2015 - 2016 Groundwater and Surface Water Monitoring Report

Camden Gas Project

Prepared for AGL Upstream Investments Pty Ltd | 26 September 2016

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Executive Summary

AGL Upstream Investments Pty Ltd (AGL) owns and operates the Camden Gas Project (CGP) located in the Macarthur region, 65 km southwest of Sydney, NSW. The CGP has been producing natural gas from coal seams for the Sydney region since 2001 and currently consists of 144 gas wells (of which, 92 were operational on 30 June 2016). The target coal seams are the Bulli and Balgownie Coal Seams within the Illawarra Coal Measures at depths of approximately 550 – 700 metres below ground level (mbgl).

The CGP monitoring network comprises three nested groundwater monitoring sites (11 monitoring bores): Denham Court (monitored since 2011), Menangle Park (monitored since June 2013) and Glenlee (monitored since February 2014). The Denham Court site is located 12km from the CGP and acts as a control or background monitoring location. One monitoring bore is installed in the alluvium near the Nepean River, two in the Ashfield Shale and eight monitoring bores at different depths in the Hawkesbury Sandstone. Groundwater levels have been recorded at six-hourly intervals and water quality data has been collected on a quarterly basis since installation, with the exception of one of the Ashfield Shale monitoring bores where there has been insufficient water present to allow for water level and quality data to be collected. Surface water is monitored annually at one monitoring location along the Nepean River next to the Menangle Park site. This report presents an assessment of water level and water quality data from the groundwater monitoring network and from the Nepean River for the period up to 30 June 2016, with an emphasis on data obtained during the past 12 months.

The groundwater level in the Nepean River alluvium is shallow and shows a direct response to rainfall and flood events during the monitoring period. Groundwater levels in the Ashfield Shale are deep (approximately 80 m bgl) and show no apparent response to rainfall over the monitoring period. Groundwater levels appear to follow similar trends in each of the screened Hawkesbury Sandstone water bearing zones (defined as upper, middle and lower). There is no apparent response to individual rainfall events over the monitoring period at the Denham Court and Glenlee sites, while a clear response to rainfall and flood events can be observed at the three uppermost monitoring bores at the Menangle Park site. Groundwater levels during the 2015/16 monitoring year were comparable to groundwater levels as recorded during previous monitoring years.

Groundwater sampled from the alluvium at the Menangle Park site is characterised as fresh to marginally saline. Dissolved metal concentrations were generally low and hydrocarbons (dissolved methane and polycyclic aromatic hydrocarbons) were detected at low levels. Groundwater sampled from the Ashfield Shale at the Denham Court site is slightly saline. Concentrations of dissolved metals, dissolved methane, ethane and propane, and benzene, toluene and xylenes were detected. Groundwater sampled from the Hawkesbury Sandstone is fresh to marginal at the Menangle Park site and slightly saline at the Denham Court and Glenlee sites. Salinity decreases with depth at the Denham Court and Glenlee sites. Dissolved metal concentrations are generally low and minor detections of hydrocarbons were present at the three monitoring sites. Dissolved methane was detected at all Hawkesbury Sandstone bores, although concentrations at the Menangle Park and Glenlee sites were comparable to the control site at Denham Court. Low concentrations of dissolved ethane were detected at the Denham Court and Glenlee sites and low concentrations of propane and butane were detected only at the Glenlee site. Toluene was detected at all lower Hawkesbury Sandstone monitoring bores and xylenes were detected in the Ashfield Shale.

Groundwater quality during the 2015/16 monitoring year was overall comparable to groundwater quality as measured during the previous monitoring years.

The Nepean River water is characterised as fresh, neutral pH and dissolved metal concentrations were comparably lower than occurring in groundwater in the alluvium and underlying Hawkesbury Sandstone. Ammonia concentrations in Nepean River water exceeded the ANZECC (2000) guideline value and minor dissolved methane concentrations and no hydrocarbons were detected. The water quality of the Nepean River was overall comparable to that of the sample collected in September 2014.

Based on assessment of the available data, there are no observable impacts to groundwater levels or quality that could be attributable to the CSG operations. There is also no evidence of connectivity between the shallower monitored zones and the coal seams and this is in agreement with the conceptual model (Parsons Brinckerhoff 2011), that indicates the presence of extensive and thick claystone formations (aquitards and aquicludes) between the Hawkesbury Sandstone and coal seams restricting upward depressurisation and impeding the vertical flow of groundwater.

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1 Introduction

AGL Upstream Investments Pty Ltd (AGL) owns and operates the Camden Gas Project (CGP) located in the Macarthur region, 65 km southwest of Sydney, NSW. The CGP has been producing natural gas from coal seams for the Sydney region since 2001 and currently consists of 144 gas wells (of which, 92 were operational on 30 June 2016) within the Stage 1 and Stage 2 areas (Figure 1.1). A proposal for the expansion of the project into Stage 3 (Northern Expansion) was suspended in 2013 and was officially withdrawn in July 2015. The target coal seams are the Bulli and Balgownie Coal Seams within the Illawarra Coal Measures at depths of approximately 550 – 700 metres below ground level (m bgl).

EMM Consulting Pty Ltd (EMM) was engaged by AGL to compile groundwater and surface water monitoring results collected between the July 2015 and June 2016 (2015/16) monitoring year and to analyse with reference to the CGP activities Installation of a dedicated water monitoring network of 11 monitoring bores occurred between October 2011 and February 2014. The groundwater monitoring network comprises dedicated monitoring bores in the alluvium, the Ashfield Shale, and the Hawkesbury Sandstone. The collection of groundwater level and groundwater quality data commenced in October 2011. Groundwater levels have been recorded at six-hourly intervals and, following one initial sample in November 2011, water quality data was collected on a quarterly basis between May 2013 and April 2015. From April 2015 onwards, water quality data has been collected at six-monthly intervals. In addition, one surface water monitoring location is monitored annually for water quality. This report contains an evaluation of the data obtained during the 2015/16 monitoring year, with comparison to the data obtained during the previous monitoring years (Parsons Brinckerhoff 2012, 2013a, 2014a, 2014b and 2015e).

Monitoring is undertaken at three sites located within the Camden-Campbelltown area, NSW (Figure 1.1). The Denham Court site is located to the north, outside of the CGP area, and can be considered as a control site given the distance from the operating CGP. The Menangle Park and Glenlee sites are located within the existing CGP wellfield (Stage 1 and 2, Figure 1.1).

The objective of the groundwater monitoring program is to provide water levels and water quality attributes for each of the monitored groundwater systems of the region, in areas within and distant from the currently operating CGP.

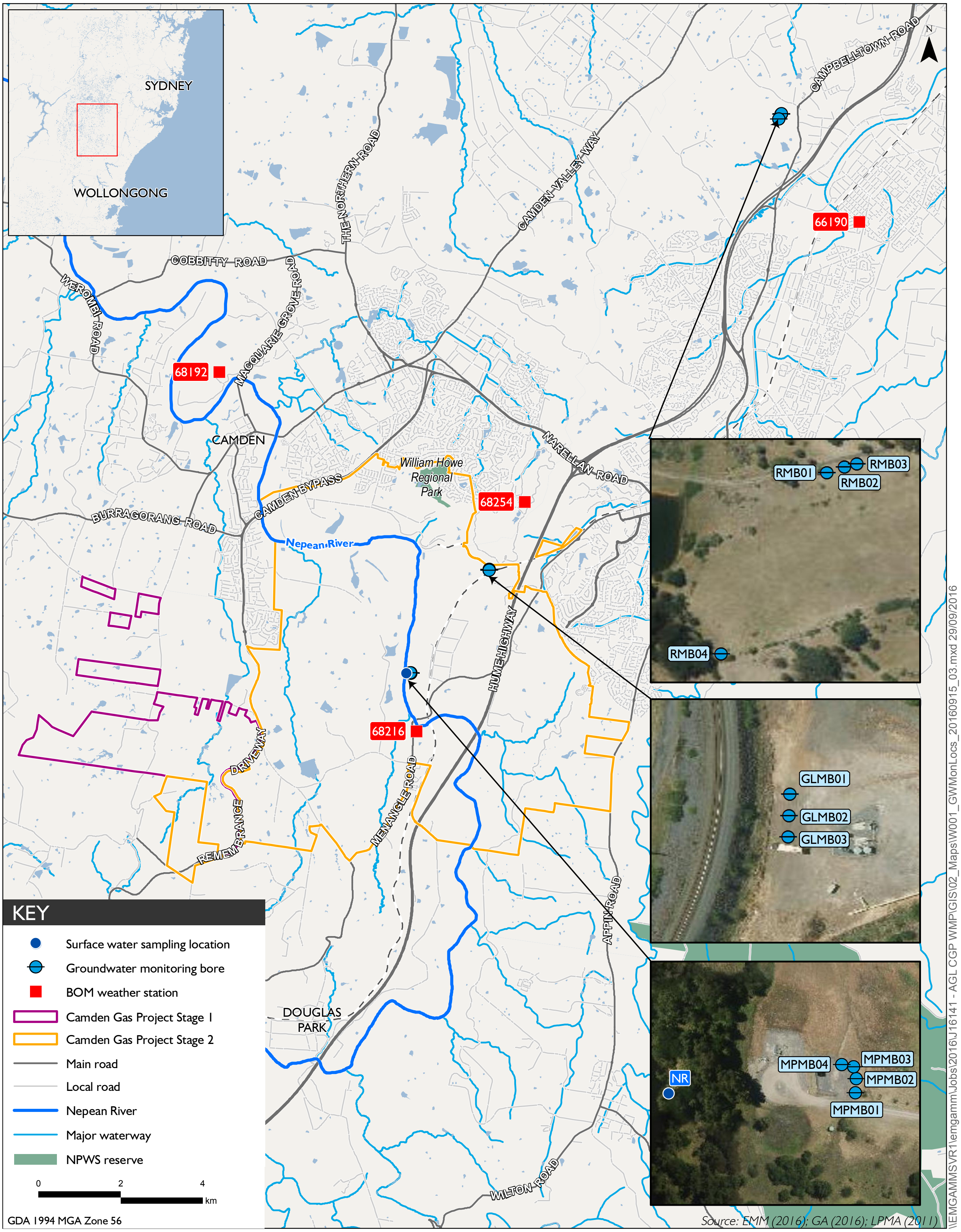
1.1 Scope of works for the 2015/16 monitoring program

This report presents and interprets groundwater level data collected at six-hourly intervals and groundwater quality data collected since monitoring began at each of the established sites up to 7 April 2016, with emphasis on the data obtained during the 2015/16 monitoring year.

The scope of works was to:

- conduct groundwater monitoring, including six-hourly groundwater level measurements and two groundwater quality sampling events testing for field parameters, major cations and anions, dissolved metals, nutrients, dissolved methane and hydrocarbons (undertaken by Parsons Brinckerhoff);
- conduct surface water quality sampling on one occasion (October 2015) at one location (the Nepean River near the Menangle Park site as shown on Figure 1.1) (undertaken by Parsons Brinckerhoff);

- analyse and interpret water level and hydrochemical results with reference to the conceptual model where relevant (EMM this report); and
- establish whether there are any observable impacts from CSG activities within the shallow aquifers (EMM this report).



Groundwater monitoring locations

Camden Gas Project

2015-2016 groundwater and surface water monitoring report

Figure 1.1

2 Site characterisation

2.1 Rainfall

The nearest Bureau of Meteorology (BoM) weather station with consistent historical climate measurements is located at Camden airport (BoM site number 68192), approximately 2.5 km northwest of the Stage 2 area (Figure 1.1). Mean temperatures at Camden airport range from 17.3°C in July to 29.5°C in January (based on records from 1971 to 2016). The average annual rainfall is 788 mm (based on records from 1972 to 2016). On average, July receives the least rain, with a mean rainfall of 37.0 mm, while February receives the most rain, with a mean of 97.0 mm (BoM 2016).

The long-term, annual cumulative deviation from mean (CDFM) rainfall for Camden airport is plotted in Figure 2.1. Annual rainfall data for BoM site number 68216 (located approximately 10 km southeast from the Camden airport 68192 station) is presented from 2009 onwards as rainfall records at Camden airport were incomplete for that period. The long-term CDFM is generated by subtracting the long-term average annual rainfall for the recorded period from the actual annual rainfall and then accumulating these residuals over the assessment period. Periods of below average rainfall are represented as downward trending slopes while periods of above average rainfall are represented as upward trending slopes.

The cumulative deviation plot for Camden airport (Figure 2.1) shows a relatively wet period between 1972 and 1992, followed by a relatively dry period between 1998 and 2007. From 2007 onwards the rainfall has been typically close to the mean rainfall of 776 mm per year.

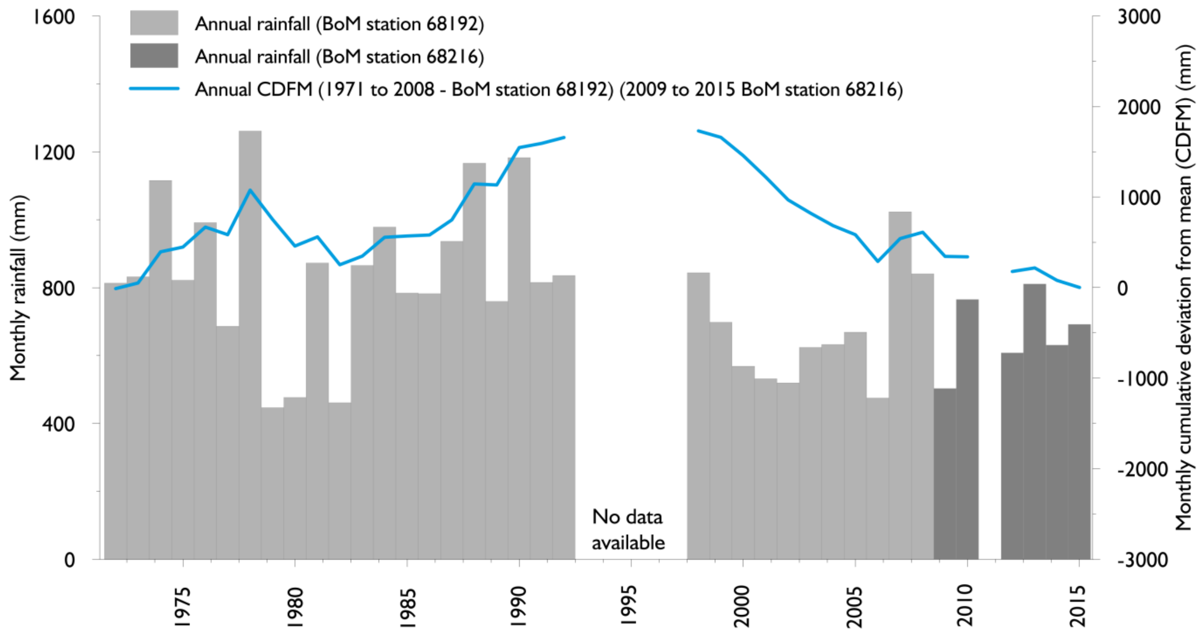


Figure 2.1 Cumulative deviation from annual mean rainfall

The monitoring bore sites are separated by up to a distance of 16 km and therefore groundwater level data for each site have been compared with rainfall data from the closest BoM station (Figure 1.1) as follows:

- Denham Court: 66190 Ingleburn Station;
- Menangle Park: 68216 Menangle Bridge; and
- Glenlee: 68254 Mount Annan Botanic Garden.

The rainfall characteristics are broadly similar between these BoM stations during the monitoring period, as presented in Figure 2.2. Total monthly rainfall for this monitoring period was overall higher than the long-term average.

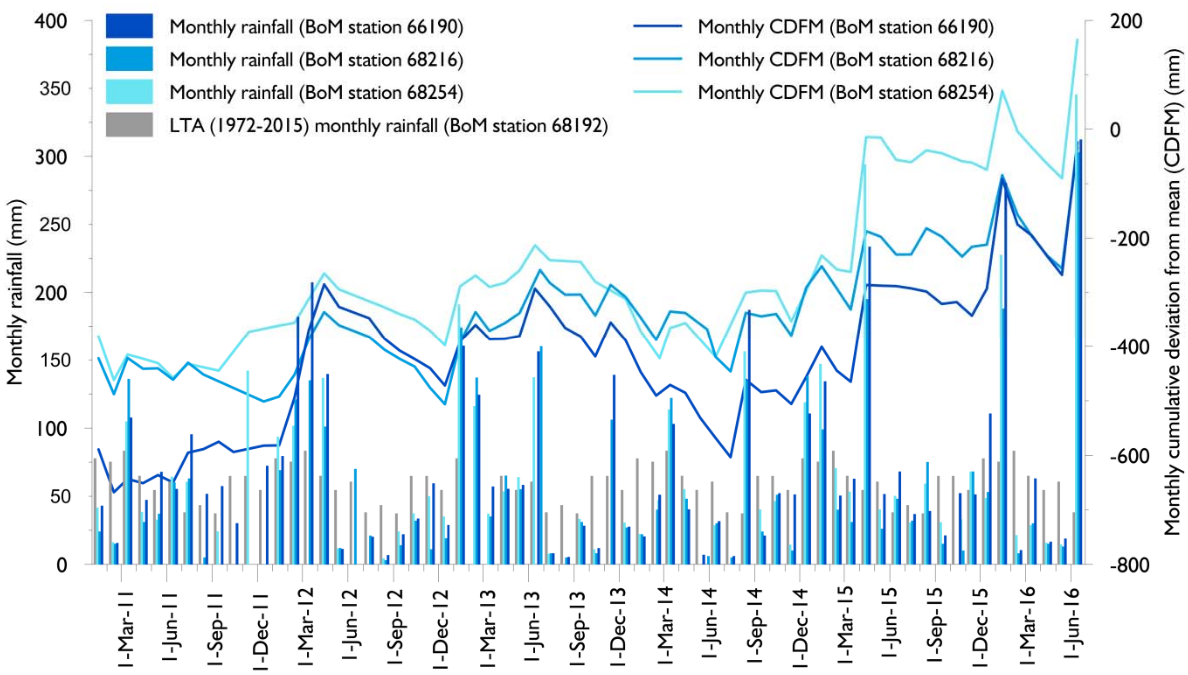


Figure 2.2 Monthly rainfall for the monitoring period (2011 – 2016)

2.2 Surface hydrology

The CGP includes two catchment areas: the Hawkesbury Nepean Catchment and the Sydney Metropolitan Catchment. The major surface hydrology features in the CGP are the Nepean River and its tributaries, which meander in a south to north direction within the project area; and the Georges River, which flows in a northerly direction, in the south-east of the project area.

Small farm dams are common in rural areas and provide water for stock, limited garden and irrigation purposes. Dams are replenished by rainfall and runoff, although some seepage flow through weathered soil profiles occurs after long wet periods. Dams and seepage flows are not related to the regional groundwater systems. There are no known springs in the CGP area.

2.3 Geological setting

The CGP is part of the Southern Coalfield of the Sydney Geological Basin. The Basin is primarily a Permo-Triassic sedimentary rock sequence (Parkin 2002) and is underlain by undifferentiated sediments of Carboniferous and Devonian age. The stratigraphy of the CGP in the Camden-Campbelltown area is summarised in Table 2.1. The geology and structure of the CGP is shown on Figure 2.3.

Table 2.1 Summary of regional Permo-Triassic geological stratigraphy

Period	Group	Sub-group	Formation	Description	Average thickness (m)[1]
Quaternary			Alluvium	Quartz and lithic 'fluvial' sand, silt and clay.	<20
Tertiary			Alluvium	High level alluvium.	
Triassic	Wianamatta Group		Bringelly Shale	Shale, carbonaceous claystone, laminate, lithic sandstone, rare coal.	80 (top eroded)
Triassic	Wianamatta Group		Minchinbury Shale	Fine to medium-grained lithic sandstone.	-
Triassic	Wianamatta Group		Ashfield Shale[2]	Black to light grey shale and laminate (Bembrick *et al*. 1987).	-
Triassic			Mittagong Formation	Dark grey to grey alternating beds of shale laminate, siltstone and quartzose sandstone (Alder *et al.* 1991).	11
Triassic			Hawkesbury Sandstone	Massive or thickly bedded quartzose sandstone with siltstone, claystone and grey shale lenses up to several metres thick (Bowman 1974; Moffitt 2000).	173
Triassic	Narrabeen Sub-group	Gosford Sub-group	Newport Formation	Fine-grained sandstone (less than 3 m thick) interbedded with light to dark grey, fine-grained sandstones, siltstones and minor claystones (Bowman 1974).	35
Triassic	Narrabeen Sub-group	Gosford Sub-group	Garie Formation	Cream, massive, kaolinite-rich pelletal claystone, which grades upwards to grey, slightly carbonaceous claystone containing plant fossils at the base of the Newport Formation (Moffitt 2000).	8
Triassic	Narrabeen Sub-group	Clifton Sub-group	Bald Hill Claystone[2]	Massive chocolate coloured and cream pelletal claystones and mudstones, and occasional fine-grained channel sand units (Moffitt 2000).	34
Triassic	Narrabeen Sub-group	Clifton Sub-group	Bulgo Sandstone	Thickly bedded sandstone with intercalated siltstone and claystone bands up to 3 m thick (Moffitt 2000).	251
Triassic	Narrabeen Sub-group	Clifton Sub-group	Stanwell Park Claystone[2]	Red-green-grey shale and quartz sandstone (Moffitt 1999).	36
Triassic	Narrabeen Sub-group	Clifton Sub-group	Scarborough Sandstone	Quartz-lithic sandstone, pebbly in part (Moffitt 1999).	20
Triassic	Narrabeen Sub-group	Clifton Sub-group	Wombarra Claystone[2]	Grey shale and minor quartz-lithic sandstone (Moffitt 1999).	32

Table 2.1 Summary of regional Permo-Triassic geological stratigraphy

Period	Group	Sub-group	Formation	Description	Average thickness (m)[1]
Permian		Sydney sub-group	Bulli Coal Seam	Coal interbedded with shale, quartz-lithic sandstone, conglomerate, chert, torbanite seams and occasionally carbonaceous mudstone (Moffitt 2000).	4
			Loddon Sandstone		12
			Balmain Coal Member		24
			Balgownie Coal Seam		2
			(Remaining Sydney Subgroup)		
		Cumberland Subgroup			
	Shoalhaven Group			Sandstone, siltstone, shale, polymictic conglomerate, claystone; rare tuff, carbonate, evaporate.	
Palaeozoic	Lachlan Fold Belt			Intensely folded and faulted slates, phyllites, quartzite sandstones and minor limestones of Ordovician to Silurian age (Moffitt 2000).	

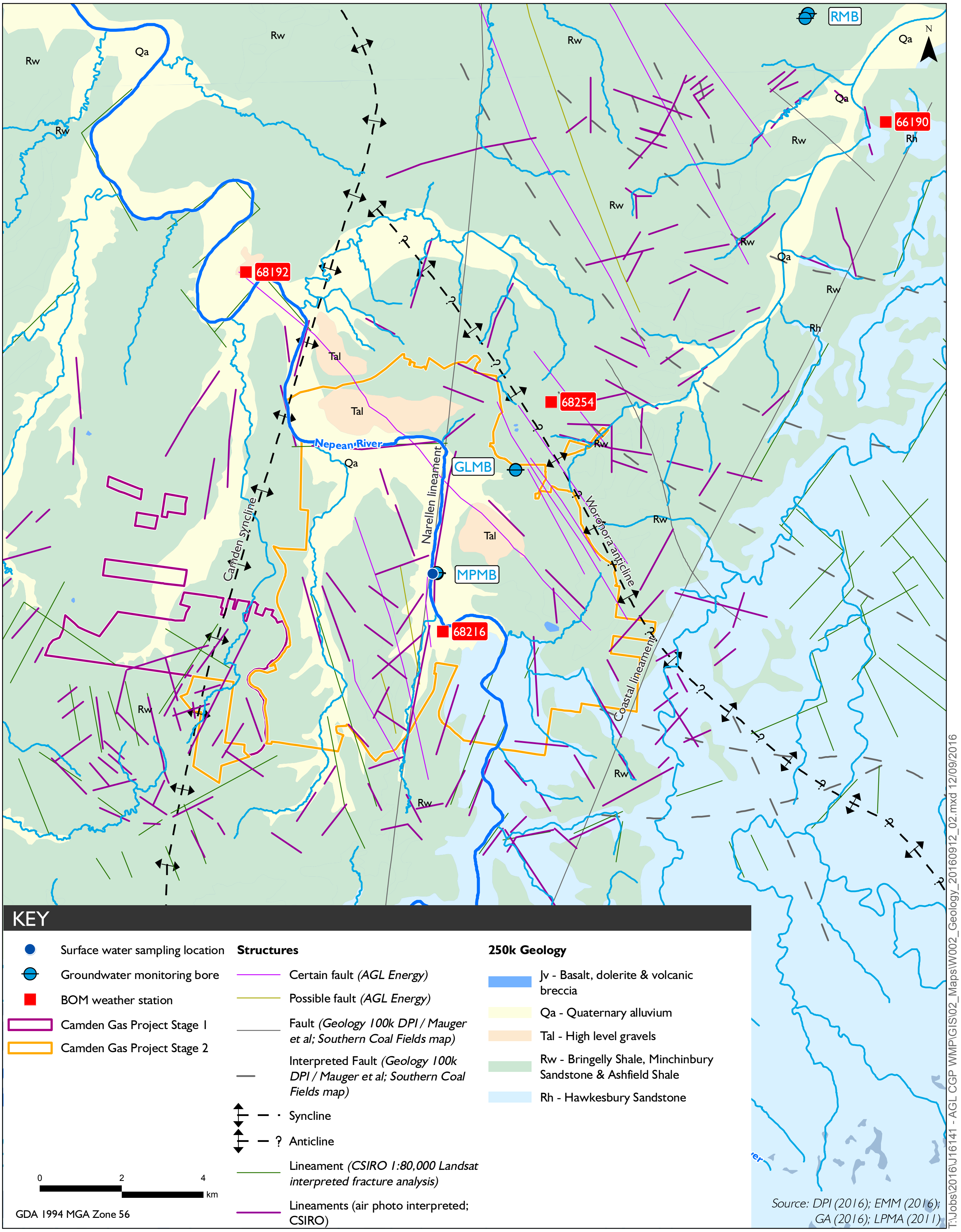
Notes: 1. Average thickness from available well data within CGP (AGL 2013).
2. Aquitard or aquiclude.

The Illawarra Coal Measures is the economic sequence of interest for CSG development in the area, and consists of interbedded sandstone, shale and coal seams, with a thickness of approximately 300 m. The upper sections of the Permian Illawarra Coal Measures (Sydney Subgroup) contain the major coal seams: Bulli Coal Seam, Balgownie Coal Seam, Wongawilli Coal Seam, and Tongarra Coal Seam. The seams targeted for CSG production within the CGP are the Bulli and Balgownie coal seams, both of which are 2 m to 5 m thick within the CGP.

The Illawarra Coal Measures is overlain by Triassic sandstones, siltstones and claystones of the Narrabeen Group and the Hawkesbury Sandstone. Overlying the Hawkesbury Sandstone is the Triassic Wianamatta Group shales which comprises the majority of the surficial geology (where thin alluvial deposits are not present).

Structurally, the CGP area and surrounds are dominated by the north-northeast plunging Camden Syncline, which is a broad and gentle warp structure (Alder et al 1991 and Bray et al 2010). The Camden Syncline is bounded in the west and truncated in the southwest by the north-south trending Nepean Structural Zone, part of the Lapstone Structural Complex.

The CGP is relatively unaffected by major faulting apart from a set of NW-NNW trending faults associated with the Lapstone Monocline Structure (Alder et al 1991 and Blevin et al 2007). These faults have been identified from exploration and 2D seismic studies and they have been identified as high-angle, low to moderate displacement normal faults (Blevin et al 2007). Many of these features intersect coal seams however very few, if any, affect the entire stratigraphic sequence and display no expression at surface.



Surface geology

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Figure 2.3

2.4 Hydrogeological setting

The Southern Coalfield is located within the area covered by the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources. The CGP is located across two porous rock water sources – the Sydney Basin Nepean water source to the south and the Sydney Basin Central water source to the north (NOW, 2011). The recognised hydrogeological units within the CGP are shown in Table 2.2.

Table 2.2 Hydrogeological units within the CGP area

Hydrogeological unit	Aquifer type
Alluvium	Unconfined aquifer
Ashfield Shale (Wianamatta Group)	Aquitard or unconfined/perched
Hawkesbury Sandstone	Unconfined/semi-confined aquifer
Bald Hill Claystone (Narrabeen Group)	Aquitard/aquiclude
Bulgo Sandstone (Narrabeen Group)	Confined aquifer
Stanwell Park Claystone (Narrabeen Group)	Aquitard/aquiclude
Scarborough Sandstone (Narrabeen Group)	Confined aquifer
Wombarra Claystone (Narrabeen Group)	Aquitard/aquiclude
Illawarra Coal Measures	Confined water bearing zones

Alluvium occurs along the floodplain of the Nepean River and its tributaries. Alluvial deposits are generally thin, discontinuous (except along the Nepean River) and relatively permeable. The unconfined groundwater systems within the alluvium are responsive to rainfall and stream flow and form a minor beneficial groundwater system. There are also small terrace areas of Tertiary alluvium within the CGP area that contain localised groundwater systems of variable quality (Figure 2.3).

The Ashfield Shale (which outcrops across the majority of the CGP) is generally of low permeability and yield; however small water bearing zones are sometimes present. Water is typically brackish to saline, especially in low relief areas of western Sydney (due to the marine depositional environment of the shales) (Old 1942). Average bore yields are 1.3 litres per second (L/s) (AGL 2013).

The Hawkesbury Sandstone and Narrabeen Group form part of an extensive generally semi-confined regional groundwater system within the Sydney Basin sequence. The Hawkesbury Sandstone is more widely exploited for groundwater than the overlying and underlying formations, being of generally higher yield, better water quality and either outcropping or buried to shallow depths over the basin. Groundwater flow within the Hawkesbury Sandstone and Narrabeen Group groundwater systems at a regional scale has a major horizontal component, due to the alternation of sheet and massive facies, with some vertical leakage. The Hawkesbury Sandstone and Narrabeen Group are characterised by dual porosity. The primary porosity is imparted by connected void space between sand grains and the secondary porosity is due to the interconnected rock defects such as joints, fractures, faults and bedding planes. Superior bore yield in the sandstone groundwater systems of the Hawkesbury Sandstone is often associated with major fractures or a high fracture zone density, and yields of up to 40 L/s have been recorded in bores intercepting these zones within deformed areas of the Sydney Basin (McLean and Ross 2009). Typically within the CGP area bore yields within the Hawkesbury Sandstone rarely exceed 2 L/s (SCA 2007 and Ross 2014). The Narrabeen Group aquifer is generally not used as a water source as it is considered to be poorer quality and lower permeability compared to the overlying Hawkesbury Sandstone groundwater systems (Madden 2009).

There is a lack of major fracturing and fault systems intersecting the Hawkesbury Sandstone within the CGP. Yields in the Hawkesbury Sandstone are highest and salinities are freshest south of the Nepean River due to the proximity to recharge areas. North of the Nepean River, the groundwater within the Hawkesbury Sandstone is characterised by higher salinity, becoming moderately saline. Groundwater is used for irrigation and domestic purposes to the south and immediately to the north of the Nepean River; however, further north of the river, groundwater quality is typically only suitable for stock (AGL 2013).

The coal seams present in the Illawarra Coal Measures are both regionally and locally minor water bearing zones. Due to the greater depth of burial of the coal measures and fine-grained nature of the sedimentary rocks, the permeability is generally lower than the overlying sandstone aquifers. Recharge to the Permian water bearing zones is likely to occur where formations are outcropping, which occurs a significant distance to the south of the CGP. Salinity of the water bearing zones is typically brackish to moderately saline.

Within the CGP, there is limited rainfall recharge to the Ashfield Shale with most rainfall generating runoff and overland flow. Some leakage through the Ashfield Shale into the Hawkesbury Sandstone is expected where there is adequate fracture spacing, however, it is anticipated that most recharge to the sandstone aquifers occurs via lateral groundwater through-flow from upgradient and updip areas to the south. There is insufficient data within the CGP to define local flow paths and natural discharge zones; however, regionally, groundwater flow is predominantly towards the north or northeast, eventually discharging via the Georges, Parramatta or Hawkesbury River systems, and ultimately offshore to the east. Locally, there may be a small base flow or interflow discharge component to local stream headwaters during wet periods; however groundwater-surface water interactions are not well defined within the area (Parsons Brinckerhoff 2010).

3 Monitoring program

3.1 Monitoring network

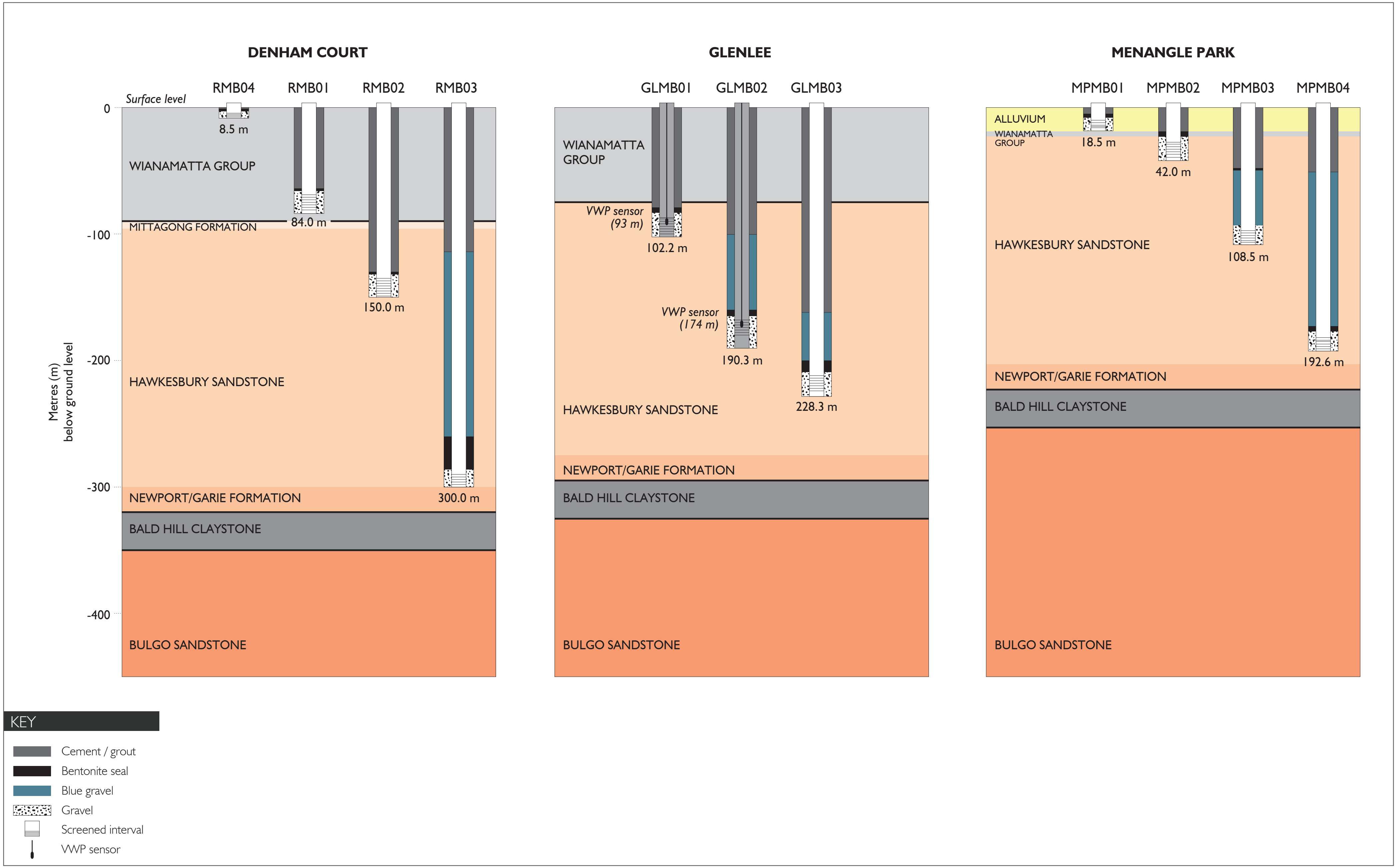
Construction details for the 11 monitoring bores within the CGP area are presented in Table 3.1 and Table 3.1.

Table 3.1 Groundwater monitoring bore details

Monitoring bore	Location	Total depth (m bgl)	Screened depth (m bgl)	Lithology	Formation
RMB01	Denham Court	84.0	69.0 – 81.0	Siltstone	Ashfield Shale
RMB02	Denham Court	150.0	135.0 – 147.0	Sandstone	Hawkesbury Sandstone (upper)
RMB03	Denham Court	300.0	290.0 – 299.0	Sandstone	Hawkesbury Sandstone (lower)
RMB04	Denham Court	8.5	4.5 – 7.5	Clay/siltstone	Ashfield Shale (weathered)
MPMB01	Menangle Park	18.5	10.0 – 16.0	Clay	Alluvium
MPMB02	Menangle Park	42.0	27.4 – 39.4	Sandstone	Hawkesbury Sandstone (upper)
MPMB03	Menangle Park	108.5	97.0 – 106.0	Sandstone	Hawkesbury Sandstone (middle)
MPMB04	Menangle Park	192.6	182.6 – 191.6	Sandstone	Hawkesbury Sandstone (lower)
GLMB01	Glenlee	102.2	87.0 – 99.0[1]	Sandstone	Hawkesbury Sandstone (upper)
GLMB02	Glenlee	190.3	168.0 – 180.0[1]	Sandstone	Hawkesbury Sandstone (middle)
GLMB03	Glenlee	228.3	212.0 – 224.0	Sandstone	Hawkesbury Sandstone (lower)

Notes: 1.Monitoring bores GLMB01 and GLMB02 were converted to vibrating wire piezometers (VWP) on 12 March 2015 to maintain borehole integrity (Parsons Brinckerhoff 2015b); the VWP sensors are installed at 93 m bgl and 174 m bgl respectively.

m bgl – metres below ground level.



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Nested groundwater monitoring bores at the Denham Court, Glenlee, and Menangle Park sites

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Figure 3.1

3.2 Water level monitoring

3.2.1 Groundwater levels

Following completion of each monitoring bore, pressure transducers (Solinist Levelogger (M30) dataloggers) were suspended from a galvanised steel wire in the water column and programmed to record a groundwater level every six hours. To verify the level recorded by the dataloggers, manual measurements are recorded periodically using an electronic dip meter. The monitoring start date of the datalogger data at each monitoring bore is shown in Table 3.2.

Barometric loggers installed above the water table at monitoring bores RMB01 and MPMB01 record changes in atmospheric pressure. Data from these loggers is used to correct for the effects of changing barometric pressure on water level loggers in the adjacent monitoring bores.

Table 3.2 Summary of current water level monitoring locations and data collection periods

Monitoring locations	Monitoring start date
Denham Court (RMB01, RMB02, RMB03, RMB04)	November 2011 (and June 2013 for RMB04)
Menangle Park (MPMB01, MPMB02, MPMB03, MPMB04)	June 2013
Glenlee (GLMB01, GLMB02, GLMB03)	February 2014

The VWP sensors at GLMB01 and GLMB02, which were installed in March 2015, have not stabilised since installation. As such, the data has not been presented in this report; however, groundwater level data that was collected from these bores prior to their conversion to VWPs is included in this report.

3.2.2 Surface water levels

Water levels in the Nepean River are monitored by the BoM (gauging station 68216) using automatic dataloggers close to the Menangle Park site (Figure 1.1). These water levels have been included in the hydrograph for the Menangle Park site for comparison (refer to Section 4 Groundwater levels; Figure 4.2). The river height data is real-time operational data from automated telemetry systems and has been processed to remove erroneous data.

3.3 Water quality monitoring

Groundwater sampling has been undertaken on 11 occasions at Denham Court (since November 2011), nine occasions at Menangle Park (since August 2013) and seven occasions at Glenlee (since February 2014) with details provide in Table 3.3. Two sampling events occurred in the 2015/16 monitoring year.

Surface water quality sampling was undertaken on one occasion (21 October 2015) at the Nepean River site next to the Menangle Park groundwater monitoring site.

Sampling of groundwater and surface water has been undertaken by Parsons Brinckerhoff since monitoring commenced.

Table 3.3 Groundwater quality program

Sampling event	Denham Court	Menangle Park	Glenlee	Reference report
November 2011	√[1]	-	-	Parsons Brinckerhoff (2012)
May 2013	√[1]	-	-	Parsons Brinckerhoff (2013a)
August 2013	√[2]	√[3]	-	Parsons Brinckerhoff (2013c)
November 2013	√[4]	√	-	Parsons Brinckerhoff (2014c)
February 2014	√[2]	√	√	Parsons Brinckerhoff (2014d)
May 2014	√[2]	√	√	Parsons Brinckerhoff (2014e)
August 2014	√[2]	√	√	Parsons Brinckerhoff (2014f)
January 2015	√[2]	√	√	Parsons Brinckerhoff (2015a)
April 2015	√[2]	√	√[5]	Parsons Brinckerhoff (2015b)
October 2015	√[4]	√	√[5]	Parsons Brinckerhoff (2015d)
April 2016	√[4]	√	√[5]	Parsons Brinckerhoff (2016a)

Notes: *1. RMB01 not sampled due to insufficient water in monitoring bore.*

2. RMB01 and RMB02 not sampled due to insufficient water in monitoring bores.

3. MPMB04 not sampled due to blockage in monitoring bore (Parsons Brinckerhoff 2013b).

4. RMB04 not sampled due to insufficient water in monitoring bore.

5. GLMB01 and GLMB02 not sampled as converted to vibrating wire piezometers (VWP) in March 2015 (Parsons Brinckerhoff 2015b).

– = monitoring locations not yet installed.

3.3.1 Sampling techniques

Three methods were used to obtain groundwater quality samples from the monitoring bores. The methods were selected based on the permeability of the screened formation of each bore, which was determined during hydraulic conductivity testing. In summary:

- a submersible 12V pump was used at higher yielding bores MPMB01 and MPMB02;
- a micro-purge™ low flow sampling pump was used at lower in monitoring bores and selected deeper bores: RMB02, RMB03, MPMB03, MPMB04, GLMB01, GLMB02 and GLMB03;
- a stainless steel double check bailer was used to sample RMB01; and
- RMB04 has never been sampled because no perched water has ever been detected within the bore.

Where a submersible pump was used, a minimum of three well volumes was purged from the monitoring bore prior to sampling to allow a representative groundwater sample to be collected. Water quality parameters were measured during and immediately after purging to monitor water quality changes and to indicate representative groundwater suitable for sampling and analysis.

The micro-purge™ system allows groundwater to be drawn into the pump intake directly from the screened portion of the aquifer, eliminating the need to purge relatively large volumes of groundwater from these bores. Water quality parameters were monitored during the micro-purge™ pumping to ensure that a representative groundwater sample was collected.

Physicochemical parameters (pH, electrical conductivity (EC), temperature, total dissolved solids (TDS), dissolved oxygen (DO) and oxidation reduction potential (ORP)) were measured during and following purging using a calibrated hand-held water quality meter.

The surface water sample was taken at the river bank using a telescopic sampler. The sample was collected from just below the water surface and approximately 1 m away from the river bank.

3.3.2 Chemical analysis of water

Groundwater and surface water samples collected in the field were analysed for a broad chemical suite designed specifically to assess the chemical characteristics of the different water bearing zones at the monitoring sites. Table 3.4 details the analytical suite.

Table 3.4 Analytical suite

Category	Parameters	
Physicochemical parameters (measured in the field)	EC	pH
	Temperature	ORP
	DO	TDS
General parameters	EC[1]	pH[1, 3]
	TDS	
Major ions	Calcium	Chloride
	Magnesium	Bicarbonate
	Sodium	Sulphate
	Potassium	Fluoride
		Silica
Metals and minor/trace elements	Aluminium	Iron
	Antimony[1]	Lead
	Arsenic	Manganese
	Barium	Molybdenum
	Boron	Mercury[2]
	Bromine	Nickel
	Beryllium	Selenium
	Cadmium	Strontium
	Cobalt	Zinc
	Copper	Uranium
	Cyanide[1]	Vanadium
Nutrients	Ammonia	Total organic carbon (TOC)
	Nitrite	Phosphorus (total)
	Nitrate	Phosphorus (reactive)
Hydrocarbons	Phenol compounds	Total petroleum hydrocarbons (TPH)
	Polycyclic aromatic hydrocarbons (PAH)	Benzene, toluene, ethyl benzene and xylenes (BTEX)
Dissolved gases	Methane	Propane
	Ethene	Butene
	Ethane	Butane
	Propene	

Notes: 1.For samples collected since the May 2013 event.
2. For samples collected since the August 2013 sampling event.
3. Generally analysed outside of recommended holding times

Samples requiring laboratory analysis were analysed by Australian Laboratory Services (ALS) in Smithfield, a NATA accredited laboratory.

Parsons Brinckerhoff informed EMM that water samples for laboratory analysis were collected in sample bottles specified by the laboratory, with appropriate preservation where required. Samples undergoing dissolved metal analysis were filtered through 0.45 µm filters in the field prior to collection.

3.3.3 Quality assurance and quality control (QA/QC)

i Field QA/QC

Parsons Brinckerhoff informed EMM that the field sampling procedures conformed to Parsons Brinckerhoff's QA/QC protocols to prevent cross-contamination and preserve sample integrity. The following QA/QC procedures were applied:

- samples were collected in clearly labelled bottles with appropriate preservation solutions;
- samples were delivered to the laboratories within the specified holding times (except for pH); and
- unstable parameters were analysed in the field (physiochemical parameters).

ii Laboratory QA/QC

The laboratories conduct their own internal QA/QC program to assess the repeatability of the analytical procedures and instrument accuracy. These programs include analysis of laboratory sample duplicates, spike samples, certified reference standards, surrogate standards/spikes and laboratory blanks. In addition, a duplicate sample is collected in the field for every ten samples collected to assess sampling and laboratory analysis accuracy.

4 Groundwater levels

Hydrographs showing groundwater levels and rainfall from the start of monitoring until April 2016 (the most recent collection of data) are presented for Denham Court in Figure 4.1, Menangle Park in Figure 4.2 and Glenlee in Figure 4.3. The Menangle Park site is located close to the Nepean River and river levels from BoM gauging station 68216 have also been included in the hydrograph for comparison (Figure 4.2). Individual hydrographs for each monitoring bore are included in Appendix A.

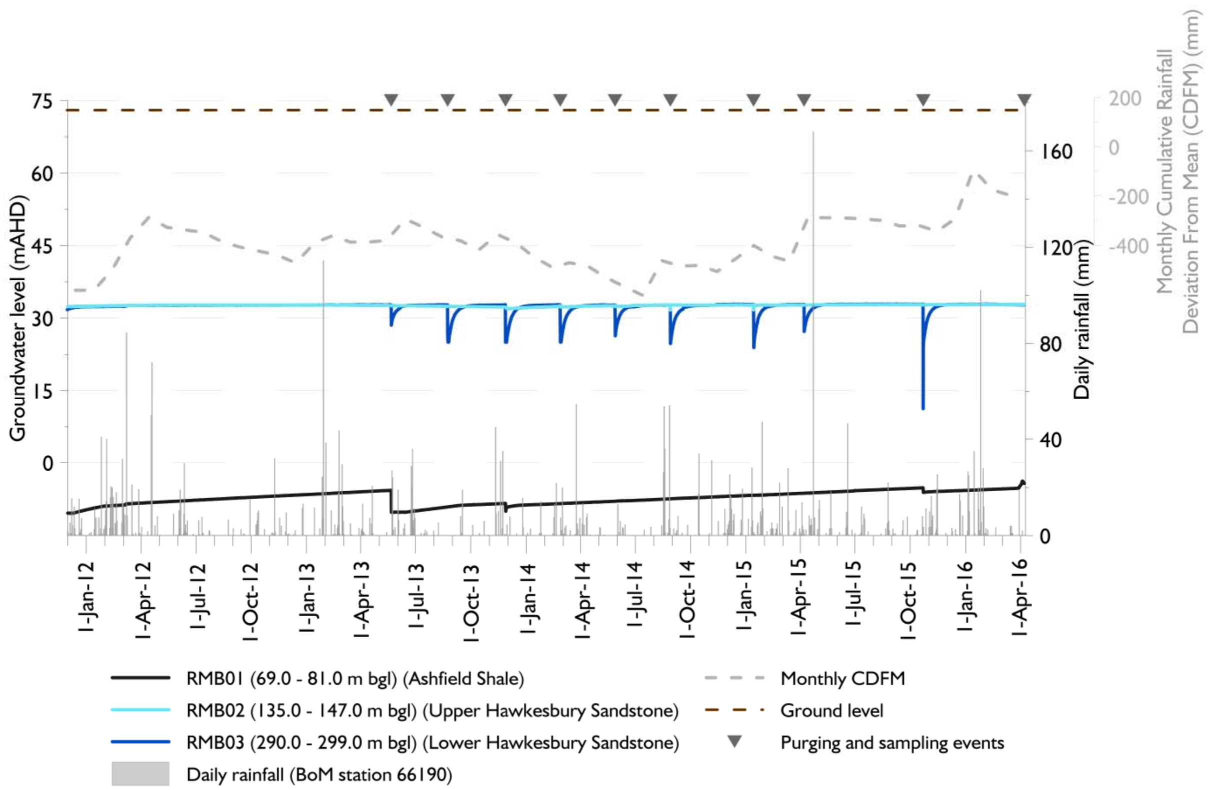

Figure 4.1 Groundwater levels at the Denham Court site

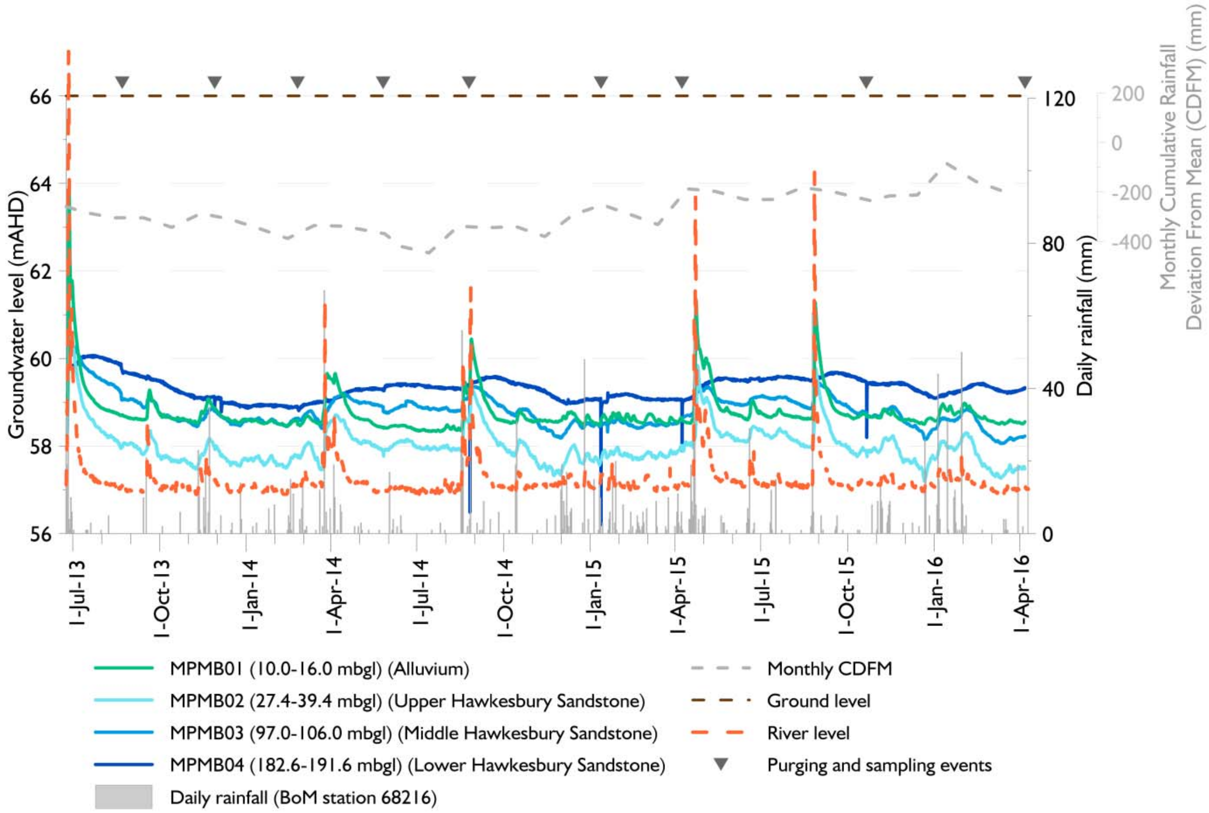

Figure 4.2 Groundwater levels at the Menangle Park site

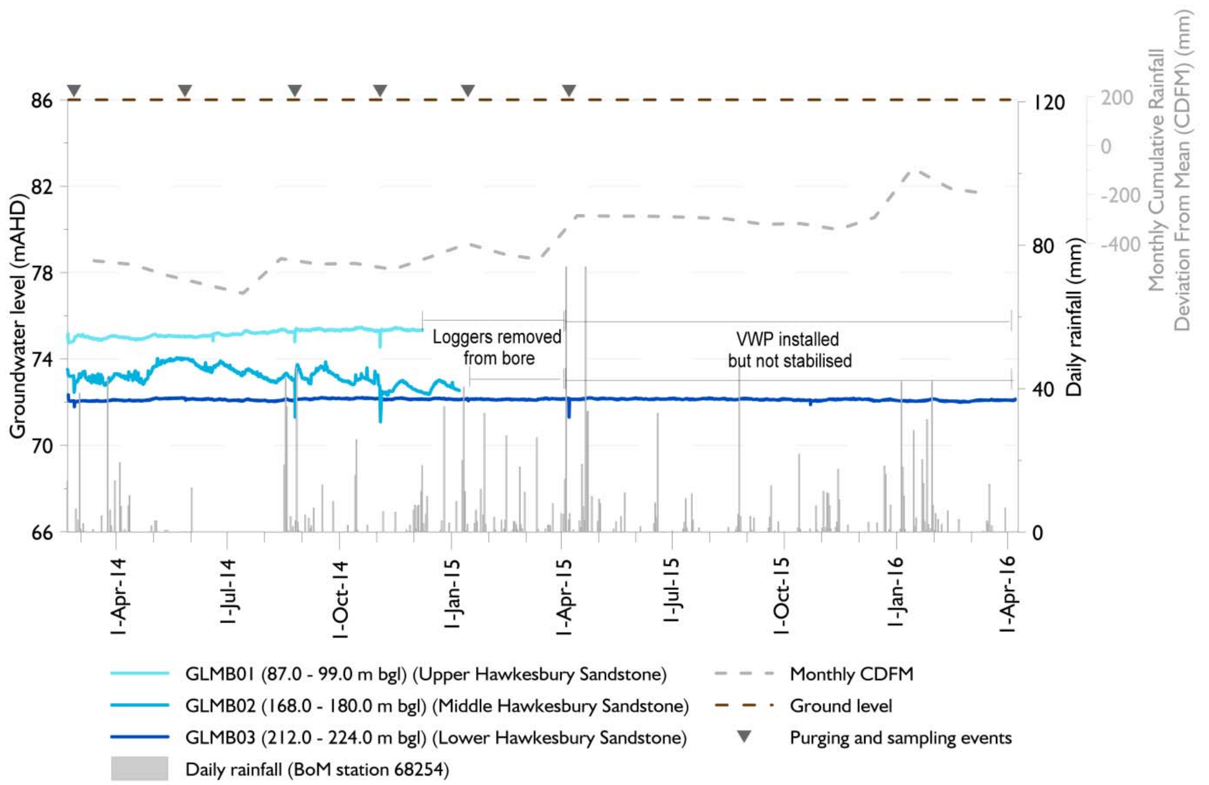

Figure 4.3 Groundwater levels at the Glenlee site

4.1 Temporal trends

4.1.1 Alluvium

The groundwater level in the alluvium (MPMB01) is shallow (less than 10 m bgl) and shows a direct response to rainfall and flood events (Figure 4.2). During the monitoring year, the groundwater level increased in response to high rainfall events in August 2015 and January 2016, after which it receded to pre-rainfall level. The water level receded to pre-rainfall events over a period of up to two months.

4.1.2 Ashfield Shale

Groundwater levels in the Ashfield Shale (RMB01) are deep (approximately 80 m bgl) and show no apparent response to rainfall over the monitoring year as shown in Figure 4.1.

The groundwater level in RMB01 shows very slow recovery (longer than 1 year) after installation and after purging and sampling. This slow recovery is due to the very low permeability of the formation. Because of the slow recovery in RMB01, the observed water levels do not reflect the regional groundwater level or trends during the monitoring year.

Since its installation in June 2013, there has been insufficient perched water present in shallow bore RMB04 to allow for water level data to be collected. As a result, the water level datalogger was removed from this monitoring bore in June 2015. This monitoring bore was installed to monitor the presence of perched water that may sustain the adjacent Cumberland Plain Woodlands' vegetation.

4.1.3 Hawkesbury Sandstone

Groundwater levels in the Hawkesbury Sandstone show no apparent response to individual rainfall events over the monitoring year at the Denham Court and Glenlee sites (Figure 4.1 and Figure 4.3 respectively), while at the Menangle Park site, located next to the Nepean River, a definite response to rainfall and flood events is observed at the upper and middle Hawkesbury Sandstone monitoring bores (MPMB02 and MPMB03) and a subdued and delayed response in the lower Hawkesbury Sandstone monitoring bore (MPMB04) (Figure 4.2).

Groundwater levels are deep (approximately 40 m bgl) at the Denham Court site and are above the base of the Ashfield Shale indicating confining conditions. The groundwater levels remained fairly constant with fluctuations of less than approximately 0.5 m throughout the monitoring year. Sudden decreases and slow recovery of groundwater level in the lower Hawkesbury Sandstone (RMB03) are related to sampling events and are consistent with the low permeability of the lower Hawkesbury Sandstone at this location.

Groundwater levels are shallow (less than 15 m bgl) at the Glenlee site. The groundwater level at GLMB03 remained fairly constant with fluctuations of less than approximately 0.5 m throughout the monitoring year.

Groundwater levels are shallow (less than 10 m bgl) in the Hawkesbury Sandstone at the Menangle Park site. Groundwater levels at the upper and middle Hawkesbury Sandstone monitoring bores (MPMB02 and MPMB03) increased in response to rainfall events in August 2015 and January 2016, followed by a decrease in groundwater levels over a period of two months. The response to rainfall in the lower Hawkesbury Sandstone (MPMB04) indicates slow and delayed recharge after high rainfall periods.

4.2 Spatial trends in the Hawkesbury Sandstone

The conceptual model (AGL 2013) and hydrogeological setting (Section 2.4) suggest that regional groundwater flow within the Hawkesbury Sandstone is from south to north towards the incised river systems of the Sydney Basin.

The groundwater level elevations in the Hawkesbury Sandstone aquifer can be compared between each of the three monitoring sites. The data collected at the CGP suggests that groundwater flow (in the Hawkesbury Sandstone at least) is more complex than the regional conceptual model. The data suggests that:

- the Nepean River in the vicinity of the Menangle Park site is a probable groundwater discharge area (as there is upward groundwater flow within the Hawkesbury Sandstone and there is no Ashfield Shale to act as a cap rock) - groundwater elevations here are between 58 and 61 m AHD and the Nepean River height is typically between 57 and 58 m AHD (Parsons Brinckerhoff 2015e);

- the Glenlee site may be close to a groundwater divide as groundwater elevations are between 72 and 75 m AHD; and

- the Denham Court site may be on the other side of the groundwater divide as groundwater elevations are lower at around 31 m AHD.

Further studies and data from a larger number of monitoring sites would be required to further understand the regional flow patterns in the Hawkesbury Sandstone.

4.3 Groundwater-surface water interactions

Hydraulic connection between surface water and groundwater exists where the river is in direct contact with the underlying aquifer (Bouwer and Maddock 1997). A ‘gaining’ stream exists where the water table or groundwater level in a connected aquifer is higher than the running level in a stream and groundwater will flow or discharge to the stream (Land and Water Australia 2007).

The Nepean River level shows a clear response to rainfall (Figure 4.2). The river level is usually lower than the level in the alluvium and Hawkesbury Sandstone units, indicating the river is a gaining river at the Menangle Park site during most of the monitoring period, except for short periods during extremely high rainfall events, when recharge to the alluvial groundwater system occurs.

4.4 Vertical gradients

Vertical gradients provide an indication of the potential for groundwater to flow vertically upward or downward at that particular location. A downward hydraulic gradient indicates a potential for downward flow from the shallower unit to the deeper unit, while an upward gradient indicates the opposite. It is noted that the actual flow direction and velocity is also governed by permeability, particularly the permeability of the confining units.

Potential vertical gradients between the various hydrogeological units were assessed and vary between sites:

- groundwater levels are comparable in the upper and lower Hawkesbury Sandstone at the Denham Court site indicating no vertical gradient between these monitored zones. Although the sandstone is confined, there is an apparent upward gradient between the upper Hawkesbury Sandstone and the Ashfield Shale;

- there is an apparent upward hydraulic gradient at the Menangle Park site within the monitored zones of the Hawkesbury Sandstone; however a downward gradient exists between the alluvium and the upper Hawkesbury Sandstone. The similar response to rainfall and flooding events between the alluvial monitoring bore and the Hawkesbury Sandstone monitoring bores indicates connectivity between the two formations at this location, which is expected given the lack of a substantial confining layer (for example shale) between the formations; and

- there is an apparent downward hydraulic gradient within the Hawkesbury Sandstone at the Glenlee site (Parsons Brinckerhoff 2015e).

Vertical gradients can be influenced by structural geological features (ie faults, folds, and lineaments) and low permeability strata, as described in sections 2.3 and 2.4 respectively.

5 Water quality

Water quality monitoring was undertaken between November 2011 and April 2016. Water quality results for the 2015/16 monitoring year are summarised in this chapter and are compared to previous monitoring years (Parsons Brinckerhoff 2014, 2014b and 2015e). The 2015/16 monitoring year full water quality results are presented in Appendix B and laboratory results in Appendix C.

5.1 Groundwater quality

5.1.1 Field parameters

Time series of field EC and pH for the CGP monitoring bores are presented in Figure 5.1 and Figure 5.2.

Groundwater sampled from the alluvium at Menangle Park (MPMB01) is classified as fresh to marginally saline and has a pH of 4.5 to 6.1. The Menangle Park site is a former sand and gravel quarry that has been subsequently rehabilitated. The observed low pH may be related to these previous land use activities.

Groundwater sampled from the Ashfield Shale at Denham Court (RMB01) is classified as moderately saline and has a neutral pH.

Groundwater in the Hawkesbury Sandstone at the Menangle Park site (MPMB02-04) is classified as fresh to marginal, while slightly saline conditions are observed at the Glenlee site (GLMB01-03) and slightly saline to moderately saline conditions are observed at the Denham Court site (RMB02-03). The fresh to marginal conditions at the Menangle Park site are likely due to the influence of rainfall recharge and connectivity with the Nepean River.

Salinity within the Hawkesbury Sandstone does not show a clear depth related trend at Menangle Park, however, salinity decreases with depth at the Denham Court and Glenlee sites. This decrease is likely a result of saline groundwater within the Ashfield Shale migrating into the underlying aquifer as a result of vertical leakage. The pH generally increases with depth within the Hawkesbury Sandstone. The pH has generally decreased in the Hawkesbury Sandstone at the Menangle Park and Glenlee sites since monitoring begun.

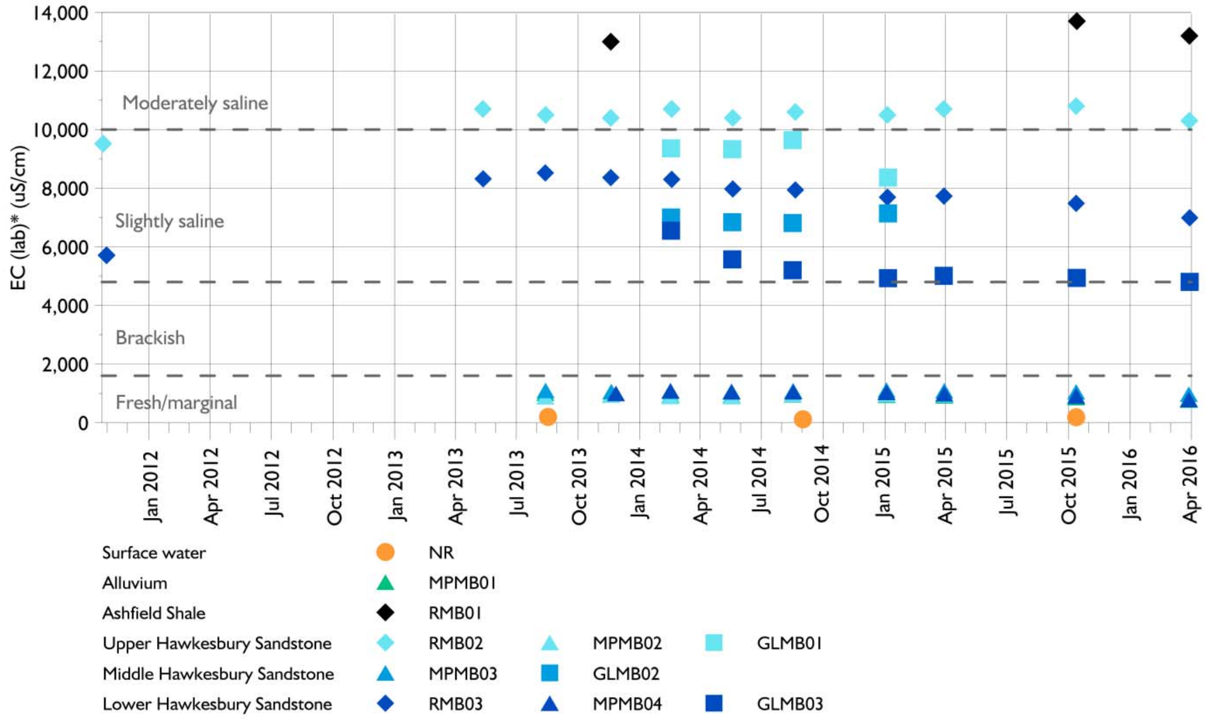

Figure 5.1 EC time series for CGP monitoring bores and Nepean River sample

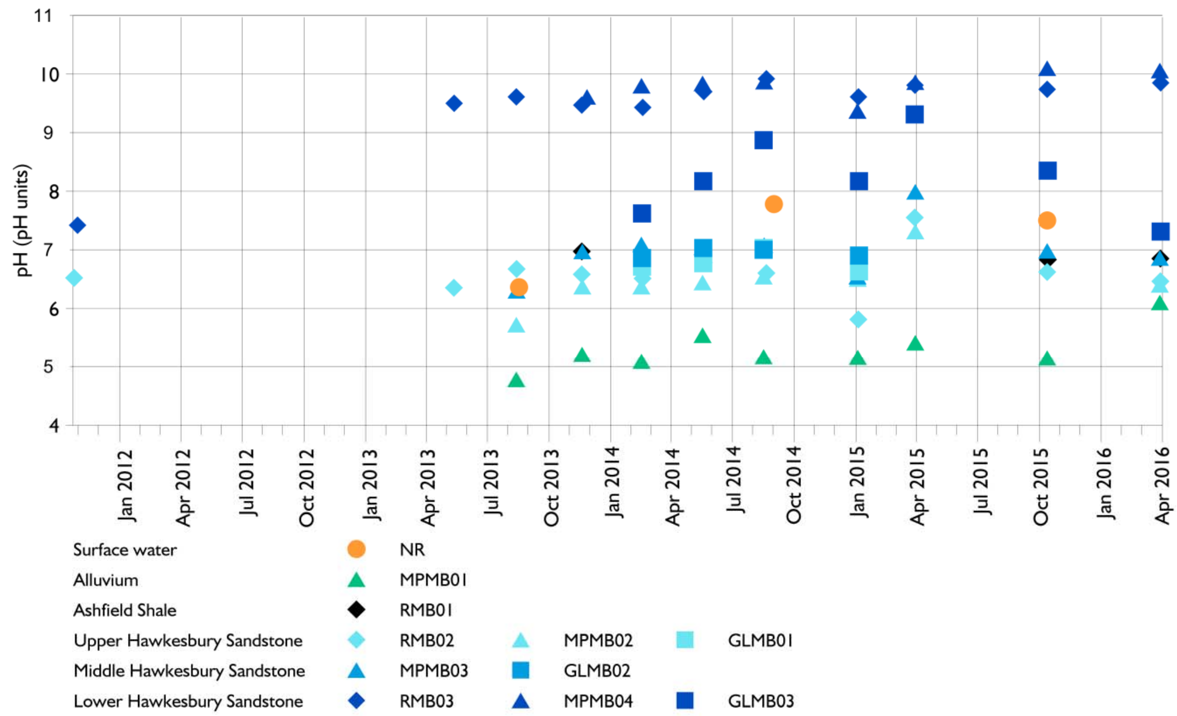

Figure 5.2 pH time series for CGP monitoring bores and Nepean River sample

5.1.2 Major ions

The major ion characteristics of groundwater samples for this monitoring year are shown in a piper diagram and representative bivariate plots in Figure 5.3. A piper diagram is a graphical representation of the relative concentrations of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-}, CO_3^{2-} and SO_4^{2-}). The ratios of sodium/chloride and magnesium/chloride versus chloride concentrations are also presented in two bivariate plots. Chloride is typically assumed to be a conservative (non-reactive) ion in groundwater systems. Evapotranspiration of the initial water with low chloride concentration would therefore be expected to result in a horizontal trend in a major ion/chloride versus chloride plot.

Groundwater at the majority of monitoring sites is typically dominated by sodium and chloride, although, groundwater at the Menangle Park site is a mixed ion, Na-Mg-Ca-HCO_3 type water. Interestingly, the water type at each of the four nested monitoring bores at the Menangle Park site is different.

The Hawkesbury Sandstone at the Menangle Park site has a different geochemical signature to the Denham Court and Glenlee sites; this may be related to local recharge and connectivity with the overlying alluvium at this site.

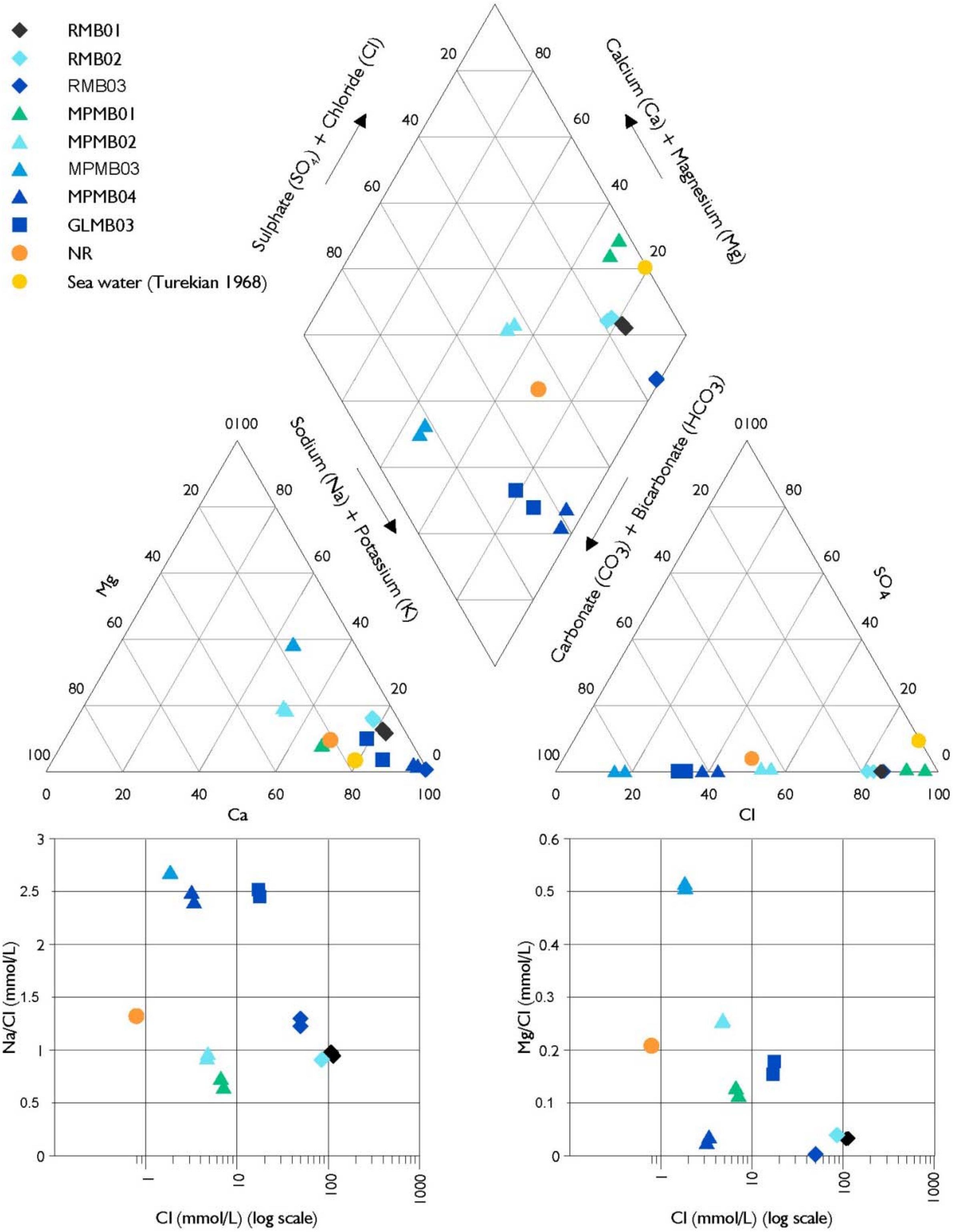

Figure 5.3 Major ion chemistry of groundwater for CGP monitoring bores and Nepean River sample (2015/16 monitoring year)

5.1.3 Dissolved metals

Concentrations of dissolved metals in groundwater are presented in Figure 5.4. The major findings for dissolved metals for this monitoring year are as follows:

- dissolved metal concentrations are generally similar in the alluvium and the Hawkesbury Sandstone. The exceptions are copper, cobalt, manganese and nickel concentrations, which are higher in the alluvium compared to the other hydrogeological units. Dissolved metal concentrations in the alluvium were generally comparable to previous monitoring years;
- dissolved metal concentrations are generally similar in the Ashfield Shale and the Hawkesbury Sandstone at the Denham Court site. The exceptions are nickel concentrations which are higher in the Ashfield Shale compared to the Hawkesbury Sandstone; and
- slightly elevated dissolved metal concentrations were detected in the Hawkesbury Sandstone at the Denham Court and Glenlee sites (eg barium, bromine and strontium) compared with the Menangle Park site. This is not unexpected given the higher salinity at these locations and the influence from the overlying Ashfield Shale. Elevated concentrations of barium, cadmium, molybdenum, strontium and zinc are not uncommon for groundwater in the Hawkesbury Sandstone (Parsons Brinckerhoff 2006 and 2013b). Dissolved metal concentrations in the Hawkesbury Sandstone were generally comparable to previous monitoring years, with the exception of decreasing barium concentrations at RMB03 and MPMB04 and increasing barium concentrations at RMB02 and GLMB03 and increasing iron concentrations at most monitoring sites.

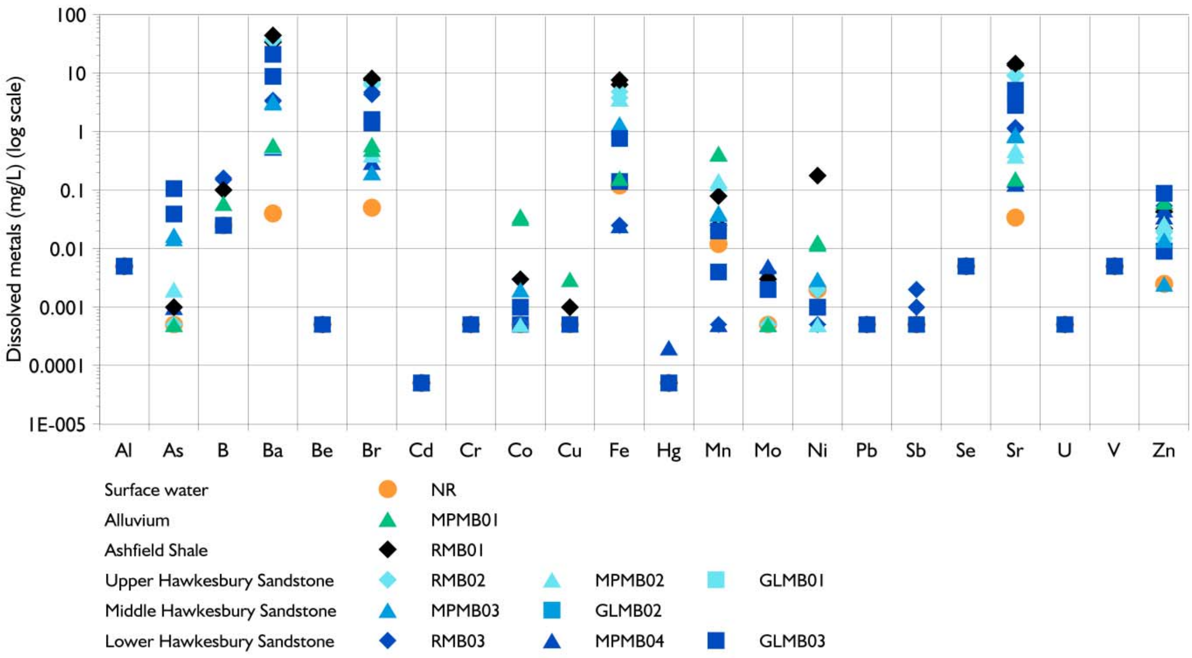

Figure 5.4 Dissolved metal concentrations in groundwater for CGP monitoring bores the Nepean River sample (2015/16 monitoring year)

5.1.4 Nutrients

A plot showing ammonia versus nitrate in groundwater is presented in Figure 5.5.

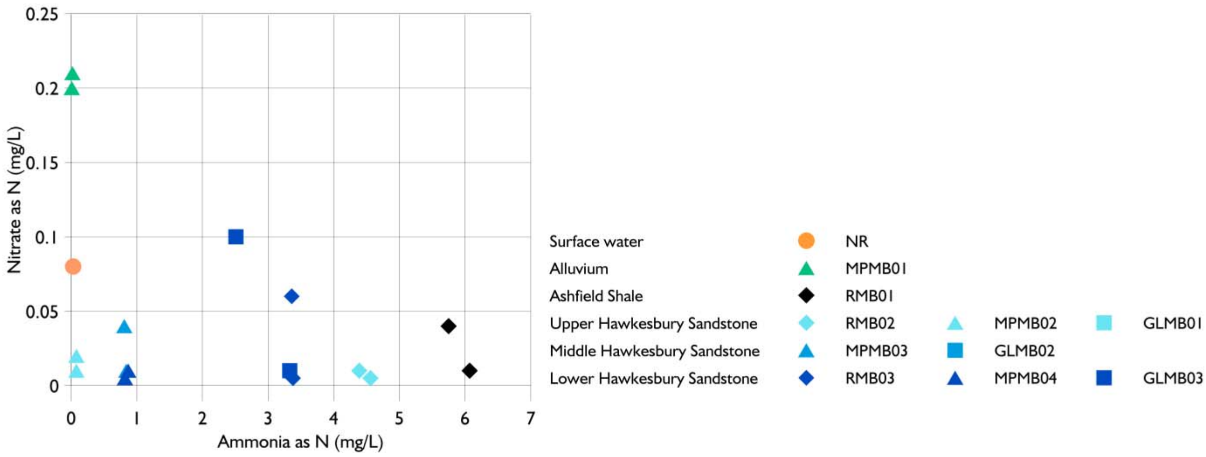

Figure 5.5 Ammonia versus nitrate concentrations in groundwater for CGP monitoring bores and the Nepean River sample (2015/16 monitoring year)

The major findings for nutrients are as follows:

- nitrate concentrations in groundwater remained low at all CGP monitoring bores (<0.25 mg/L as N). The highest concentrations continued to be recorded in the alluvial aquifer (MPMB01) (Figure 5.5);
- ammonia concentrations were the lowest at Menangle Park and the highest at Denham Court, which is consistent with previous monitoring years (Figure 5.5);
- nitrite concentrations remained below the laboratory LOR at all monitoring bores;
- total phosphorus concentrations were detected in the Ashfield Shale (RMB01), the alluvial aquifer (MPMB01) and in the Hawkesbury Sandstone (MPMB02 and GLMB03). Reactive phosphorus concentrations were detected at all monitoring sites, with the exception of MPMB02-03; and
- total organic carbon (TOC) concentrations differ between hydrogeological units, being generally the highest in the lower Hawkesbury Sandstone at all sites and comparable in the middle and upper Hawkesbury Sandstone and alluvium.

5.1.5 Dissolved gasses

A time series plot of dissolved methane concentrations in groundwater is presented in Figure 5.6.

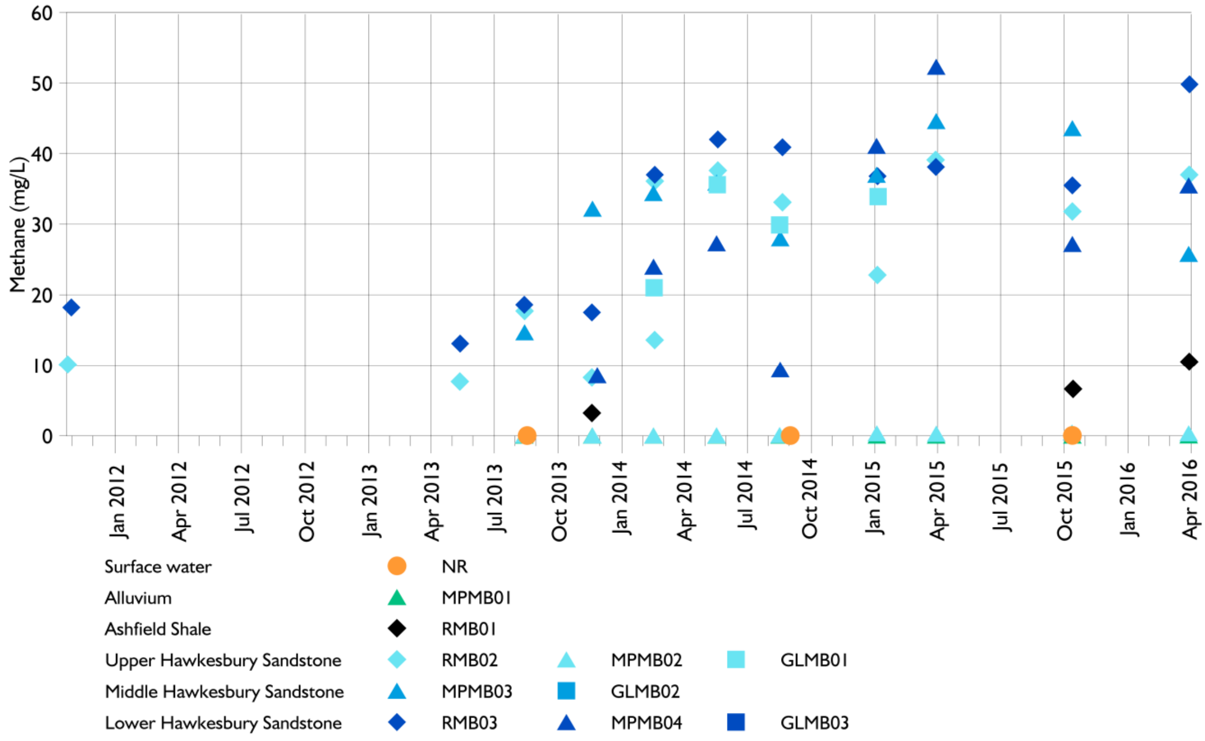

Figure 5.6 Dissolved methane time series for CGP monitoring bores and Nepean River samples

The major findings for dissolved gases are as follows:

- dissolved methane was detected in the alluvium (MPMB01) for the first time since monitoring commenced (0.03 mg/L in April 2016) (Figure 5.6);
- dissolved methane was detected in the Ashfield Shale (RMB01) at increasing concentrations over the monitoring year and compared to previous results (Figure 5.6);
- dissolved methane was detected in the Hawkesbury Sandstone at all monitoring sites, with increased concentrations at depth. Dissolved methane was also detected at the control site (RMB) remote from the CGP activities. Dissolved methane concentrations continued to be the lowest at MPMB02. Dissolved methane concentrations in the Hawkesbury Sandstone continued to increase during this monitoring year at RMB03 and GLMB03, with the April 2016 concentrations being the highest recorded since monitoring commenced; concentrations decreased at RMB02 and MPMB03-04 (Figure 5.6);
- ethane, propane, and butane were detected at low concentrations in groundwater from the Ashfield Shale at the Denham Court site; and
- ethane continued to be detected at low concentrations in groundwater from the Hawkesbury Sandstone at the Denham Court and Glenlee sites and propane continued to be detected at low concentrations at the Glenlee site only. Concentrations of these dissolved gases decreased overall at the Glenlee site since monitoring commenced in February 2014.

Dissolved methane is shown to be of mostly thermogenic origin (Parsons Brinckerhoff 2014). The presence of dissolved hydrocarbons observed in the groundwater within the Hawkesbury Sandstone and Ashfield Shale is assessed to be naturally occurring, based on the values present within the groundwater at the control site (Denham Court, RMB) located at significant distance from the CGP gas production occurring methane after drilling and after purging during groundwater sampling events. Future trends will be monitored.

5.1.6 Dissolved hydrocarbons

The Menangle Park site is a former sand and gravel quarry that has been subsequently rehabilitated. Hydrocarbon detections (PAHs and TPH/TRH) at this site in the alluvium may be related to these previous land use activities. During the 2015/16 monitoring years, hydrocarbon detections decreased to below the laboratory LOR, with the exception of phenanthrene which was detected in October 2015 at MPMB01.

Toluene continued to be present in the lower Hawkesbury Sandstone. It is assessed to be naturally occurring, given that it has been detected in groundwater at all monitoring sites since monitoring commenced, including the control site (Denham Court, RMB) located at a significant distance from development activities. No other BTEX compounds (ie benzene, xylenes and ethyl benzene) were detected during this monitoring year, with the exception of xylenes and benzene in the Ashfield Shale (RMB01).

Dissolved hydrocarbons can occur naturally in groundwater, with concentrations derived from carbonaceous material (CSIRO 2011). Detections of PAHs, phenols and heavy chain hydrocarbons in both upper and lower Hawkesbury Sandstone across all sites are most likely natural, however possible residues from monitoring bore drilling (eg lubricating oils) cannot be excluded. Future trends will be monitored.

5.2 Surface water quality

Surface water quality results from a single sample collected from the Nepean River on 21 October 2015 were compared to ANZECC (2000) guidelines for freshwater ecosystems (95% protection level) and it was found that:

- pH is neutral, within the ANZECC (2000) guideline range (6.5 – 8.0 pH units) and higher than the pH of groundwater in the alluvium;
- salinity is fresh, and within the ANZECC (2000) guideline range (125 – 2,200 µS/cm) and lower than groundwater in the alluvium;
- dominant major ions are sodium, chloride and bicarbonate (Figure 5.3);
- dissolved metal concentrations were lower than those of groundwater in the alluvium and underlying Hawkesbury Sandstone units, except for iron and molybdenum concentrations. All dissolved metal concentrations were below the ANZECC (2000) guideline values;
- ammonia concentrations were above the ANZECC (2000) guideline (0.02 mg/L) and are similar to the alluvial groundwater. Total phosphorus concentration remained below the laboratory LOR and the ANZECC (2000) guideline value (0.05 mg/L);
- dissolved methane was detected at low concentrations (0.02 mg/L); and
- no other dissolved hydrocarbons were detected.

The water quality of the Nepean River was overall comparable to that of the sample collected in September 2014.

6 Discussion and conclusions

Monitoring of groundwater levels at three nested monitoring bore sites was undertaken using dataloggers, allowing water level trends to be identified in the alluvium, Ashfield Shale and Hawkesbury Sandstone. Sampling of water quality at all sites also established useful trends.

The main findings for the 2015/16 monitoring year in regards to **water levels** are:

- the groundwater level in the alluvium at Menangle Park is less than 10 m bgl and shows a direct response to rainfall and flood events;

- groundwater levels appear to follow similar trends in each of the Hawkesbury Sandstone units (upper, middle and lower) at each site. There is no apparent response to individual rainfall events at the Denham Court and Glenlee sites. A clear response to rainfall and flood events can be observed at most monitoring bores at the Menangle Park site even though this is an apparent groundwater discharge area;

- groundwater levels are deep (approximately 40 m bgl) at the Denham Court site, although they are above the base of the Ashfield Shale, indicating confining conditions. In contrast, groundwater levels are shallow (less than 15 m bgl) at the Menangle Park and Glenlee sites;

- for the regional Hawkesbury Sandstone aquifer, groundwater elevations are highest at the Glenlee site (approximately 75 m AHD); lower at the Menangle Park site (approximately 60 m AHD); and lowest at the Denham Court site (approximately 31 m AHD);

- vertical gradients vary between sites. No vertical gradient is apparent between the lower and upper Hawkesbury Sandstone at the Denham Court site. Upward and downward gradients are evident at the Menangle Park and Glenlee sites respectively;

- the Nepean River elevation is usually lower than the water elevation in the alluvium and Hawkesbury Sandstone units, indicating the river is a gaining stream around the Menangle Park site, except for short periods during extremely high rainfall events when recharge to the underlying groundwater systems is observed; and

- the groundwater level data collected in the alluvium and Hawkesbury Sandstone is indicative of natural systems in long-term equilibrium with occasional seasonal responses to recharge when there is a connection with surface features, as evident at the Menangle site within the alluvium and Hawkesbury Sandstone.

No long term drawdown trends have been observed in the groundwater level data at any of the monitored locations and therefore it can be assumed that no depressurisation due to CSG operations (which involves dewatering of the deep coal seams) is occurring within the monitored zones.

The main findings for this monitoring year in regards to **water quality** are:

- groundwater quality in the alluvium at the Menangle Park site is characterised as fresh to marginally saline and slightly acidic pH. Dissolved metal concentrations are typically low. Minor dissolved hydrocarbons were detected and may be related to previous land use activities;

- groundwater quality in the Ashfield Shale is characterised as slightly saline and of neutral pH. Minor detections of dissolved metals and hydrocarbons were present. Dissolved methane, ethane, propane, and butane were detected in the Ashfield Shale. These compounds are assessed to be naturally occurring given that they have been detected at the control site (RMB01, Denham Court);

- groundwater quality in the Hawkesbury Sandstone ranges from fresh to marginally saline at the Menangle Park site and is slightly to moderately saline at the Denham Court and Glenlee sites. Salinity decreases with depth at the Denham Court and Glenlee sites. Minor detections of dissolved hydrocarbons were present in the Hawkesbury Sandstone. Dissolved methane was detected at all Hawkesbury Sandstone bores and it is likely related to degassing of naturally occurring methane after purging during groundwater sampling events. Dissolved ethane was detected at the Denham Court and Glenlee sites and propane was detected at the Glenlee site only. These compounds are assessed to be naturally occurring given that methane has been observed to occur at all sites, including the control site (Denham Court) which is located at a significant distance from any development activities;

- toluene was detected at all lower Hawkesbury Sandstone monitoring points. It is assessed to be naturally occurring given that it has been detected at all sites, including the control site (Denham Court) which is located at a significant distance from the CGP gas production wells. No other BTEX compounds were detected, with the exception of xylenes and benzene in the Ashfield Shale;

- the Nepean River at the Menangle Park site is of neutral pH and fresh water quality. Dissolved metal concentrations were typically lower for the surface water than the alluvium and underlying Hawkesbury Sandstone. Ammonia concentrations were above the ANZECC (2000) guideline values and similar to alluvial groundwater. Minor dissolved methane concentrations were detected however no other hydrocarbons were detected; and

- no significant change in water quality was detected during the 2015/16 monitoring year compared to the previous monitoring year (Parsons Brinckerhoff 2015e).

No adverse water quality impacts that can be attributed to CSG operations were observed at any of the monitored sites. Water quality results are not significantly different between the control site (Denham Court) and monitoring sites located within the CGP footprint (Menangle Park and Glenlee).

From the available data, there are no observable impacts to groundwater levels or quality or surface water quality that could be attributable to the CSG operations. There is also no evidence of connectivity between the shallower monitored zones and the coal seams. This is in agreement with the conceptual model developed during the Phase 1 studies (Parsons Brinckerhoff 2011). The presence of extensive and thick claystone formations (aquitards and aquicludes) between the Hawkesbury Sandstone and the targeted coal seams restricts depressurisation and impedes the vertical flow of groundwater.

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Glossary

Acidity	Base neutralising capacity.
Alkalinity	Acid neutralising capacity.
Alluvium	Unconsolidated sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains, and alluvial fans.
Alluvial aquifer	Permeable zones that store and produce groundwater from unconsolidated alluvial sediments. Shallow alluvial aquifers are generally unconfined aquifers.
Ammonia	A compound of nitrogen and hydrogen (NH3) that is a common by-product of animal waste and landfills but is also found naturally in reduced environments. Ammonia readily converts to nitrate in soils and streams.
Anion	An ion with a negative charge – usually non-metal ions when disassociated and dissolved in water.
Aquatic ecosystem	The stream channel, lake or estuary bed, water, and (or) biotic communities and the habitat features that occur therein.
Aquiclude	An impermeable unit that acts as a barrier to the flow of groundwater from one formation to another.
Aquifer	Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water.
Aquifer properties	The characteristics of an aquifer that determine its hydraulic behaviour and its response to abstraction.
Aquifer, confined	An aquifer that is overlain by low permeability strata. The hydraulic conductivity of the confining bed is significantly lower than that of the aquifer.
Aquifer, semi-confined	An aquifer overlain by a low-permeability layer that permits water to slowly flow through it. During pumping, recharge to the aquifer can occur across the leaky confining layer – also known as a leaky artesian or leaky confined aquifer.
Aquifer, unconfined	Also known as a water table aquifer. An aquifer in which there are no confining beds between the zone of saturation and the surface. The water table is the upper boundary of an unconfined aquifer.
Aquitard	A low permeability unit that can store groundwater and also transmit it slowly from one formation to another. Aquitards retard but do not prevent the movement of water to or from adjacent aquifers.
Australian Height Datum (AHD)	The reference point (very close to mean sea level) for all elevation measurements, and used for correlating depths of aquifers and water levels in bores.
Beneficial aquifer	An aquifer with a water resource of sufficient quality and quantity to provide either ecosystem protection, raw water for drinking water supply, and agricultural or industrial water.
Bore	A structure drilled below the surface to obtain water from an aquifer or series of aquifers.
Boundary	A lateral discontinuity or change in the aquifer resulting in a significant change in hydraulic conductivity, storativity or recharge.
Cation	An ion with a positive charge – usually metal ions when disassociated and dissolved in water.
Claystone	A non-fissile rock of sedimentary origin composed primarily of clay-sized particles (less than 0.004 mm).
Coal	A sedimentary rock derived from the compaction and consolidation of vegetation or swamp deposits to form a fossilised carbonaceous rock.
Coal seam	A layer of coal within a sedimentary rock sequence.
Coal seam gas (CSG)	Coal seam gas is a form of natural gas (predominantly methane) that is extracted from coal seams.

Concentration	The amount or mass of a substance present in a given volume or mass of sample, usually expressed as milligram per litre (water sample) or micrograms per kilogram (sediment sample).
Conceptual model	A simplified and idealised representation (usually graphical) of the physical hydrogeologic setting and the hydrogeological understanding of the essential flow processes of the system. This includes the identification and description of the geologic and hydrologic framework, media type, hydraulic properties, sources and sinks, and important aquifer flow and surface-groundwater interaction processes.
Confining layer	Low permeability strata that may be saturated but will not allow water to move through it under natural hydraulic gradients.
Datalogger	A digital recording instrument that is inserted in monitoring and pumping bores to record pressure measurements and water level variations.
Dual permeability aquifer	An aquifer in which groundwater flow is through both the primary porosity of the rock matrix and the secondary porosity of fractures and fissures.
Electrical conductivity (EC)	A measure of a fluid's ability to conduct an electrical current and is an estimation of the total ions dissolved. It is often used as a measure of water salinity.
Facies	An assemblage or association of mineral, rock, or fossil features reflecting the environment and conditions of origin of the rock. It refers to the appearance and peculiarities that distinguish a rock unit from associated or adjacent units.
Fault	A fracture in rock along which there has been an observable amount of displacement. Faults are rarely single planar units; normally they occur as parallel to sub-parallel sets of planes along which movement has taken place to a greater or lesser extent. Such sets are called fault or fracture zones.
Groundwater	The water contained in interconnected pores or fractures located below the water table in the saturated zone.
Groundwater level	The water level measured in a bore; this may be at or close to the water table in unconfined aquifers, or represent the average piezometric level across the screened interval in confined aquifers.
Groundwater flow	The movement of water through openings in sediment and rock within the zone of saturation.
Groundwater system	A system that is hydrogeologically more similar than different in regard to geological province, hydraulic characteristics and water quality, and may consist of one or more geological formations.
Hydraulic conductivity	The rate at which water of a specified density and kinematic viscosity can move through a permeable medium (notionally equivalent to the permeability of an aquifer to fresh water).
Hydraulic gradient	The change in total hydraulic head with a change in distance in a given direction.
Hydraulic head	A specific measurement of water pressure above a datum. It is usually measured as a water surface elevation, expressed in units of length. In an aquifer, it can be calculated from the depth to water in a monitoring bore. The hydraulic head can be used to determine a hydraulic gradient between two or more points.
Hydrogeology	The study of the interrelationships of geologic materials and processes with water, especially groundwater.
Hydrology	The study of the occurrence, distribution, and chemistry of all surface waters.
Ion	An ion is an atom or molecule where the total number of electrons is not equal to the total number of protons, giving it a net positive or negative electrical charge.
Limit or reporting (LOR)	The concentration below which a particular analytical method cannot determine, with a high degree of certainty, a concentration.
Lithology	The study of rocks and their depositional or formational environment on a large specimen or outcrop scale.

Major ions	Constituents commonly present in concentrations exceeding 10 milligram per litre. Dissolved cations generally are calcium, magnesium, sodium, and potassium; the major anions are sulphate, chloride, fluoride, nitrate, and those contributing to alkalinity, most generally assumed to be bicarbonate and carbonate.
Methane (CH4)	An odourless, colourless, flammable gas, which is the major constituent of natural gas. It is used as a fuel and is an important source of hydrogen and a wide variety of organic compounds.
MicroSiemens per centimetre (µS/cm)	A measure of water salinity commonly referred to as EC (see also electrical conductivity). Most commonly measured in the field with calibrated field meters.
Monitoring bore	A non-pumping bore, is generally of small diameter that is used to measure the elevation of the water table and/or water quality. Bores generally have a short well screen against a single aquifer through which water can enter.
Monitoring period	Refers to data collected between October 2011 and June 2015.
Monitoring year	Refers to data collected between July 2015 and June 2016.
Normal faulting	Where the fault plane is vertical or dips towards the downthrow side of a fault.
Oxidising conditions	Conditions in which a species loses electrons and is present in oxidised form.
Permeability	The property or capacity of a porous rock, sediment, clay or soil to transmit a fluid. It is a measure of the relative ease of fluid flow under unequal pressure. The hydraulic conductivity is the permeability of a material for water at the prevailing temperature.
Permeable material	Material that permits water to move through it at perceptible rates under the hydraulic gradients normally present.
Permian	The last period of the Palaeozoic era that finished approximately 252 million years before present.
pH	Potential of Hydrogen; the logarithm of the reciprocal of hydrogen-ion concentration in gram atoms per litre; provides a measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral, greater than 7 is alkaline and less than 7 is acidic).
Porosity	The proportion of open space within an aquifer, comprised of intergranular space, pores, vesicles and fractures.
Porosity, primary	The porosity that represents the original pore openings when a rock or sediment formed.
Porosity, secondary	The porosity caused by fractures or weathering in a rock or sediment after it has been formed.
Quaternary	The most recent geological period extending from approximately 2.6 million years ago to the present day.
Quality assurance	Evaluation of quality-control data to allow quantitative determination of the quality of chemical data collected during a study. Techniques used to collect, process, and analyse water samples are evaluated.
Recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and by river water reaching the water table or exposed aquifers. The addition of water to an aquifer.
Recharge area	A geographic area that directly receives infiltrated water from surface and in which there are downward components of hydraulic head in the aquifer. Recharge generally moves downward from the water table into the deeper parts of an aquifer then moves laterally and vertically to recharge other parts of the aquifer or deeper aquifer zones.
Recovery	The difference between the observed water level during the recovery period after cessation of pumping and the water level measured immediately before pumping stopped.

Redox potential (ORP or Eh)	The redox potential is a measure (in volts) of the affinity of a substance for electrons – its electronegativity – compared with hydrogen (which is set at 0). Substances more strongly electronegative than (i.e. capable of oxidising) hydrogen have positive redox potentials. Substances less electronegative than (i.e. capable of reducing) hydrogen have negative redox potentials. Also known as oxidation-reduction potential and Eh.
Redox reaction	Redox reactions, or oxidation-reduction reactions, are a family of reactions that are concerned with the transfer of electrons between species, and are mediated by bacterial catalysis. Reduction and oxidation processes exert an important control on the distribution of species like O2, Fe2+, H2S and CH4 etc. in groundwater.
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS).
Salinity classification	Fresh water quality – water with a salinity <800 µS/cm. Marginal water quality – water that is more saline than freshwater and generally waters between 800 and 1,600 µS/cm. Brackish quality – water that is more saline than freshwater and generally waters between 1,600 and 4,800 µS/cm. Slightly saline quality – water that is more saline than brackish water and generally waters with a salinity between 4,800 and 10,000 µS/cm. Moderately saline quality – water that is more saline than slightly saline water and generally waters between 10,000 and 20,000 µS/cm. Saline quality – water that is almost as saline as seawater and generally waters with a salinity greater than 20,000 µS/cm. Seawater quality – water that is generally around 55,000 µS/cm. (Australian Water Resources Council 1988)
Sandstone	Sandstone is a sedimentary rock composed mainly of sand-sized minerals or rock grains (predominantly quartz).
Screen	A type of bore lining or casing of special construction, with apertures designed to permit the flow of water into a bore while preventing the entry of aquifer or filter pack material.
Sedimentary rock aquifer	These occur in consolidated sediments such as porous sandstones and conglomerates, in which water is stored in the intergranular pores, and limestone, in which water is stored in solution cavities and joints. These aquifers are generally located in sedimentary basins that are continuous over large areas and may be tens or hundreds of metres thick. In terms of quantity, they contain the largest volumes of groundwater.
Shale	A laminated sedimentary rock in which the constituent particles are predominantly of clay size.
Siltstone	A fine-grained rock of sedimentary origin composed mainly of silt-sized particles (0.004 to 0.06 mm).
Standing water level (SWL)	The height to which groundwater rises in a bore after it is drilled and completed, and after a period of pumping when levels return to natural atmospheric or confined pressure levels.
Stratigraphy	The depositional order of sedimentary rocks in layers.
Surface water-groundwater interaction	This occurs in two ways: (1) streams gain water from groundwater through the streambed when the elevation of the water table adjacent to the streambed is greater than the water level in the stream; and (2) streams lose water to groundwater through streambeds when the elevation of the water table is lower than the water level in the stream.
Tertiary	Geologic time at the beginning of the Cainozoic era, 65 to 2.6 million years ago, after the Cretaceous and before the Quaternary.
Total Dissolved Solids (TDS)	A measure of the salinity of water, usually expressed in milligrams per litre (mg/L). See also EC.
Water quality	Term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water quality data	Chemical, biological, and physical measurements or observations of the characteristics of surface and ground waters, atmospheric deposition, potable water, treated effluents, and waste water and of the immediate environment in which the water exists.
Well	Pertaining to a gas exploration well or gas production well.

Abbreviations

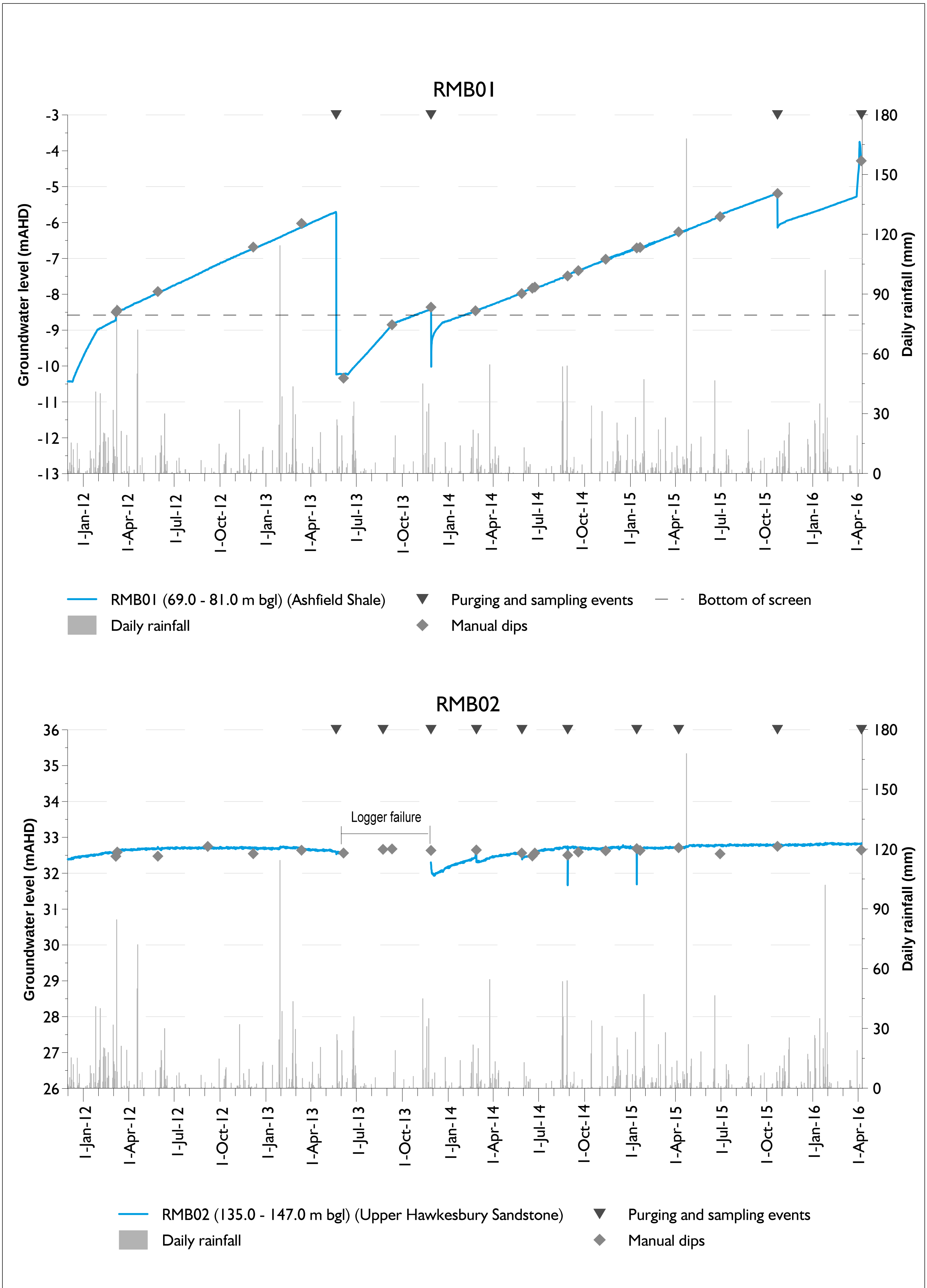
AGL	AGL Upstream Investments Pty Ltd
BoM	Bureau of Meteorology
BTEX	Benzene, toluene, ethyl benzene and xylenes
CDFM	Cumulative deviation from mean
CGP	Camden Gas Project
CSG	Coal seam gas
DO	Dissolved oxygen
EC	Electrical conductivity
LOR	Limit of reporting
ORP	Oxidation reduction potential
PAH	Polycyclic aromatic hydrocarbons
SCA	Sydney Catchment Authority
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
VWP	Vibrating wire piezometer

Units

°C	degrees Celsius
L/s	litres per second
m	metres
mAHD	metres Australian Height Datum
mbgl	metres below ground level
m/d	metres per day
mg/L	milligrams per litre
µg/L	micrograms per litre
mV	millivolt
µg/L	micro grams per litre
µS/cm	microSiemens per centimetre

Appendix A

Groundwater hydrographs

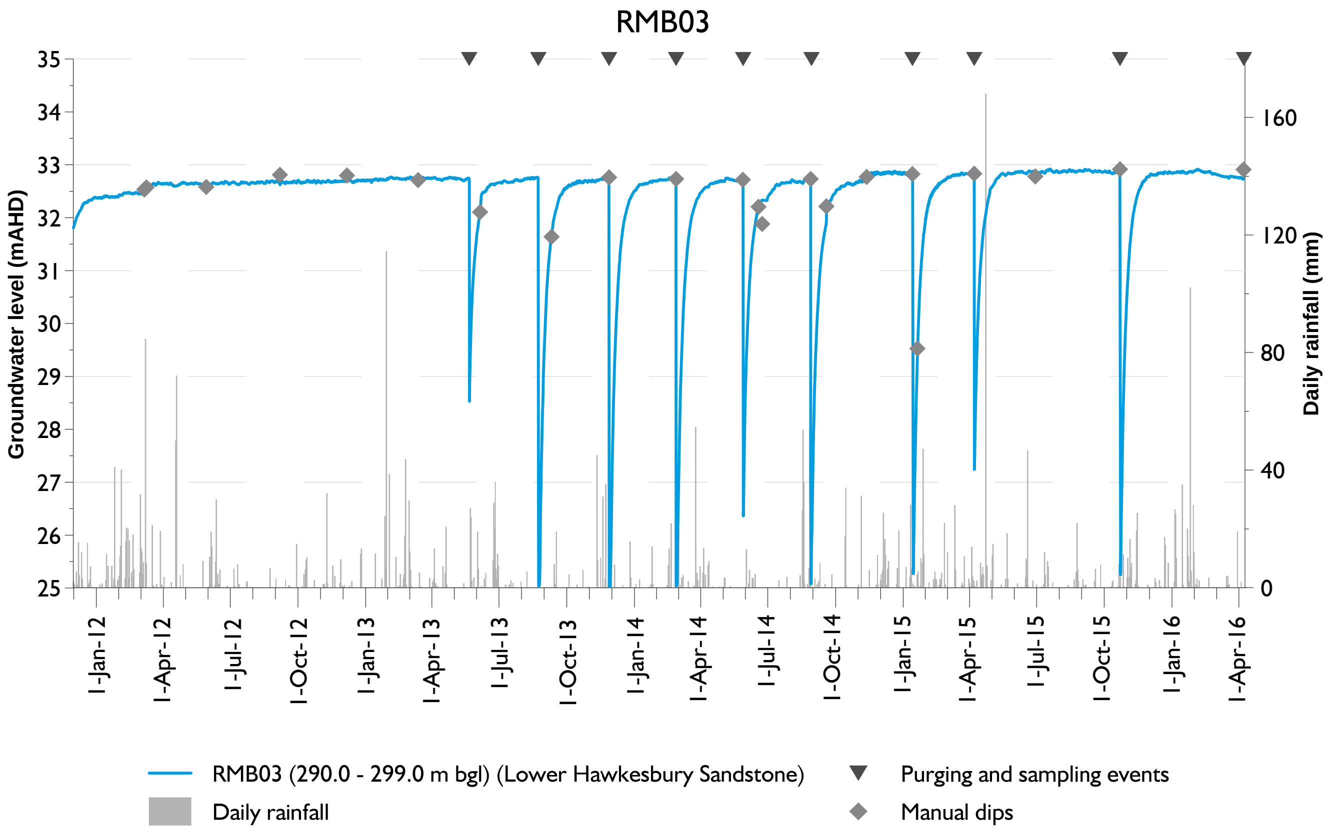


RMB01 and RMB02 hydrographs

Camden Gas Project

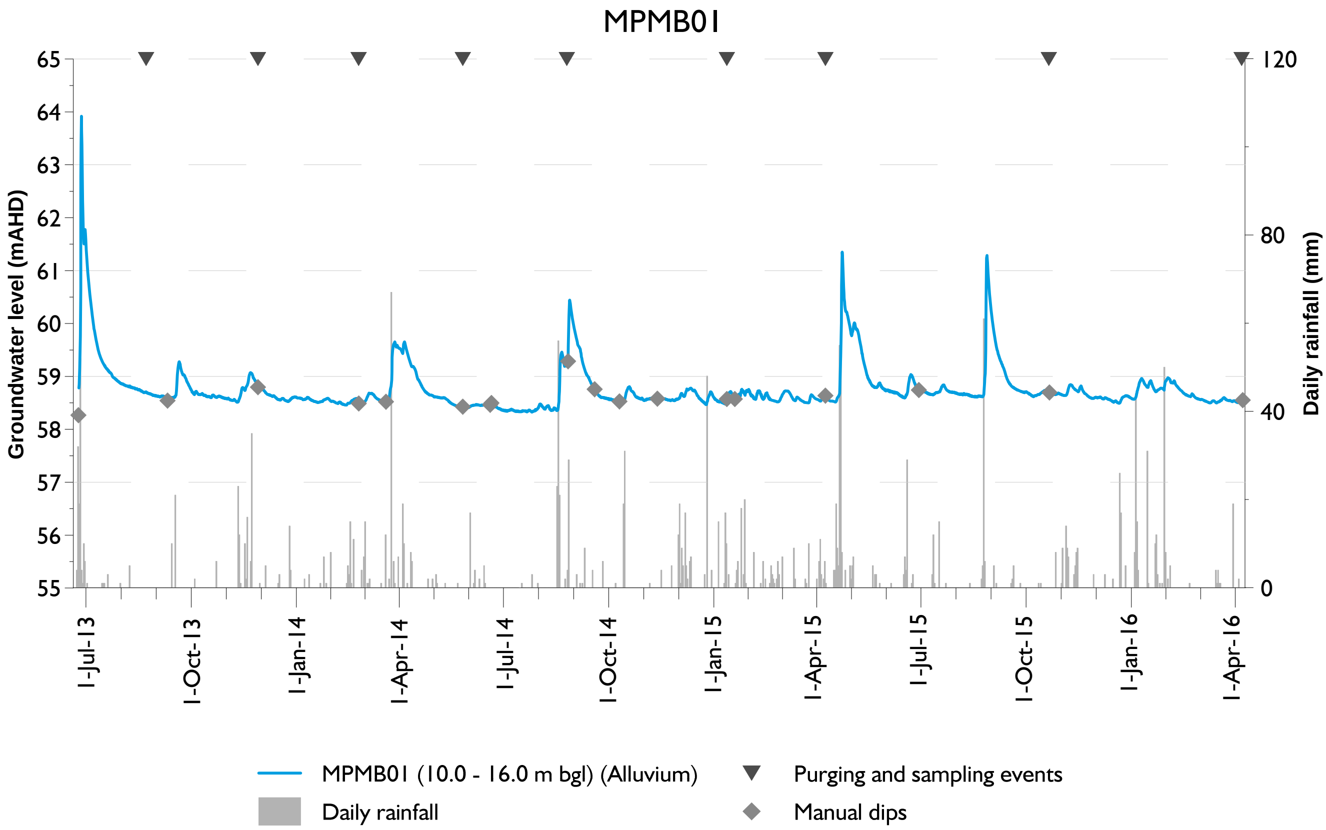
2015 - 2016 Water Monitoring Report

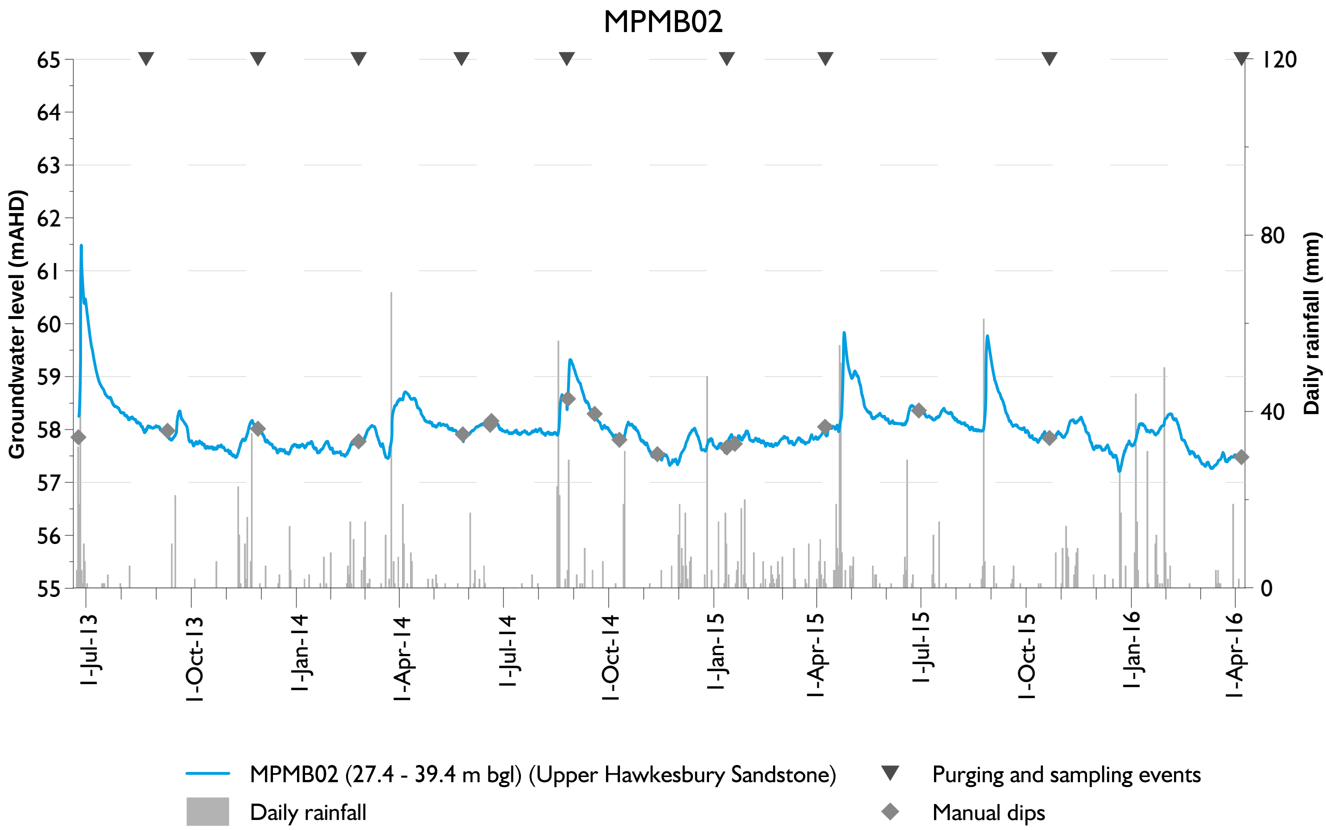
Figure A.1



RMB03 monitoring bore

Camden Gas Project
2015 - 2016 Water Monitoring Report
Figure A.2

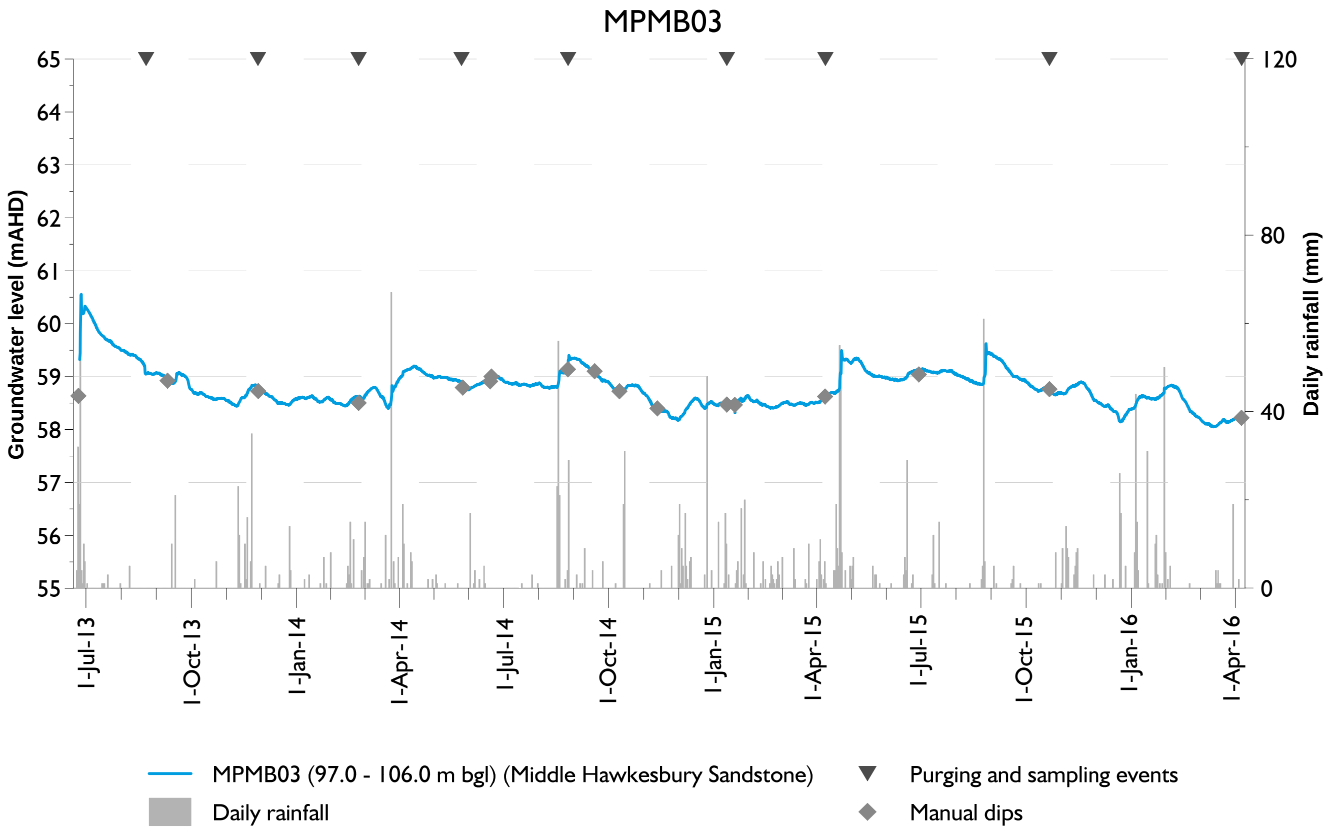


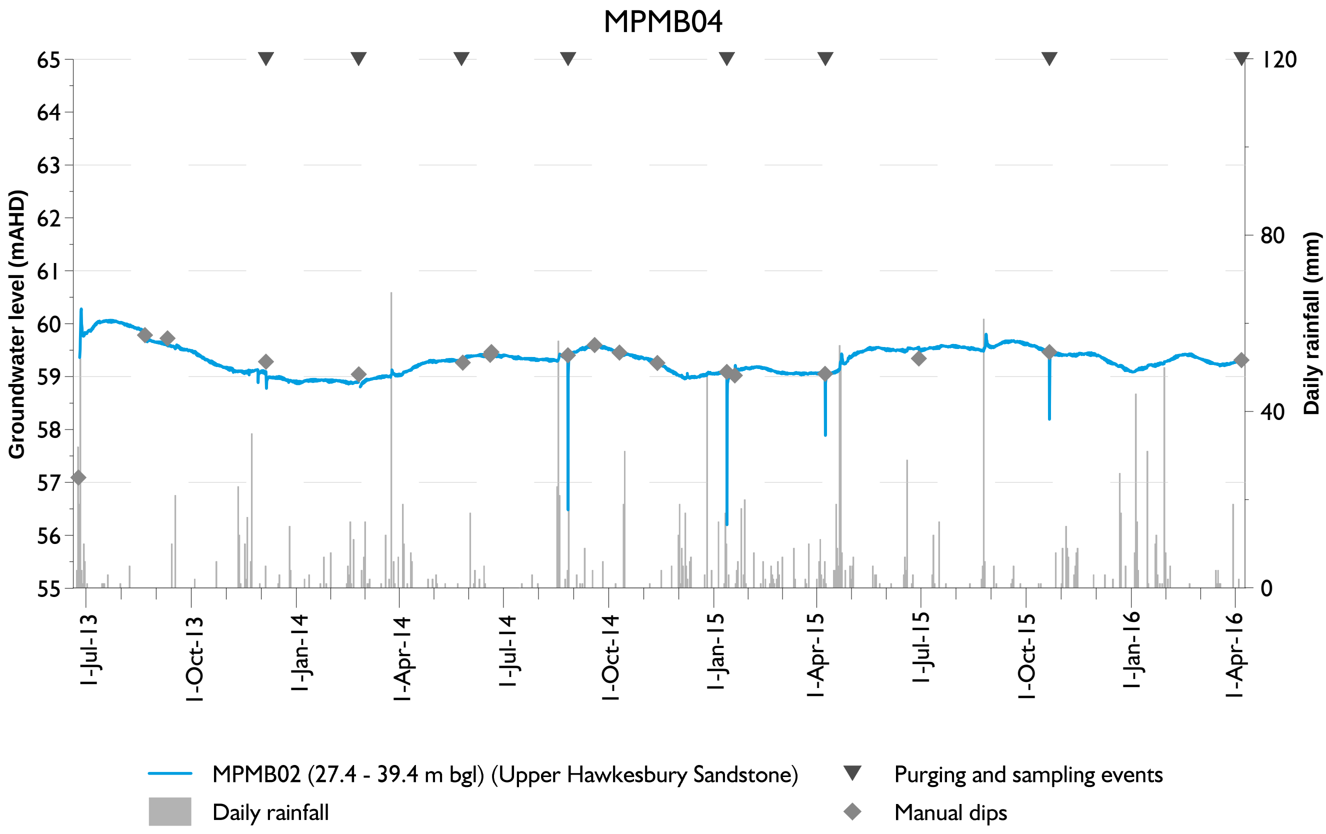


EMM

MPMB01 and MPMB02 hydrographs

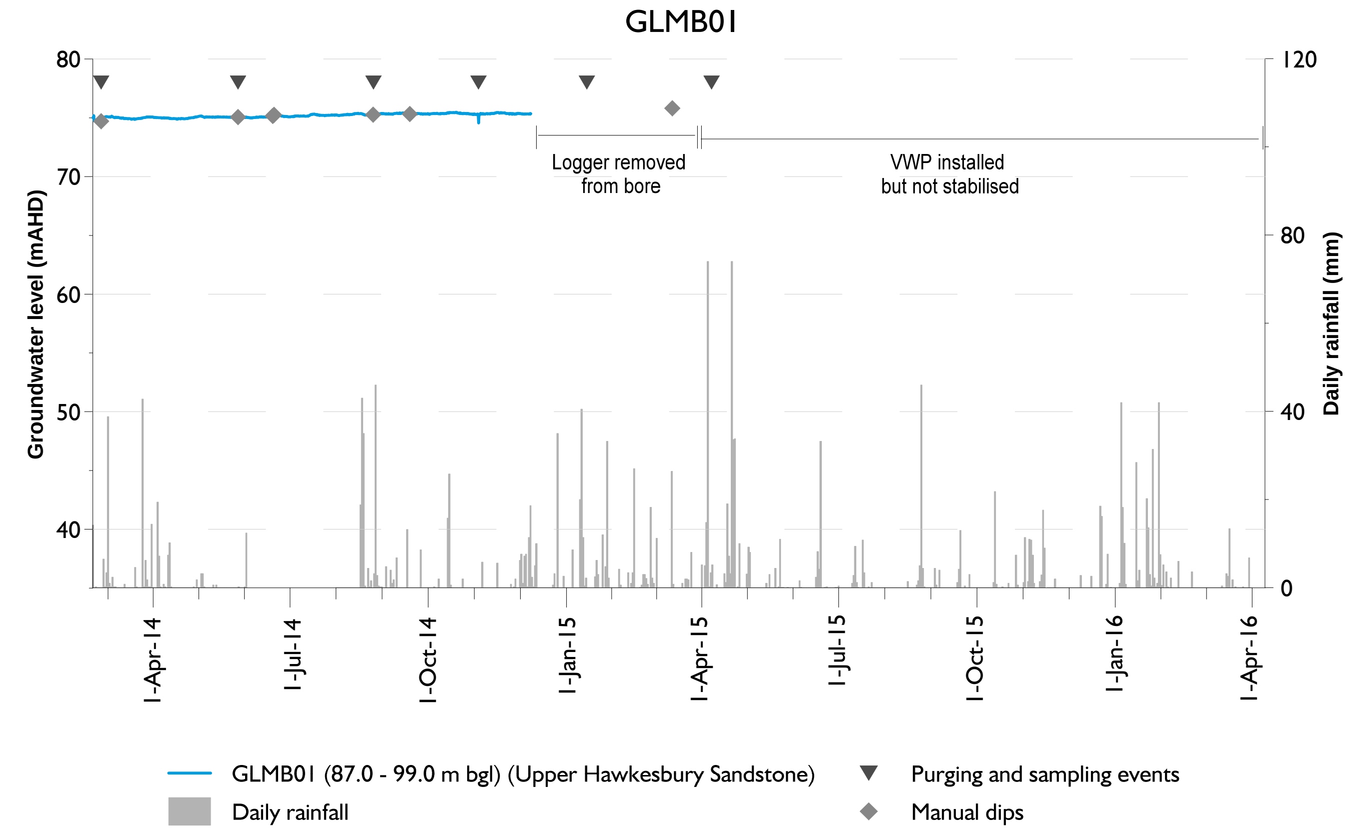
Camden Gas Project
2015 - 2016 Water Monitoring Report
Figure A.3

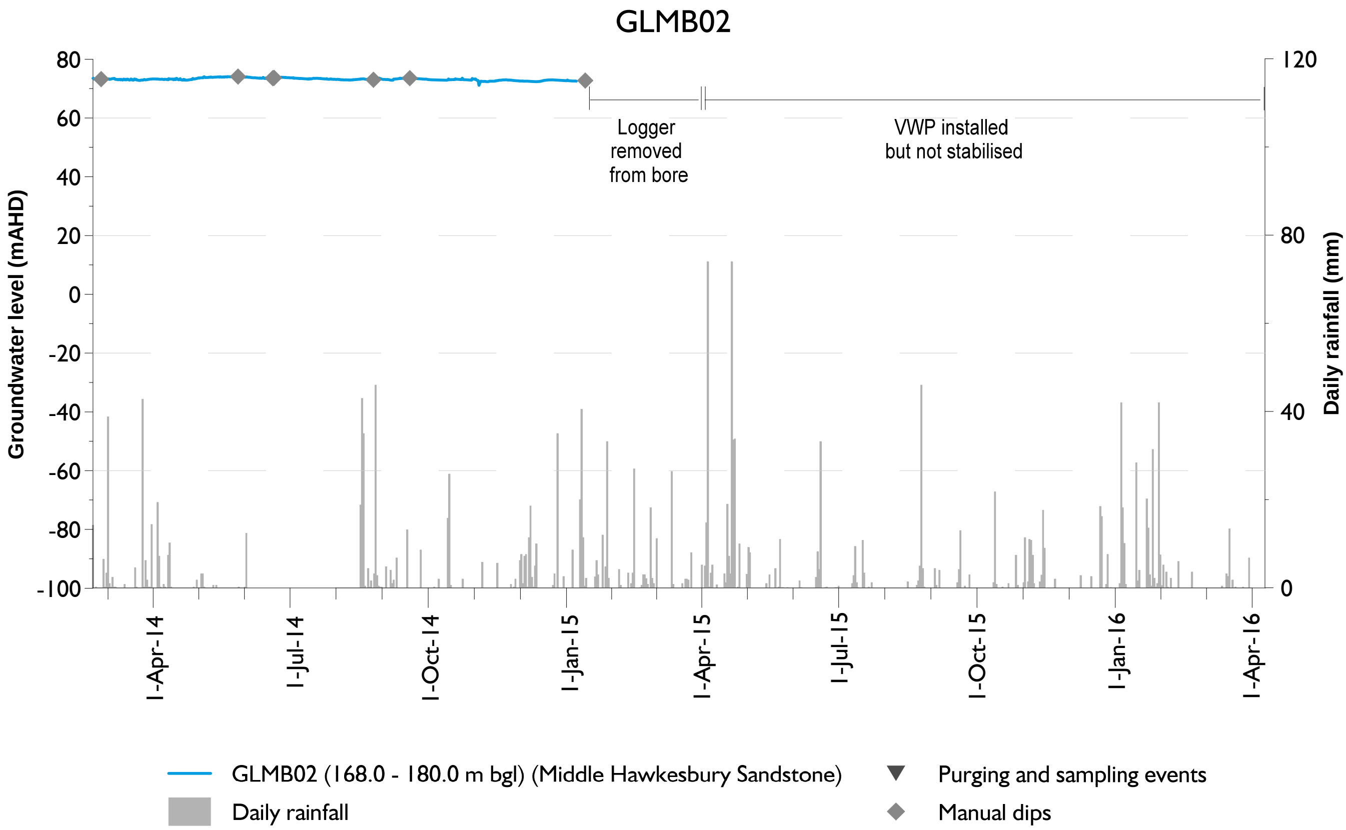




EMM

MPMB03 and MPMB04 hydrographs

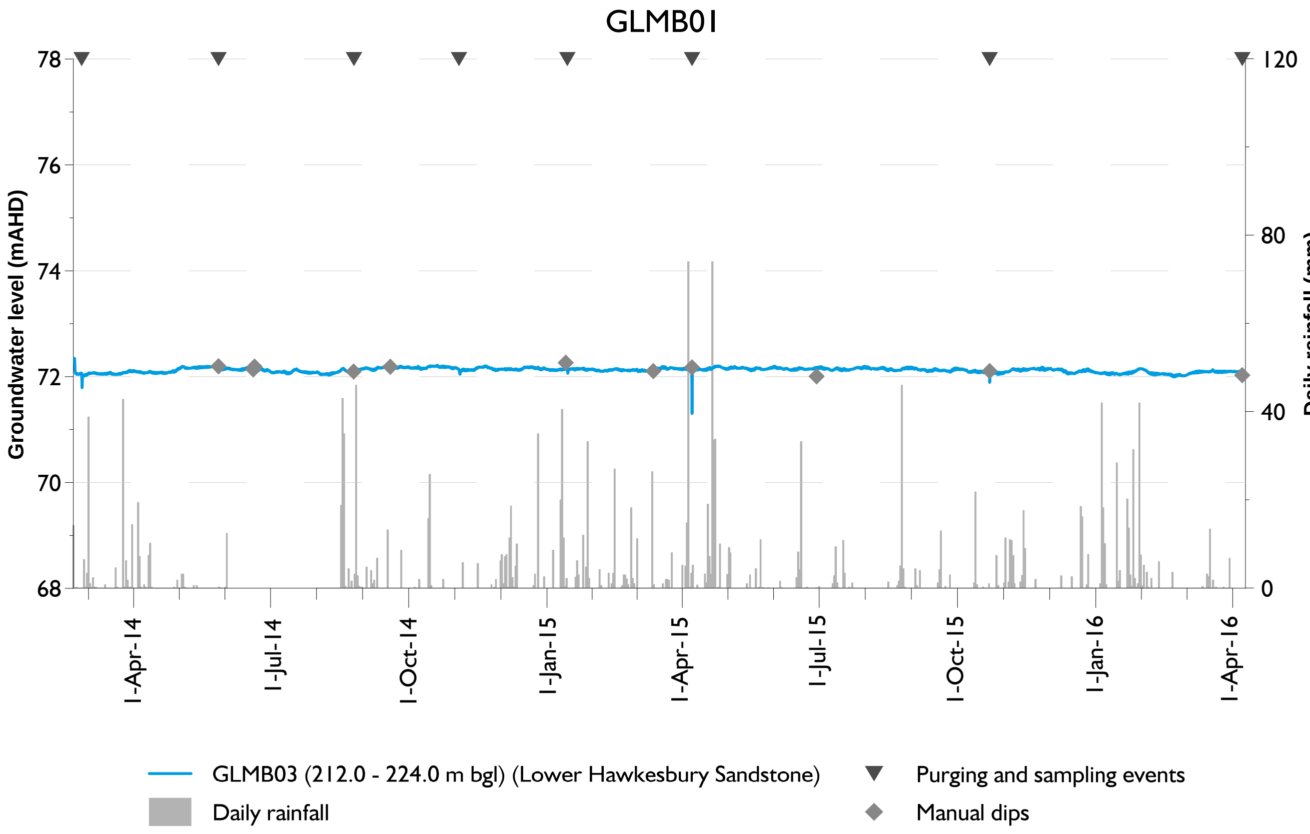




EMM

GLMB01 and GLMB02 hydrographs

Camden Gas Project
2015 - 2016 Water Monitoring Report
Figure A.5



GLMB03 hydrograph

Camden Gas Project
2015 - 2016 Water Monitoring Report
Figure A.6

Appendix B

Water quality summary tables

SUMMARY TABLE B.1 - Water quality results at the Denham Court and Glenee sites (2015/16 monitoring year)

			Site ID	RMB01		RMB02		RMB03		GLMB03	
			Sample date	22/10/2015	7/04/2016	21/10/2015	7/04/2016	21/10/2015	7/04/2016	22/10/2015	7/04/2016
Chemical group	**Analyte**	**Units**	**EQL**								
General parameters	pH (field)	pH units		6.83	6.85	6.62	6.46	9.74	9.85	8.35	7.31
	Electrical conductivity (field)	µS/cm		13,020	13,090	10,250	10,130	7107	7058	4755	4887
	Electrical conductivity (lab)		1	13,700	13,200	10,800	10,300	7480	6990	4940	4800
	Temperature	°C		21.4	19.78	19.2	18.99	19.08	18.96	20.06	20.46
	Dissolved oxygen	%		25	25.8	24.8	8.1	4.3	4.3	2.7	4.6
	Total dissolved solids (field)	mg/L		8463	8510	6662	6566	4620	4580	3091	3182
	Total dissolved solids (lab)	mg/L	1	7630	7820	6180	6080	3970	4020	2660	2930
	Suspended solids	mg/L	5	1350	109	<5	<5	<5	<5	<5	<5
	Redox	mV		-119.2	-141.3	-179.4	-150.2	-274.3	-244.1	-151.1	-232.9
Laboratory analytes	Hydroxide alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Carbonate alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	234	282	184	<1
	Bicarbonate alkalinity as $CaCO_3$	mg/L	1	926	1000	859	976	179	140	1480	1880
	Total alkalinity as $CaCO_3$	mg/L	1	926	1000	859	976	414	421	1670	1880
	Sulphate as SO_4^{2-}	mg/L	1	<1	<1	<10	<10	<1	<1	<1	<10
	Chloride	mg/L	1	3820	4020	3000	3060	1760	1760	607	628
	Calcium	mg/L	1	293	337	308	333	7	8	36	111
	Magnesium	mg/L	1	84	91	81	82	4	3	64	77
	Sodium	mg/L	1	2420	2470	1770	1810	1400	1480	991	999
	Potassium	mg/L	1	28	28	27	29	12	13	34	38
	Reactive Silica	mg/L	0.05	13.5	14.2	10	11.1	7.11	7.53	12.2	21.6
	Fluoride	mg/L	0.1	0.3	0.3	0.2	0.1	0.4	0.4	0.1	<0.1
	Bromide	mg/L	0.01	5.86	6.78	4.84	5.1	3.51	3.86	1.36	1.42
	Cyanide Total	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Dissolved metals	Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001	<0.001
	Arsenic	mg/L	0.001	0.001	0.001	<0.001	<0.001	<0.001	0.001	0.039	0.106
	Barium	mg/L	0.001	33.8	44.1	35.2	36.5	3.42	3.3	8.76	20.9
	Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Boron	mg/L	0.05	0.1	0.1	<0.05	<0.05	0.15	0.16	<0.05	<0.05
	Bromine	mg/L	0.1	7.6	8.1	6.2	6.7	4.3	4.7	1.4	1.6
	Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Cobalt	mg/L	0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
	Copper	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Iron	mg/L	0.05	6.33	7.59	3.77	4.81	<0.05	<0.05	0.14	0.76
	Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	0.025	0.079	0.021	0.021	<0.001	<0.001	0.004	0.02
	Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Molybdenum	mg/L	0.001	<0.001	0.003	<0.001	<0.001	0.004	0.004	0.002	0.002
	Nickel	mg/L	0.001	0.002	0.177	<0.001	0.002	<0.001	<0.001	0.001	0.001
	Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Strontium	mg/L	0.001	13.6	14.5	8.89	9.2	1.17	1.12	2.8	5.09
	Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Zinc	mg/L	0.005	0.022	0.043	0.015	0.019	0.048	0.054	0.009	0.088
Nutrients	Ammonia (as N)	mg/L	0.01	6.07	5.75	4.39	4.56	3.36	3.38	2.51	3.33
	Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrate (as N)	mg/L	0.01	0.01	0.04	0.01	<0.01	0.06	<0.01	0.1	0.01
	Nitrate + Nitrite (as N)	mg/L	0.01	0.01	0.04	0.01	<0.01	0.06	<0.01	0.1	0.01
	Total phosphorus	mg/L	0.01	0.15	0.06	<0.01	<0.01	<0.01	<0.01	0.02	0.04
	Reactive phosphorus (as P)	mg/L	0.01	0.02	0.08	0.02	0.05	0.01	<0.01	0.05	0.04
	Total organic carbon	mg/L	1	57	57	4	15	44	72	5	14
Dissolved gases	Methane	mg/L	0.01	6.6	10.5	31.8	37	35.5	49.8	20.9	47.6
	Ethane	mg/L	0.01	0.155	0.188	0.012	<0.01	0.014	0.013	0.061	0.129
	Ethene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Propane	mg/L	0.01	0.351	0.413	<0.01	<0.01	<0.01	<0.01	0.017	0.035
	Propene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Butene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Butane	mg/L	0.01	0.057	0.095	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenolic compounds	Phenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2-chlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	3-&4-methylphenol	µg/L	2	<2	<2	<2	<2	<2	2.2	<2	<2
	2-nitrophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2,4-dimethylphenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2,4-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2,6-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	4-chloro-3-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2,4,6-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	2,4,5-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Pentachlorophenol	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Polycyclic aromatic hydrocarbons	Acenaphthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Acenaphthylene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Fluorene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Phenanthrene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Anthracene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Pyrene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Benz(a)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Chrysene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Benzo(b&j)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Benzo(a) pyrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Benzo(a)pyrene TEQ calc (Zero)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Indeno(1,2,3-c,d)pyrene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dibenz(a,h)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	Benzo(g,h,i)perylene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
	PAHs (Sum of total)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total petroleum hydrocarbons	C_6-C_9 fraction	µg/L	20	80	90	<20	<20	60	70	220	200
	C_{10}-C_{14} fraction	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50
	C_{15}-C_{28} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100
	C_{29}-C_{36} fraction	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50
	C_{10}-C_{36} fraction (sum)	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50
Total recoverable hydrocarbons	C_6-C_{10} fraction	µg/L	20	80	80	<20	<20	70	70	230	200
	C_6-C_{10} fraction minus BTEX	µg/L	20	50	50	<20	<20	40	40	130	100
	>C_{10}-C_{16} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100
	>C_{16}-C_{34} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100
	>C_{34}-C_{40} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100
	>C_{10}-C_{40} fraction (sum)	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100
Aromatic hydrocarbons	Benzene	µg/L	1	21	21	<1	<1	<1	<1	<1	<1
	Toluene	µg/L	2	3	<2	<2	<2	34	32	104	104
	Ethylbenzene	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2
	Xylene (m & p)	µg/L	2	5	6	<2	<2	<2	<2	<2	<2
	Xylene (o)	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2
	Xylene Total	µg/L	2	5	6	<2	<2	<2	<2	<2	<2
	Total BTEX	µg/L	1	29	27	<1	<1	34	32	104	104
	Naphthalene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1

SUMMARY TABLE B.2 - Water quality results at the Menangle Park site (2015/16 monitoring year)

			Site ID	MPMB01		MPMB02		MPMB03		MPMB04		ANZECC 2000 guideline values for fresh water ecosystems 95%*	NR
			Sample date	21/10/2015	6/04/2016	21/10/2015	6/04/2016	21/10/2015	6/04/2016	21/10/2015	6/04/2016		21/10/2015
Chemical group	**Analyte**	**Units**	**EQL**										
General parameters	pH (field)	pH units		5.15	6.1	6.5	6.4	6.98	6.86	10.1	10.06	6.5 - 8.0**	7.5
	Electrical conductivity (field)	µS/cm	1	864	995	929	905	1066	1063	926	782	125 - 2,200**	199
	Electrical conductivity (lab)			854	768	906	812	1050	970	903	787		183
	Temperature	°C		18.99	22.7	19.57	20.75	21.02	20.54	22.13	24.5		23.03
	Dissolved oxygen	%		16.7	17.6	18.4	9.5	11.2	7	1.5	4.6	80 - 110**	63.6
	Total dissolved solids (field)	mg/L		561	647	604	588	693	691	602	525		129
	Total dissolved solids (lab)	mg/L	1	555	540	589	484	682	593	587	484		119
	Suspended solids	mg/L	5	41	20	18	6	<5	7	<5	<5		6
	Redox	mV		109.8	-41.4	-88.5	-120.9	-100.1	-130.4	-334.8	-162.8		-35.2
Laboratory analytes	Hydroxide alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Carbonate alkalinity as $CaCO_3$	mg/L	1	<1	<1	<1	<1	<1	<1	136	170		<1
	Bicarbonate alkalinity as $CaCO_3$	mg/L	1	11	28	185	201	422	507	94	87		37
	Total alkalinity as $CaCO_3$	mg/L	1	11	28	185	201	422	507	230	257		37
	Sulphate as SO_4^{2-}	mg/L	1	2	3	4	4	<1	<1	<1	<1		3
	Chloride	mg/L	1	253	236	170	166	66	65	120	113		28
	Calcium	mg/L	1	11	12	33	33	91	89	4	3		3
	Magnesium	mg/L	1	20	21	30	29	23	23	3	2		4
	Sodium	mg/L	1	107	113	107	100	115	113	187	183		24
	Potassium	mg/L	1	1	2	3	3	13	13	12	11		2
	Reactive Silica	mg/L	0.05	18.9	20	13.1	13.8	9.68	8.98	3.48	3.65		1.5
	Fluoride	mg/L	0.1	<0.1	<0.1	0.2	0.2	0.2	0.2	0.4	0.4		<0.1
	Bromide	mg/L	0.01	0.49	0.527	0.313	0.36	0.133	0.146	0.229	0.243		0.058
	Cyanide Total	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.007	<0.004
Dissolved metals	Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.055	<0.01
	Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Arsenic	mg/L	0.001	<0.001	<0.001	0.001	0.002	0.017	0.015	0.001	0.002		<0.001
	Barium	mg/L	0.001	0.575	0.588	0.544	0.561	3.12	3.29	0.569	0.525		0.04
	Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Boron	mg/L	0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.37	<0.05
	Bromine	mg/L	0.1	0.6	0.5	0.4	0.4	0.2	0.2	0.3	0.2		<0.1
	Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
	Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Cobalt	mg/L	0.001	0.036	0.033	<0.001	<0.001	0.002	0.002	<0.001	<0.001		<0.001
	Copper	mg/L	0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0014	<0.001
	Iron	mg/L	0.05	<0.05	0.16	3.63	3.7	1.22	1.35	<0.05	<0.05		0.12
	Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0034	<0.001
	Manganese	mg/L	0.001	0.414	0.426	0.126	0.145	0.041	0.039	<0.001	<0.001	1.9	0.012
	Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	0.0006	<0.0001
	Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.005		<0.001
	Nickel	mg/L	0.001	0.013	0.012	<0.001	<0.001	0.003	0.003	<0.001	<0.001	0.011	0.002
	Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.011	<0.01
	Strontium	mg/L	0.001	0.127	0.156	0.38	0.479	0.855	0.891	0.148	0.128		0.034
	Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
	Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Zinc	mg/L	0.005	0.055	0.063	0.016	0.027	<0.005	0.014	0.035	0.046	0.008	<0.005
Nutrients	Ammonia (as N)	mg/L	0.01	0.02	0.01	0.1	0.08	0.84	0.81	0.87	0.82	0.02*	0.03
	Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Nitrate (as N)	mg/L	0.01	0.21	0.2	0.01	0.01	0.01	0.04	0.01	<0.01		0.08
	Nitrate + Nitrite (as N)	mg/L	0.01	0.21	0.2	0.01	0.01	0.01	0.04	0.01	<0.01		0.08
	Total phosphorus	mg/L	0.01	0.02	0.08	0.02	0.02	<0.01	<0.01	<0.01	<0.01	0.05*	<0.01
	Reactive phosphorus (as P)	mg/L	0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02*	<0.01
	Total organic carbon	mg/L	1	<1	4	2	2	<1	1	18	15		3
Dissolved gases	Methane	mg/L	0.01	<0.01	0.029	0.452	0.325	43.6	25.8	27.2	35.5		0.022
	Ethane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Ethene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Propane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Propene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Butene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
	Butane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01
Phenolic compounds	Phenol	µg/L	1	<1	<1	<1	<1	<1	<1	3.2	3.2	320	<1
	2-chlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	490	<1
	2-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	3-&4-methylphenol	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2		<2
	2-nitrophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	2,4-dimethylphenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	2,4-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	160	<1
	2,6-dichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	4-chloro-3-methylphenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	2,4,6-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	20	<1
	2,4,5-trichlorophenol	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Pentachlorophenol	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2	10	<2
Polycyclic aromatic hydrocarbons	Acenaphthene	µg/L	1	<1	<1	1.4	<1	<1	<1	<1	<1		<1
	Acenaphthylene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Fluorene	µg/L	1	<1	<1	1.2	<1	<1	<1	<1	<1		<1
	Phenanthrene	µg/L	1	2.2	<1	2.6	<1	<1	<1	<1	<1		<1
	Anthracene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Pyrene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Benz(a)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Chrysene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Benzo(b&j)fluoranthene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Benzo(a) pyrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5
	Benzo(a)pyrene TEQ calc (Zero)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5
	Indeno(1,2,3-c,d)pyrene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Dibenz(a,h)anthracene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	Benzo(g,h,i)perylene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1		<1
	PAHs (Sum of total)	µg/L	0.5	2.2	<0.5	5.2	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5
Total petroleum hydrocarbons	C_6-C_9 fraction	µg/L	20	<20	<20	<20	<20	<20	<20	100	90		<20
	C_{10}-C_{14} fraction	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50		<50
	C_{15}-C_{28} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100		<100
	C_{29}-C_{36} fraction	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50		<50
	C_{10}-C_{36} fraction (sum)	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50		<50
Total recoverable hydrocarbons	C_6-C_{10} fraction	µg/L	20	<20	<20	<20	<20	<20	<20	100	90		<20
	C_6-C_{10} fraction minus BTEX	µg/L	20	<20	<20	<20	<20	<20	<20	40	30		<20
	>C_{10}-C_{16} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100		<100
	>C_{16}-C_{34} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100		<100
	>C_{34}-C_{40} fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100		<100
	>C_{10}-C_{40} fraction (sum)	µg/L	100	<100	<100	<100	<100	<100	<100	<100	<100		<100
Aromatic hydrocarbons	Benzene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	950	<1
	Toluene	µg/L	2	<2	<2	<2	<2	<2	<2	57	60		<2
	Ethylbenzene	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2		<2
	Xylene (m & p)	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2		<2
	Xylene (o)	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2	350	<2
	Xylene Total	µg/L	2	<2	<2	<2	<2	<2	<2	<2	<2		<2
	Total BTEX	µg/L	1	<1	<1	<1	<1	<1	<1	57	60		<1
	Naphthalene	µg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	16	<1

*Notes: * ANZECC (2000) Water Quality Guidelines only apply to Nepean River (NR) sample.*

*** ANZECC (2000) Water Quality Guidelines: 95% protection levels for the protection of freshwater aquatic ecosystems, south-east Australia, low lying river ecosystems.*

Appendix C

ALS laboratory reports

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1534327**	Page	: 1 of 12
Amendment	: **2**		
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS CAROLINA SARDELLA	Contact	:
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: csardella@pb.com.au	E-mail	:
Telephone	: +61 02 92725100	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 92725101	Facsimile	: +61-2-8784 8500
Project	: 2200564A	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 22-Oct-2015 16:30
C-O-C number	: ----	Date Analysis Commenced	: 23-Oct-2015
Sampler	: ANDREW FARINA, ANGUS MCFARLANE	Issue Date	: 06-Nov-2015 15:00
Site	: ----		
		No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

NATA WORLD RECOGNISED ACCREDITATION

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

General Comments

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG035: Positive Hg results have been confirmed by reanalysis.
- It has been noted that Reactive P is greater than Total P for sample 4, however this difference is within the limits of experimental variation.
- This report has been amended and re-released to allow the reporting of additional analytical data.
- This report has been amended to alter the project reference number. All analysis results are as per the previous report.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	NR NP
			Client sampling date / time	21-Oct-2015 14:30	21-Oct-2015 13:45	21-Oct-2015 11:30	21-Oct-2015 12:00	21-Oct-2015 13:00
Compound	CAS Number	LOR	Unit	ES1534327-001	ES1534327-002	ES1534327-003	ES1534327-004	ES1534327-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.82**	**7.11**	**7.66**	**9.85**	**7.79**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**854**	**906**	**1050**	**903**	**183**
EA016: Calculated TDS (from Electrical Conductivity)								
^ Total Dissolved Solids (Calc.)	----	1	mg/L	**555**	**589**	**682**	**587**	**119**
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	5	mg/L	**41**	**18**	<5	<5	**6**
ED009: Anions								
Bromide	24959-67-9	0.01	mg/L	**0.490**	**0.313**	**0.133**	**0.229**	**0.058**
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	**136**	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**11**	**185**	**422**	**94**	**37**
Total Alkalinity as CaCO3	----	1	mg/L	**11**	**185**	**422**	**230**	**37**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	**4**	<1	<1	**3**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**253**	**170**	**66**	**120**	**28**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**11**	**33**	**91**	**4**	**3**
Magnesium	7439-95-4	1	mg/L	**20**	**30**	**23**	**3**	**4**
Sodium	7440-23-5	1	mg/L	**107**	**107**	**115**	**187**	**24**
Potassium	7440-09-7	1	mg/L	**1**	**3**	**13**	**12**	**2**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	**0.017**	**0.001**	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Strontium	7440-24-6	0.001	mg/L	**0.127**	**0.380**	**0.855**	**0.148**	**0.034**
Barium	7440-39-3	0.001	mg/L	**0.575**	**0.544**	**3.12**	**0.569**	**0.040**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	**0.036**	<0.001	**0.002**	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	NR NP
			Client sampling date / time	21-Oct-2015 14:30	21-Oct-2015 13:45	21-Oct-2015 11:30	21-Oct-2015 12:00	21-Oct-2015 13:00
Compound	CAS Number	LOR	Unit	ES1534327-001	ES1534327-002	ES1534327-003	ES1534327-004	ES1534327-005
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.003**	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.414**	**0.126**	**0.041**	<0.001	**0.012**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	**0.004**	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.013**	<0.001	**0.003**	<0.001	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.055**	**0.016**	<0.005	**0.035**	<0.005
Iron	7439-89-6	0.05	mg/L	<0.05	**3.63**	**1.22**	<0.05	**0.12**
Bromine	7726-95-6	0.1	mg/L	**0.6**	**0.4**	**0.2**	**0.3**	<0.1
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0002**	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**18.9**	**13.1**	**9.68**	**3.48**	**1.50**
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	**0.2**	**0.2**	**0.4**	<0.1
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**0.10**	**0.84**	**0.87**	**0.03**
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	<0.01
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.21**	**0.01**	**0.01**	**0.01**	**0.08**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.21**	**0.01**	**0.01**	**0.01**	**0.08**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.02**	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01
EN055: Ionic Balance								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	NR NP
			Client sampling date / time	21-Oct-2015 14:30	21-Oct-2015 13:45	21-Oct-2015 11:30	21-Oct-2015 12:00	21-Oct-2015 13:00
Compound	CAS Number	LOR	Unit	ES1534327-001	ES1534327-002	ES1534327-003	ES1534327-004	ES1534327-005
				Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued								
^ Total Anions	----	0.01	meq/L	**7.40**	**8.58**	**10.3**	**7.98**	**1.59**
^ Total Cations	----	0.01	meq/L	**6.87**	**8.85**	**11.8**	**8.89**	**1.57**
^ Ionic Balance	----	0.01	%	**3.68**	**1.54**	**6.68**	**5.33**	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	**2**	<1	**18**	**3**
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	<10	**452**	**43600**	**27200**	**22**
Ethene	74-85-1	10	µg/L	<10	<10	<10	<10	<10
Ethane	74-84-0	10	µg/L	<10	<10	<10	<10	<10
Propene	115-07-1	10	µg/L	<10	<10	<10	<10	<10
Propane	74-98-6	10	µg/L	<10	<10	<10	<10	<10
Butene	25167-67-3	10	µg/L	<10	<10	<10	<10	<10
Butane	106-97-8	10	µg/L	<10	<10	<10	<10	<10
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	<1.0	<1.0	<1.0	**3.2**	<1.0
2-Chlorophenol	95-57-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2-Methylphenol	95-48-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
2-Nitrophenol	88-75-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorophenol	87-86-5	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1	µg/L	<1.0	**1.4**	<1.0	<1.0	<1.0
Fluorene	86-73-7	1	µg/L	<1.0	**1.2**	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1	µg/L	**2.2**	**2.6**	<1.0	<1.0	<1.0
Anthracene	120-12-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	NR NP
			Client sampling date / time	21-Oct-2015 14:30	21-Oct-2015 13:45	21-Oct-2015 11:30	21-Oct-2015 12:00	21-Oct-2015 13:00
Compound	CAS Number	LOR	Unit	ES1534327-001	ES1534327-002	ES1534327-003	ES1534327-004	ES1534327-005
				Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Pyrene	129-00-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	**2.2**	**5.2**	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	**100**	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	**100**	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	**40**	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	**57**	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L	<2	<2	<2	<2	<2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	NR NP
			Client sampling date / time	21-Oct-2015 14:30	21-Oct-2015 13:45	21-Oct-2015 11:30	21-Oct-2015 12:00	21-Oct-2015 13:00
Compound	CAS Number	LOR	Unit	ES1534327-001	ES1534327-002	ES1534327-003	ES1534327-004	ES1534327-005
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	57	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1	%	28.1	30.2	21.3	16.5	24.8
2-Chlorophenol-D4	93951-73-6	1	%	67.3	63.6	43.2	37.4	50.6
2.4.6-Tribromophenol	118-79-6	1	%	58.9	53.5	38.2	44.6	37.3
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1	%	76.3	76.2	61.4	65.2	58.5
Anthracene-d10	1719-06-8	1	%	98.1	84.5	80.1	87.9	88.5
4-Terphenyl-d14	1718-51-0	1	%	95.7	91.0	68.3	82.6	76.8
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	107	105	112	100	88.4
Toluene-D8	2037-26-5	2	%	102	91.9	116	113	110
4-Bromofluorobenzene	460-00-4	2	%	73.9	93.6	87.4	97.0	106

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA1	----	----	----	----
			Client sampling date / time	21-Oct-2015 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1534327-006	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.13**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**904**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
^ Total Dissolved Solids (Calc.)	----	1	mg/L	**588**	----	----	----	----
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	5	mg/L	**6**	----	----	----	----
ED009: Anions								
Bromide	24959-67-9	0.01	mg/L	**0.317**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**182**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**182**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**4**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**164**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**34**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**30**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**106**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.384**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.546**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA1	----	----	----	----
			Client sampling date / time	21-Oct-2015 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1534327-006	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.130**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.016**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**3.62**	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	**0.4**	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**13.0**	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.08**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EN055: Ionic Balance								
^ Total Anions	----	0.01	meq/L	**8.34**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA1	----	----	----	----
			Client sampling date / time	21-Oct-2015 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1534327-006	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued								
^ Total Cations	----	0.01	meq/L	**8.85**	----	----	----	----
^ Ionic Balance	----	0.01	%	**2.94**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**2**	----	----	----	----
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	**438**	----	----	----	----
Ethene	74-85-1	10	µg/L	<10	----	----	----	----
Ethane	74-84-0	10	µg/L	<10	----	----	----	----
Propene	115-07-1	10	µg/L	<10	----	----	----	----
Propane	74-98-6	10	µg/L	<10	----	----	----	----
Butene	25167-67-3	10	µg/L	<10	----	----	----	----
Butane	106-97-8	10	µg/L	<10	----	----	----	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	<1.0	----	----	----	----
2-Chlorophenol	95-57-8	1	µg/L	<1.0	----	----	----	----
2-Methylphenol	95-48-7	1	µg/L	<1.0	----	----	----	----
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	----	----	----	----
2-Nitrophenol	88-75-5	1	µg/L	<1.0	----	----	----	----
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	----	----	----	----
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	----	----	----	----
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	----	----	----	----
Pentachlorophenol	87-86-5	2	µg/L	<2.0	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1	µg/L	<1.0	----	----	----	----
Acenaphthylene	208-96-8	1	µg/L	<1.0	----	----	----	----
Acenaphthene	83-32-9	1	µg/L	**1.1**	----	----	----	----
Fluorene	86-73-7	1	µg/L	<1.0	----	----	----	----
Phenanthrene	85-01-8	1	µg/L	**2.1**	----	----	----	----
Anthracene	120-12-7	1	µg/L	<1.0	----	----	----	----
Fluoranthene	206-44-0	1	µg/L	<1.0	----	----	----	----
Pyrene	129-00-0	1	µg/L	<1.0	----	----	----	----

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

	Compound	CAS Number	LOR	Unit	QA1	----	----	----	----
	Client sampling date / time				21-Oct-2015 00:00	----	----	----	----
					ES1534327-006	--------	--------	--------	--------
					Result	Result	Result	Result	Result
	EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
	Benz(a)anthracene	56-55-3	1	µg/L	<1.0	----	----	----	----
	Chrysene	218-01-9	1	µg/L	<1.0	----	----	----	----
	Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	----	----	----	----
	Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	----	----	----	----
	Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	----	----	----	----
	Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	----	----	----	----
	Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	----	----	----	----
	Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	----	----	----	----
^	Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	**3.2**	----	----	----	----
^	Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	----	----	----	----
	EP080/071: Total Petroleum Hydrocarbons								
	C6 - C9 Fraction	----	20	µg/L	<20	----	----	----	----
	C10 - C14 Fraction	----	50	µg/L	<50	----	----	----	----
	C15 - C28 Fraction	----	100	µg/L	<100	----	----	----	----
	C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
^	C10 - C36 Fraction (sum)	----	50	µg/L	<50	----	----	----	----
	EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
	C6 - C10 Fraction	C6_C10	20	µg/L	<20	----	----	----	----
^	C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	----	----	----	----
	>C10 - C16 Fraction	----	100	µg/L	<100	----	----	----	----
	>C16 - C34 Fraction	----	100	µg/L	<100	----	----	----	----
	>C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
^	>C10 - C40 Fraction (sum)	----	100	µg/L	<100	----	----	----	----
^	>C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	----	----	----	----
	EP080: BTEXN								
	Benzene	71-43-2	1	µg/L	<1	----	----	----	----
	Toluene	108-88-3	2	µg/L	<2	----	----	----	----
	Ethylbenzene	100-41-4	2	µg/L	<2	----	----	----	----
	meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	----	----	----	----
	ortho-Xylene	95-47-6	2	µg/L	<2	----	----	----	----
^	Total Xylenes	1330-20-7	2	µg/L	<2	----	----	----	----
^	Sum of BTEX	----	1	µg/L	<1	----	----	----	----
	Naphthalene	91-20-3	5	µg/L	<5	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA1	----	----	----	----
			Client sampling date / time	21-Oct-2015 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1534327-006	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1	%	27.0	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1	%	53.2	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1	%	44.0	----	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1	%	65.2	----	----	----	----
Anthracene-d10	1719-06-8	1	%	87.7	----	----	----	----
4-Terphenyl-d14	1718-51-0	1	%	80.8	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	89.2	----	----	----	----
Toluene-D8	2037-26-5	2	%	108	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%	102	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1534446**	Page	: 1 of 7
Amendment	: **3**		
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS CAROLINA SARDELLA	Contact	:
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: csardella@pb.com.au	E-mail	:
Telephone	: +61 02 92725100	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 92725101	Facsimile	: +61-2-8784 8500
Project	: 2200564A	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 23-Oct-2015 16:10
C-O-C number	: ----	Date Analysis Commenced	: 24-Oct-2015
Sampler	: ANDREW FARINA, ANGUS MCFARLANE	Issue Date	: 26-Nov-2015 15:00
Site	: ----		
		No. of samples received	: 4
Quote number	: ----	No. of samples analysed	: 4

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

General Comments

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- ED041G: LOR raised for Sulfate analysis on sample no:3 due to matrix interferences.
- It has been noted that Reactive P is greater than Total P, however this difference is within the limits of experimental variation.
- This report has been amended as a result of misinterpretation of sampling dates. All analysis results are as per the previous report
- This report has been amended to alter the project number. All analysis results are as per the previous report.
- This report has been amended following changes to the analytical data reported. The quality system is being utilised to resolve this issue. The specific data affected includes sample 4 chloride results.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GLMB03	RMB01	RMB02	RMB03	----
			Client sampling date / time	22-Oct-2015 10:30	22-Oct-2015 13:30	22-Oct-2015 13:00	22-Oct-2015 13:00	----
Compound	CAS Number	LOR	Unit	ES1534446-001	ES1534446-002	ES1534446-003	ES1534446-004	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.68**	**7.61**	**7.35**	**9.71**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**4940**	**13700**	**10800**	**7480**	----
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	----	10	mg/L	**2660**	**7630**	**6180**	**3970**	----
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	<5	**1350**	<5	<5	----
ED009: Anions								
Bromide	24959-67-9	0.01	mg/L	**1.36**	**5.86**	**4.84**	**3.51**	----
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	**184**	<1	<1	**234**	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**1480**	**926**	**859**	**179**	----
Total Alkalinity as CaCO3	----	1	mg/L	**1670**	**926**	**859**	**414**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<10	<1	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**607**	**3820**	**3000**	**1760**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**36**	**293**	**308**	**7**	----
Magnesium	7439-95-4	1	mg/L	**64**	**84**	**81**	**4**	----
Sodium	7440-23-5	1	mg/L	**991**	**2420**	**1770**	**1400**	----
Potassium	7440-09-7	1	mg/L	**34**	**28**	**27**	**12**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.039**	**0.001**	<0.001	<0.001	----
Boron	7440-42-8	0.05	mg/L	<0.05	**0.10**	<0.05	**0.15**	----
Strontium	7440-24-6	0.001	mg/L	**2.80**	**13.6**	**8.89**	**1.17**	----
Barium	7440-39-3	0.001	mg/L	**8.76**	**33.8**	**35.2**	**3.42**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GLMB03	RMB01	RMB02	RMB03	----
			Client sampling date / time	22-Oct-2015 10:30	22-Oct-2015 13:30	22-Oct-2015 13:00	22-Oct-2015 13:00	----
Compound	CAS Number	LOR	Unit	ES1534446-001	ES1534446-002	ES1534446-003	ES1534446-004	--------
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.004**	**0.025**	**0.021**	<0.001	----
Molybdenum	7439-98-7	0.001	mg/L	**0.002**	<0.001	<0.001	**0.004**	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.002**	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	**0.002**	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	**0.009**	**0.022**	**0.015**	**0.048**	----
Iron	7439-89-6	0.05	mg/L	**0.14**	**6.33**	**3.77**	<0.05	----
Bromine	7726-95-6	0.1	mg/L	**1.4**	**7.6**	**6.2**	**4.3**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**12.2**	**13.5**	**10.0**	**7.11**	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	<0.004	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.1**	**0.3**	**0.2**	**0.4**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**2.51**	**6.07**	**4.39**	**3.36**	----
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	**0.10**	**0.01**	**0.01**	**0.06**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.10**	**0.01**	**0.01**	**0.06**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.15**	<0.01	<0.01	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.05**	**0.02**	**0.02**	**0.01**	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**5**	**57**	**4**	**44**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GLMB03	RMB01	RMB02	RMB03	----
			Client sampling date / time	22-Oct-2015 10:30	22-Oct-2015 13:30	22-Oct-2015 13:00	22-Oct-2015 13:00	----
Compound	CAS Number	LOR	Unit	ES1534446-001	ES1534446-002	ES1534446-003	ES1534446-004	--------
				Result	Result	Result	Result	Result
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	**20900**	**6600**	**31800**	**35500**	----
Ethene	74-85-1	10	µg/L	<10	<10	<10	<10	----
Ethane	74-84-0	10	µg/L	**61**	**155**	**12**	**14**	----
Propene	115-07-1	10	µg/L	<10	<10	<10	<10	----
Propane	74-98-6	10	µg/L	**17**	**351**	<10	<10	----
Butene	25167-67-3	10	µg/L	<10	<10	<10	<10	----
Butane	106-97-8	10	µg/L	<10	**57**	<10	<10	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2-Chlorophenol	95-57-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2-Methylphenol	95-48-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	<2.0	<2.0	<2.0	----
2-Nitrophenol	88-75-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Pentachlorophenol	87-86-5	2	µg/L	<2.0	<2.0	<2.0	<2.0	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluorene	86-73-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Anthracene	120-12-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Pyrene	129-00-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Chrysene	218-01-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GLMB03	RMB01	RMB02	RMB03	----
			Client sampling date / time	22-Oct-2015 10:30	22-Oct-2015 13:30	22-Oct-2015 13:00	22-Oct-2015 13:00	----
Compound	CAS Number	LOR	Unit	ES1534446-001	ES1534446-002	ES1534446-003	ES1534446-004	--------
				Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	**220**	**80**	<20	**60**	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	**230**	**80**	<20	**70**	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	**130**	**50**	<20	**40**	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	<100	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	**21**	<1	<1	----
Toluene	108-88-3	2	µg/L	**104**	**3**	<2	**34**	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	**5**	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	----
^ **Total Xylenes**	1330-20-7	2	µg/L	<2	**5**	<2	<2	----
^ **Sum of BTEX**	----	1	µg/L	**104**	**29**	<1	**34**	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1	%	**27.1**	**22.4**	**24.6**	**20.4**	----
2-Chlorophenol-D4	93951-73-6	1	%	**51.7**	**44.6**	**54.8**	**36.5**	----
2.4.6-Tribromophenol	118-79-6	1	%	**45.7**	**43.2**	**45.6**	**39.8**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GLMB03	RMB01	RMB02	RMB03	----
			Client sampling date / time	22-Oct-2015 10:30	22-Oct-2015 13:30	22-Oct-2015 13:00	22-Oct-2015 13:00	----
Compound	CAS Number	LOR	Unit	ES1534446-001	ES1534446-002	ES1534446-003	ES1534446-004	--------
				Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1	%	**75.5**	**59.9**	**65.1**	**63.3**	----
Anthracene-d10	1719-06-8	1	%	**69.6**	**54.8**	**61.2**	**55.0**	----
4-Terphenyl-d14	1718-51-0	1	%	**85.5**	**77.2**	**80.5**	**72.8**	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**93.0**	**102**	**111**	**111**	----
Toluene-D8	2037-26-5	2	%	**117**	**109**	**116**	**117**	----
4-Bromofluorobenzene	460-00-4	2	%	**100**	**97.4**	**98.7**	**97.5**	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1607467**	Page	: 1 of 8
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS CAROLINA SARDELLA	Contact	:
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 92725100	Telephone	: +61-2-8784 8555
Project	: AGL CAMDEN GAS PROJECT	Date Samples Received	: 06-Apr-2016 17:20
Order number	: ----	Date Analysis Commenced	: 06-Apr-2016
C-O-C number	: ----	Issue Date	: 14-Apr-2016 13:52
Sampler	: CAROLINA SARDELLA, CHRISTOPHER RICHARD		
Site	: ----		
Quote number	: ----		
No. of samples received	: 5		
No. of samples analysed	: 5		

NATA Accredited Laboratory 825
Accredited for compliance with
ISO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Pabi Subba	Senior Organic Chemist	Sydney Organics, Smithfield, NSW
RICHARD TEA	Lab technician	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.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	QA
			Client sampling date / time	06-Apr-2016 11:45	06-Apr-2016 11:15	06-Apr-2016 10:45	06-Apr-2016 11:45	[06-Apr-2016]
Compound	CAS Number	LOR	Unit	ES1607467-001	ES1607467-002	ES1607467-003	ES1607467-004	ES1607467-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.85**	**6.87**	**7.58**	**9.87**	**6.80**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**768**	**812**	**970**	**787**	**816**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**540**	**484**	**593**	**484**	**476**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**20**	**6**	**7**	<5	**8**
ED009: Anions								
Bromide	24959-67-9	0.01	mg/L	**0.527**	**0.360**	**0.146**	**0.243**	**0.314**
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	**170**	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**28**	**201**	**507**	**87**	**203**
Total Alkalinity as CaCO3	----	1	mg/L	**28**	**201**	**507**	**257**	**203**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**3**	**4**	<1	<1	**4**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**236**	**166**	**65**	**113**	**165**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**12**	**33**	**89**	**3**	**35**
Magnesium	7439-95-4	1	mg/L	**21**	**29**	**23**	**2**	**30**
Sodium	7440-23-5	1	mg/L	**113**	**100**	**113**	**183**	**103**
Potassium	7440-09-7	1	mg/L	**2**	**3**	**13**	**11**	**3**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.002**	**0.015**	**0.002**	**0.002**
Boron	7440-42-8	0.05	mg/L	**0.06**	<0.05	<0.05	<0.05	<0.05
Strontium	7440-24-6	0.001	mg/L	**0.156**	**0.479**	**0.891**	**0.128**	**0.489**
Barium	7440-39-3	0.001	mg/L	**0.588**	**0.561**	**3.29**	**0.525**	**0.593**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	**0.033**	<0.001	**0.002**	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**MPMB01**	**MPMB02**	**MPMB03**	**MPMB04**	**QA**
			Client sampling date / time	06-Apr-2016 11:45	06-Apr-2016 11:15	06-Apr-2016 10:45	06-Apr-2016 11:45	[06-Apr-2016]
Compound	*CAS Number*	*LOR*	*Unit*	**ES1607467-001**	**ES1607467-002**	**ES1607467-003**	**ES1607467-004**	**ES1607467-005**
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.426**	**0.145**	**0.039**	<0.001	**0.149**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	**0.005**	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.012**	<0.001	**0.003**	<0.001	**0.001**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.063**	**0.027**	**0.014**	**0.046**	**0.022**
Iron	7439-89-6	0.05	mg/L	**0.16**	**3.70**	**1.35**	<0.05	**3.76**
Bromine	7726-95-6	0.1	mg/L	**0.5**	**0.4**	**0.2**	**0.2**	**0.4**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**20.0**	**13.8**	**8.98**	**3.65**	**13.7**
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	**0.2**	**0.2**	**0.4**	**0.2**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	**0.08**	**0.81**	**0.82**	**0.08**
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	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.20**	**0.01**	**0.04**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.20**	**0.01**	**0.04**	<0.01	<0.01
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.08**	**0.02**	<0.01	<0.01	**0.02**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.08**	<0.01	<0.01	<0.01	**0.01**
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**7.28**	**8.78**	**12.0**	**8.32**	**8.79**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	QA
			Client sampling date / time	06-Apr-2016 11:45	06-Apr-2016 11:15	06-Apr-2016 10:45	06-Apr-2016 11:45	[06-Apr-2016]
Compound	CAS Number	LOR	Unit	ES1607467-001	ES1607467-002	ES1607467-003	ES1607467-004	ES1607467-005
				Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued								
Total Cations	----	0.01	meq/L	**7.29**	**8.46**	**11.6**	**8.56**	**8.77**
Ionic Balance	----	0.01	%	**0.09**	**1.88**	**1.63**	**1.34**	**0.13**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**4**	**2**	**1**	**15**	**2**
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	**29**	**325**	**25800**	**35500**	**330**
Ethene	74-85-1	10	µg/L	<10	<10	<10	<10	<10
Ethane	74-84-0	10	µg/L	<10	<10	<10	<10	<10
Propene	115-07-1	10	µg/L	<10	<10	<10	<10	<10
Propane	74-98-6	10	µg/L	<10	<10	<10	<10	<10
Butene	25167-67-3	10	µg/L	<10	<10	<10	<10	<10
Butane	106-97-8	10	µg/L	<10	<10	<10	<10	<10
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	<1.0	<1.0	<1.0	**3.2**	<1.0
2-Chlorophenol	95-57-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2-Methylphenol	95-48-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
2-Nitrophenol	88-75-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorophenol	87-86-5	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MPMB01	MPMB02	MPMB03	MPMB04	QA
			Client sampling date / time	06-Apr-2016 11:45	06-Apr-2016 11:15	06-Apr-2016 10:45	06-Apr-2016 11:45	[06-Apr-2016]
Compound	CAS Number	LOR	Unit	ES1607467-001	ES1607467-002	ES1607467-003	ES1607467-004	ES1607467-005
				Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	**90**	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	**90**	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	**30**	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	**60**	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L	<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	**60**	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MPMB01	MPMB02	MPMB03	MPMB04	QA
Client sampling date / time				06-Apr-2016 11:45	06-Apr-2016 11:15	06-Apr-2016 10:45	06-Apr-2016 11:45	[06-Apr-2016]
				ES1607467-001	ES1607467-002	ES1607467-003	ES1607467-004	ES1607467-005
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1	%	**25.9**	**28.3**	**32.5**	**21.4**	**28.8**
2-Chlorophenol-D4	93951-73-6	1	%	**55.4**	**60.1**	**69.1**	**18.1**	**63.4**
2.4.6-Tribromophenol	118-79-6	1	%	**55.2**	**49.0**	**40.3**	**19.9**	**56.5**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1	%	**88.1**	**55.5**	**77.6**	**76.0**	**71.2**
Anthracene-d10	1719-06-8	1	%	**70.6**	**68.7**	**77.3**	**78.8**	**71.7**
4-Terphenyl-d14	1718-51-0	1	%	**42.5**	**64.6**	**74.6**	**72.8**	**99.7**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**105**	**108**	**110**	**107**	**117**
Toluene-D8	2037-26-5	2	%	**116**	**109**	**112**	**116**	**119**
4-Bromofluorobenzene	460-00-4	2	%	**119**	**120**	**120**	**124**	**124**

Surrogate Control Limits

Sub-Matrix: **WATER**

		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

CERTIFICATE OF ANALYSIS

Work Order	: **ES1607670**	Page	: 1 of 8
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS CAROLINA SARDELLA	Contact	:
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 92725100	Telephone	: +61-2-8784 8555
Project	: AGL CAMDEN GAS PROJECT	Date Samples Received	: 08-Apr-2016 16:16
Order number	: ----	Date Analysis Commenced	: 08-Apr-2016
C-O-C number	: ----	Issue Date	: 14-Apr-2016 14:50
Sampler	: CAROLINA SARDELLA, CHRISTOPHER RICHARD		
Site	: ----		
Quote number	: ----		
No. of samples received	: 4		
No. of samples analysed	: 4		

NATA Accredited Laboratory 825
Accredited for compliance with
ISO/IEC 17025.

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao		Sydney Inorganics, Smithfield, NSW
Pabi Subba	Senior Organic Chemist	Sydney Organics, 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.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- ED041G: LOR raised for Sulfate samples 2 and 4 due to sample matrix.
- EP075(SIM) :Result of sample ES1607670-3 has been confirmed by re extraction and re analysis.
- EK071G: It has been noted that Reactive P is greater than Total P for samples 1 and 2, however this difference is within the limits of experimental variation.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	RMB01	RMB02	RMB03	GLMB03	----
			Client sample ID	RMB01	RMB02	RMB03	GLMB03	----
			Client sampling date / time	07-Apr-2016 09:45	07-Apr-2016 09:45	07-Apr-2016 11:00	07-Apr-2016 13:00	----
				ES1607670-001	ES1607670-002	ES1607670-003	ES1607670-004	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.64**	**7.43**	**9.72**	**7.97**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**13200**	**10300**	**6990**	**4800**	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**7820**	**6080**	**4020**	**2930**	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**109**	<5	<5	<5	----
ED009: Anions								
Bromide	24959-67-9	0.01	mg/L	**6.78**	**5.10**	**3.86**	**1.42**	----
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	**282**	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**1000**	**976**	**140**	**1880**	----
Total Alkalinity as CaCO3	----	1	mg/L	**1000**	**976**	**421**	**1880**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<10	<1	<10	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**4020**	**3060**	**1760**	**628**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**337**	**333**	**8**	**111**	----
Magnesium	7439-95-4	1	mg/L	**91**	**82**	**3**	**77**	----
Sodium	7440-23-5	1	mg/L	**2470**	**1810**	**1480**	**999**	----
Potassium	7440-09-7	1	mg/L	**28**	**29**	**13**	**38**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	<0.001	**0.001**	**0.106**	----
Boron	7440-42-8	0.05	mg/L	**0.10**	<0.05	**0.16**	<0.05	----
Strontium	7440-24-6	0.001	mg/L	**14.5**	**9.20**	**1.12**	**5.09**	----
Barium	7440-39-3	0.001	mg/L	**44.1**	**36.5**	**3.30**	**20.9**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	**0.003**	<0.001	<0.001	**0.001**	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB01	RMB02	RMB03	GLMB03	----
			Client sampling date / time	07-Apr-2016 09:45	07-Apr-2016 09:45	07-Apr-2016 11:00	07-Apr-2016 13:00	----
Compound	CAS Number	LOR	Unit	ES1607670-001	ES1607670-002	ES1607670-003	ES1607670-004	--------
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.079**	**0.021**	<0.001	**0.020**	----
Molybdenum	7439-98-7	0.001	mg/L	**0.003**	<0.001	**0.004**	**0.002**	----
Nickel	7440-02-0	0.001	mg/L	**0.177**	**0.002**	<0.001	**0.001**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	**0.043**	**0.019**	**0.054**	**0.088**	----
Iron	7439-89-6	0.05	mg/L	**7.59**	**4.81**	<0.05	**0.76**	----
Bromine	7726-95-6	0.1	mg/L	**8.1**	**6.7**	**4.7**	**1.6**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**14.2**	**11.1**	**7.53**	**21.6**	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	<0.004	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.1**	**0.4**	<0.1	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**5.75**	**4.56**	**3.38**	**3.33**	----
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	**0.04**	<0.01	<0.01	**0.01**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	<0.01	<0.01	**0.01**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.06**	<0.01	<0.01	**0.04**	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.08**	**0.05**	<0.01	**0.04**	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**133**	**106**	**58.0**	**55.3**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB01	RMB02	RMB03	GLMB03	----
			Client sampling date / time	07-Apr-2016 09:45	07-Apr-2016 09:45	07-Apr-2016 11:00	07-Apr-2016 13:00	----
Compound	CAS Number	LOR	Unit	ES1607670-001	ES1607670-002	ES1607670-003	ES1607670-004	--------
				Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued								
Total Cations	----	0.01	meq/L	**132**	**103**	**65.4**	**56.3**	----
Ionic Balance	----	0.01	%	**0.36**	**1.44**	**5.88**	**0.88**	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**57**	**15**	**72**	**14**	----
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	**10500**	**37000**	**49800**	**47600**	----
Ethene	74-85-1	10	µg/L	<10	<10	<10	<10	----
Ethane	74-84-0	10	µg/L	**188**	<10	**13**	**129**	----
Propene	115-07-1	10	µg/L	<10	<10	<10	<10	----
Propane	74-98-6	10	µg/L	**413**	<10	<10	**35**	----
Butene	25167-67-3	10	µg/L	<10	<10	<10	<10	----
Butane	106-97-8	10	µg/L	**95**	<10	<10	<10	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2-Chlorophenol	95-57-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2-Methylphenol	95-48-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	<2.0	**2.2**	<2.0	----
2-Nitrophenol	88-75-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Pentachlorophenol	87-86-5	2	µg/L	<2.0	<2.0	<2.0	<2.0	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthylene	208-96-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Acenaphthene	83-32-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluorene	86-73-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Phenanthrene	85-01-8	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Anthracene	120-12-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Fluoranthene	206-44-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Pyrene	129-00-0	1	µg/L	<1.0	<1.0	<1.0	<1.0	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB01	RMB02	RMB03	GLMB03	----
			Client sampling date / time	07-Apr-2016 09:45	07-Apr-2016 09:45	07-Apr-2016 11:00	07-Apr-2016 13:00	----
Compound	CAS Number	LOR	Unit	ES1607670-001	ES1607670-002	ES1607670-003	ES1607670-004	--------
				Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Benz(a)anthracene	56-55-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Chrysene	218-01-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	<1.0	<1.0	<1.0	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	**90**	<20	**70**	**200**	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	**80**	<20	**70**	**200**	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	**50**	<20	**40**	**100**	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	**21**	<1	<1	<1	----
Toluene	108-88-3	2	µg/L	<2	<2	**32**	**104**	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	**6**	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	----
^ Total Xylenes	1330-20-7	2	µg/L	**6**	<2	<2	<2	----
^ Sum of BTEX	----	1	µg/L	**27**	<1	**32**	**104**	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	RMB01	RMB02	RMB03	GLMB03	----
			Client sampling date / time	07-Apr-2016 09:45	07-Apr-2016 09:45	07-Apr-2016 11:00	07-Apr-2016 13:00	----
Compound	CAS Number	LOR	Unit	ES1607670-001	ES1607670-002	ES1607670-003	ES1607670-004	--------
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1	%	29.9	28.6	22.7	36.9	----
2-Chlorophenol-D4	93951-73-6	1	%	60.5	60.0	27.2	75.0	----
2.4.6-Tribromophenol	118-79-6	1	%	72.9	58.2	19.3	87.0	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1	%	74.5	68.8	84.1	90.8	----
Anthracene-d10	1719-06-8	1	%	87.2	75.1	94.3	99.8	----
4-Terphenyl-d14	1718-51-0	1	%	85.6	72.9	88.8	100.0	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	98.3	106	81.4	84.1	----
Toluene-D8	2037-26-5	2	%	117	117	96.5	91.9	----
4-Bromofluorobenzene	460-00-4	2	%	103	107	80.4	80.5	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

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