLD 4878
- Gold Coast 1000 E. Seagraves Rd, Gold Coast QLD 4217
- Townsville 14-15 Darwin Ct, Raine QLD 4878
- Cairns 1000 E. Seagraves Rd, Gold Coast QLD 4217
- Mackay 1000 E. Seagraves Rd, Gold Coast QLD 4217
- Brisbane 1000 E. Seagraves Rd, Gold Coast QLD 4217
- Sydney 1000 E. Seagraves Rd, Gold Coast QLD 4217

CLIENT: **Kiama Municipal Council**

OFFICE: **PO Box 75 Kiama NSW 2533**

PROJECT: **Minimurra Landfill**

ORDER NUMBER: **87896**

PROJECT MANAGER: **Paul Czulowski**

SAMPLER: **Craig Wilson**

COC emailed to ALS? (YES / NO)

Turnaround Requirements: Standard TAT (last due date); Non Standard or urgent TAT (last due date)

ALS QUOTE NO.: **SY-146-10**

RELINQUISHED BY: **Craig Wilson**

DATE/TIME: **29/11/17, 13:50**

RECEIVED BY:

DATE/TIME:

PROJECT NUMBER:	CONTACT PH:	SAMPLER MOBILE:	EDD FORMAT (or default):	RELINQUISHED BY:	DATE/TIME:
87896	4232 0418	0408 251 560		Craig Wilson	29/11/17, 13:50

Comments/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY

SAMPLE DETAILS

MATRIX: Solid(S) Water(W)

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	ANALYSIS REQUIRED INCLUDING SUITES (NB. Suite Codes must be listed to attract suite price)	Additional Information
1	MD 1A	29/11/17	W	500mL, SP, 2 X VS, N	5	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K)	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
2	MD 1B	-	W	500mL, SP, 2 X VS, N	5	Nitrate, Ammonia, Total Phenolics	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
3	MD 2A	11:45	W	500mL, SP, 2 X VS, N	5	DOC (Filtered)	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
4	MD 2B	11:55	W	500mL, SP, 2 X VS, N	5	TOC	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
20	MD 2C	12:10	W	500mL, SP, 2 X VS, N	5	(Dissolved Filtered) Fe, Mn, (Total) Fe, Mn, Mg, Ca, Na, K	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
5	MD 4A	11:10	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
6	MD 4B	11:15	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
7	MD 4C	11:30	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
8	MD 6A	12:45	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
9	MD 6B	12:55	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
10	MD 6C	13:05	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
11	MD 9A	14:40	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
TOTAL							

Environmental Division
Wollongong
Work Order Reference
EW1704933

Telephone: 02 42253125

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 Vial HQ Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Air-tight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation Bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; S = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

- Sydney: 271 Woodbank Rd, Southfield NSW 2178
- Brisbane: 32 Strand St, Stalton QLD 4053
- Melbourne: 2-4 Westall Rd, Springvale VIC 3171
- Perth: 10 Hot Way, Malaga WA 6096
- Newcastle: 3 Rossmore Rd, Warneck NSW 2304
- Townsville: 14-15 Deane Ct, Ernie QLD 4813
- Adelaide: 2-1 Burna Rd, Richards SA 5085
- Launceston: 27 Wallington St, Launceston TAS 7250
- Ph: 02 8781 8655 E: sydney@als.com.au
- Ph: 07 3213 7222 E: brisbane@als.com.au
- Ph: 03 9543 3600 E: melbourne@als.com.au
- Ph: 08 9359 0900 E: perth@als.com.au
- Ph: 02 4960 0433 E: newcastle@als.com.au
- Ph: 07 4798 0000 E: townsville@als.com.au
- Ph: 08 8356 0900 E: adelaide@als.com.au
- Ph: 03 6331 2158 E: launceston@als.com.au

CLIENT: Kiama Municipal Council

OFFICE: PO Box 75 Kiama NSW 2533

PROJECT: Mimmamura Landfill

ORDER NUMBER: PROJECT MANAGER: Paul Czuiowski

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

FOR LABORATORY USE ONLY (Circle)

Client Seal Intact? Yes No N/A

Freeze Ice / frozen ice blocks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: Other comment: C

RECEIVED BY: DATE/TIME:

RECEIVED BY: DATE/TIME:

RECEIVED BY: DATE/TIME:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	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))	Additional Information
12	MD 9B	29/11/17 10:45	W	500mL, SP, 2 X VS, N	5	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K) Nitrate, Ammonia, Total Phenolics DOC (Filtered) TOC (Dissolved Filtered) Fe, Mn, (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
13	MD 9C	10:55	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
14	MD 10A	10:10	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10B	10:15	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
16	Rocklow Down	8:45	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
17	Rocklow Middle	9:45	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Up	9:20	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
19	Blank	8:35	W	VS, N	2		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 Preserved Plastic, S = Sodium Hydroxide Preserved Plastic, AG = Amber Glass Unpreserved AP - Airtight Unpreserved Plastic
 V = 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 Bottle, E = EDTA Preserved Bottles, ST = Sterile Bottle, ASS = Plastic Bag for Acid Sulphate Solids, B = Unpreserved Bag

ENTM 204

CERTIFICATE OF ANALYSIS

Work Order : **EW1800512**
Client : **KIAMA COUNCIL**
Contact : MR PAUL CZULOWSKI
Address : 11 MANNING STREET
 KIAMA NSW, AUSTRALIA 2533

Telephone : +61 02 4232 0444
Project : Minnamurra Landfill
Order number : 87896
C-O-C number : ----
Sampler : Robert DaLio
Site : MINNAMURRA LANDFILL
Quote number : WO/026/15 - Minnamurra Landfill
No. of samples received : 20
No. of samples analysed : 20

Page : 1 of 10
Laboratory : Environmental Division NSW South Coast
Contact : Glenn Davies
Address : 1/19 Ralph Black Dr, North Wollongong 2500
 4/13 Geary Pl, North Nowra 2541
 Australia NSW
Telephone : 02 42253125
Date Samples Received : 09-Feb-2018 16:00
Date Analysis Commenced : 09-Feb-2018
Issue Date : 19-Feb-2018 16:23



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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW



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
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED041G: LOR raised for Sulfate on sample nos: 15 due to sample matrix.
- EK055G: LOR raised for Ammonia on sample 18 due to sample matrix.
- EP002 and EP005 : NPDOC and NPOC analysis was carried out for sample 4 and 15 due to high inorganic carbon content.
- EP002 : It has been noted that NPDOC is greater than NPOC for sample 15, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Client sampling date / time				09-Feb-2018 13:05	09-Feb-2018 13:05	09-Feb-2018 11:40	09-Feb-2018 11:50	09-Feb-2018 11:00	
Compound	CAS Number	LOR	Unit	EW1800512-001	EW1800512-002	EW1800512-003	EW1800512-004	EW1800512-005	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	----	6.8	7.1	----	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	26200	25400	----	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	----	17.2	16.9	----	
EA116: Temperature									
Temperature	----	0.1	°C	----	----	21.9	19.5	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	----	<1	<1	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	----	<1	<1	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	----	912	762	----	
Total Alkalinity as CaCO3	----	1	mg/L	----	----	912	762	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	----	944	1120	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	----	7740	7960	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	333	347	----	
Magnesium	7439-95-4	1	mg/L	----	----	623	576	----	
Sodium	7440-23-5	1	mg/L	----	----	4640	4560	----	
Potassium	7440-09-7	1	mg/L	----	----	238	192	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	0.091	0.085	----	
Iron	7439-89-6	0.05	mg/L	----	----	7.94	0.91	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	----	1.2	1.0	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	----	21.8	6.66	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	----	0.03	<0.01	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	----	1.45	<0.01	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Client sampling date / time				09-Feb-2018 13:05	09-Feb-2018 13:05	09-Feb-2018 11:40	09-Feb-2018 11:50	09-Feb-2018 11:00	
Compound	CAS Number	LOR	Unit	EW1800512-001	EW1800512-002	EW1800512-003	EW1800512-004	EW1800512-005	
				Result	Result	Result	Result	Result	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	1.48	<0.01	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	----	256	263	----	
Total Cations	----	0.01	meq/L	----	----	276	268	----	
Ionic Balance	----	0.01	%	----	----	3.68	0.92	----	
EN67 PK: Field Tests									
Field Observations	----	0.01	--	DESTROYED	DESTROYED	----	----	DRY	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	----	----	51	----	----	
Nonpurgeable Dissolved Organic Carbon	----	1	mg/L	----	----	----	26	----	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	----	----	53	----	----	
Nonpurgeable Organic Carbon	----	1	mg/L	----	----	----	26	----	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	----	----	3.49	0.91	----	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	39.7	9.9	----	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	----	----	<0.05	<0.05	----	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	----	0.57	0.78	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				09-Feb-2018 11:05	09-Feb-2018 11:10	09-Feb-2018 12:30	09-Feb-2018 12:40	09-Feb-2018 12:50	
Compound	CAS Number	LOR	Unit	EW1800512-006	EW1800512-007	EW1800512-008	EW1800512-009	EW1800512-010	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.0	7.0	6.8	6.8	7.4	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	13100	40800	2040	1580	31400	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	8.7	30.2	1.1	0.9	21.5	
EA116: Temperature									
Temperature	----	0.1	°C	18.7	18.6	22.9	21.4	20.8	
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	964	553	756	706	453	
Total Alkalinity as CaCO3	----	1	mg/L	964	553	756	706	453	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	396	1960	63	54	1480	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	3860	12300	150	101	9800	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	315	466	148	131	383	
Magnesium	7439-95-4	1	mg/L	261	1060	60	39	726	
Sodium	7440-23-5	1	mg/L	2040	8370	190	89	5680	
Potassium	7440-09-7	1	mg/L	131	299	53	41	201	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.095	0.192	0.053	0.105	0.066	
Iron	7439-89-6	0.05	mg/L	1.54	1.64	1.09	0.19	19.5	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.6	0.9	1.0	0.6	0.5	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	44.9	1.45	27.1	35.3	45.9	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.06	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.01	0.16	0.20	<0.01	<0.01	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				09-Feb-2018 11:05	09-Feb-2018 11:10	09-Feb-2018 12:30	09-Feb-2018 12:40	09-Feb-2018 12:50	
Compound	CAS Number	LOR	Unit	EW1800512-006	EW1800512-007	EW1800512-008	EW1800512-009	EW1800512-010	
				Result	Result	Result	Result	Result	
EPK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.16	0.26	<0.01	<0.01	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	136	399	20.6	18.1	316	
Total Cations	----	0.01	meq/L	----	----	----	17.2	----	
Total Cations	----	0.01	meq/L	129	482	21.9	----	331	
Ionic Balance	----	0.01	%	----	----	----	2.55	----	
Ionic Balance	----	0.01	%	2.67	9.46	3.04	----	2.28	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	38	18	32	28	11	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	38	18	33	28	14	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	1.16	1.00	1.13	0.69	0.58	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	12.8	10.6	13.1	7.8	6.5	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	1.24	1.22	1.26	1.32	1.52	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Client sampling date / time				09-Feb-2018 10:55	09-Feb-2018 10:55	09-Feb-2018 10:55	09-Feb-2018 10:05	09-Feb-2018 10:10	
Compound	CAS Number	LOR	Unit	EW1800512-011	EW1800512-012	EW1800512-013	EW1800512-014	EW1800512-015	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	----	----	6.2	6.7	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	----	53600	2000	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	----	----	36.8	1.1	
EA116: Temperature									
Temperature	----	0.1	°C	----	----	----	23.3	21.7	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	----	----	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	----	----	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	----	----	289	762	
Total Alkalinity as CaCO3	----	1	mg/L	----	----	----	289	762	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	----	----	2480	<10	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	----	----	16100	181	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	1880	94	
Magnesium	7439-95-4	1	mg/L	----	----	----	1410	42	
Sodium	7440-23-5	1	mg/L	----	----	----	8360	152	
Potassium	7440-09-7	1	mg/L	----	----	----	189	77	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	1.09	0.301	
Iron	7439-89-6	0.05	mg/L	----	----	----	4.42	0.65	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	----	----	0.4	1.0	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	----	----	1.29	78.8	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	----	----	0.02	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	----	----	0.33	0.02	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Client sampling date / time				09-Feb-2018 10:55	09-Feb-2018 10:55	09-Feb-2018 10:55	09-Feb-2018 10:05	09-Feb-2018 10:10	
Compound	CAS Number	LOR	Unit	EW1800512-011	EW1800512-012	EW1800512-013	EW1800512-014	EW1800512-015	
				Result	Result	Result	Result	Result	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	----	0.35	0.02	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	----	----	512	20.3	
Total Cations	----	0.01	meq/L	----	----	----	----	22.3	
Total Cations	----	0.01	meq/L	----	----	----	578	----	
Ionic Balance	----	0.01	%	----	----	----	----	4.76	
Ionic Balance	----	0.01	%	----	----	----	6.12	----	
EN67 PK: Field Tests									
Field Observations	----	0.01	--	NO ACCESS	NO ACCESS	NO ACCESS	----	----	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	----	----	----	30	----	
Nonpurgeable Dissolved Organic Carbon	----	1	mg/L	----	----	----	----	46	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	----	----	----	30	----	
Nonpurgeable Organic Carbon	----	1	mg/L	----	----	----	----	43	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	----	----	----	1.39	0.53	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	----	16.2	6.1	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	----	----	----	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	----	----	0.63	0.83	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Client sampling date / time				09-Feb-2018 09:10	09-Feb-2018 10:40	09-Feb-2018 09:40	09-Feb-2018 10:15	09-Feb-2018 12:00	
Compound	CAS Number	LOR	Unit	EW1800512-016	EW1800512-017	EW1800512-018	EW1800512-019	EW1800512-020	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.3	7.1	7.2	----	7.0	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	52000	48700	53600	----	43600	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	35.5	32.3	37.2	----	32.6	
EA116: Temperature									
Temperature	----	0.1	°C	23.3	24.3	22.8	----	18.6	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	226	258	146	----	589	
Total Alkalinity as CaCO3	----	1	mg/L	226	258	146	----	589	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2320	2160	2380	----	2150	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	15100	14100	15600	----	13900	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	----	499	
Magnesium	7439-95-4	1	mg/L	----	----	----	----	1100	
Sodium	7440-23-5	1	mg/L	----	----	----	----	8750	
Potassium	7440-09-7	1	mg/L	----	----	----	----	320	
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	470	440	476	----	----	
Magnesium	7439-95-4	1	mg/L	1270	1170	1360	----	----	
Sodium	7440-23-5	1	mg/L	10400	9630	11200	----	----	
Potassium	7440-09-7	1	mg/L	376	344	396	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	0.161	
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	1.55	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.211	0.493	0.178	----	----	
Iron	7439-89-6	0.05	mg/L	1.16	0.90	0.57	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Client sampling date / time				09-Feb-2018 09:10	09-Feb-2018 10:40	09-Feb-2018 09:40	09-Feb-2018 10:15	09-Feb-2018 12:00	
Compound	CAS Number	LOR	Unit	EW1800512-016	EW1800512-017	EW1800512-018	EW1800512-019	EW1800512-020	
				Result	Result	Result	Result	Result	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	1.0	0.9	0.9	----	0.7	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	1.07	1.39	<0.05	----	1.58	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.12	0.05	0.02	----	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.12	0.05	0.02	----	<0.01	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	----	----	----	449	
Total Cations	----	0.01	meq/L	----	----	----	----	504	
Ionic Balance	----	0.01	%	----	----	----	----	5.83	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	6	8	4	<1	18	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	7	8	4	----	18	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	4.68	2.03	3.50	----	0.80	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	54.9	24.4	40.5	----	8.6	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	----	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	----	----	----	0.82	



CHAIN OF CUSTODY

ALS Laboratory - please tick →

- Sydney: 277 Woodpark Rd, Smithfield NSW 2176
- Brisbane: 32 Grand St, Stalford QLD 4063
- Melbourne: 2-4 Westall Rd, Springvale VIC 3171
- Perth: 10 Hurl Way, Malaga WA 6060
- Ph: 02 8781 0255 E: samplesydney@alsenviro.com
- Ph: 07 3243 7222 E: samplesbrisbane@alsenviro.com
- Ph: 03 9546 8600 E: samplesmelbourne@alsenviro.com
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- Newcastle: 5 Pruequin Rd, Warabook NSW 2304
- Townsville: 14-15 Darling Ct, Goolie QLD 4813
- Adelaide: 2-1 Burna Rd, Poonah SA 5095
- Ph: 08 8331 2158 E: samplesnewcastle@alsenviro.com
- Ph: 07 4799 0600 E: hpc-table@alsenviro.com
- Ph: 08 8359 0590 E: endstade@alsenviro.com
- Ph: 03 8331 2158 E: launceston@alsenviro.com

CLIENT: **Kiama Municipal Council** TURNAROUND REQUIREMENTS: Standard TAT (last due date): Non Standard or urgent TAT (last due date):

OFFICE: **PO Box 75 Kiama NSW 2533** (Standard TAT may be longer for some tests) **ALS QUOTE NO.:** SY-146-10

PROJECT: **Minnamurra Landfill** PROJECT MANAGER: **Paul Czulkowski** CONTACT PH: **4232 0418**

ORDER NUMBER: **87896** PROJECT MANAGER: **Paul Czulkowski** CONTACT PH: **4232 0418**

SAMPLER: **Robert Dalio** SAMPLER MOBILE: **0408 251 560** RELINQUISHED BY: **Robert Dalio** RECEIVED BY: **Aneta**

COC emailed to ALS? (YES / NO) **YES** EDD FORMAT (for default): **EDD** DATE/TIME: **9/12/18 14:15** DATE/TIME: **9/12/18 14:15**

Email Reports to (will default to PM if no other addressees are listed): paulc@kiama.nsw.gov.au, juliam@kiama.nsw.gov.au

Email Invoice to (will default to PM if no other addressees are listed): paulc@kiama.nsw.gov.au, juliam@kiama.nsw.gov.au

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	ANALYSIS REQUIRED including SUITES (NB: Suite Codes must be listed in Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filter)	RELINQUISH DATE/TIME
1	MD 1A	9/12/18 13:05	W	500mL, SP, 2 X VS, N	5	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K)	Destroyed
2	MD 1B	13:05	W	500mL, SP, 2 X VS, N	5	Nitrate, Ammonia, Total Phenolics	Destroyed
3	MD 2A	11:40	W	500mL, SP, 2 X VS, N	5	DOC (Filtered)	Destroyed
4	MD 2B	11:50	W	500mL, SP, 2 X VS, N	5	TOC	Destroyed
20	MD 2C	12:00	W	500mL, SP, 2 X VS, N	5	(Dissolved Filtered) Fe, Mn,	Destroyed
5	MD 4A	11:00	W	500mL, SP, 2 X VS, N	5	(Total) Fe, Mn, Mg, Ca, Na, K	Dry.
6	MD 4B	11:05	W	500mL, SP, 2 X VS, N	5		
7	MD 4C	11:10	W	500mL, SP, 2 X VS, N	5		
8	MD 6A	12:30	W	500mL, SP, 2 X VS, N	5		
9	MD 6B	12:40	W	500mL, SP, 2 X VS, N	5		
10	MD 6C	12:50	W	500mL, SP, 2 X VS, N	5		
11	MD 9A	10:55	W	500mL, SP, 2 X VS, N	5		NO ACCESS
TOTAL							

ALS USE ONLY SAMPLE DETAILS MATRIX: Solid(S) Water(W)

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VS = VOA Vial Sodium Bisphosphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Specialisation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ASS = Plastic Bag for Acid Sulfate Soils; B = Unpreserved Bag

Environmental Division
 Wollongong
 Work Order Reference
EW1800512

25-02



CHAIN OF CUSTODY

ALS Laboratory, please tick →

- Sydney 271 Woodhead Rd, Smithfield NSW 2176
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- Ph: 08 8359 0980 E: samples.adelaide@alsenviro.com
- Ph: 03 6331 2158 E: samples.launceston@alsenviro.com

FOR LABORATORY USE ONLY (circle)

CLIENT: Kiama Municipal Council

OFFICE: PO Box 75 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER: [Blank]

PROJECT MANAGER: Paul Czulowski

SAMPLER: Craig Wilson

COC emailed to ALS? (YES / NO): YES

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

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

TURNAROUND REQUIREMENTS: Standard TAT (list due date):
 Non Standard or urgent TAT (list due date):

ALSO QUOTE NO.: SY-146-10

RELINQUISHED BY: [Blank]

RECEIVED BY: [Blank]

DATE/TIME: [Blank]

DATE/TIME: [Blank]

DATE/TIME: [Blank]

DATE/TIME: [Blank]

COCK	1	2	3	4	5	6	7
COC SEQUENCE NUMBER (Circle)							
RELINQUISHED BY:							
RECEIVED BY:							
DATE/TIME:							

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	ANALYSIS REQUIRED including SITES (NB: Suite Codes must be listed to attract suite price)	Additional Information
12	MD 9B	9/11/10 10:53	W	500mL, SP, 2 X VS, N	5	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K)	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
13	MD 9C	10:55	W	500mL, SP, 2 X VS, N	5	Nitrate, Ammonia, Total Phenolics	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
14	MD 10A	10:05	W	500mL, SP, 2 X VS, N	5	DOC (Filtered)	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10B	10:10	W	500mL, SP, 2 X VS, N	5	TOC	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
16	Rocklow Down	9:10	W	500mL, SP, 2 X VS, N	5	(Dissolved Filtered) Fe, Mn	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
17	Rocklow Middle	10:45	W	500mL, SP, 2 X VS, N	5	(Total) Fe, Mn, Mg, Ca, Na, K	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Up	9:40	W	500mL, SP, 2 X VS, N	5		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
19	Blank	10:15	W	VS, N	2		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 Preserved Plastic; AG = Amber Glass Unpreserved; AP = Antifreeze Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Antifreeze Unpreserved Via SG = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulfu

Z = Zipc Acetate Preserved Bottle; E = EDTA Preserved Bottle; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Comments on likely contaminant levels, dilutions, or samples requiring specific OC analysis etc:

CERTIFICATE OF ANALYSIS

Work Order : **EW1802121**
Client : **KIAMA COUNCIL**
Contact : **MR PAUL CZULOWSKI**
Address : **11 MANNING STREET**
KIAMA NSW, AUSTRALIA 2533

Telephone : **+61 02 4232 0444**
Project : **Minnamurra Landfill**
Order number : **87896**
C-O-C number : **----**
Sampler : **Robert DaLio**
Site : **MINNAMURRA LANDFILL**
Quote number : **WO/026/15 - Minnamurra Landfill**
No. of samples received : **20**
No. of samples analysed : **20**

Page : 1 of 10
Laboratory : Environmental Division NSW South Coast
Contact : Glenn Davies
Address : 1/19 Ralph Black Dr, North Wollongong 2500
 4/13 Geary Pl, North Nowra 2541
 Australia NSW

Telephone : 02 42253125
Date Samples Received : 24-May-2018 05:00
Date Analysis Commenced : 24-May-2018
Issue Date : 01-Jun-2018 15:51



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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



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
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP035G: Poor spike recovery for Phenol due to matrix interferences.
- ED041G: LOR raised for Sulfate on sample 12 & 14 due to sample matrix.
- EG020: LOR's have been raised due to matrix interference. (High Total Dissolved Solids)
- EP002 : It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Client sampling date / time				24-May-2018 13:25	24-May-2018 13:30	24-May-2018 11:55	24-May-2018 12:10	24-May-2018 11:15	
Compound	CAS Number	LOR	Unit	EW1802121-001	EW1802121-002	EW1802121-003	EW1802121-004	EW1802121-005	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	7.7	7.1	6.8	----	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	627	25700	32900	----	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	0.3	18.9	24.2	----	
EA116: Temperature									
Temperature	----	0.1	°C	----	20.0	17.0	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	----	209	935	778	----	
Total Alkalinity as CaCO3	----	1	mg/L	----	209	935	778	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	20	1130	1640	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	46	7800	9910	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	45	297	406	----	
Magnesium	7439-95-4	1	mg/L	----	7	553	717	----	
Sodium	7440-23-5	1	mg/L	----	36	4180	5600	----	
Potassium	7440-09-7	1	mg/L	----	13	221	227	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.042	0.073	0.116	----	
Iron	7439-89-6	0.05	mg/L	----	0.44	0.68	1.23	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.2	0.9	0.6	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	13.0	9.41	6.58	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	<0.01	0.02	<0.01	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.18	1.81	<0.01	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 4A
Client sampling date / time				24-May-2018 13:25	24-May-2018 13:30	24-May-2018 11:55	24-May-2018 12:10	24-May-2018 11:15	
Compound	CAS Number	LOR	Unit	EW1802121-001	EW1802121-002	EW1802121-003	EW1802121-004	EW1802121-005	
				Result	Result	Result	Result	Result	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.18	1.83	<0.01	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	5.89	262	329	----	
Total Cations	----	0.01	meq/L	----	5.65	----	----	----	
Total Cations	----	0.01	meq/L	----	----	248	329	----	
Ionic Balance	----	0.01	%	----	2.09	----	----	----	
Ionic Balance	----	0.01	%	----	----	2.83	0.09	----	
EN67 PK: Field Tests									
Field Observations	----	0.01	--	Insufficient Volume	----	----	----	DRY	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	----	6	54	32	----	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	----	6	55	34	----	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	----	1.09	1.70	0.90	----	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	11.9	17.3	9.4	----	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	<0.05	----	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	1.50	0.42	0.55	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				24-May-2018 11:20	24-May-2018 11:35	24-May-2018 12:40	24-May-2018 12:50	24-May-2018 13:05	
Compound	CAS Number	LOR	Unit	EW1802121-006	EW1802121-007	EW1802121-008	EW1802121-009	EW1802121-010	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	6.9	6.9	7.2	7.1	7.2	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	19000	43800	1790	1760	35800	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	13.3	33.6	1.0	1.0	25.9	
EA116: Temperature									
Temperature	----	0.1	°C	17.9	17.5	19.4	19.8	19.0	
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	796	483	741	772	467	
Total Alkalinity as CaCO3	----	1	mg/L	796	483	741	772	467	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	753	2240	49	49	1790	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	5860	12900	154	113	10700	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	424	407	128	128	367	
Magnesium	7439-95-4	1	mg/L	399	988	42	43	775	
Sodium	7440-23-5	1	mg/L	2870	8250	108	95	6020	
Potassium	7440-09-7	1	mg/L	152	303	40	44	215	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.140	0.172	0.036	0.102	0.063	
Iron	7439-89-6	0.05	mg/L	2.23	1.36	0.21	0.20	18.4	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.4	0.9	0.7	0.5	0.5	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	28.7	0.82	31.4	36.7	45.2	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.05	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	1.57	0.02	<0.01	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				24-May-2018 11:20	24-May-2018 11:35	24-May-2018 12:40	24-May-2018 12:50	24-May-2018 13:05	
Compound	CAS Number	LOR	Unit	EW1802121-006	EW1802121-007	EW1802121-008	EW1802121-009	EW1802121-010	
				Result	Result	Result	Result	Result	
EPK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	1.62	0.02	<0.01	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	197	420	20.2	19.6	348	
Total Cations	----	0.01	meq/L	----	----	17.8	17.7	----	
Total Cations	----	0.01	meq/L	183	468	----	----	349	
Ionic Balance	----	0.01	%	----	----	6.20	5.03	----	
Ionic Balance	----	0.01	%	3.73	5.41	----	----	0.14	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	40	19	31	38	13	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	41	16	33	38	13	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	1.61	1.82	3.13	0.93	1.29	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	16.7	17.6	33.4	10.0	13.7	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	1.02	0.98	1.14	1.16	1.34	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10B	MD 10A
Client sampling date / time				24-May-2018 10:25	24-May-2018 10:45	24-May-2018 10:55	24-May-2018 10:20	24-May-2018 10:10	
Compound	CAS Number	LOR	Unit	EW1802121-011	EW1802121-012	EW1802121-013	EW1802121-014	EW1802121-015	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	6.4	7.0	7.0	7.0	7.1	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	10500	3250	5770	51800	1930	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	7.0	2.1	3.6	39.3	1.1	
EA116: Temperature									
Temperature	----	0.1	°C	17.8	18.7	18.5	18.8	20.7	
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	388	1200	1220	716	333	
Total Alkalinity as CaCO3	----	1	mg/L	388	1200	1220	716	333	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	357	<5	<1	<10	2800	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	3250	438	1110	187	14700	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	89	146	137	80	1660	
Magnesium	7439-95-4	1	mg/L	219	69	81	33	1430	
Sodium	7440-23-5	1	mg/L	1580	266	622	104	7860	
Potassium	7440-09-7	1	mg/L	77	96	130	70	178	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.023	0.201	0.147	0.278	0.472	
Iron	7439-89-6	0.05	mg/L	0.08	3.59	5.48	0.51	<0.10	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.1	0.6	0.5	0.9	0.4	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	7.33	68.5	120	71.0	0.05	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	0.06	0.03	<0.01	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.28	<0.01	<0.01	0.32	0.32	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10B	MD 10A
Client sampling date / time				24-May-2018 10:25	24-May-2018 10:45	24-May-2018 10:55	24-May-2018 10:20	24-May-2018 10:10	
Compound	CAS Number	LOR	Unit	EW1802121-011	EW1802121-012	EW1802121-013	EW1802121-014	EW1802121-015	
				Result	Result	Result	Result	Result	
EPK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.34	<0.01	<0.01	0.32	0.32	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	107	36.3	55.7	19.6	480	
Total Cations	----	0.01	meq/L	----	31.5	52.5	18.1	----	
Total Cations	----	0.01	meq/L	93.2	----	----	----	547	
Ionic Balance	----	0.01	%	----	7.20	2.98	3.98	----	
Ionic Balance	----	0.01	%	6.85	----	----	----	6.56	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	101	75	88	58	46	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	107	76	86	57	60	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	1.00	1.51	0.88	8.38	0.77	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	10.3	15.9	9.3	88.3	8.5	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	0.51	0.67	0.71	1.34	0.62	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Client sampling date / time				24-May-2018 09:05	24-May-2018 09:40	24-May-2018 08:25	24-May-2018 08:10	24-May-2018 12:20	
Compound	CAS Number	LOR	Unit	EW1802121-016	EW1802121-017	EW1802121-018	EW1802121-019	EW1802121-020	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.4	7.3	7.4	----	6.9	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	41600	43100	52800	----	45300	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	35.0	35.7	46.1	----	35.0	
EA116: Temperature									
Temperature	----	0.1	°C	13.6	14.4	13.4	----	17.4	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	160	179	152	----	686	
Total Alkalinity as CaCO3	----	1	mg/L	160	179	152	----	686	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1670	2220	2670	----	2320	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	10000	14600	14900	----	13300	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	----	446	
Magnesium	7439-95-4	1	mg/L	----	----	----	----	1030	
Sodium	7440-23-5	1	mg/L	----	----	----	----	8320	
Potassium	7440-09-7	1	mg/L	----	----	----	----	319	
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	341	359	424	----	----	
Magnesium	7439-95-4	1	mg/L	984	989	1210	----	----	
Sodium	7440-23-5	1	mg/L	8250	8370	10300	----	----	
Potassium	7440-09-7	1	mg/L	292	306	378	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	0.148	
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	1.50	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.049	0.043	0.020	----	----	
Iron	7439-89-6	0.05	mg/L	0.20	<0.10	<0.10	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK	MD 2C
Client sampling date / time				24-May-2018 09:05	24-May-2018 09:40	24-May-2018 08:25	24-May-2018 08:10	24-May-2018 12:20	
Compound	CAS Number	LOR	Unit	EW1802121-016	EW1802121-017	EW1802121-018	EW1802121-019	EW1802121-020	
				Result	Result	Result	Result	Result	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	1.0	1.1	1.2	----	0.7	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.16	0.35	0.20	----	1.20	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	<0.01	----	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.01	0.03	0.02	----	<0.01	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.05	0.02	----	<0.01	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	----	----	----	437	
Total Cations	----	0.01	meq/L	----	----	----	----	477	
Ionic Balance	----	0.01	%	----	----	----	----	4.36	
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L	6	7	4	<1	34	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L	6	7	4	----	34	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L	7.17	5.85	6.93	----	0.90	
Dissolved Oxygen - % Saturation	----	0.1	% saturation	68.0	56.7	65.4	----	9.2	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	<0.05	----	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m	----	----	----	----	0.66	



CHAIN OF CUSTODY

ALS Laboratory: please tick →

□ Sydney 277 Yorkbank Rd, Smithfield NSW 2116
Ph: 02 9374 6595 E: samples@als.com.au
□ Newcastle 5 Roseglen Rd, Warbrook NSW 2304
Ph: 02 4958 3433 E: samples@als.com.au

□ Brisbane 32 Stuart St, Stafford QLD 4053
Ph: 07 3243 7222 E: samples@als.com.au
□ Townsville 14-15 Denham Ct, Bahle QLD 4818
Ph: 07 4736 0500 E: samples@als.com.au

□ Melbourne 2-4 Westall Rd, Springvale VIC 3171
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□ Adelaide 2-1 Barina Rd, Poracola SA 5095
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□ Perth 10 Ford Way, Malaga WA 6090
Ph: 08 9209 7686 E: samples@als.com.au
□ Launceston 27 Wallington St, Launceston TAS 7250
Ph: 03 6331 2158 E: samples@als.com.au

FOR LABORATORY USE ONLY (Circle)

Consent: Seal intact? Yes No N/A
Freezer / Fridge / Ice packs present upon receipt? Yes No N/A
Random Sample Temperature on Receipt
Other comment:

CLIENT: Kama Municipal Council

OFFICE: PO Box 75 Kama NSW 2533

PROJECT: Mimmamura 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 (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

RELINQUISHED BY: *Paul Czulkowski*
DATE/TIME: *24/5/18*

RECEIVED BY: *Paul Czulkowski*
DATE/TIME: *24/5/18*

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

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>Water 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 <i>(refer to codes below)</i>	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn,	(Total) Fe, Mn, Mg, Ca, Na, K	
12	MD 9B	<i>24/5/18 10:45</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
13	MD 9C	<i>10:55</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
14	MD 10A	<i>10:20</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10B	<i>10:10</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
16	Rocklow Down	<i>9:05</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
17	Rocklow Middle	<i>9:40</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Up	<i>8:25</i>	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
19	Blank	<i>8:10</i>	W	VS, N	2	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
TOTAL												

Water Containers 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 Vial HQ Preserved; VB = VOA Vial Sodium Bisulfate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Air-tight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulfuric
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 : **EW1803367**
Client : **KIAMA COUNCIL**
Contact : **MR PAUL CZULOWSKI**
Address : **11 MANNING STREET**
KIAMA NSW, AUSTRALIA 2533

Telephone : **+61 02 4232 0444**
Project : **Minnamurra Landfill**
Order number : **87896**
C-O-C number : **----**
Sampler : **Robert DaLio**
Site : **MINNAMURRA LANDFILL**
Quote number : **WO/026/15 - Minnamurra Landfill**
No. of samples received : **20**
No. of samples analysed : **20**

Page : 1 of 10
Laboratory : Environmental Division NSW South Coast
Contact : Glenn Davies
Address : 1/19 Ralph Black Dr, North Wollongong 2500
4/13 Geary Pl, North Nowra 2541
Australia NSW Australia
Telephone : 02 42253125
Date Samples Received : 23-Aug-2018 16:30
Date Analysis Commenced : 23-Aug-2018
Issue Date : 31-Aug-2018 08:56



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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Robert DaLio	Sampler	Laboratory - Wollongong, NSW



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
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: Some samples were diluted and rerun due to matrix interference and LOR's have been raised accordingly. (High Total Dissolved Solids)
- EP002 : It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Client sampling date / time				23-Aug-2018 14:00	23-Aug-2018 14:05	23-Aug-2018 12:35	23-Aug-2018 12:50	23-Aug-2018 13:00	
Compound	CAS Number	LOR	Unit	EW1803367-001	EW1803367-002	EW1803367-003	EW1803367-004	EW1803367-005	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	7.7	7.4	6.9	7.0	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	585	19900	32300	45200	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	0.3	14.2	24.0	34.5	
EA116: Temperature									
Temperature	----	0.1	°C	----	22.7	17.1	17.5	17.9	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	205	828	665	566	
Total Alkalinity as CaCO3	----	1	mg/L	----	205	828	665	566	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	16	844	1530	2260	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	44	6390	10000	15300	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	39	253	403	428	
Magnesium	7439-95-4	1	mg/L	----	6	460	719	964	
Sodium	7440-23-5	1	mg/L	----	37	3520	5840	7730	
Potassium	7440-09-7	1	mg/L	----	13	188	229	292	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.048	0.060	0.108	0.143	
Iron	7439-89-6	0.05	mg/L	----	0.57	0.39	1.12	1.48	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.2	1.0	0.8	0.8	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	15.5	12.1	6.57	0.90	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	<0.01	0.03	<0.01	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.04	4.37	0.10	<0.01	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Client sampling date / time					23-Aug-2018 14:00	23-Aug-2018 14:05	23-Aug-2018 12:35	23-Aug-2018 12:50	23-Aug-2018 13:00
Compound	CAS Number	LOR	Unit		EW1803367-001	EW1803367-002	EW1803367-003	EW1803367-004	EW1803367-005
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		----	0.04	4.40	0.10	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	5.67	214	327	490
Total Cations	----	0.01	meq/L		----	5.49	----	----	----
Total Cations	----	0.01	meq/L		----	----	208	339	444
Ionic Balance	----	0.01	%		----	1.66	----	----	----
Ionic Balance	----	0.01	%		----	----	1.41	1.79	4.88
EN67 PK: Field Tests									
Field Observations	----	0.01	--		DRY	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		----	6	49	31	22
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		----	6	44	31	20
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L		----	1.05	1.68	1.13	0.92
Dissolved Oxygen - % Saturation	----	0.1	% saturation		----	11.6	16.6	11.7	9.6
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		----	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m		----	1.60	0.54	0.72	0.76



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Client sampling date / time				23-Aug-2018 12:00	23-Aug-2018 12:05	23-Aug-2018 12:15	23-Aug-2018 13:20	23-Aug-2018 13:35	
Compound	CAS Number	LOR	Unit	EW1803367-006	EW1803367-007	EW1803367-008	EW1803367-009	EW1803367-010	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	----	6.9	7.0	7.6	7.2	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	18300	44600	2250	1610	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	----	12.7	34.3	1.3	0.9	
EA116: Temperature									
Temperature	----	0.1	°C	----	18.0	17.5	18.7	19.0	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	769	441	574	608	
Total Alkalinity as CaCO3	----	1	mg/L	----	769	441	574	608	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	770	2180	65	40	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	----	5950	14700	327	105	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	370	406	128	110	
Magnesium	7439-95-4	1	mg/L	----	373	970	58	40	
Sodium	7440-23-5	1	mg/L	----	2880	7970	210	80	
Potassium	7440-09-7	1	mg/L	----	147	291	44	44	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.108	0.180	0.032	0.092	
Iron	7439-89-6	0.05	mg/L	----	1.64	1.41	0.12	0.17	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.6	1.1	0.8	0.5	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	26.4	0.68	18.7	39.2	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	----	<0.01	<0.01	0.10	<0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.11	<0.01	8.75	0.02	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Client sampling date / time					23-Aug-2018 12:00	23-Aug-2018 12:05	23-Aug-2018 12:15	23-Aug-2018 13:20	23-Aug-2018 13:35
Compound	CAS Number	LOR	Unit		EW1803367-006	EW1803367-007	EW1803367-008	EW1803367-009	EW1803367-010
					Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		----	0.11	<0.01	8.85	0.02
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	199	469	22.0	15.9
Total Cations	----	0.01	meq/L		----	178	454	21.4	13.4
Ionic Balance	----	0.01	%		----	5.58	1.59	1.44	8.72
EN67 PK: Field Tests									
Field Observations	----	0.01	--		DRY	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		----	38	16	27	27
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		----	39	15	27	26
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L		----	0.76	0.95	1.96	0.79
Dissolved Oxygen - % Saturation	----	0.1	% saturation		----	8.0	9.5	20.7	8.4
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		----	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m		----	1.16	1.15	1.27	1.25



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Client sampling date / time				23-Aug-2018 13:45	23-Aug-2018 11:20	23-Aug-2018 11:35	23-Aug-2018 11:45	23-Aug-2018 10:50	
Compound	CAS Number	LOR	Unit	EW1803367-011	EW1803367-012	EW1803367-013	EW1803367-014	EW1803367-015	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.3	7.2	7.1	7.1	6.4	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	35700	14400	3400	6730	44900	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	25.6	10.5	2.1	4.3	36.8	
EA116: Temperature									
Temperature	----	0.1	°C	19.3	15.1	17.8	18.5	15.0	
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	393	296	1070	980	240	
Total Alkalinity as CaCO3	----	1	mg/L	393	296	1070	980	240	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1740	467	<1	95	2600	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	11000	4720	434	1330	14200	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	375	117	126	172	1360	
Magnesium	7439-95-4	1	mg/L	787	297	63	109	1110	
Sodium	7440-23-5	1	mg/L	6510	2420	288	740	6700	
Potassium	7440-09-7	1	mg/L	225	106	112	143	154	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.061	0.035	0.172	0.168	0.768	
Iron	7439-89-6	0.05	mg/L	17.3	0.06	2.45	5.50	<0.10	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.6	<0.1	0.7	0.6	0.4	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	44.3	9.56	106	134	0.45	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.31	<0.01	<0.01	0.27	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.01	0.06	<0.01	0.58	0.88	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Client sampling date / time					23-Aug-2018 13:45	23-Aug-2018 11:20	23-Aug-2018 11:35	23-Aug-2018 11:45	23-Aug-2018 10:50
Compound	CAS Number	LOR	Unit		EW1803367-011	EW1803367-012	EW1803367-013	EW1803367-014	EW1803367-015
					Result	Result	Result	Result	Result
EPK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.01	0.37	<0.01	0.58	1.15
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		354	149	33.6	59.1	459
Total Cations	----	0.01	meq/L		----	----	34.4	----	----
Total Cations	----	0.01	meq/L		372	138	----	53.4	454
Ionic Balance	----	0.01	%		----	----	1.16	----	----
Ionic Balance	----	0.01	%		2.48	3.67	----	5.05	0.54
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		12	53	72	62	30
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		12	60	73	64	31
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L		0.85	2.68	0.81	1.04	1.87
Dissolved Oxygen - % Saturation	----	0.1	% saturation		9.1	26.4	8.3	10.9	18.3
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m		1.51	0.53	0.78	0.83	0.63



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 10B	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK
Client sampling date / time				23-Aug-2018 11:05	23-Aug-2018 09:35	23-Aug-2018 10:30	23-Aug-2018 10:15	23-Aug-2018 09:30	
Compound	CAS Number	LOR	Unit	EW1803367-016	EW1803367-017	EW1803367-018	EW1803367-019	EW1803367-020	
				Result	Result	Result	Result	Result	
EA005FD: Field pH									
pH	----	0.1	pH Unit	7.1	7.2	7.0	7.6	----	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	----	1	µS/cm	1850	37200	38700	34400	----	
EA020FD: Field Salinity									
Salinity	----	0.2	g/L	1.4	33.3	33.3	39.4	----	
EA116: Temperature									
Temperature	----	0.1	°C	18.6	10.9	12.5	12.2	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	619	212	222	168	----	
Total Alkalinity as CaCO3	----	1	mg/L	619	212	222	168	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<10	1920	1770	1620	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	180	11700	12100	10800	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	80	----	----	----	----	
Magnesium	7439-95-4	1	mg/L	35	----	----	----	----	
Sodium	7440-23-5	1	mg/L	110	----	----	----	----	
Potassium	7440-09-7	1	mg/L	65	----	----	----	----	
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	----	313	325	287	----	
Magnesium	7439-95-4	1	mg/L	----	825	851	757	----	
Sodium	7440-23-5	1	mg/L	----	6800	7110	6310	----	
Potassium	7440-09-7	1	mg/L	----	244	254	228	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.281	----	----	----	<0.001	
Iron	7439-89-6	0.05	mg/L	0.55	----	----	----	<0.05	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.071	0.094	0.077	----	
Iron	7439-89-6	0.05	mg/L	----	0.25	0.22	0.28	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 10B	ROCKLOW DOWN	ROCKLOW MIDDLE	ROCKLOW UP	BLANK
Client sampling date / time					23-Aug-2018 11:05	23-Aug-2018 09:35	23-Aug-2018 10:30	23-Aug-2018 10:15	23-Aug-2018 09:30
Compound	CAS Number	LOR	Unit		EW1803367-016	EW1803367-017	EW1803367-018	EW1803367-019	EW1803367-020
					Result	Result	Result	Result	Result
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		1.0	1.1	1.0	1.0	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		72.0	0.56	1.09	0.08	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	0.01	0.02	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		0.06	0.10	0.08	0.04	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		0.06	0.11	0.10	0.04	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		17.4	----	----	----	----
Total Cations	----	0.01	meq/L		18.5	----	----	----	----
Ionic Balance	----	0.01	%		2.80	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		43	7	7	6	<1
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		40	7	7	6	----
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	----	0.01	mg/L		0.97	5.05	4.37	7.80	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation		10.1	45.4	40.8	72.4	----
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	----	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	----
FWI-EN/001: Groundwater Sampling - Depth									
Depth	----	0.01	m		0.70	----	----	----	----



CHAIN OF CUSTODY

ALS Laboratory: Please Tick →

Sydney 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 9764 8656 E: samples.sydney@alsenviro.com
Newcastle 5 Rosegum Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsenviro.com

Brisbane 32 Strand St, Sturford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com
Townsville 1415 Dorrain Ct, Bohle QLD 4818
Ph: 07 4780 0600 E: samples.townsville@alsenviro.com

Melbourne 24 Westall Rd, Springvale VIC 3171
Ph: 03 8849 9600 E: samples.melbourne@alsenviro.com
Adelaide 2-11 Burnaj Rd, Pennington SA 5095
Ph: 08 8399 0590 E: samples.adelaide@alsenviro.com

Perth 10 Havel Way, Malaga WA 6030
Ph: 08 9206 7895 E: samples.perth@alsenviro.com
Launceston 27 Wallington St, Launceston TAS 7250
Ph: 03 6331 2199 E: samples.launceston@alsenviro.com

FOR LABORATORY USE ONLY (Circle)

Quality Seal (used) Yes No

Field use / freezer / on break / in use / in lab Yes No

Random Sample Temperature on Receipt Yes No

Other comment: Yes No

CLIENT: Kiama Municipal Council

OFFICE: PO Box 76 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER: PROJECT MANAGER: Paul Czulowski

SAMPLER: Craig Wilson

COC emailed to ALST (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 (List due date):
 Non Standard or urgent TAT (List due date):
ALS QUOTE NO.: SY-146-10

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 251 560

EED FORMAT (or default):

RELINQUISHED BY: DATE/TIME:

RECEIVED BY: DATE/TIME:

SAMPLE DETAILS

MATRIX: Solid(s) Water(W)

CONTAINER INFORMATION

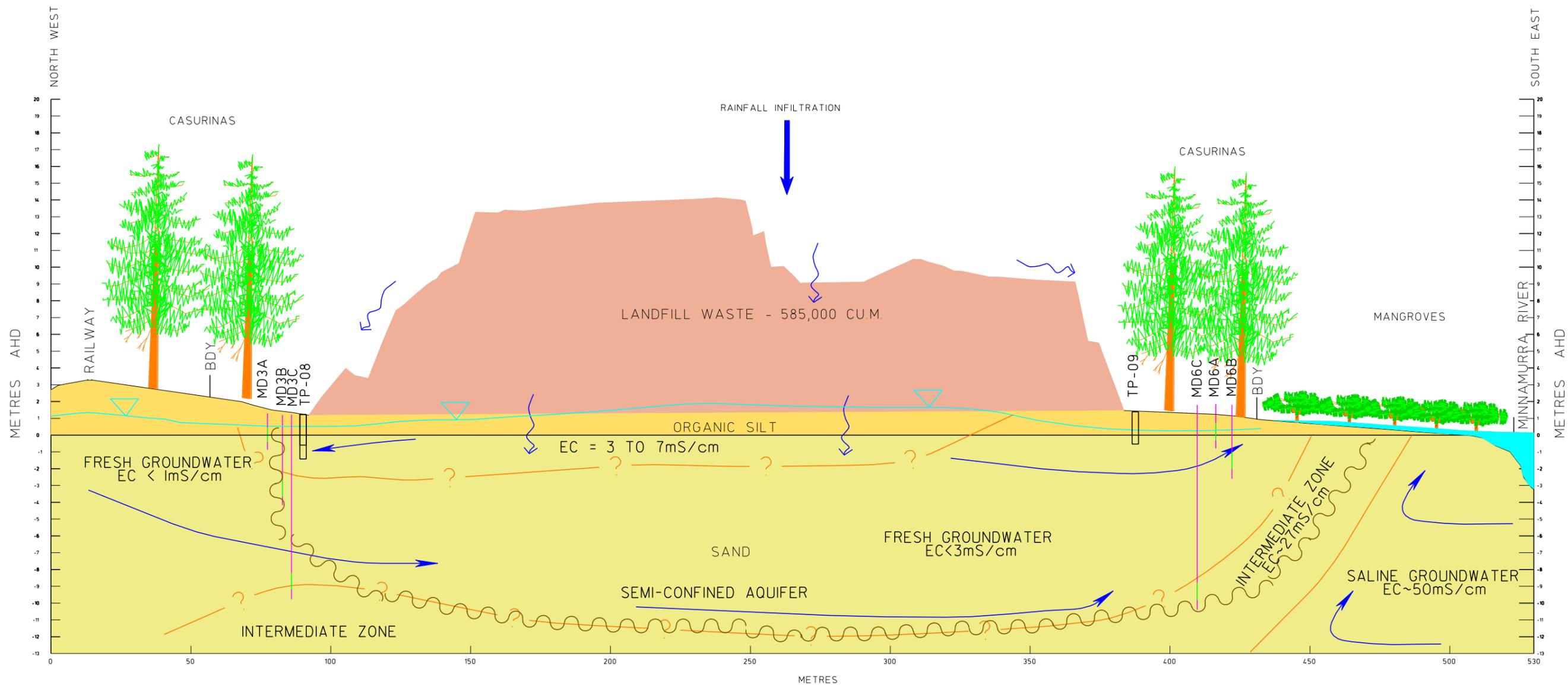
ANALYSIS REQUIRED INCLUDING SUITES (NB: Suite Codes must be listed to attract suite price)
Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (filtered bottle required)

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn,	(Total) Fe, Mn, Mg, Ca, Na, K	Additional Information
13	MD 9B	23/8/18 11:35	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
14	MD 9C	11:45	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10A	10:50	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
16	MD 10B	11:05	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
17	Rocklow Down	9:35	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Middle	10:30	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
19	Rocklow Up	10:15	W	500mL, 2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
20	Blank	9:30	W	VS, N	2	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
TOTAL												

Kit or Container Codes: P = Unpreserved Plastic, N = Nitric Preserved Plastic, ORC = Nitric Preserved Plastic, SH = Sodium Hydroxide/Cl Preserved, S = Sodium Hydroxide Preserved Plastic, AG = Amber Glass Unpreserved, AP = Airtight Unpreserved Plastic
 V = VOA Via HCl Preserved, VB = VOA Via Sodium Bisulfate Preserved, VS = VOA Via Sulfuric Preserved, AV = Airtight Unpreserved Vial, SV = Sulfuric Preserved Vial, SG = Sulfuric Preserved Amber Glass, H = HCl Preserved Plastic, HS = HCl Preserved Specimen on bottle, SP = Sulfuric
 Z = Zinc Acetate Preserved Bottle, E = EDTA Preserved Bottle, ST = Sterile Bottle, ASS = Plastic Bag for Acid Soluble Solids, B = Unpreserved Bag

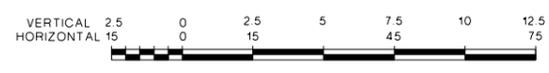
Appendix A

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



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COUNCIL OF THE MUNICIPALITY OF KIAMA

NCPL
 Neil Charles Pty Ltd
 SURVEY AND DESIGN SERVICES
 Ph: 02 4256 5031 email: info@ncpl.com.au
 Mob: 0412 149 691 www.ncpl.com.au

SCALE: H 1:750 AT A1 SIZE
 V 1:125 AT A1 SIZE
 DATE: 6-7-05
 DWN: [blank]
 INC: APPROD

KIAMA MUNICIPAL COUNCIL
MINNAMURRA WASTE DISPOSAL DEPOT
CLOSURE PLAN
NORTH WEST - SOUTH EAST CROSS SECTION

NCPL DRG No. **FIGURE 7**

Appendix C

LANDFILL GAS MONITORING

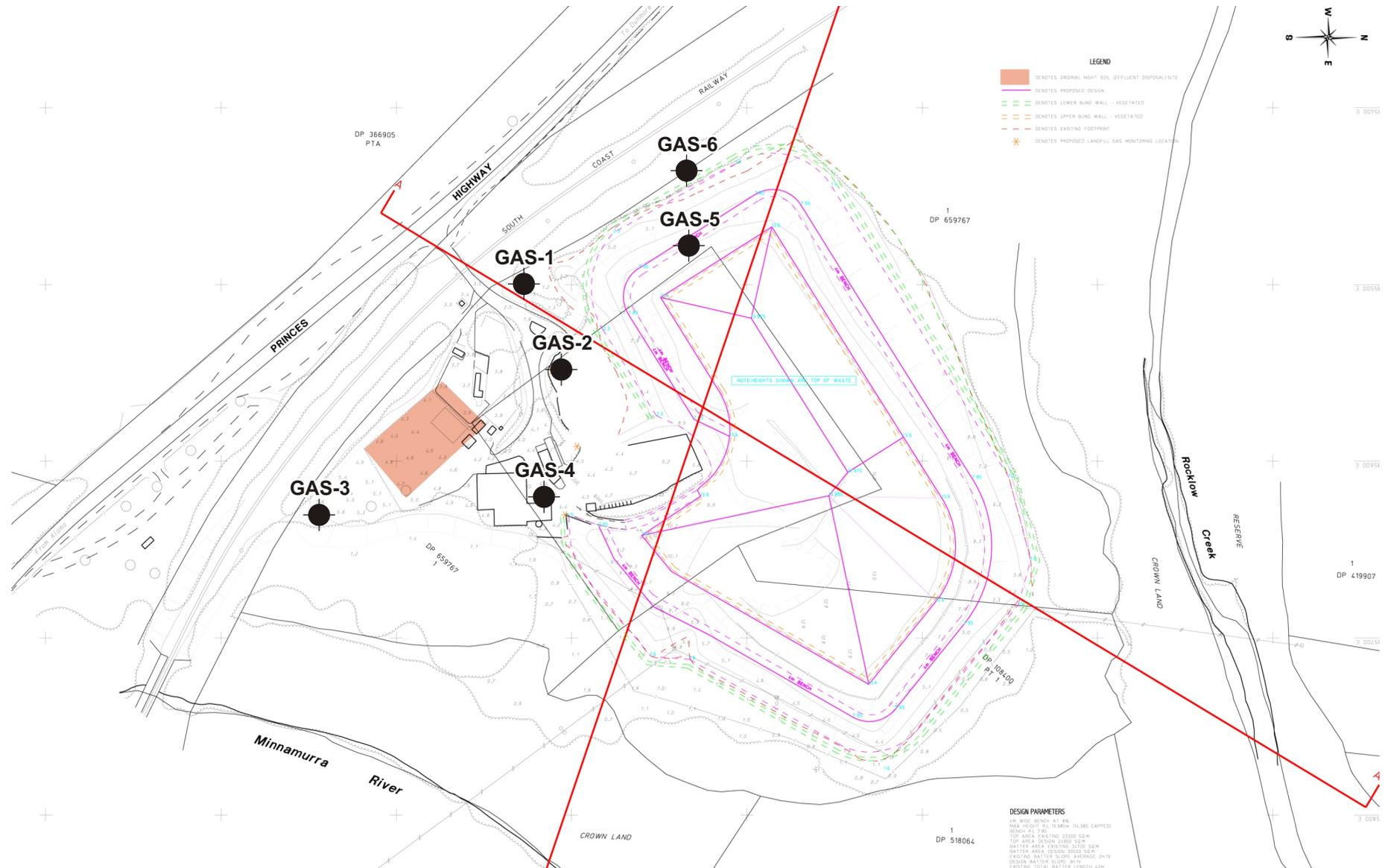
Monitoring By KMC (GHardy)

GAS 1	Site Entrance
GAS 2	40m South of Landfill (Removed)
GAS 3	Carpark South of Landfill
GAS 4	Next to Secondhand Shop
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	7-Feb-18	730		1,150		400	Good Readings
Trench 1	7-Feb-18	735	95	700		220	.....
Trench 2	7-Feb-18	740		500		150	.....
Trench 3	7-Feb-18	750	100	1,050		230	.....
Trench 6	7-Feb-18	755		680		150	.....
Trench 5	7-Feb-18	800	100	900		140	.....
Trench 7	7-Feb-18	805	90	1,100		200	.....
Gas 1	7-Feb-18	810		250		120	
Gas 2							Removed due to new CRC site
Gas 3	7-Feb-18	815		330		120	Good Readings
Gas 4	7-Feb-18	820		360		110	.....
Weighbridge	7-Feb-18	830		0		0	All Building with clear readings
Cleaning Shed	7-Feb-18	835		0		0	.....
MRF	7-Feb-18	840		0		0	.....
Lunchroom	7-Feb-18	845		0		0	.....
Ute Shed	7-Feb-18	850		0		0	.....
Trench 4	12-Jun-18	855		1,000		390	Good Readings Wet Ground
Trench 1	12-Jun-18	900	98	750		200	.....
Trench 2	12-Jun-18	905		450		120	.....
Trench 3	12-Jun-18	910	100	1,050		160	.....
Trench 6	12-Jun-18	915		590		190	.....
Trench 5	12-Jun-18	920	100	650		170	.....
Trench 7	12-Jun-18	925	100	1,200		200	.....
Gas 1	12-Jun-18	930		300		120	.....
Gas 2							Removed due to new CRC site
Gas 3	12-Jun-18	935		310		140	Good Readings Wet Ground
Gas 4	12-Jun-18	940		320		110	.....
Weighbridge	12-Jun-18	945		0		0	All Building with clear readings
Cleaning Shed	12-Jun-18	950		0		0	.....
MRF	12-Jun-18	955		0		0	.....
CRC Lunchroom	12-Jun-18	1000		0		0	.....
Ute Shed	12-Jun-18	1005		0		0	.....
Trench 4	17-Oct-18	710		1,100		420	Good Readings
Trench 1	17-Oct-18	715	90	640		250	.....
Trench 2	17-Oct-18	720		450		100	.....
Trench 3	17-Oct-18	725	95	1,150		120	.....
Trench 6	17-Oct-18	730		780		140	.....
Trench 5	17-Oct-18	735	100	850		150	.....
Trench 7	17-Oct-18	740	80	1,300		280	.....
Gas 1	17-Oct-18	745		200		100	.....
Gas 2				0		0	Removed due to new CRC site
Gas 3	17-Oct-18	750		400		130	Good Readings
Gas 4	17-Oct-18	755		340		110	.....
Weighbridge	17-Oct-18	800		0		0	All Building with clear readings
Cleaning Shed	17-Oct-18	805		0		0	.....
MRF	17-Oct-18	810		0		0	New Luchroom tested
Lunchroom	17-Oct-18	815		0		0	.....
Ute Shed	17-Oct-18	820		0		0	.....

CALIBRATED WITH SPAN GAS:



Source: Neil Charters Pty Ltd

GAS WELL MONITORING LOCATIONS

KIAMA MUNICIPAL COUNCIL - MINNAMURRA LANDFILL

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)

