AGL Upstream Investments Pty Ltd

Drilling Completion Report - Wards River Groundwater Monitoring Bores

Gloucester Gas Project

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PARSONS BRINCKERHOFF

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Author, Reviewer and Approver details

Prepared by:	Angus McFarlane	Date: 29/01/2016	Signature: 
Reviewed by:	Sean Daykin	Date: 08/03/2016	Signature: 
Approved by:	Angus McFarlane	Date: 09/03/2016	Signature: 

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Parsons Brinckerhoff Australia Pty Limited

ABN 80 078 004 798

Level 27 Ernst & Young Centre
680 George Street, Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001
Australia
Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
Email: sydney@pb.com.au
www.pbworld.com

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Glossary

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.
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, 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.
Bore	A structure drilled below the surface to obtain water from an aquifer or series of aquifers.
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 microgram per litre (water sample) or micrograms per kilogram (sediment sample).
Datalogger	A digital recording instrument that is inserted in monitoring and pumping bores to record pressure measurements and water level variations.
Discharge	The volume of water flowing in a stream or through an aquifer past a specific point in a given period of time.
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.
Fracture	Breakage in a rock or mineral along a direction or directions that are not cleavage or fissility directions.
Groundwater	The water contained in interconnected pores or fractures located below the water table in the saturated zone.

Groundwater age classification	Groundwater ages are commonly referred to as: ▪ Recent – direct connection to surface water (measured in days by, for example, ^{222}Rn) ▪ Modern – permeable alluvium or fractured shallow aquifers (years - tritium; recharge since 1952); ▪ Sub-modern - permeable alluvium or fractured shallow aquifers (<1,000 years; ^{32}Si, ^{14}C); ▪ Old – palaeoclimate (1,000 to 50,000 years; ^{14}C); ▪ Very old - >50,000 to 1 million years (multiple methods including ^{36}Cl, ^{4}He, $^{234}U/^{238}U$);and Fossil - > 1 million years (^{129}I).
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	Is 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.
Lithology	The study of rocks and their depositional or formational environment on a large specimen or outcrop scale.
Micro Siemens 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.
Oxidation reduction potential (ORP)	The oxidation 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 redox potential.
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.

Permian	The last period of the Palaeozoic era that finished approximately 230 million years before present.
Piezometer	See monitoring bore.
Quaternary	The most recent geological period extending from approximately 2.5 million years ago to the present day.
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.
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.
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.
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.
Sandstone	Sandstone is a sedimentary rock composed mainly of sand-sized minerals or rock grains (predominantly quartz).
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.
Total dissolved solids (TDS)	A measure of the salinity of water, usually expressed in milligrams per litre (mg/L). See also EC.
Water bearing zone	Geological strata that are saturated with groundwater but not of sufficient permeability to be called an aquifer.
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.
Water table	The top of an unconfined aquifer. It is at atmospheric pressure and indicates the level below which soil and rock are saturated with water.
Well	Pertaining to a gas exploration well or gas production well.
Siltstone	A fine-grained rock of sedimentary origin composed mainly of silt-sized particles (0.004 to 0.06 mm).

Abbreviations

AGL	AGL Upstream Investments Pty Ltd
ALS	Australian Laboratory Service
BoM	Bureau of Meteorology
BoP	Blowout preventer
BP	Before present
BTEX	Benzene, toluene, ethyl benzene and xylenes
CBL	Cement bond log
CEMP	Construction and Environment Management Plan
CDFM	Cumulative deviation from mean
CSG	Coal seam gas
DO	Dissolved oxygen
DRE	Division of Resources and Energy
EC	Electrical conductivity
GGP	Gloucester Gas Project
GFDA	Gas Field Development Area
GMWL	Global Meteoric Water Line
HESP	Health, Environment and Safety Plan
JSA	Job Safety Analysis
LOQ	Limit of Quantification
LOR	Limit of Reporting
MDA	Minimum Detectable Activity
MGA	Map Grid Australia
NOW	NSW Office of Water
NUDLC	National Uniform Drillers Licencing Committee
ORP	Oxidation reduction potential
PAH	Polycyclic aromatic hydrocarbons

PEL	Petroleum Exploration Licence
pMC	Percent modern carbon
PPE	Personal protective equipment
QA/QC	Quality assurance/quality control
SMP	Safety Management Plan
SWL	Standing water level
SWMS	Safe Work Methods Statements
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total recoverable hydrocarbons
VPDB	Vienna Pee Dee Belemnite
VSMOW	Vienna Standard Mean Ocean Water
VOC	Volatile organic compound

Units

°C	degrees Celsius
L/s	litres per second
m	metres
mAHD	metres Australian Height Datum
mbgl	metres below ground level
mbtoc	metres below top of casing
m/d	metres per day
mm	millimetres
µS/cm	microSiemens per centimetre
mg/L	milligrams per litre
µg/L	micrograms per litre

Executive summary

On 4 February 2016, AGL Upstream Investments Pty Ltd (AGL) announced that the Gloucester Gas Project (GGP) will not proceed to final investment stage. AGL will relinquish Petroleum Exploration Licence (PEL) 285 to the NSW Government and will commence a comprehensive decommissioning and rehabilitation program for well sites and other infrastructure in the Gloucester region.

A comprehensive surface water and groundwater monitoring network comprising nested monitoring bores and stream gauges was established during the Phase 2 Groundwater Investigations (Parsons Brinckerhoff 2012). Subsequent and ongoing site investigations have continued to expand this network since January 2011.

This report details the drilling, completion, hydraulic testing and water quality analysis of the Wards River nested groundwater monitoring site, which is located south of the GGP Stage 1 Gas Field Development Area (GFDA) in the Karuah River catchment. The drilling program which commenced in November 2013, involved the establishment of one monitoring bore in the Quaternary alluvium (WRMB01A), two monitoring bores in the shallow sandstone of the Jilleon Formation (shallow rock) (WRMB01B and C) and one monitoring bore in the deep sandstone of the Jilleon Formation of the Gloucester Coal Measures (interburden) (WRMB01D). Following the completion of all bores, in situ pressure transducers (dataloggers) were installed, permeability testing performed and baseline groundwater quality testing undertaken.

The initial findings for groundwater levels at this Wards River site are:

- Groundwater levels in the alluvium show a minor response to rainfall events and otherwise have been relatively stable since the start of monitoring in January 2014.
- Groundwater levels in the shallow rock do not show strong responses to individual rainfall events, with a minor response observed at monitoring bore WRMB01C. Groundwater levels in WRMB01B showed slow recovery following airlifting due to the low permeability of the target formation, as measured during permeability testing.

The initial findings for groundwater quality at this Wards River site are:

- Groundwater in the alluvium is of marginal water quality and slightly acidic. Groundwater salinity in the shallow rock is brackish and slightly alkaline.
- Elevated concentrations of aluminium, barium, bromine, iron, strontium and zinc were detected in groundwater in the alluvium and the shallow rock. Higher levels of iron and zinc were detected in groundwater in the alluvium compared to the shallow rock.
- No phenolic compounds or polycyclic aromatic hydrocarbons were detected, however low levels of toluene and total petroleum hydrocarbons were detected in the shallow rock groundwater (WRMB01C only).
- Dissolved methane was detected in the alluvium and the shallow rock groundwater.
- Stable isotope data indicates that groundwater in all hydrogeological units is of meteoric origin. Tritium and radiocarbon data confirms the presence of modern water in the alluvium, and indicates groundwater in shallow rock and interburden is much older ranging between 16,000 and 38,000 years BP.
- Methane isotopes indicate that dissolved methane present in all hydrogeological units is thermogenic.

1. Introduction

1.1 Background

On 4 February 2016 AGL Upstream Investments Pty Ltd (AGL) announced that the Gloucester Gas Project (GGP) will not proceed to final investment stage. AGL will relinquish Petroleum Exploration Licence (PEL) 285 to the NSW Government and will commence a comprehensive decommissioning and rehabilitation program for coal seam gas (CSG) well sites and other infrastructure in the Gloucester region.

The GGP was to involve several stages of gas field development. A comprehensive groundwater investigation (*Phase 2 Groundwater Investigations*) was completed in early 2012 to inform the hydrogeological conceptual model across the GGP Stage 1 Gas Field Development Area (GFDA) (Parsons Brinckerhoff 2012). The Stage 1 GFDA in relation to the PEL 285 boundary is shown in Figure 1.1.The dedicated water monitoring network has allowed the collection of baseline water level, water quality and hydraulic conductivity data for the different groundwater and surface water systems. Since 2013, the water monitoring network has been extended beyond the Stage 1 GFDA to allow baseline assessment of groundwater systems in the wider Gloucester Basin.

There are now more than 50 dedicated water monitoring locations across the Gloucester Basin area, including four monitoring bores installed as part of this investigation.

This report presents the drilling, installation and initial testing of four monitoring bores at Wards River, to the south of the Stage 1 GFDA (Figure 1.2) between November 2013 and October 2015. Following the completion of the three shallow monitoring bores (WRMB01A-C), in situ pressure transducers (dataloggers) were installed, and permeability testing and baseline groundwater quality testing completed. Deep monitoring bore WRMB01D was perforated in November 2014; and permeability testing and baseline groundwater quality sampling was completed in September 2015 and October 2015 respectively. Water level monitoring commenced in September 2015.

1.2 Objectives

The objectives of the drilling program were to:

- expand the groundwater monitoring network across the Gloucester Basin to collect additional baseline groundwater quality and level data;
- assess the natural characteristics and variability of the local groundwater systems;
- and enhance the conceptual understanding of the groundwater systems, including groundwater flow and aquifer connectivity, across the broader Gloucester Basin.

1.3 Scope of works

The Wards River drilling program comprised of:

- establishment of one alluvial monitoring bore targeting the Wards River alluvium;
- establishment of two monitoring bores targeting the shallow sandstone of the Jilleon Formation;
- establishment of one monitoring bore targeting the deep sandstone of the Jilleon Formation;
- installation of in situ pressure transducers (dataloggers) at all monitoring bores;

- permeability testing (rising and falling head tests) at all monitoring bores;
- baseline groundwater quality testing including field parameters, major cations and anions, dissolved metals, nutrients, dissolved gases, hydrocarbons and isotopes;
- and a report outlining the drilling, installation and permeability testing of the monitoring bores and initial results of groundwater level and groundwater quality monitoring.

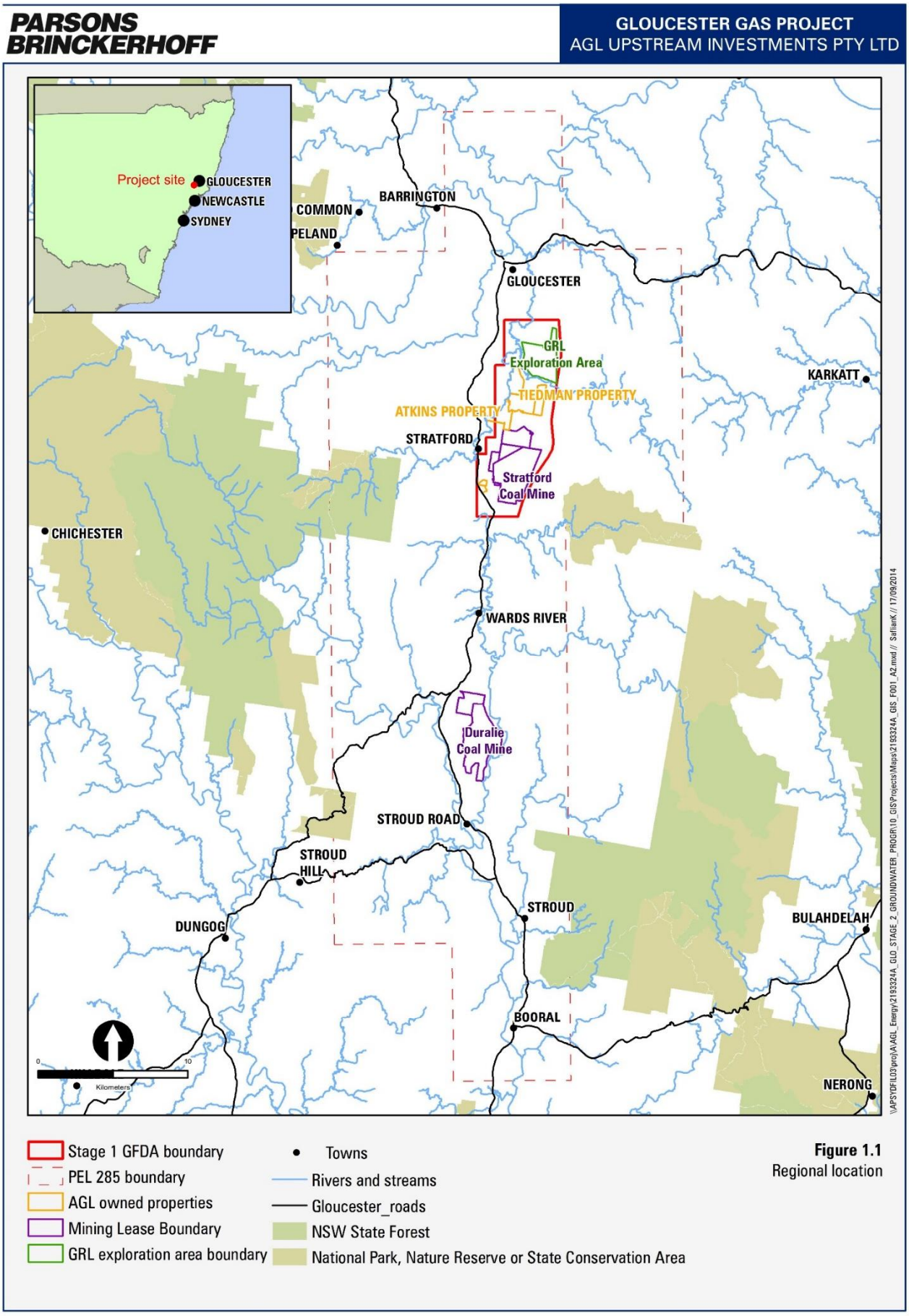

Figure 1.1 Regional location

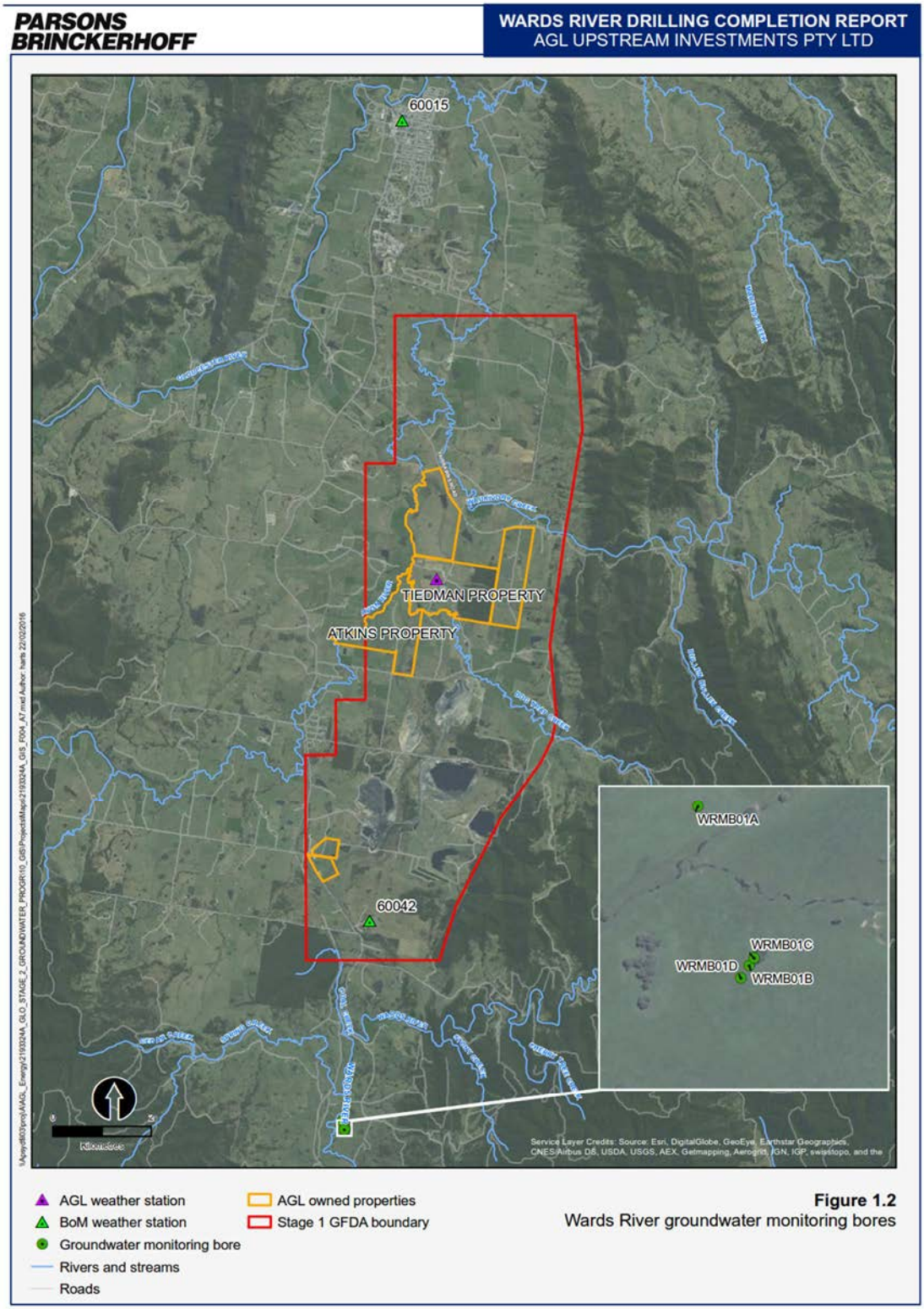

Figure 1.2 Wards River groundwater monitoring bores

2. Site characterisation

2.1 Site location

The Wards River site is located approximately 3 km north of the village of Wards River on privately owned land. The main monitoring site comprises the three deeper bores and is positioned off the floodplain to the east of Wards River while the alluvial site is approximately 200 m to the north-north-east on an alluvial terrace associated with the river. The main monitoring site is situated at an elevation of approximately 89.5 metres Australian Height Datum (mAHD), slopes gently to the west and is surrounded by gently undulating hills. The alluvial site has an elevation of 84.8 mAHD and is relatively flat.

The surrounding properties are primarily used for grazing. The Stratford Coal mine is located approximately 8 km to the north and the Duralie Coal Mine is located approximately 11 km to the south.

2.2 Rainfall

AGL has operated a weather station on the Tiedman property to the north of Wards River and within the Stage 1 GFDA since July 2011. The closest Bureau of Meteorology (BoM) weather station to the Wards River site is located at Craven (Longview – Stn 60042). However the BoM station with the longest period of record is at Gloucester Post Office (Stn 60015) (operational since 1888). The locations of the weather stations are shown in Figure 1.2.

Long-term average annual rainfall (1888 to 2015) at Gloucester Post Office is 980 mm. Rainfall is seasonal, with the highest mean monthly rainfall occurring in the summer months between January and March.

The long-term, annual cumulative deviation from mean (CDFM) rainfall for Gloucester Post Office is plotted in Figure 2.1. The long-term cumulative rainfall residual plots are formulated by subtracting the 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.

Rainfall data from the AGL weather station for the period July 2011 (installation) to December 2015 are presented in Figure 2.1. Since the Wards River monitoring bores have been installed there have been three significant rainfall events (September 2014, December 2014 and June 2015). Total annual rainfall in 2015 was 1,113 mm which is slightly above the long-term annual average for Gloucester (980 mm).

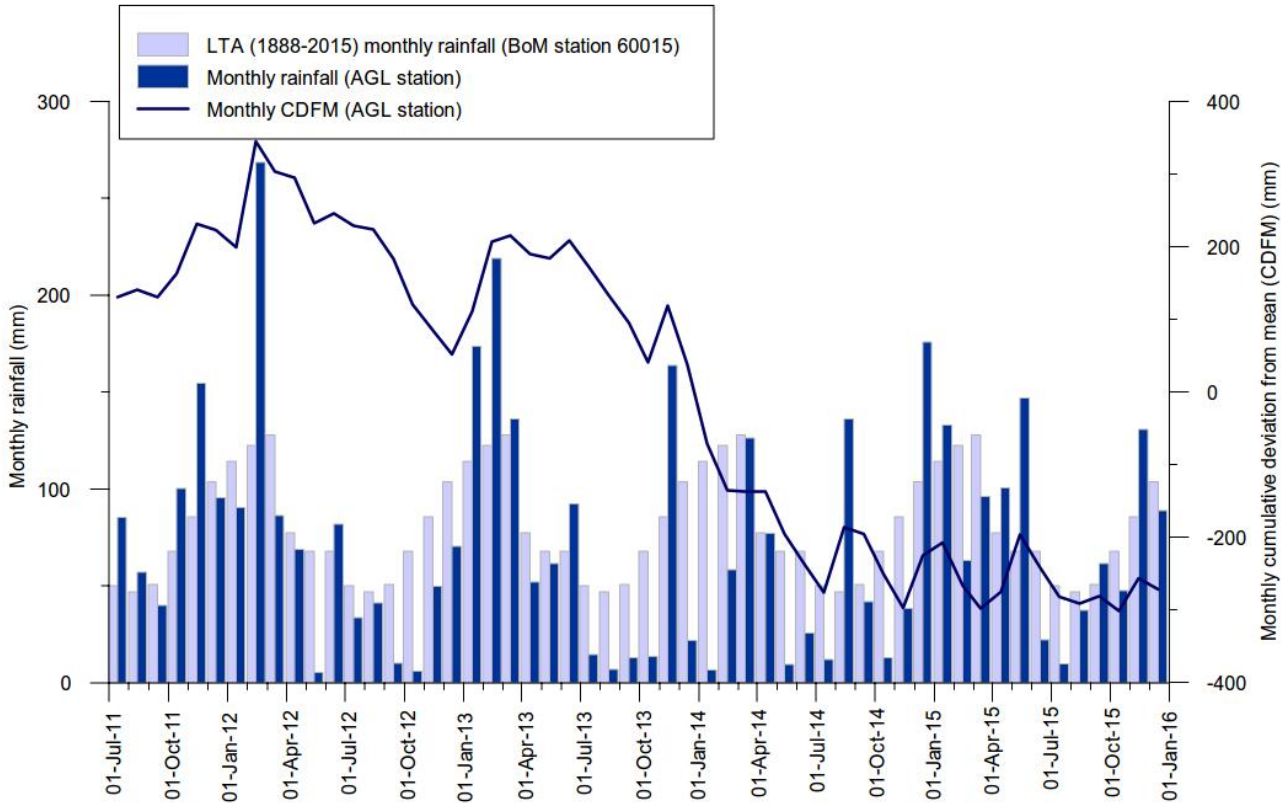

Figure 2.1 Monthly rainfall and cumulative deviation from the monthly mean (CDFM) rainfall at the AGL Gloucester station since installation in July 2011 (AGL 2015a)

2.3 Surface hydrology

The Gloucester Basin is a narrow, north-south trending, elongated basin approximately 40 km long and 10 km wide, extending from Gloucester in the north to Stroud in the south. The Gloucester Basin is located high in the Manning River and Karuah River coastal catchments. The area occupied by the Permian Coal Measures (about 217 km^2) is small in comparison to the size of these catchments.

The Wards River investigation site is located in the Wards River catchment of the much larger Karuah River catchment.

There is a surface water divide between the Wards River catchment and the Avon River catchment (part of the Manning River catchment). In the northern Manning River catchment, surface water flow is generally to the north. In the southern Karuah River catchment, surface water flow is generally to the south.

The Avon River flows to the north, and includes the tributaries of Dog Trap Creek and Waukivory Creek within the Stage 1 GFDA. The Gloucester River joins the Avon River at the north of the Gloucester Basin. Wards River flows to the south, and is outside of the Stage 1 GFDA (Figure 1.2).

2.4 Geological setting

The Gloucester Basin represents a complex geological system formed by the interplay of extensional tectonic faulting and high rates of sedimentation. The Basin stratigraphy comprises a thick succession of Permian sedimentary rocks representing deposition in both terrestrial and marine environments during a complex period of subsidence, uplift and relative sea level change (marine transgression and regression).

The Basin is a synclinal intermontane structure formed in part of the New England Fold Belt between a major Permian plate margin and the Sydney-Gunnedah Basin (Lennox 2009). The north – south trending synclinal nature of the Gloucester Basin resulted from the collision between the East Australian and Pacific Plates.

Following a period of extension during the Early Permian the Gloucester Basin has undergone periods of normal and reverse faulting, with large scale tilting associated with late stage compressional movements towards the end of the Permian (Hughes 1984). Reverse faults dominate present day structure.
A comparison with the contemporary horizontal stress field map (Hillis *et al* 1998) indicates the Basin is likely to be under compression in an east-west orientation.

The stratigraphy dips steeply (up to 90°) on the flanks of the Basin, dipping towards the north-south trending synclinal basin axis and flattening toward the centre of the Basin. Early Permian and Carboniferous hard resistive volcanics form the ridgelines of the Basin: the Mograni Range to the east; and the Gloucester and Barrington Tops to the west.

Overlying the Permian stratigraphy is a thin sequence of surficial Quaternary sedimentary deposits and regolith. The Quaternary sediments are non-uniform in thickness, and comprise unconsolidated alluvial sediments (sand, gravel, silt and clay) along the drainage channels and colluvial deposits across the rest of the plain sourced from the surrounding outcropping Permian deposits.

The Gloucester Basin is divided into three major Permian stratigraphic units each representing a distinct depositional setting: the Gloucester Coal Measures, the Dewrang Group, and the Alum Mountain Volcanics. The generalised stratigraphy of the basin is summarised in Table 2.1. A geological map of the basin is shown in Figure 2.2. AGL's previously proposed Stage 1 GFDA was to target the intermediate and deep coal seams in the Gloucester Coal Measures generally below depths of 250 m to around 1,000 m.

Table 2.1 Stratigraphy of the Gloucester Basin

Period	Group	Sub-group	Formation	Approx. thickness (m)	Coal seam	Depositional environment	Tectonic events
Upper Permian	Gloucester Coal Measures	Craven	Crowthers Road Conglomerate	350		Marine regression, pro-gradation of alluvial fans	Uplift to west of Gloucester Basin
			Leloma	585	Linden		
					JD		
					Bindaboo		
					Deards		
			Jilleon	175	Cloverdale		
					Roseville		
					Tereel/Fairbairns		
			Wards River Conglomerate	Variable			
			Wenham	23.9	Bowens Road		
					Bowens Road Lower		
		Speldon Formation				Marine transgression but also some progradation of alluvial fans in the west related to uplift	Extension (normal fault development) and regional subsidence. Uplift to west of Basin
		Avon	Dog Trap Creek	126	Glenview		
			Waukivory Creek	326	Avon		
					Triple		
					Rombo		
					Glen Road		
					Valley View		
					Parkers Road		
	Dewrang	Mammy Johnsons		300	Mammy Johnsons	Marine transgression, regression and further marine transgression	Extension (normal fault development) and regional subsidence
		Weismantel		20	Weismantel		
		Duralie Road		250			
Lower Permian	Alum Mountain Volcanics				Clareval	Arc-related rift	Rift?
					Basal		

(1) Modified from AECOM (2009) and SRK (2005).

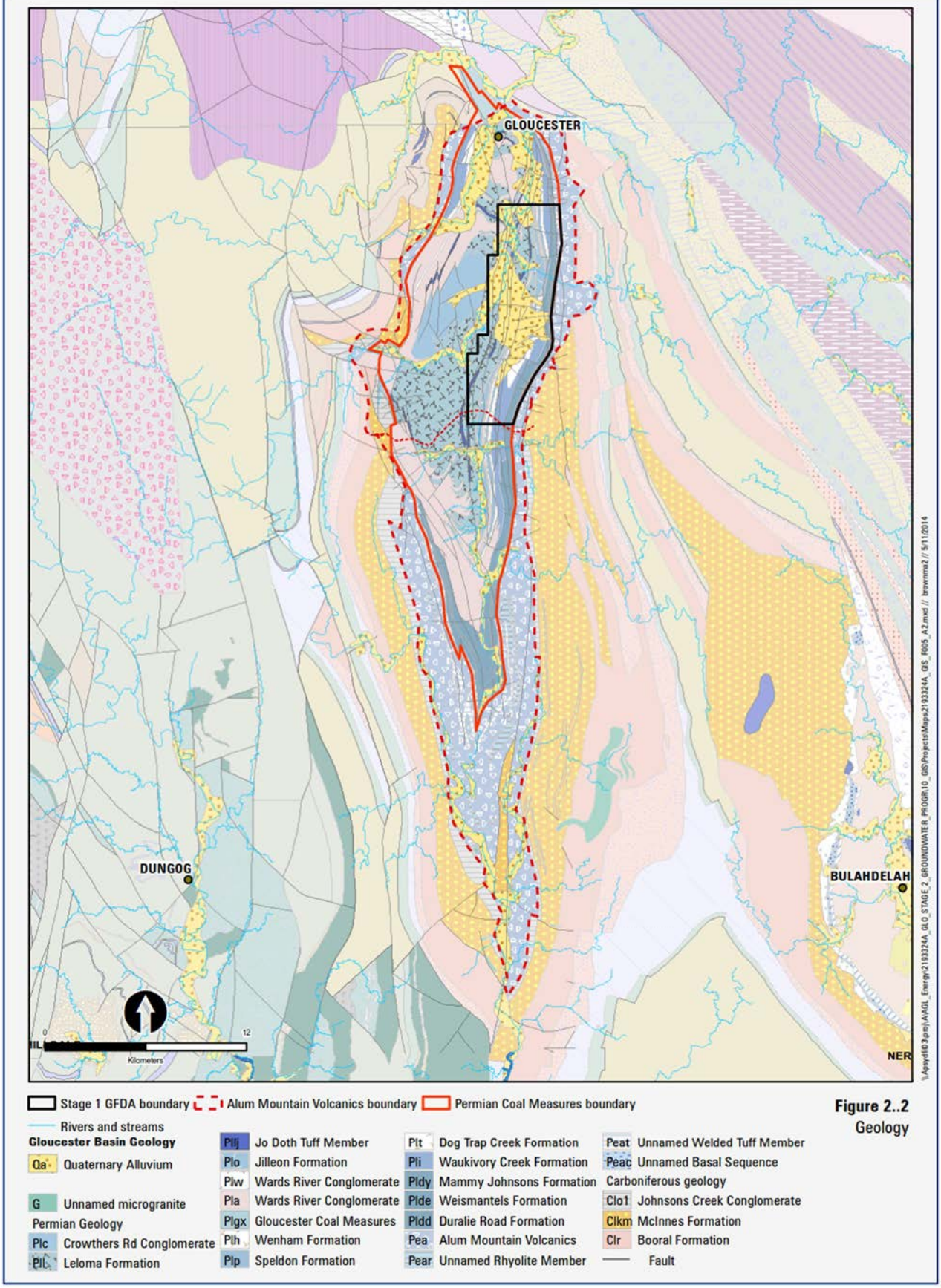

Figure 2.2 Regional geology

2.5 Hydrogeological setting

Four broad hydrogeological units have been identified within the Gloucester Basin (Table 2.2). The permeability and groundwater flow characteristics of rocks within the Gloucester Basin are controlled by several factors including lithology, depth and the degree of fracturing and faulting. In this sense hydrogeological units and flow systems do not always correspond with defined geological boundaries.

Table 2.2 Four hydrogeological units – Gloucester Basin

Unit	Aquifer type	Formation name	General lithology	Hydraulic characteristics
Alluvium	Semi-confined, clay capped, porous, granular	Quaternary alluvium	Clay/mixed gravels	Heterogeneous, highly variable permeability associated with varying lithology
Shallow Rock (<150 m)	Semi-confined, fractured rock	Upper Permian Coal Measures, Alum Mountain Volcanics	Interbedded sandstone/siltstone with bedding plane fractures	Heterogeneous, high and low permeability domains associated with fault zones and fracturing
Interburden	Confined, fractured rock	Upper Permian Coal Measures	Interbedded indurated sandstone/siltstone and claystone	Low permeability associated with sparse fractures, permeability decreases with depth
Coal Seams	Confined, fractured rock	Upper Permian Coal Measures	Coal/shale	Low permeability associated with cleating and fractures in coal seams, permeability decreases with depth

The four hydrogeological units are summarised as follows:

1. **Alluvial deposits** adjacent to major creeks and rivers comprising unconsolidated sand, gravel and clay. The deposits are typically 12–15 m thick. These systems are heterogeneous but generally permeable aquifers with rapid recharge, through-flow and discharge associated with interactions with streams, and to a lesser extent with the underlying less permeable shallow rock. Hydraulic conductivity measurements range from 0.3 m/d to 300 m/d, averaging around 10 m/d.
2. **Shallow fractured rock** comprising variably weathered and fractured Permian rocks extending to approximately 150 m below the surface, across all sub-cropping Permian units. The shallow rock zone is heterogeneous with relatively impermeable domains separated by more permeable domains, but on the whole it is more permeable than the deeper coal measures. The domains of higher permeability are due to a higher density of fracturing associated with an irregular weathering profile and the near-surface expression of faulting. Water bearing zones (minor aquifers) observed during drilling occur within 75 m of surface. Groundwater flow within this zone is more strongly controlled by weathering and fracturing than the attitude of geological strata. Hydraulic conductivity of the shallow rock ranges from 10 m/d to $1x10^{-6}$ m/d at a depth of 150 m, but is typically in the order of 10^{-3} m/d to 10^{-4} m/d.
3. **Deep Coal Measures interburden**. Sandstone and siltstone units that form the interburden to coal seams are indurated and typically of very low permeability, forming aquitards and confining layers. The permeability of the interburden decreases with depth such that, at the maximum depth of CSG production, it is likely to be in the order of 10^{-5} m/d to 10^{-7} m/d, or less.
4. **Deep coal seams**. Coal seams tend to be slightly more permeable than interburden and commonly form weak water bearing zones. Permeability and storage are provided by small fractures and cleats in the coal. As with interburden, drill-stem tests clearly show that the permeability of coal seams generally decreases with depth. At the maximum depth of CSG production, the permeability of coal seams is very low (10^{-4} m/d-10^{-6} m/d), but may be an order of magnitude higher than the interburden.

The Alum Mountain Volcanics underlie the Permian Coal Measures, and form the impermeable base of the Gloucester Basin. The Alum Mountain Volcanics outcrop in the eastern and western boundaries of the basin, forming the elevated topography of the Gloucester and Barrington Tops to the west, and the Mograni Range to the east.

3. Bore installation and field testing

Parsons Brinckerhoff was the Principal Contractor for the site investigation program for all phases bar the perforation program and provided all project management services, including the management of subcontractors. A drilling specification and program was developed for the site (Parsons Brinckerhoff 2013a).

Parsons Brinckerhoff supplied all the required technical services including geological, hydrogeological and surveying services, while AGL engaged Vause Wireline Australia Pty Ltd directly for the perforation phase. The subcontractors engaged to complete the site investigation program were:

- Highland Drilling Pty Ltd (drilling and bore completions)
- Groundsearch Australia Pty Ltd (geophysical logging)
- Vause Wireline Australia Pty Ltd (borehole perforation of deep monitoring bore)
- Water N Tipper Hire Pty Ltd (fresh water deliveries)
- Mid Coast Liquid Waste Pty Ltd (offsite water and mud disposal)
- CalCo Surveyors Pty Ltd (surveying services)

3.1 Health, safety and environment

Onsite health, safety and environment aspects were managed through a health, environment and safety plan (HESP) (Parsons Brinckerhoff 2013b), construction and environment management plan (CEMP) (Parsons Brinckerhoff 2013c) and safety management plan (SMP) (Parsons Brinckerhoff 2013e); these documents were prepared in advance of the drilling program and were reviewed and approved by AGL's safety team. Highland Drilling provided safe working methods statements (SWMS) (Highland Drilling 2013a) and job safety analyses (JSA) (Highland Drilling 2013b) covering works relating to the drilling and construction of the boreholes, these documents were also reviewed and approved by AGL.

Highland Drilling and Parsons Brinckerhoff staff as well as any site visitors were required to undergo a site induction during which they were given an overview of the commitments included in the HESP, SMP and CEMP and how these applied to their specific duties.

3.1.1.1 Health, environment and safety plan

Parsons Brinckerhoff developed a comprehensive site specific HESP for the supervision of drilling work and groundwater monitoring activities at the Gloucester sites. This plan detailed the field tasks and the associated risk, and introduced mitigation measures to manage and reduce the risks. Measures included task elimination, substitution and implementation of controls, training and use of personal protective equipment (PPE).

3.1.1.2 Safety management plan

The installation of the monitoring bores was conducted in accordance with the SMP which was developed by Parsons Brinckerhoff in collaboration with Highland Drilling and approved by AGL (Parsons Brinckerhoff 2012c). The SMP should be read in conjunction with the following AGL and Highland Drilling documents which together cover the health, safety and environmental working procedures for AGL's GGP:

- Gloucester Gas Project Health and Safety Management Plan (AGL 2013a)
- Gloucester Gas Project Emergency Response Procedure (AGL 2013b)
- Upstream Gas Golden Rules (AGL 2010)
- Standard Work Method Statement – Gloucester drilling task (Highland Drilling 2013a)
- Job Safety Analysis – Gloucester drilling (Highland Drilling 2013b)

All fieldwork undertaken at the Wards River site was covered under the aforementioned documents, including exploratory drilling and subsequent testing, and groundwater monitoring and sampling. These documents aim to maintain the health, safety and welfare of Parsons Brinckerhoff employees and subcontractors through systematically identifying and documenting hazards, and assessing and controlling the associated risks.

Prior to the commencement of the field program, a desktop risk assessment for the drilling and construction of each borehole was undertaken, as per the requirements of the SMP. Taking into consideration the borehole depth and the likely strata to be encountered (i.e. faults and/or producing coal seams), the bores were assessed to be high, medium or low risk. The risk rating determines the construction method and level of well control required i.e. the practices used to prevent and/or manage the influx of formation fluids/gas in the borehole (blowouts) and this is often via the use of a Blowout Preventer (BoP) and appropriately weighted drill muds.

3.1.1.3 Construction and environment management plan

All site operations were undertaken in accordance with the environmental management systems as detailed in the site specific construction and environment management plan (CEMP).

A detailed water management plan was a critical part of the CEMP detailing the stringent measures implemented to ensure compliance to zero discharge of produced (drilling) waters to adjacent land and surface water receivers. The water management plan stated that for:

- bores drilled with air rotary:
  - All water utilised during the drilling process was supplied by AGL through Water N Tipper Hire Pty Ltd.
  - All groundwater produced during the drilling operations was contained in above ground storage tanks. If the capacity of the tanks reached 80%, work on that bore ceased until excess water in the tanks could be emptied.
  - All cuttings produced during drilling were contained in above ground tanks and were dried and used for internal farm track maintenance.
  - All groundwater produced during the drilling was collected by Mid Coast Liquid Waste Pty Ltd and transported to AGL's Tiedman property for storage.
- bores drilled with mud rotary:
  - All drill muds were contained in a designated mud tank that was bunded using heavy duty PVC matting. The mud pump was also bunded using black plastic.
  - All drill cuttings were contained in a designated cuttings tank, which was collected at the end of the drilling program and transported to a treatment facility, no records of the contractors used were kept.

Runoff waters from rainfall events were diverted from the drilling pad areas by the construction of diversion bunds on the upgradient side of the site. Water from the drill pads and any constructed access tracks was diverted away by sand bag bunds, silt fencing and other control structures so as to direct water onto adjacent grassed areas and not erode the drill pads and track areas.

3.1.1.4 Wellsite Permit to Work System

The internationally recognised Wellsite Permit to Work System (www.wellsite.org.au) was utilised in the GGP groundwater drilling program. The system provides the means to manage field safety aspects in a systematic, formalised and auditable manner. As a standardised work planning mechanism, the Permit to Work System was used for all non-routine tasks where a health and safety plan did not exist (including hot works), thus forcing the individual to undertake a documented work plan and assessment of the risks.

3.2 Drilling and installation

The drilling and installation of the bores was undertaken by Highland Drilling, using a rotary drilling rig under the supervision of a Parsons Brinckerhoff hydrogeologist. The target depth of the boreholes was confirmed by the supervising Parsons Brinckerhoff hydrogeologist.

The alluvial (WRMB01A) and shallow rock (WRMB01B and WRMB01C) monitoring bores were drilled in November and December 2013. The deeper monitoring bore (WRMB01D), installed in the interburden unit, was completed in June 2014 (although the perforating was not completed until November 2014). AGL submitted a Category 1 notification together with the required Site Disturbance Notices to the Division of Resources and Energy (DRE) under the reconnaissance drilling program requirements of PEL 285. A test (monitoring bore) licence under the Water Act 1912 was obtained by AGL prior to the monitoring bore drilling program (Table 3.1). The bore licence and Form As are included in Appendix A and the geological bore logs are included in Appendix B.

Table 3.1 Monitoring bore licence

NOW Licence no.	No. of bores	Local bore ID	Site location (property)	Lot	DP	Bore type
20BL173575	4	WRMB01A WRMB01B WRMB01C WRMB01D	Wards River	2	1128605	Monitoring

The drilling and completion of the groundwater monitoring bores was carried out in accordance with the NSW Office of Water (NOW) bore licence conditions and followed a detailed design and specification compliant with the *National Uniform Drillers Licencing Committee (NUDLC) 2012, Minimum Construction Requirements for Water Bores in Australia, Edition 3*.

The Wards River monitoring bores were drilled using two methods, air rotary and mud rotary. The predominant bit used in the bores drilled with air rotary was down hole hammer (WRMB01A, WRMB01B and WRMB01C). Due to the depth and possible intersection of a coal seam, WRMB01D was assessed as being high risk and was therefore drilled with a polycrystalline diamond PCD bit with muds and the use of BoP.

A detailed geological log of the lithology recorded at 1 m intervals was produced, and instantaneous water flow recorded at the end of each drill rod (every 6 m) where applicable. Water quality field parameters were measured (using a calibrated YSI water quality meter) including temperature, electrical conductivity (EC), pH, dissolved oxygen (DO), total dissolved solids (TDS) and oxidation reduction potential (ORP). These parameters are shown on the geological bore logs in Appendix B.

Airlift development was continuous during drilling and the air rotary boreholes were further developed at termination until the discharge water was free of sediment and the water quality field parameters stabilised.

The screened section of each monitoring bore targeted the most productive water bearing zone. A washed and graded (3 mm – 5 mm) gravel filter pack was installed in the annulus around the screen and extended 0.5 m – 5 m above the screened section in the three uppermost bores.

Coated bentonite pellets were installed 2 m – 4 m above the gravel pack. A cement grout mix was then tremmied in a controlled manner to the surface of the shallow monitoring bores. The bentonite seal and cement grout ensure hydraulic isolation of the screened section preventing any ingress of surface water or groundwater through the annulus of the bore column. Following the construction of each bore, the site was reinstated and a lockable steel monument welded over the bores and surrounded at its base by a concrete slab.

Monitoring bore WRMB01D was not able to be air lifted (nor was it required) due to the drilling method, pressure cementing and its final completion. The bore was constructed using threaded API certified steel casing and pressure cemented with 14 pounds per gallon cement grout slurry. The bore was subsequently perforated in November 2014. Further information on the perforating program is provided in Section 3.3.

All bores were surveyed by CalCo Surveyors to Map Grid Australia (MGA), a grid coordinate system based on the Universal Transverse Mercator projection and the Geocentric Datum of Australia 1994. The bores were also surveyed for surface elevation to mAHD.

Bore construction details and initial manual standing water levels (SWLs) following bore installation are presented in Table 3.2.

Table 3.2 Bore construction details

	WRMB01A	WRMB01B	WRMB01C	WRMB01D
Easting	400527	400580	400585	400571
Northing	6438013	6437851	6437859	6437838
Ground level elevation (mAHD)	84.83	89.49	89.41	89.48
Top of casing (mAHD)	85.38	90.04	89.99	90.10
Total depth (mbgl)	8.12	56.40	126.46	199.0
Bore diameter (mm)	140	140	140	127
Predominant drill bit	Down hole hammer	Down hole hammer	Down hole hammer	Polycrystalline diamond
Depth of 6" casing	2.0	11.5	11.5	30.0
Construction details	50 mm uPVC casing and screen	50 mm uPVC casing and screen	50 mm uPVC casing and screen	60 mm (ID)/ 75 mm (OD) flush threaded steel casing
Screened interval (mbgl)	4.5 – 7.0	48.4 – 54.4	111.5 – 123.5	178.0 – 184.0
Screened interval (mAHD)	80.83 – 77.83	41.01 – 35.09	-22.04 – -34.04	-85.52 – -94.52
Screened formation	Alluvium	Jilleon Formation	Jilleon Formation	Jilleon Formation
Hydrogeological unit	Alluvium	Shallow rock	Shallow rock	Interburden
Lithology	Alluvium	Sandstone	Sandstone	Sandstone
Inflow (L/s)	<0.1	<0.1	0.4	N/A
Peak inflow depth (mbgl)	4.5 – 8.12	33.0 – 56.4	108 – 120	N/A
Initial SWL (mbtoc)	3.98	7.2	5.77	6.28

Note: mAHD – metres Australian Height Datum (AHD); mbgl – metres below ground level; mbtoc – metres below top of casing; SWL – standing water level; Not applicable – data not available due to drilling method.

3.3 Perforating program

On completion of the drilling operations at WRMB01D, the pressure cemented steel casing was perforated to allow water to enter and establish connectivity with the target formation.

The first task of the perforating program was to run a cement bond log (CBL) to assess the effectiveness of the pressure cementing around the steel casing. The casing must be fully cemented in place with the annulus fully sealed to surface before any perforating can take place. The CBL for WRMB01D proved an effective cement seal and confirmed the depth of cased bore to 199 mbgl.

The perforating was undertaken by Vause Wireline Australia Pty Ltd in November 2014 using a scalloped gun system (43 mm diameter firing 6 shots per foot (over a length of 9 m) at a phase spacing of 60^0) run from a gauged wireline to ensure the correct depth is targeted.

Geophysical logging was previously carried out by Groundsearch Australia Pty Ltd in June 2014 after the bore was drilled to total depth but prior to the installation and pressure cementing of casing. The 9239 suite of logs (gamma, resistivity, calliper and density) was used to define the exact location of the high permeability sandstone interburden horizon immediately above the Fairbairns coal seam.

3.4 Field testing

3.4.1 Permeability testing

Falling and rising head ('slug') tests were conducted at the monitoring bores (except WKMB01D) in October 2014 to estimate the horizontal hydraulic conductivity of the screened water bearing zones. Testing of WRMB01D was completed in September 2015 after a failed attempt at testing in February 2015.

Slug tests are simple field procedures designed to calculate the approximate hydraulic conductivity of water bearing formations adjacent to monitoring bore screens. A falling head test is achieved by introducing a 'slug' to displace the water column within the monitoring bore causing the water level to instantaneously rise and flow from the bore into the aquifer via the well screen (Waterra 2011). A rising head test is the opposite, where a volume of water is instantaneously removed from the monitoring bore, causing the water level to fall, drawing water into the bore from the aquifer. Forcing the water out of the monitoring bore and into the formation sometimes produces slightly different results and therefore by comparing the results for each test a degree of confidence in the accuracy of the test can be achieved. The slug consists of a solid 1.5 inch PVC bar (1.6 m long) used to displace 1 m of water in the groundwater monitoring bores.

At the commencement of the testing, the standing water level (SWL) was measured from a fixed reference point at the top of casing and the datalogger programmed between 0.125 to 5 second intervals to measure the groundwater level changes.

3.4.2 Groundwater level measurements

Following the completion of each monitoring bore, *in situ* pressure transducers (dataloggers) were suspended from a galvanised steel wire in the water column and programmed to record a SWL measurement every six hours. To verify the level recorded by the dataloggers, manual measurements are recorded quarterly using an electronic dip meter. There was an obstruction in WRMB01D after the initial (failed) permeability testing of this monitoring bore that prevented the immediate installation of a datalogger and water sampling. Highland Drilling returned to the site to push the obstruction to the base of the monitoring bore in August 2015 (AGL, 2015b). The installation of the datalogger was not completed until September 2015.

A barometric logger installed above the water table at monitoring bore S5MB01 on AGL's Tiedman property (part of the original Stage 1 groundwater monitoring network) records changes in atmospheric pressure. Data from this logger is used to correct for the effects of changing barometric pressure on groundwater levels.

3.4.3 Groundwater quality sampling

Groundwater quality sampling was undertaken between 4 and 17 September 2014 at WRMB01A, WRMB01B and WRMB01C, and on 9 October 2015 at WRMB01D.

3.4.3.1 Sampling techniques

A Grundfos submersible pump was used to purge and obtain groundwater quality samples from monitoring bores WRMB01A, WRMB01B and WRMB01C. A minimum of three well volumes was purged from the monitoring bores prior to sampling to allow collection of representative groundwater samples (unless purged dry). Monitoring bore WRMB01B was purged dry and the bore was allowed to recharge before it was sampled 14 days later with a double check valve stainless steel bailer.

WRMB01D was sampled using a micro-purge™ low flow sampling pump. 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.

3.4.3.2 Analytical suite

Field parameters (Table 3.3) were measured during and following purging using a calibrated hand held water quality meter to ensure a representative groundwater sample was collected.

Groundwater 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 3.3 details the groundwater analytical suite. Samples undergoing dissolved metal analysis were filtered through 0.45 µm filters in the field prior to collection.

Table 3.3 Groundwater analytical suite

Category	Parameters	
Field parameters	EC Temperature DO	pH ORP TDS
General parameters (lab)	EC Total suspended solids	TDS (measured) pH
Major ions	Calcium Magnesium Sodium Potassium Silica	Chloride Bicarbonate Carbonate Sulphate Fluoride
Metals and minor/trace elements	Aluminium Antimony Arsenic Barium Beryllium Boron Bromine Cadmium Chromium Cobalt Copper Iron	Lead Manganese Mercury Molybdenum Nickel Selenium Strontium Tin Uranium Vanadium Zinc
Nutrients	Ammonia Phosphorus (total) Phosphorus (reactive) Total nitrogen	Nitrite Nitrate Total organic carbon (TOC) Total Kjeldahl Nitrogen
Hydrocarbons	Phenol compounds Polycyclic aromatic hydrocarbons (PAH) Oil and grease	Total petroleum hydrocarbons (TPH) Benzene, toluene, ethyl benzene and xylenes (BTEX) Volatile organic compounds (VOC's)
Dissolved gases	Methane Ethene Ethane Propene	Propane Butene Butane

Category	Parameters	
Isotopes	Oxygen-18 (^{18}O) Deuterium (^{2}H) Radiocarbon (^{14}C) Tritium (^{3}H)	Carbon-13 dissolved organic carbon ($^{13}C_{DIC}$) Carbon-13 methane ($^{13}C\text{-}CH_4$) and deuterium methane ($^{2}H\text{-}CH_4$)

The samples were sent to the following laboratories under appropriate chain-of-custody protocols:

- Australian Laboratory Service (ALS) Environmental Pty Ltd, Smithfield, Sydney – chemistry analysis. NATA certified laboratory.
- GNS Stable Isotope Laboratory, Lower Hutt, New Zealand – oxygen-18 and deuterium analysis.
- Rafter Radiocarbon Laboratory, Lower Hutt, New Zealand – carbon-14 analysis.
- GNS Tritium and Water Dating Laboratory, Lower Hutt, New Zealand – tritium.
- UC Davis Stable Isotope Facility, Davis, California, USA – carbon-13 ($^{13}C_{DIC}$) and methane isotope analysis ($^{13}C\text{-}CH_4$ and $^{2}H\text{-}CH_4$).

3.4.3.3 Quality assurance and quality control

Data collection and data handling QA/QC

The quality assurance (QA) procedures during sampling and the quality control (QC) procedures during data handling are detailed in the Parsons Brinckerhoff sampling procedures (Parsons Brinckerhoff 2015). All sampling was undertaken in accordance with the Australia//New Zealand standards for water quality sampling (AS/NZS 5667).

Laboratory QA/QC

The laboratories conduct their own internal QA/QC program to assess the accuracy and precision of the analysis and reporting procedures. These programs include analysis of laboratory sample duplicates, spike samples, certified reference standards, surrogate standards/spikes and laboratory blanks.

4. Results

4.1 Permeability testing

Test data were processed and analysed using the Bouwer and Rice (Bouwer 1989), or Hvorslev (1951) method with AQTESOLV Version 4.5. Results are presented as estimates of hydraulic conductivity (as m/day) in Table 4.1. The AQTESOLV reports are included in Appendix C.

The hydraulic conductivity values for WRMB01A (alluvium), WRMB01C (shallow rock) and WRMB01D (interburden) are consistent with previous hydraulic conductivity values within the Gloucester Basin (Parsons Brinckerhoff 2014a). The result for WRMB01B is an estimate only as the hydraulic response in the bore was too slow to be effectively analysed by AQTESOLV.

Table 4.1 Hydraulic conductivity results from slug tests

	WRMB01A	WRMB01B	WRMB01C	WRMB01D
Number of slug tests	2	1	1	2
Hydraulic conductivity range (m/d)	22 - 23	<0.0001	0.007	0.0003 – 0.0001
Mean hydraulic conductivity range (m/d)	22.5	<0.0001	0.007	0.0002
Screened formation	Alluvium	Jilleon Formation	Jilleon Formation	Jilleon Formation
Hydrogeological unit	Alluvium	Shallow rock	Shallow rock	Interburden
Lithology	Alluvial gravel	Sandstone	Sandstone	Sandstone

Note: m/d - metres per day.
Analysis conducted with the Hvorselv method except for WRMB01C where the Bouwer and Rice method was applied.

4.2 Groundwater levels

A hydrograph showing groundwater levels for the Wards River monitoring bores and rainfall from the start of monitoring until October 2015 is presented in Figure 4.1. The individual hydrographs for the Wards River monitoring bores are available in Appendix D. The data suggests there is an upward hydraulic gradient within the rock strata at this site.

The groundwater level in the alluvium (WRMB01A) shows an increase (~1.0 m) in response to large rainfall events (August 2014, December 2014, April 2015 and May 2015). The groundwater level returns to antecedent groundwater level over a period of one to two months.

Groundwater levels in the shallow rock (WRMB01B and WRMB01C) show a minimal response to rainfall recharge since monitoring commenced, with a stronger response visible at WRMB01C. Groundwater levels have been relatively stable since the start of monitoring, however monitoring bore WRMB01B showed slow recovery following airlift development during drilling, indicative of very low permeability. This is supported by the hydraulic conductivity results following permeability testing (Section 4.1).

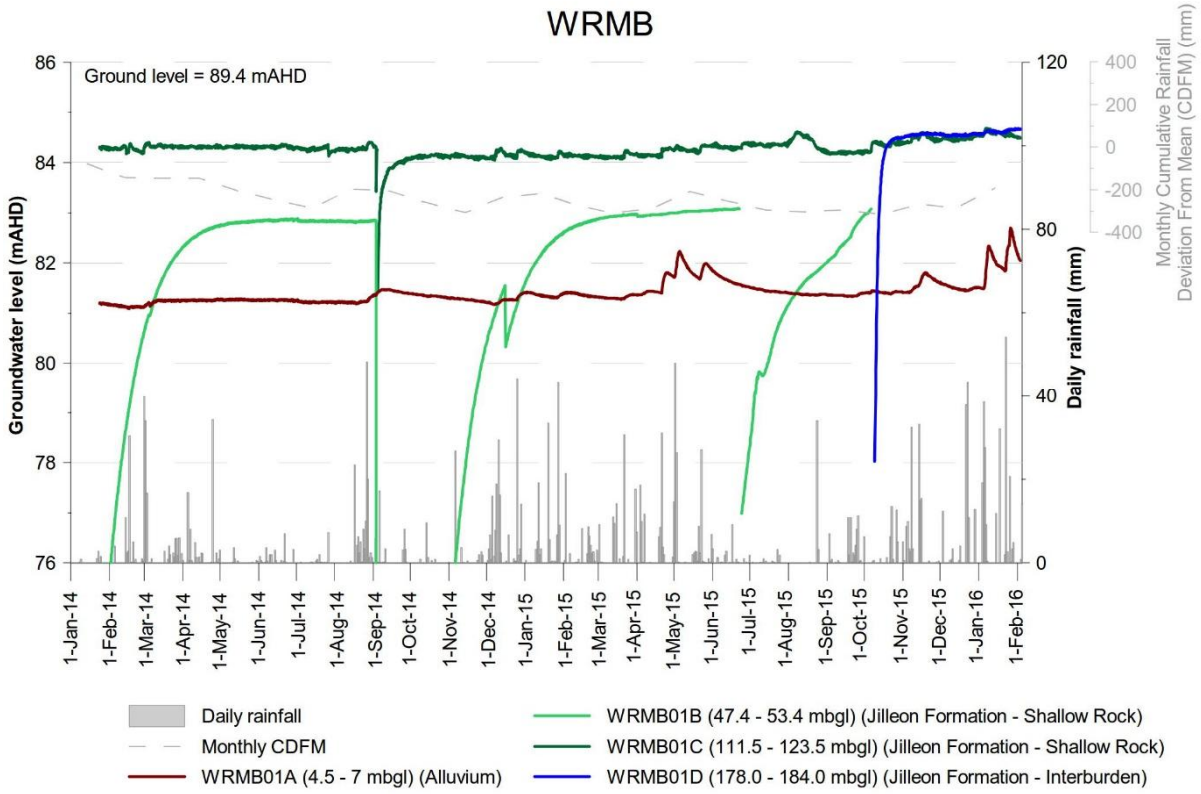

Figure 4.1 Groundwater levels and rainfall at the Wards River monitoring bores

4.3 Groundwater quality

Groundwater quality sampling was undertaken between 4 and 17 September 2014 at WRMB01A, WRMB01B and WRMB01C and on 9 October 2015 at WRMB01D. Full water quality results are presented in Appendix E and laboratory reports are presented in Appendix F.

4.3.1 Physico-chemical parameters

Groundwater in the alluvium (WRMB01A) is of marginal water quality (1,410 µS/cm) and slightly acidic (pH 6.40).

Groundwater salinity (EC) in the shallow rock bores WRMB01B and WRMB01C is brackish (3,040 µS/cm and 3,450 µS/cm respectively) and slightly alkaline (pH 7.80 and 7.91 respectively).

Groundwater salinity in the interburden (WRMB01D) is brackish (2,900 µS/cm) and alkaline (pH 9.02).

Redox conditions are typically reducing in all hydrogeological units, with the exception of the shallow rock at WRMB01B.

4.3.2 Major ions

The major ion characteristics of groundwater samples are shown in the piper diagram in Figure 4.2. 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-}). Groundwater in the alluvium is dominated by sodium, calcium, chloride and bicarbonate, and groundwater in the shallow rock and interburden is dominated by sodium, chloride and bicarbonate.

The change in water quality with depth is visible on the piper diagram as sodium and bicarbonate become increasingly more dominant with increasing depth. Chloride is more dominant in the alluvium.

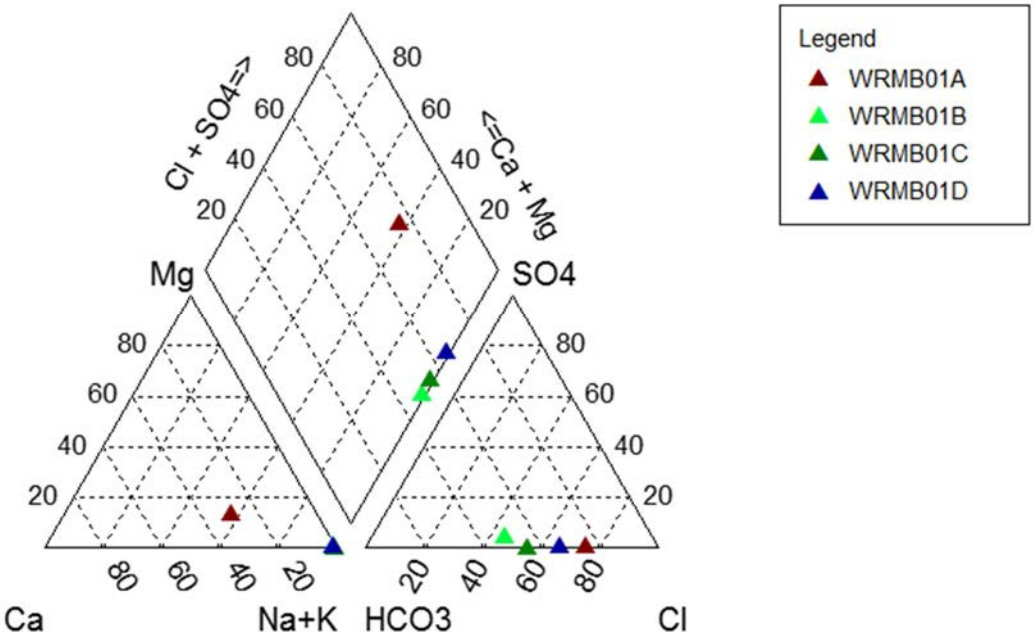

Figure 4.2 Piper diagram for the Wards River monitoring bores

4.3.3 Dissolved metals

Concentrations of detected dissolved metals in groundwater are presented in Figure 4.3. The major findings for dissolved metals are as follows:

- Concentrations of dissolved metals are generally similar in the alluvium, and shallow rock, with the exception of iron concentrations which are higher in the alluvium compared to the other hydrogeological units.
- Concentrations of dissolved metals are typically lower in the interburden than the alluvium and shallow bedrock with the exception of copper.
- Aluminium, barium, bromine, iron, strontium and zinc are detected at slightly elevated concentrations compared to other dissolved metals.
- Boron, cadmium and uranium were only detected at shallow rock monitoring bore WKMB01B. Molybdenum was only detected at monitoring bores WKMB01B and WKMB01D.

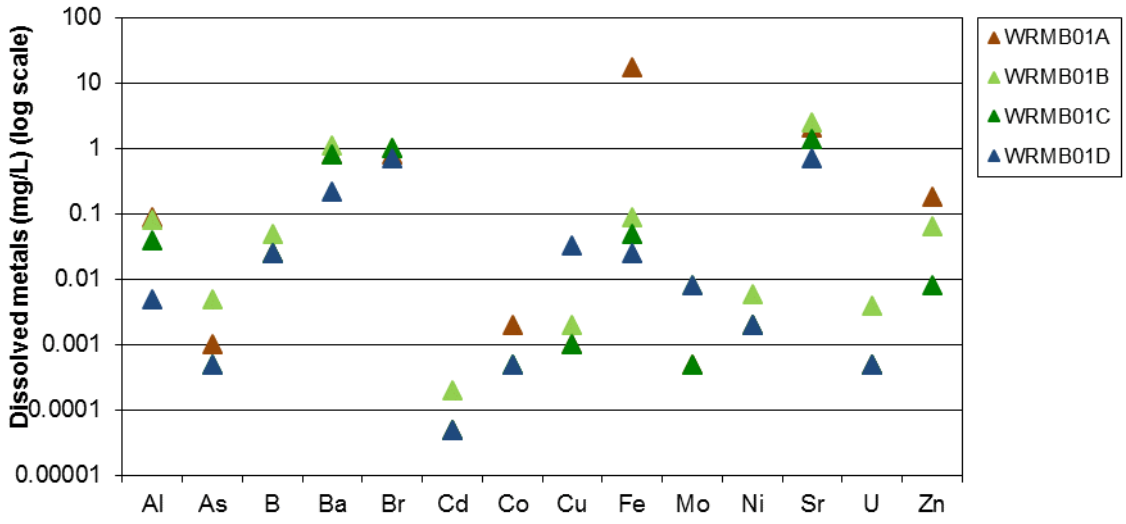

Figure 4.3 Detected dissolved metal concentrations in groundwater for Wards River monitoring bores

4.3.4 Nutrients

The major findings for nutrients are as follows:

- Ammonia concentrations ranged from 0.65 mg/L in the alluvium (WRMB01A) to 1.4 mg/L in the interburden at WRMB01D.
- Nitrate concentrations ranged from below the laboratory LOR (<0.01 mg/L) at WRMB01B and WRMB01D to 0.09 mg/L at WRMB01C.
- Nitrite concentrations were below the laboratory LOR (<0.01 mg/L) at all monitoring bores, with the exception of WRMB01B (0.07 mg/L).
- TOC concentrations ranged from 1 mg/L at WRMB01C to 10 mg/L at WRMB01D.
- Total phosphorus concentrations decreased with depth from 0.25 mg/L at WRMB01A to 0.01 mg/L at WRMB01D.

4.3.5 Dissolved gases

Dissolved methane was detected at all monitoring bores at concentrations increasing with depth (from 2,640 µg/L at WRMB01A to 29,700 µg/L at WRMB01D). No other dissolved gases were detected.

4.3.6 Hydrocarbons

No PAHs were detected in the monitoring bores. Phenolic compounds were not detected in the alluvium or shallow rock. Phenol was detected in the interburden at WRMB01D (2.3 µg/L).

Benzene was detected at WRMB01D (8 µg/L) and toluene was detected at WRMB01C (11 µg/L); no other BTEX compounds (*i.e.* ethylbenzene and xylenes) were detected. TPH C_6-C_9 fraction (20 µg/L) and TRH C_6-C_{10} fraction (30 µg/L) were detected at shallow rock monitoring bore WRMB01C.

4.4 Isotopes

4.4.1 Stable isotopes of water

Stable isotopes of water, oxygen-18 (^{18}O) and deuterium (^{2}H) provide information about the origin of natural waters and the processes that have affected groundwater since it entered the groundwater system.

Stable isotope values ($\delta^{18}O$ and $\delta^{2}H$) are plotted with the Global Meteoric Water Line (GMWL) ($\delta^{2}H = 8.13\ \delta^{18}O + 10.8$) (Rozanski et al. 1993) and the Local Meteoric Water Line (LMWL) in Figure 4.4.

The meteoric water lines (as seen on Figure 4.4) provide an important key to the interpretation of oxygen-18 and deuterium data. They are lines that define the relationship between oxygen-18 and deuterium in fresh surface waters and precipitation. Water with an isotopic composition that lies on the meteoric water line is assumed to have originated from the atmosphere and to be unaffected by other isotopic processes. The isotopic values for the groundwater samples are also compared to the LMWL ($\delta^{2}H = 8.3\ \delta^{18}O + 16.3$) (Crosbie et al. 2012). This line defines the relationship between ^{18}O and ^{2}H for rainfall in the Sydney region.

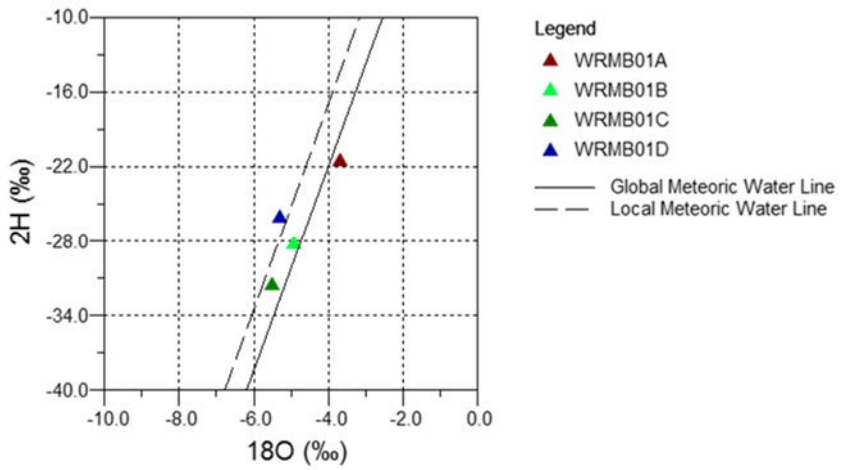

Figure 4.4 Deuterium versus oxygen-18 for Wards River monitoring bores

Stable isotope results for all the Wards River monitoring bores are presented in Table 4.2.

Table 4.2 Stable isotope results for the Wards River monitoring bores

Bore	Oxygen-18 (‰)	Deuterium (‰)
WRMB01A	-3.68	-21.5
WRMB01B	-4.92	-28.2
WRMB01C	-5.50	-31.5
WRMB01D	-5.30	-26.1

Stable isotope results indicate that WRMB01D plots closest to the LMWL and departure from the LMWL increases as the depth of the bore decreases. This is most probably due to the shallower groundwater undergoing more evaporative processes relative to the deeper groundwater and becoming enriched in the heavier ^{18}O isotope.

These isotope results are consistent with previous monitoring rounds in the Gloucester Gas Project area in 2012 (Parsons Brinckerhoff 2012) and 2013 (Parsons Brinckerhoff 2013e, 2014a and 2014b).

4.4.2 Radiogenic isotopes

Tritium, radiocarbon, Carbon-13 and dissolved inorganic carbon ($\delta^{13}C$-DIC) results are presented in Table 4.3.

Table 4.3 $\delta^{13}C$-DIC, radiocarbon and tritium results for the Wards River monitoring bores

Bore	$\delta^{13}C$ (‰)	$a^{14}C$ (pMC)	^{14}C age[a] (yrs BP)	^{14}C age[b] (yrs BP)	Tritium (TU)
WRMB01A	-14.09	87.37 ± 0.18	1,022 ± 17	Modern	0.845 ± 0.024
WRMB01B	-18.75	10.3 ± 0.19	18,194 ±151	16,350	0.052 ± 0.013
WRMB01C	-15.18	0.54 ± 0.21	41,825 ± 3,034	37,250	-0.010 ± 0.012
WRMB01D	-13.46	1.13 ± 0.22	35,958 ± 1,564	33,300	0.011 ± 0.015

(a) Uncorrected radiocarbon age.
(b) Corrected radiocarbon age.

The carbon-14 activity for WRMB01A was 87.37±0.18 pMC, corresponding to an uncorrected age of 1,022±17 yrs BP. Four correction methods are applied (Fontes-Garnier (1979); revised Fontes-Garnier; Tamers (1975) and Ingerson and Pearson (1964)) to apparent radiocarbon data to account for potential dilution of ^{14}C signature by incorporation of inactive carbon. The four models showed good agreement for corrected radiocarbon ages, and the average corrected radiocarbon age for WRMB01 was modern (<50 yrs BP). Radiocarbon age corresponded with tritium data that indicated the presence of modern water.

The carbon-14 activity for WRMB01B was 10.3 ± 0.19 pMC, corresponding to an uncorrected age of 18,194±151 yrs BP. The carbon-14 activity for WRMB01C was 0.54±0.21 pMC, corresponding to an uncorrected age of 41,825±3,034 yrs BP. Radiocarbon ages have been corrected to account for potential dilution by processes such as carbonate dissolution, sulphate reduction and methanogenesis (as defined in Clark and Fritz (1997)) and are 16,350 and 37,250 years for WRMB01B and WRMB01C, respectively. Tritium values are negligible, and confirm that water in the shallow rock is old.

Groundwater in the deep interburden is also old; the carbon-14 activity for WRMB01D was 1.13 ± 0.22 pMC, corresponding to a corrected groundwater age of 33,300 years. The tritium concentration was also negligible, confirming that the age of the water in the interburden is old.

The slightly older age for the shallower groundwater at WRMB01C compared to the groundwater at WRMB01D may be indicative of upward flow.

4.4.3 Carbon and hydrogen isotopes of methane (δ^{13}C-CH_4 and δ^{2}H-CH_4)

Compound specific isotopes of dissolved methane (carbon-13 (δ^{13}C-CH_4) and deuterium (δ^{2}H-CH_4)) were analysed in all monitoring bores. Dissolved methane concentrations and isotope results are presented in Table 4.4, and isotope results are compared to data collected by AGL from coal seams during exploration in the GGP area.

Table 4.4 Dissolved methane concentrations and isotope results

Bore	CH_4 (µg/L)	$\delta^{2}H_{CH4}$ (‰)	$\delta^{13}C_{CH4}$ (‰)
WRMB01A	2,640	606.0[a]	-50.87[a]
WRMB01B	6,840	2321.1[a]	-49.10[a]
WRMB01C	17,800	2103.2[a]	-49.17[a]
WRMB01D	29,700	-210.6	-48.63

(a) Below LOQ.

The limit of quantitation (LOQ) is the lowest concentration or quantity of a target variable that can be reported with a specified degree of confidence; therefore sample WRMB01A, WRMB01B and WRMB01C with δ^{13}C-CH_4 and δ^{2}H-CH_4 results below the LOQ cannot be interpreted with a degree of confidence; however, the δ^{13}C-CH_4 suggest a thermogenic origin of methane in alluvium and shallow rock (see Figure 4.5).

The results for WRMB01D indicate the methane is early mature thermogenic methane (Figure 4.6).

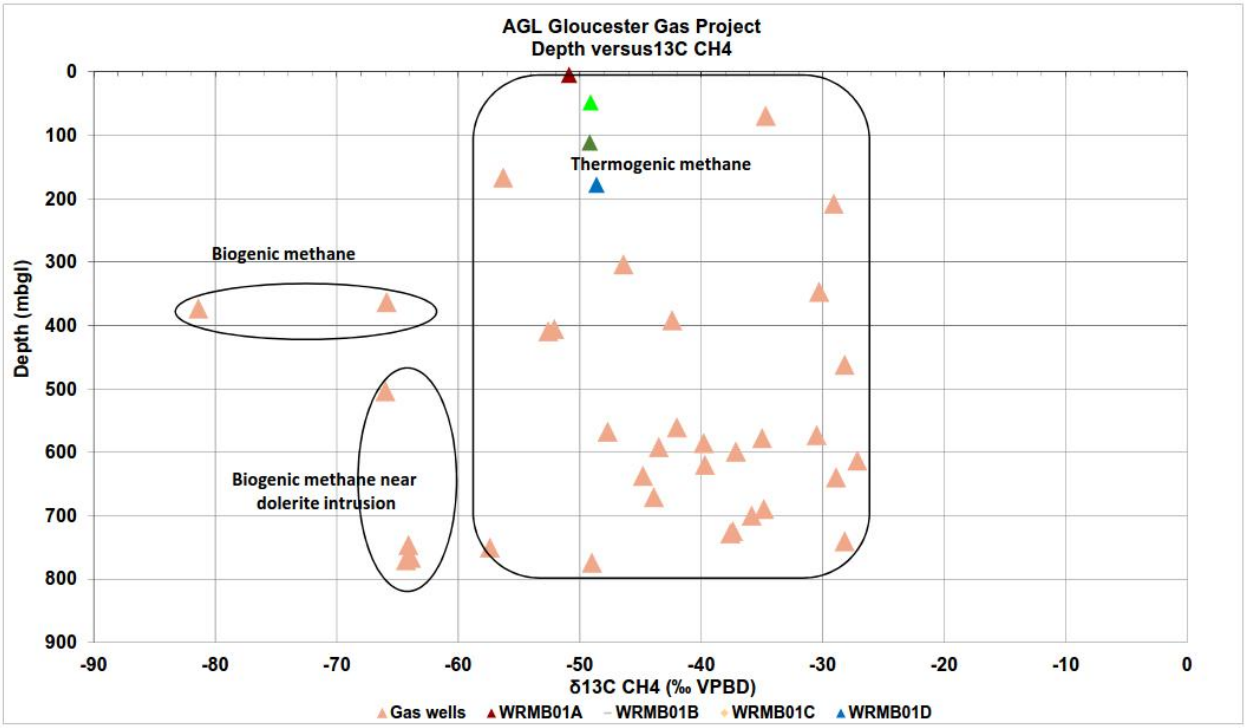

Figure 4.5 Depth versus ^{13}C-CH_4 for the Wards River monitoring bores

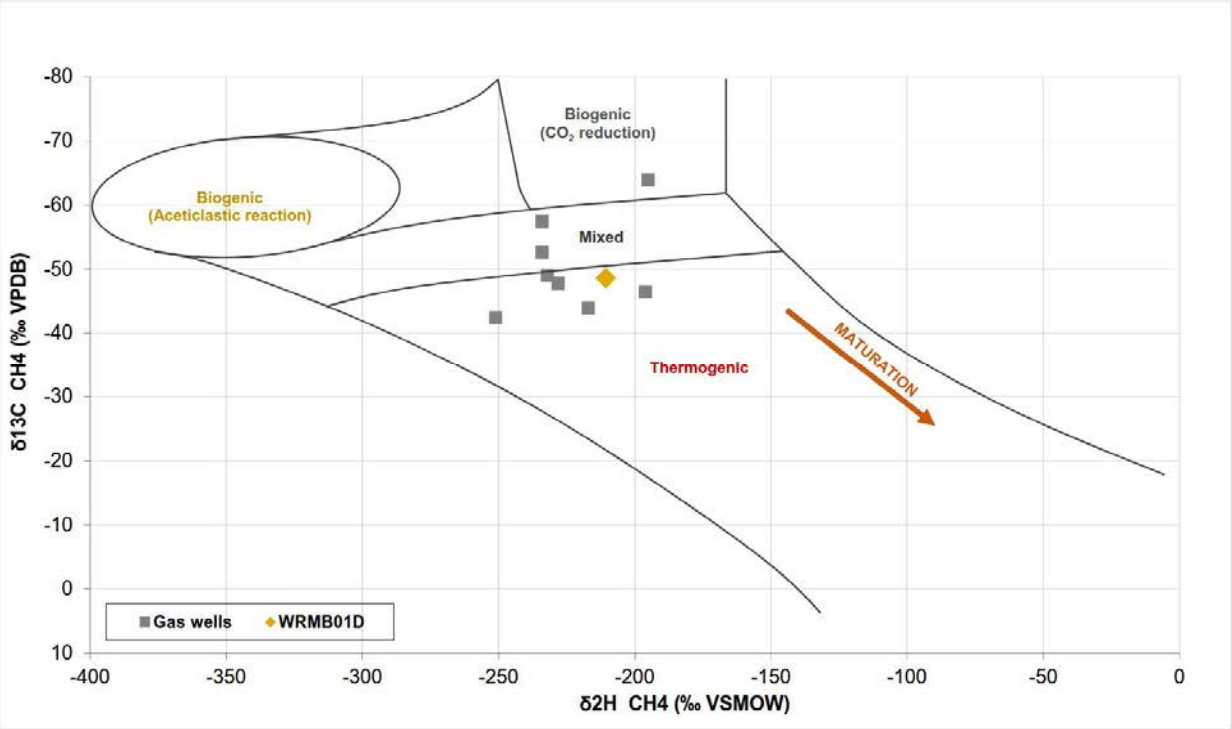

Figure 4.6 ^{13}C-CH_4 versus ^{2}H-CH_4 for the Wards River monitoring bores

5. Conclusions

This drilling program involved the establishment of one nested groundwater monitoring site (a total of four monitoring bores) within the GGP between November 2013 and June 2014. The perforating of the deep monitoring bore was not completed until November 2014. Final site testing was completed in October 2015. One monitoring bore was installed in the Quaternary alluvium (WRMB01A), two monitoring bores in the shallow sandstone of the Jilleon Formation (shallow rock) (WRMB01B and WRMB01C) and one monitoring bore in the deep sandstone of the Jilleon Formation of the Gloucester Coal Measures (interburden) (WRMB01D).

The initial findings for groundwater levels at this Wards River site are:

- Groundwater levels in the alluvium show a minor response (~1.0 m) to rainfall events and otherwise have been relatively stable since the start of monitoring.
- Groundwater levels at WRMB01B slowly recovered following airlifting, which is indicative of very low permeability and corroborated by permeability testing results.
- Small groundwater level responses to rainfall events are observed at WRMB01C.

The initial findings for groundwater quality at this Wards River site are:

- Groundwater in the alluvium is of marginal water quality and slightly acidic. Groundwater salinity (EC) in the shallow rock is brackish and slightly alkaline; and groundwater in the interburden is brackish and alkaline.
- Groundwater in the alluvium is chemically classified as Na-Ca-Cl-HCO_3 type water, and in the shallow rock and interburden groundwater is Na-Cl-HCO_3 type.
- Aluminium, barium, bromine, iron, strontium and zinc were detected in groundwater at higher concentrations in the alluvium and the shallow rock compared to the interburden (WRMB01D). Higher levels of iron and zinc were detected in groundwater in the alluvium compared to the shallow rock.
- Concentrations of dissolved metals are generally similar in the alluvium, and shallow rock, and are higher than the interburden. Aluminium, barium, bromine, iron, strontium and zinc are detected at slightly elevated concentrations in all hydrogeological units.
- No phenolic compounds or PAHs were detected in alluvium or shallow bedrock, however low levels of toluene and TPH were detected at shallow rock monitoring bore WRMB01C. Benzene and phenol were detected at low concentrations in the interburden monitoring bore WRMB01D.
- Dissolved methane was detected in all hydrogeological units, with concentrations increasing with depth.
- Stable isotope data indicates that groundwater in all hydrogeological units is of meteoric origin. Tritium and radiocarbon data confirms the presence of modern water in the alluvium, and indicates that the age of groundwater in the shallow rock and interburden is much older ranging between 16,000 and 38,000 years BP.
- Methane isotopes indicate that dissolved methane present in all hydrogeological units is thermogenic.

6. Statement of limitations

6.1 Scope of services

This report has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client (AGL) and Parsons Brinckerhoff (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

6.2 Reliance on data

In preparing the report, Parsons Brinckerhoff has relied upon data, surveys, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

6.3 Environmental conclusions

In accordance with the scope of services, Parsons Brinckerhoff has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

6.4 Report for benefit of client

The report has been prepared for the benefit of the client (and no other party). Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Parties other than the client should not rely upon the report or the accuracy or

completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

6.5 Other limitations

Parsons Brinckerhoff will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

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Appendix A

Bore licence and Form A’s

NSW Office of Water

Hunter Region
Po Box 2213
3/26 Honeysuckle Drive
Dangar NSW 2309
Phone: (02) 49042500

BORE LICENSE CERTIFICATE
UNDER SECTION 115 OF THE WATER ACT, 1912

20BL173575

Department of Primary Industries Office of Water

A G L Upstream Investments Pty Ltd
Locked Bag 1837
St Leonards NSW 2065

LICENSE NUMBER
20BL173575
DATE LICENSE VALID FROM
25-Oct-2013
DATE LICENSE VALID TO
PERPETUITY
FEE
$0.00

ABN 47661556763 GST NIL

LOCATION OF WORKS

Portion(s) or Lot/Section/DP	PARISH	COUNTY
2//1128605	Grant	Gloucester

TYPE OF WORKS	PURPOSE(S) FOR WHICH WATER MAY BE USED
Test Bore	Monitoring Bore

CONDITIONS APPLYING TO THIS LICENSE ARE

As shown on the attached Condition Statement

COPY

NSW Office of Water

CONDITIONS STATEMENT REFERRED TO ON 20BL173575 ISSUED UNDER PART V OF THE WATER ACT, 1912 ON 25-Oct-2013

(1) THE LICENCE SHALL LAPSE IF THE WORK IS NOT COMMENCED AND COMPLETED WITHIN ONE YEAR OF THE DATE OF ISSUE OF THE LICENCE.

(2) THE LICENSEE SHALL ALLOW NSW OFFICE OF WATER OR ANY PERSON AUTHORISED BY IT, FULL AND FREE ACCESS TO THE WORKS, EITHER DURING OR AFTER CONSTRUCTION, FOR THE PURPOSE OF CARRYING OUT INSPECTION OR TEST OF THE WORKS AND ITS FITTINGS AND SHALL CARRY OUT ANY WORK OR ALTERATIONS DEEMED NECESSARY BY THE DEPARTMENT FOR THE PROTECTION AND PROPER MAINTENANCE OF THE WORKS, OR THE CONTROL OF THE WATER EXTRACTED AND FOR THE PROTECTION OF THE QUALITY AND THE PREVENTION FROM POLLUTION OR CONTAMINATION OF SUB-SURFACE WATER.

(3) WATER SHALL NOT BE PUMPED FROM THE BORE AUTHORISED BY THIS LICENSE FOR ANY PURPOSE OTHER THAN GROUNDWATER INVESTIGATION.

(4) THE WORK SHOULD BE CONSTRUCTED TO SEAL OFF WATER FROM ANY AQUIFER OTHER THAN THE TARGET AQUIFER BY:
(A) INSERTING THE APPROPRIATE LENGTH OF CASING TO A DEPTH IMMEDIATELY ABOVE THE TARGET AQUIFER
(B) CEMENTING BETWEEN THE CASING(S) AND THE WALLS OF THE BORE HOLE FROM THE BOTTOM OF THE CASING TO GROUND LEVEL.

(5) THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER IF A FLOWING SUPPLY OF WATER IS OBTAINED. THE BORE SHALL THEN BE LINED WITH CASING AND CEMENTED AND A SUITABLE CLOSING GEAR SHALL BE ATTACHED TO THE BOREHEAD AS SPECIFIED BY NSW OFFICE OF WATER.

(6) IF A WORK IS ABANDONED AT ANY TIME THE LICENSEE SHALL NOTIFY NSW OFFICE OF WATER THAT THE WORK HAS BEEN ABANDONED AND SEAL OFF THE AQUIFER IN ACCORDANCE WITH THE MINIMUM CONSTRUCTION REQUIREMENTS FOR WATER BORES IN AUSTRALIA.

(7) THE LICENCE HOLDER MUST, WITHIN 2 MONTHS OF COMPLETION OF THE CONSTRUCTION OF THE WORK, OR WITHIN 2 MONTHS AFTER THE ISSUE OF THE APPROVAL IF THE WORK IS EXISTING, SUBMIT TO THE DEPARTMENT THE FOLLOWING:
(I) THE COMPLETED APPROVED FORM (FORM A),
(II) DETAILS OF THE LOCATION OF THE WORK ON A COPY OF THE LOT AND DEPOSITED PLAN, THE WORKS GPS REFERENCE, AND THE RESPECTIVE DISTANCE(S) OF THE WORK FROM THE PROPERTY BOUNDARIES,
(III) IF THE MINISTER HAS REQUESTED ANY WATER ANALYSIS AND/OR PUMPING TESTS TO BE CARRIED OUT, DETAILS OF THE WATER ANALYSIS AND/OR PUMPING TESTS AS REQUIRED BY THE MINISTER,

(8) IF, DURING THE CONSTRUCTION OF THE WORK, SALINE OR CONTAMINATED WATER IS ENCOUNTERED ABOVE THE PRODUCTION AQUIFER, THE LICENCE HOLDER MUST:
(I) NOTIFY THE DEPARTMENT,
(II) ENSURE THAT SUCH WATER IS SEALED OFF BY:
(1) INSERTING CASING TO A DEPTH SUFFICIENT TO EXCLUDE THE SALINE OR CONTAMINATED WATER FROM THE WORK,
(2) IF SPECIFIED BY THE MINISTER, PLACING AN IMPERMEABLE SEAL BETWEEN THE CASING(S) AND

THE WALLS OF THE WORK FROM THE BOTTOM OF THE CASING TO GROUND LEVEL AS SPECIFIED BY THE MINISTER,
(III) IF THE MINISTER HAS SPECIFIED ANY OTHER REQUIREMENTS, COMPLY WITH THE REQUIREMENTS (IF ANY) SPECIFIED BY THE MINISTER,

(9) THE HOLDER OF THE LICENCE SHALL NOT ALLOW ANY WATER EXTRACTED FROM THE BORE TO DISCHARGE INTO OR ONTO:
- ANY LAND
- ANY RIVER, CREEK OR WATERCOURSE;

(10) THE LICENCE HOLDER IS NOT AUTHORISED BY THIS LICENCE TO REMOVE OR CLEAR ANY NATIVE VEGETATION OR TREES AS DESCRIBED WITHIN THE NATIVE VEGETATION ACT 2003. ANY VEGETATION REMOVAL WILL REQUIRE SEPARATE WRITTEN APPROVAL FROM NSW OFFICE OF WATER.

(11) BORE DRILLING/CONSTRUCTION MUST OCCUR IN ACCORDANCE WITH THE MINIMUM CONSTRUCTION REQUIREMENTS FOR WATER BORES IN AUSTRALIA.

(12) THE LICENCE HOLDER SHALL NOT DISTURB THE HABITAT OF ANY NATIVE FLORA AND/OR FAUNA.

End Of Conditions

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

Page 1

WRMB01A

Driller's Licence No:	1913	1
Class of Licence:	CLASS 4	
Driller's Name:	IAN PALK	
Assistant Driller:	ASHLEY WILLS	
Contractor:	HIGHLAND DRILLING	
New bore ✓ / Replacement bore	/	
Deepened / Enlarged	/	
Reconditioned / Other (specify)	/	
Final Depth	8.2 m	

Work Licence No:	10BL173575	2
Name of Licensee:	AGL	
Intended Use:	MONITORING	
Completion Date:	2-12-2013	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	7.5	200mm	9
7.5	8.2	140mm	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		DDL at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
NO	WATER CUTS.											

CASING/LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	168	4.2	+.5	7.5	6
8	60.2	5	+.5	4.5	5
8	60.2	5	7.5	8	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}: N (indicate on sketch)

Sump installed {Yes/No}: Y From 7.5 m To 8.00 m

Pressure cemented {Yes/No}: N From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	4.5	7.5	5	5	.4	20	10	H

GRAVEL PACK 7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded ✓	Graded ✓	3	5	4	7.5	300	
Crushed	Ungraded			1	4		
Bentonite/Grout seal (Yes/No) Y				–			
Method of placement of Gravel Pack	See Code 7: 1						

For Departmental use only: GW

NSW GOVERNMENT | Office of Water

Form A Particulars of completed work

WRMB01A

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	2	Soil
2	4	CLAY
4	7.5	GRAVEL
7.5	8.2	SILTSTONE

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)
				N/A			

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

WRMB01A

Work Licence No:

BORE DEVELOPMENT — 8

Chemical used for breaking down drilling mud (Yes/No)	N	Name:	

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	.15 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION — 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION — 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1			N						
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method ____ See Code 4

WORK PARTLY BACKFILLED OR ABANDONED — 11

Original depth of work: ____ m Is work partly backfilled: (Yes/No) ____

Is work abandoned: (Yes/No) ____ Method of abandonment: Backfilled ____ Plugged ____ Capped ____

Has any casing been left in the work (Yes/No) ____ N From ____ m To ____ m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ✓ Geologist ____ Driller ____ Diviner ____ Client ____ Other ____ — 12

Lot No 2 DP No 1128605 — 13

Work Location Co ordinates Easting 0400532 Northing 6438014 Zone ____

GPS: (Yes/No) Y >> AMG/AGD ____ or MGA/GDA ____ (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: IAN PALK **Licensee:** ----------

Date: 10-12-2013 **Date:** ----------

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

WRMB01B

Driller's Licence No:	1913	1
Class of Licence:	CLASS 4	
Driller's Name:	IAN PALK	
Assistant Driller:	ASHLEY WILLS	
Contractor:	HIGHLAND DRILLING	
New bore	✓	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	56.4 m	

Work Licence No:	10BL173575	2
Name of Licensee:	AGL	
Intended Use:	MONITORING	
Completion Date:	2.12.2013	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	11.4	200	9
11.4	56.4	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
30	31	1		.1	.1		1			15	947	.616

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	168	4.2	+.5	11.4	6
8	60.2	5	+.5	48.4	5
8	60.2	5	54.4	56.4	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}: N (indicate on sketch)

Sump installed {Yes/No}: Y — From 54.4 m To 56.4 m

Pressure cemented {Yes/No}: Y — From 0 m To 41.45 m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	.5	48.4	54.4	5	5	.4	20	10	4

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	✓	Graded	✓	3	5	45.4	56.4	260	
Crushed		Ungraded							

Bentonite/Grout seal (Yes/No): Y

Method of placement of Gravel Pack — See Code 7: 1

For Departmental use only: GW

NSW GOVERNMENT | Office of Water

Form A Particulars of completed work

WRMB01B

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	6	CLAY
6	12	SILTSTONE
12	15	SANDSTONE
15	16	SILTSTONE
16	18	SANDSTONE
18	19	SILTSTONE
19	20	SANDSTONE
20	21	SILTSTONE
21	27	SANDSTONE
27	30	SILTSTONE
30	33	SANDSTONE
33	42	SILTSTONE
42	45	SANDSTONE
45	46	SILTSTONE
46	56.4	SANDSTONE

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

WRMB01B

Work Licence No:

BORE DEVELOPMENT — 8

Chemical used for breaking down drilling mud (Yes/No)	N	Name:									
Method	Bailing/Surging		Jetting		Airlifting	Y	Backwashing		Pumping		Other:	
Duration		hrs		hrs	30	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION — 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION — 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1				N/A					
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level: m — Test Method: See Code 4

WORK PARTLY BACKFILLED OR ABANDONED — 11

Original depth of work: m — Is work partly backfilled: (Yes/No) N

Is work abandoned: (Yes/No) — Method of abandonment: Backfilled Plugged Capped — A

Has any casing been left in the work (Yes/No) — From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ✓ Geologist Driller Diviner Client Other — 12

Lot No 2 — DP No 1128605 — 13

Work Location Co ordinates Easting 0400581 Northing 6437853 Zone

GPS: (Yes/No) Y >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: IAN PALK **Licensee:**

Date: 10-12-2013 **Date:**

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

WRMB01C

Driller's Licence No:	1913	1
Class of Licence:	CLASS 4	
Driller's Name:	IAN PALK	
Assistant Driller:	ASHLEY WILLS	
Contractor:	HIGHLAND DRILLING	
New bore	✓	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	126.60	

Work Licence No:	10BL173575	2
Name of Licensee:	AGL	
Intended Use:	MONITORING	
Completion Date:	2.12.2013	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	11.5	200	9
11.5	126.60	140	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
30	31	1		.1	.1		1			15	3179	2.066
54	55	1		.1	.2		1			15	3149	7.047
102	103	1		.2	.4		1			15	2281	1.482

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	168	4.2	+.5		6
8	60.2	5	+.5		5
8	60.2	5	123.45	126.45	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed {Yes/No}: N (indicate on sketch)

Sump installed {Yes/No}: Y — From 123.45 m To 126.45 m

Pressure cemented {Yes/No}: Y — From 0 m To 34 m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.2	5	111.45	123.45	5	5	.4	20	10	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	✓	Graded	✓	3	5	106.45	126.45	480	
Crushed		Ungraded							

Bentonite/Grout seal (Yes/No): Y

Method of placement of Gravel Pack — See Code 7: 1

For Departmental use only: GW

NSW GOVERNMENT | Office of Water

Form A Particulars of completed work

WRMB01C

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	6	CLAY
6	16	SILTSTONE
16	17	SANDSTONE
17	18	SILTSTONE
18	19	SHALE
19	21	SILTSTONE
21	27	SANDSTONE
27	42	SILTSTONE
42	49	SANDSTONE
49	61	SILTSTONE
61	70	SANDSTONE
70	80	SILTSTONE
80	126.45	SANDSTONE

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)
				N/A			

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT | Office of Water

Form A Particulars of completed work

WRM801C

Work Licence No:

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) N Name:

Method	Bailing/Surging		Jetting		Airlifting	Y	Backwashing		Pumping		Other:	
Duration		hrs		hrs	.5	hrs		hrs		hrs		hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1			N						
	Stage 2				A					
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) N From m To m

Sealing / fill type See Code 11	From depth (m)	To depth (m)	Sealing / fill type See Code 11	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ✓ Geologist Driller Diviner Client Other 12

Lot No 2 DP No 1128605 13

Work Location Co ordinates Easting 0400587 Northing 6437860 Zone

GPS: (Yes/No) Y >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: IAN PALK **Licensee:**

Date: 10-12-2013 **Date:**

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

WRMB01D

Driller's Licence No:	1913	1
Class of Licence:	CLASS 4	
Driller's Name:	IAN PALK	
Assistant Driller:	ASHLEY WILLS	
Contractor:	HIGHLAND DRILLING	
New bore	✓	Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	200 m	

Work Licence No:	10BL173575	2
Name of Licensee:	AGL.	
Intended Use:	MONITORING	
Completion Date:	23/6/2014	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	5.5	254	9
5.5	32	200	9
32	200	130	9

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4	DDL at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
54	55	1		.1	.1	1			15		2.00
102	103	1		.1	.2	1			15		7.00
150	151	1		.1	.3	1			15		2.00

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
9	219.1	4.8	+.5	5.5	
9	168.00	4.8	+.5	29	5
9	75	7.5	+.5	193	5

Casing support method — See Code 5: 1 1 2

Type of casing bottom — See Code 5: 1 1 2

Centralisers installed {Yes/No}: Y (indicate on sketch)

Sump installed {Yes/No}: Y From 184 m To 193 m

Pressure cemented {Yes/No}: Y From 0 m To 200 m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8										

STEEL TO BE PERFORATED 175 – 184 M

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded							
Crushed		Ungraded							

Bentonite/Grout seal (Yes/No)

Method of placement of Gravel Pack — See Code 7

For Departmental use only: G W

NSW GOVERNMENT | Office of Water

Form A Particulars of completed work

WRMB01D

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	8	CLAY
8	14	SHALE
14	15	SANDSTONE
15	22	SILTSTONE
22	23	SANDSTONE
23	32	SILTSTONE
32	46	SANDSTONE
46	55	SILTSTONE
55	60	SANDSTONE
60	61	SILTSTONE
61	66	SANDSTONE
66	75	SILTSTONE
75	174	SANDSTONE
174	178	SILTSTONE
178	180	SANDSTONE
180	183	SILTSTONE
183	200	SANDSTONE

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT Office of Water

Form A Particulars of completed work

WRMB01D

Work Licence No:

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) N Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1				N/A					
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ✓ Geologist Driller Diviner Client Other 12

Lot No 2 DP No 1128605 13

Work Location Co ordinates Easting 400570.97 Northing 6437838.17 Zone

GPS: (Yes/No) Y >> AMG/AGD or MGA/GDA (See explanation)

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: [signature] **Licensee:**

Date: 7/7/2014 **Date:**

Appendix B

Bore logs

BORE COMPLETION REPORT - WRMB01A

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400527.34 **Northing:** 6438012.51
Top of casing elevation: 85.38 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.55 m

Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 8.12 m

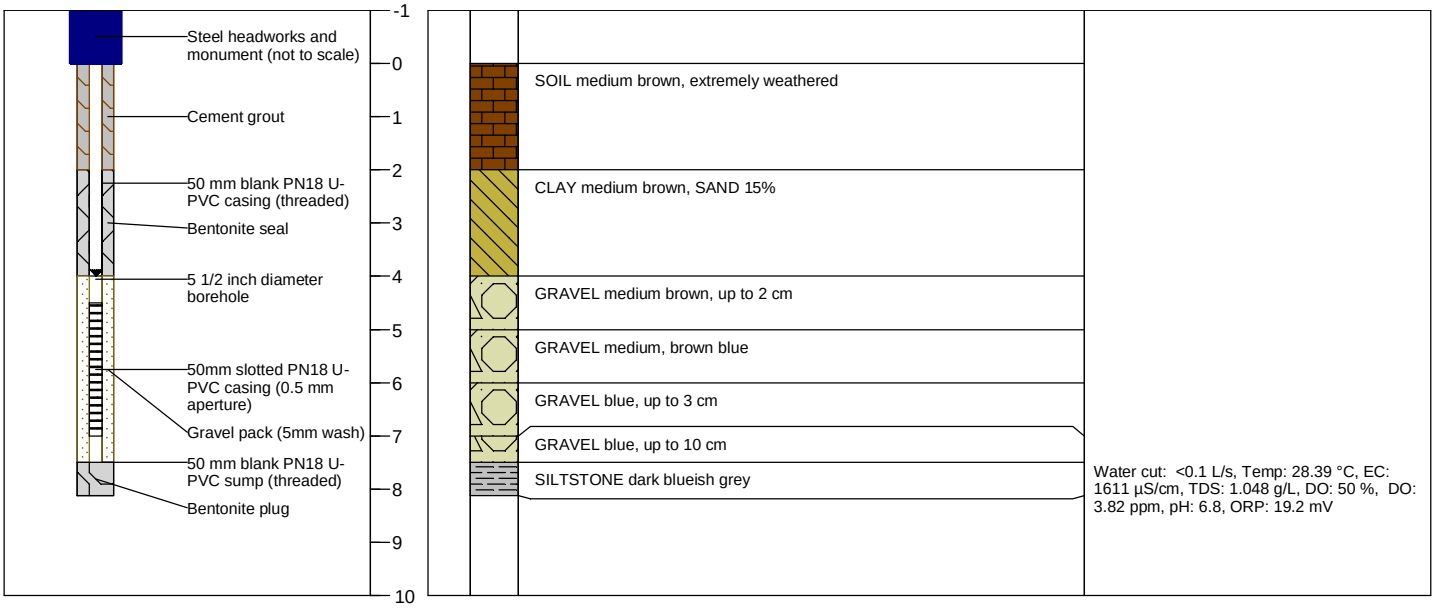
Borehole diameter:	205.0 mm	0 - 7.5 m	**Bit:** Blade
Borehole diameter:	139.0 mm	7.5 - 8.12 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Alluvium
Logged by: K. Maher
Start date: 28/11/13
Completion date: 28/11/13

Static WL: 81.39 mAHD 3.995 mbtoc
Water level date: 2/12/13

Plain casing: 0-4.5 m: 50 mm PVC Class 18 50 mm PVC
Screen: 4.5-7.0 m: 50 mm PVC Class 18 (0.5 mm slots)
Sump: 7.0-8.0 m: 50 mm PVC Class 18
Cement grout: 0-2.0 m: 0.024 m3
Gravel backfill: NA
Bentonite seal: 2.0-4.0 m
Gravel pack: 4-7.5 m: 5 mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY / GRAPHIC LOG	LITHOLOGY	WATER QUALITY



PARSONS BRINCKERHOFF

Drawing No.: WRMB01A - Bore Constructio	
Revision: A	Date drawn: 10/7/14
Drawn by: K. Maher	Checked by: E. Kwantes
Project No. 2193324A	

AGL

AGL Upstream Investments Pty Ltd
WRMB01A

Phase 2 Groundwater Investigation

BORE COMPLETION REPORT - WRMB01B

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400579.58 **Northing:** 6437850.83
Top of casing elevation: 90.04 mAH
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.55 m

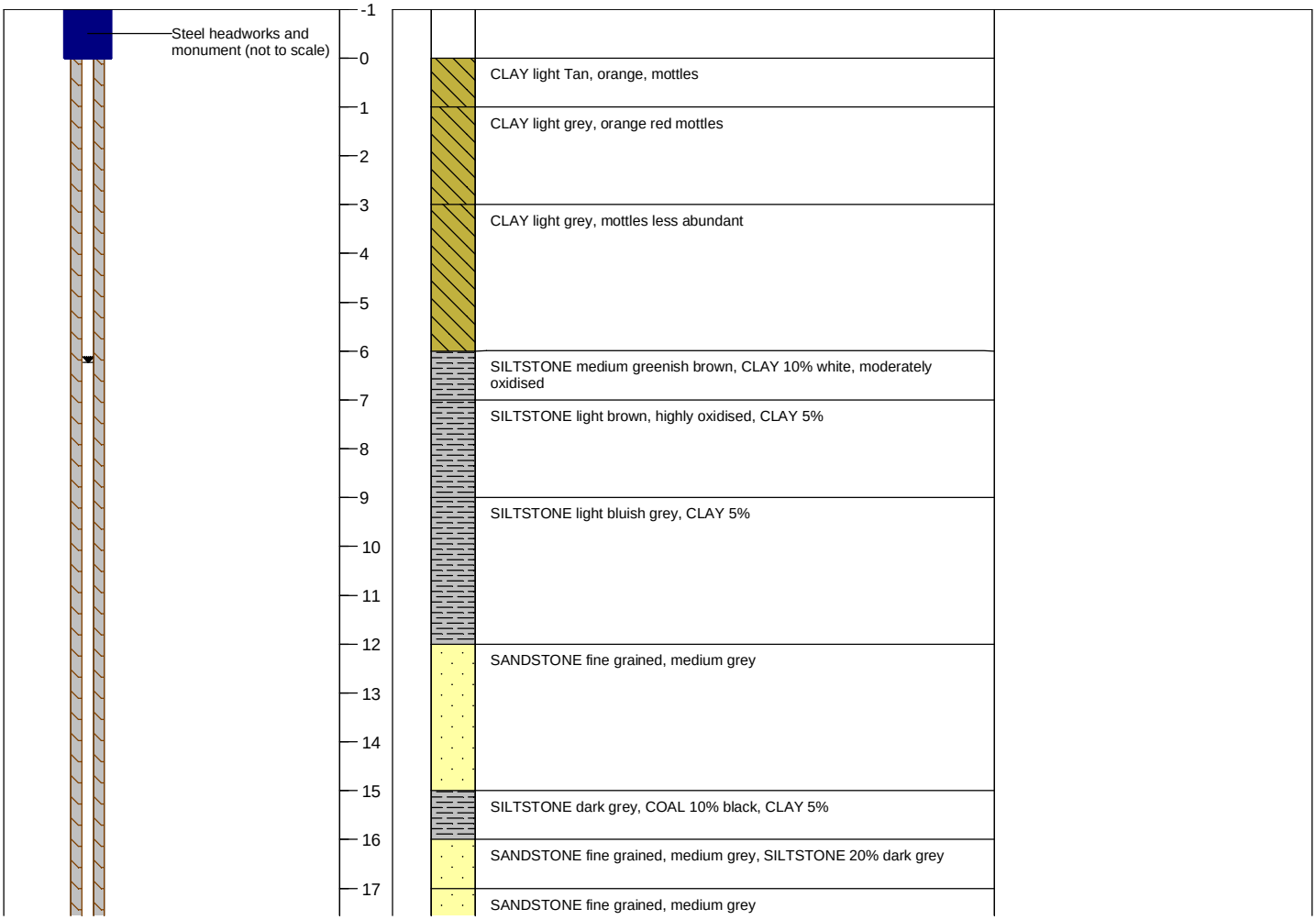
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 5 m

Borehole diameter:	205.0	0 - 6.0 m	**Bit:** Blade
Borehole diameter:	139.0	6.0 56.4 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K Maher
Start date: 27/11/13
Completion date: 27/11/13

Static WL: 83.81 mAHD 6.0 - 56.4 m
Water level date: 90.04 mAHD

Plain casing: 0-48.4 m: CLASS 18 50 mm PVC
Screen: 48.4-54.4 m: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 54.4-56.4 m: 50 mm PVC Class 18
Cement grout: 0-42.4 m
Gravel backfill: NA
Bentonite seal: 42.4-45.4 m
Gravel pack: 45.4-56.4 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.:	WRMB01B - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01B

Phase 2 Groundwater Investigation

BORE COMPLETION REPORT - WRMB01B

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400579.58 **Northing:** 6437850.83
Top of casing elevation: 90.04 mAH
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.55 m

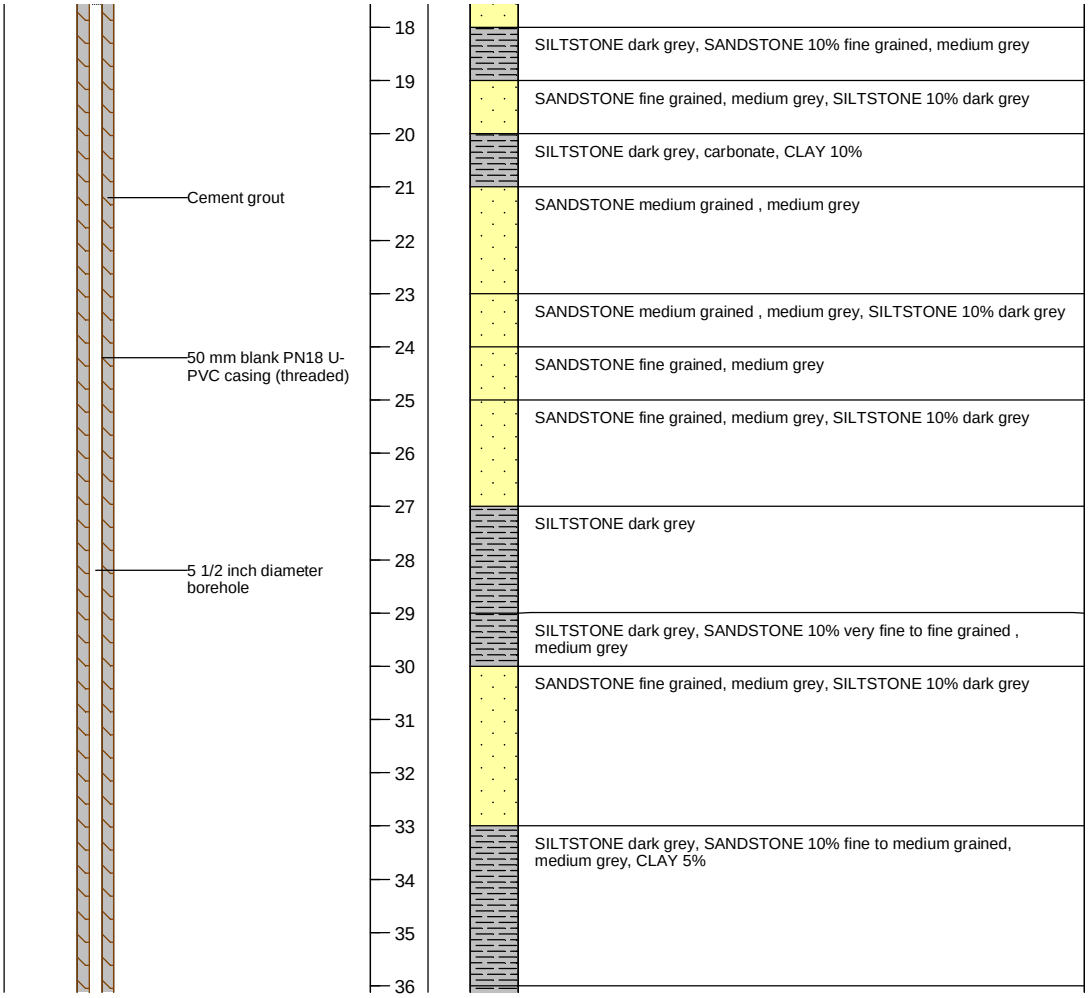
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 5 m

Borehole diameter:	205.0	0 - 6.0 m	**Bit:** Blade
Borehole diameter:	139.0	6.0 56.4 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K Maher
Start date: 27/11/13
Completion date: 27/11/13

Static WL: 83.81 mAHD 6.0 - 56.4 m
Water level date: 90.04 mAHD

Plain casing: 0-48.4 m: CLASS 18 50 mm PVC
Screen: 48.4-54.4 m: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 54.4-56.4 m: 50 mm PVC Class 18
Cement grout: 0-42.4 m
Gravel backfill: NA
Bentonite seal: 42.4-45.4 m
Gravel pack: 45.4-56.4 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.: WRMB01B - Bore Construction	
Revision: A	Date drawn: 10/7/14
Drawn by: K. Maher	Checked by: E. Kwantes
Project No. 2193324A	

AGL

AGL Upstream Investments Pty Ltd
WRMB01B

Phase 2 Groundwater Investigation

BORE COMPLETION REPORT - WRMB01B

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400579.58 **Northing:** 6437850.83
Top of casing elevation: 90.04 mAH
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.55 m

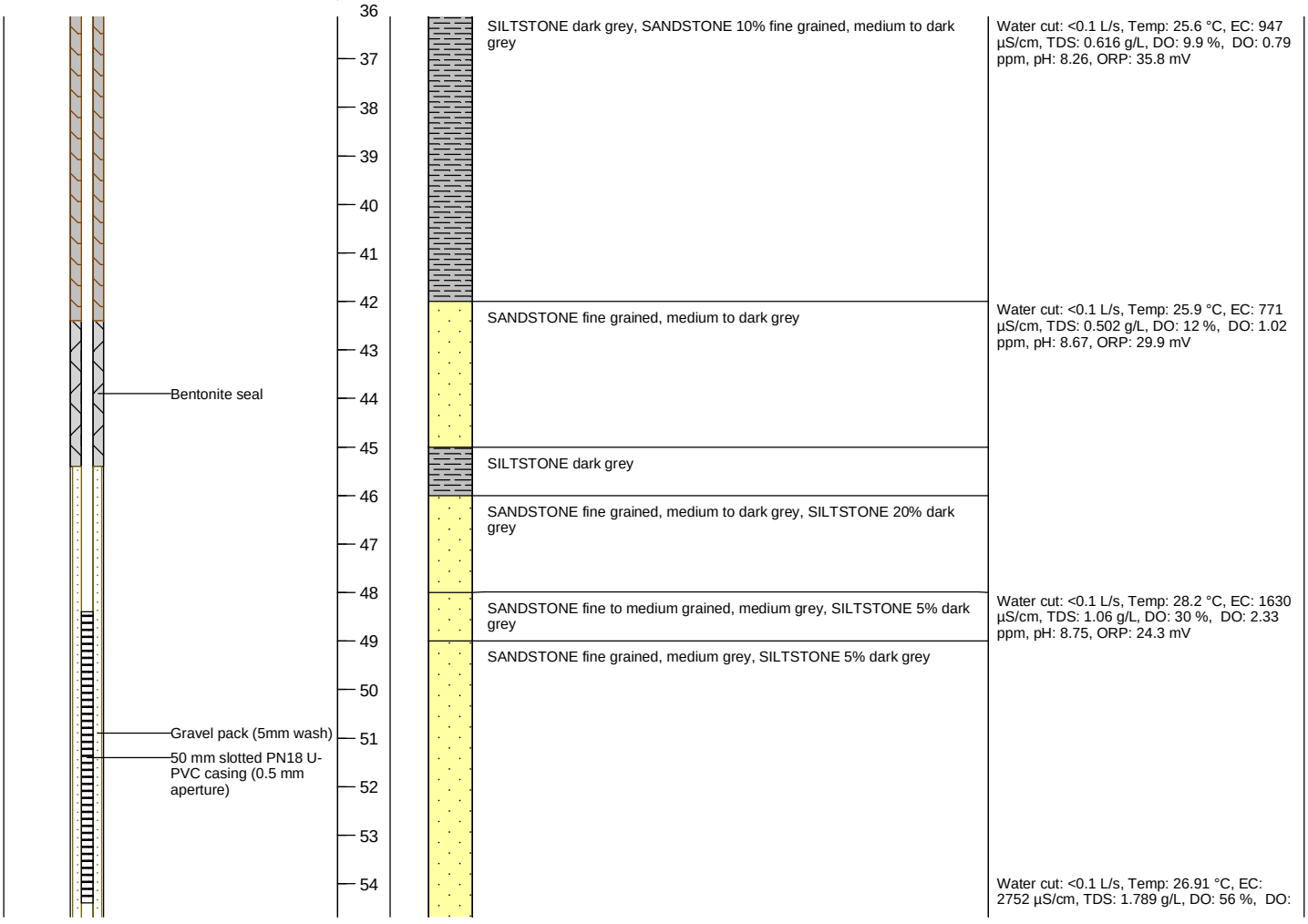
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 5 m

Borehole diameter:	205.0	0 - 6.0 m	**Bit:** Blade
Borehole diameter:	139.0	6.0 56.4 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K Maher
Start date: 27/11/13
Completion date: 27/11/13

Static WL: 83.81 mAHD 6.0 - 56.4 m
Water level date: 90.04 mAHD

Plain casing: 0-48.4 m: CLASS 18 50 mm PVC
Screen: 48.4-54.4 m: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 54.4-56.4 m: 50 mm PVC Class 18
Cement grout: 0-42.4 m
Gravel backfill: NA
Bentonite seal: 42.4-45.4 m
Gravel pack: 45.4-56.4 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.: WRMB01B - Bore Construction	
Revision: A	Date drawn: 10/7/14
Drawn by: K. Maher	Checked by: E. Kwantes
Project No. 2193324A	

AGL

AGL Upstream Investments Pty Ltd
WRMB01B

Phase 2 Groundwater Investigation

BORE COMPLETION REPORT - WRMB01B

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400579.58 **Northing:** 6437850.83
Top of casing elevation: 90.04 mAH
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.55 m

Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 5 m

Borehole diameter:	205.0	0 - 6.0 m	**Bit:** Blade
Borehole diameter:	139.0	6.0 56.4 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K Maher
Start date: 27/11/13
Completion date: 27/11/13

Static WL: 83.81 mAHD 6.0 - 56.4 m
Water level date: 90.04 mAHD

Plain casing: 0-48.4 m: CLASS 18 50 mm PVC
Screen: 48.4-54.4 m: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 54.4-56.4 m: 50 mm PVC Class 18
Cement grout: 0-42.4 m
Gravel backfill: NA
Bentonite seal: 42.4-45.4 m
Gravel pack: 45.4-56.4 m: 5 mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
50 mm blank PN18 U-PVC sump (threaded)	55 56 57				4.01 ppm, pH: 8.77, ORP: 22 mV Water cut: <0.1 L/s, Temp: 33.11 °C, EC: 2655 µS/cm, TDS: 1.726 g/L, DO: 56.3 %, DO: 4 ppm, pH: 8.16, ORP: 33.8 mV

PARSONS BRINCKERHOFF

Drawing No.:	WRMB01B - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01B

Phase 2 Groundwater Investigation

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

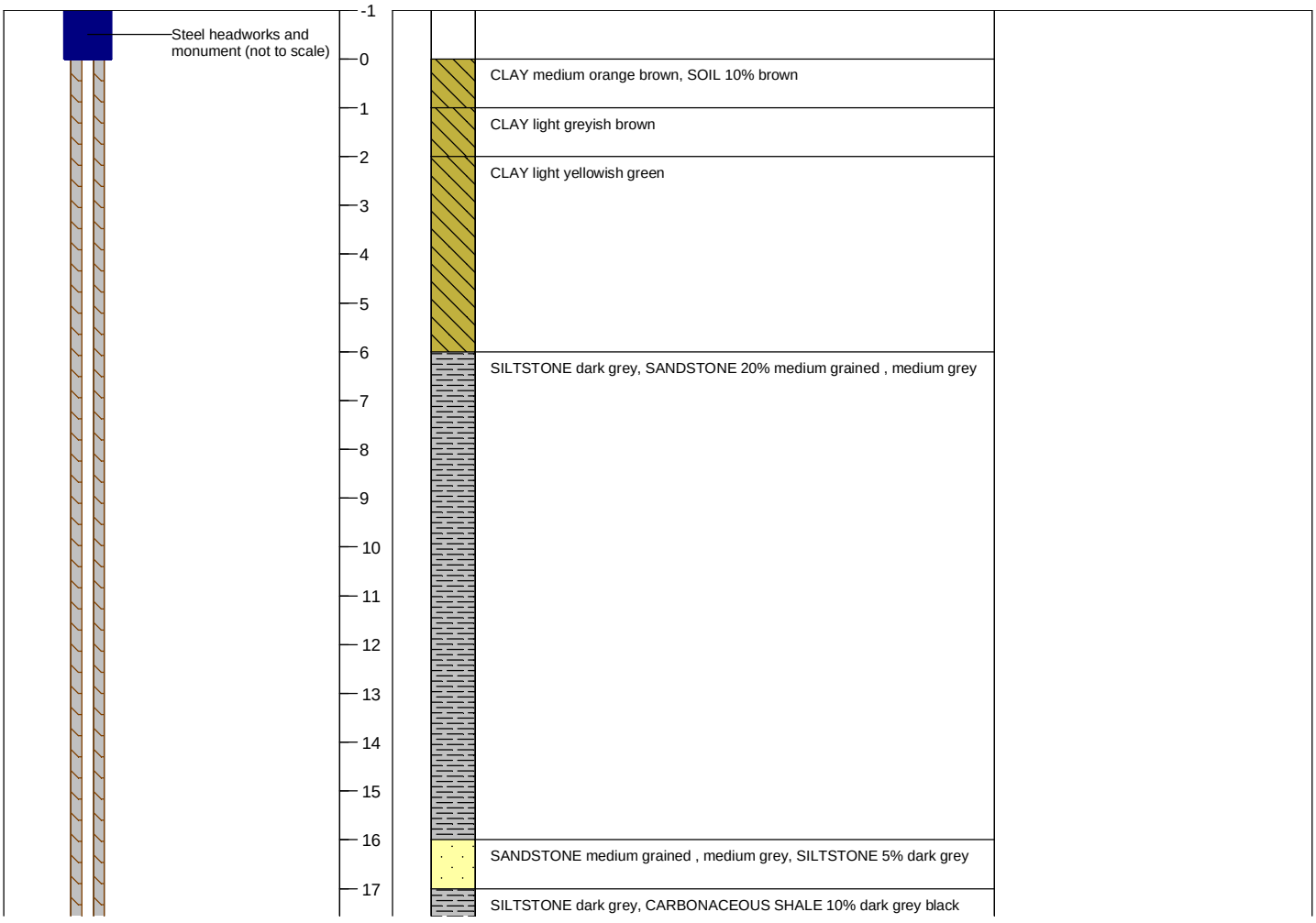
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.:	WRMB01C - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

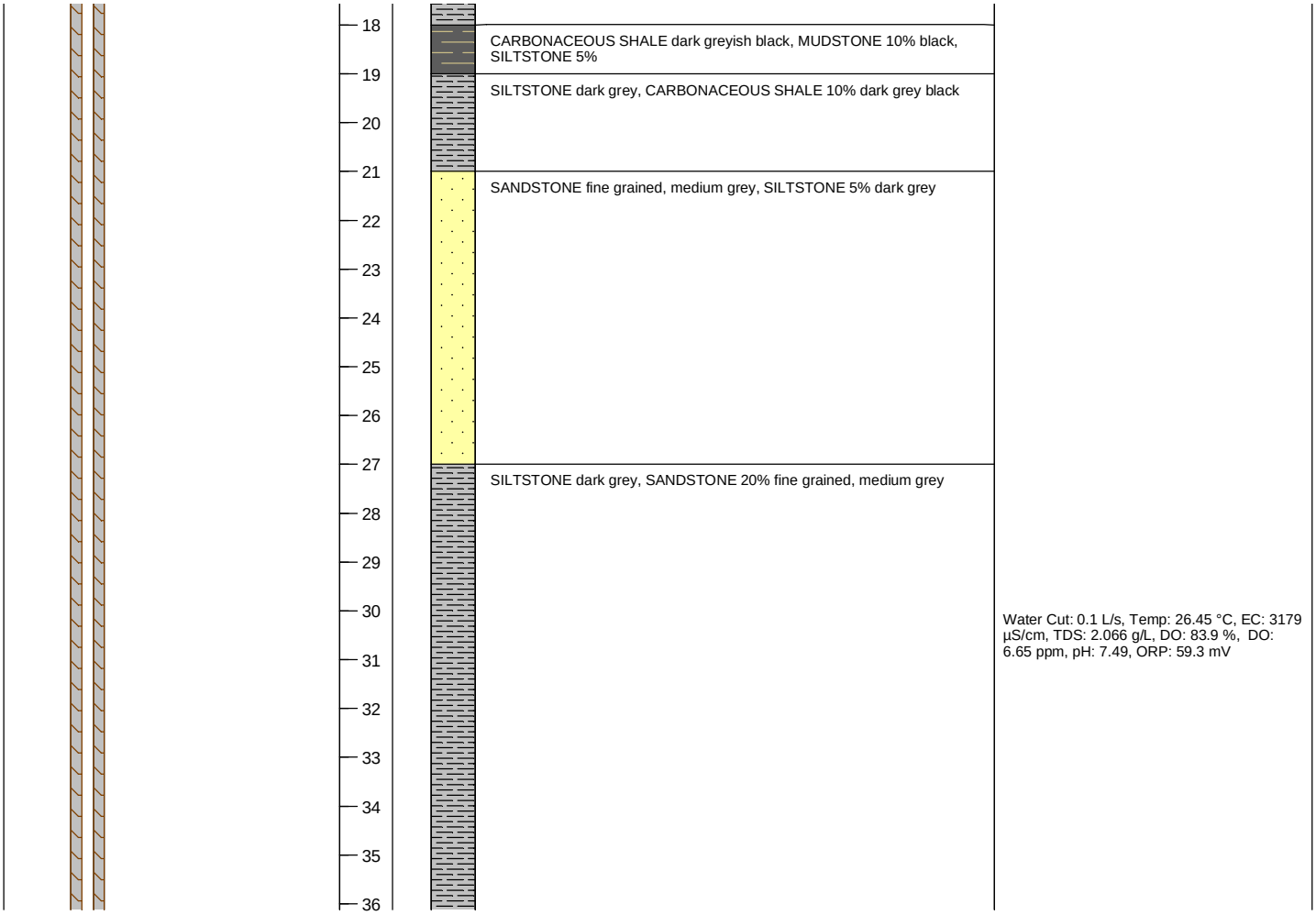
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.:	WRMB01C - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

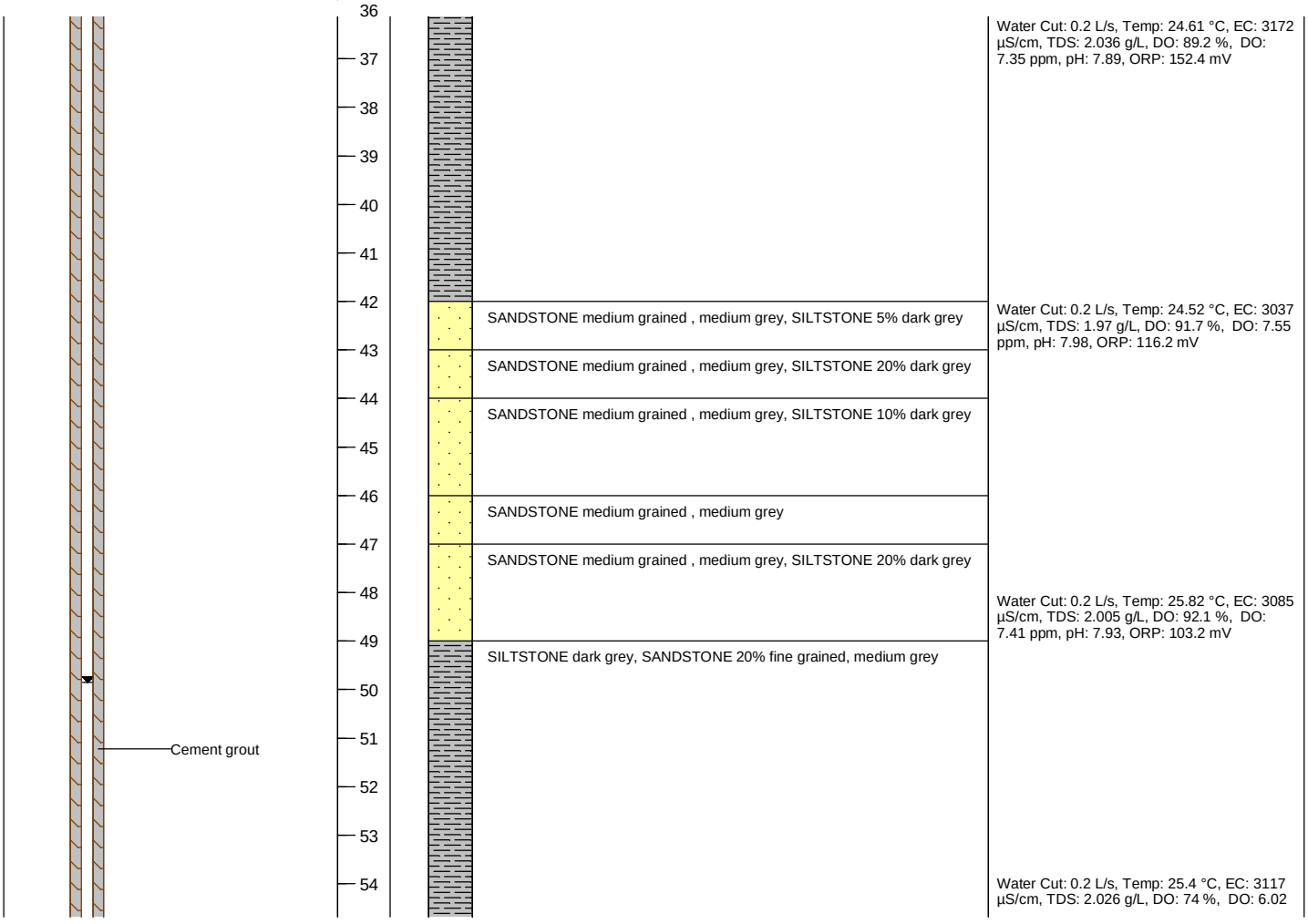
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.: WRMB01C - Bore Construction	
Revision: A	Date drawn: 10/7/14
Drawn by: K. Maher	Checked by: E. Kwantes
Project No. 2193324A	

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

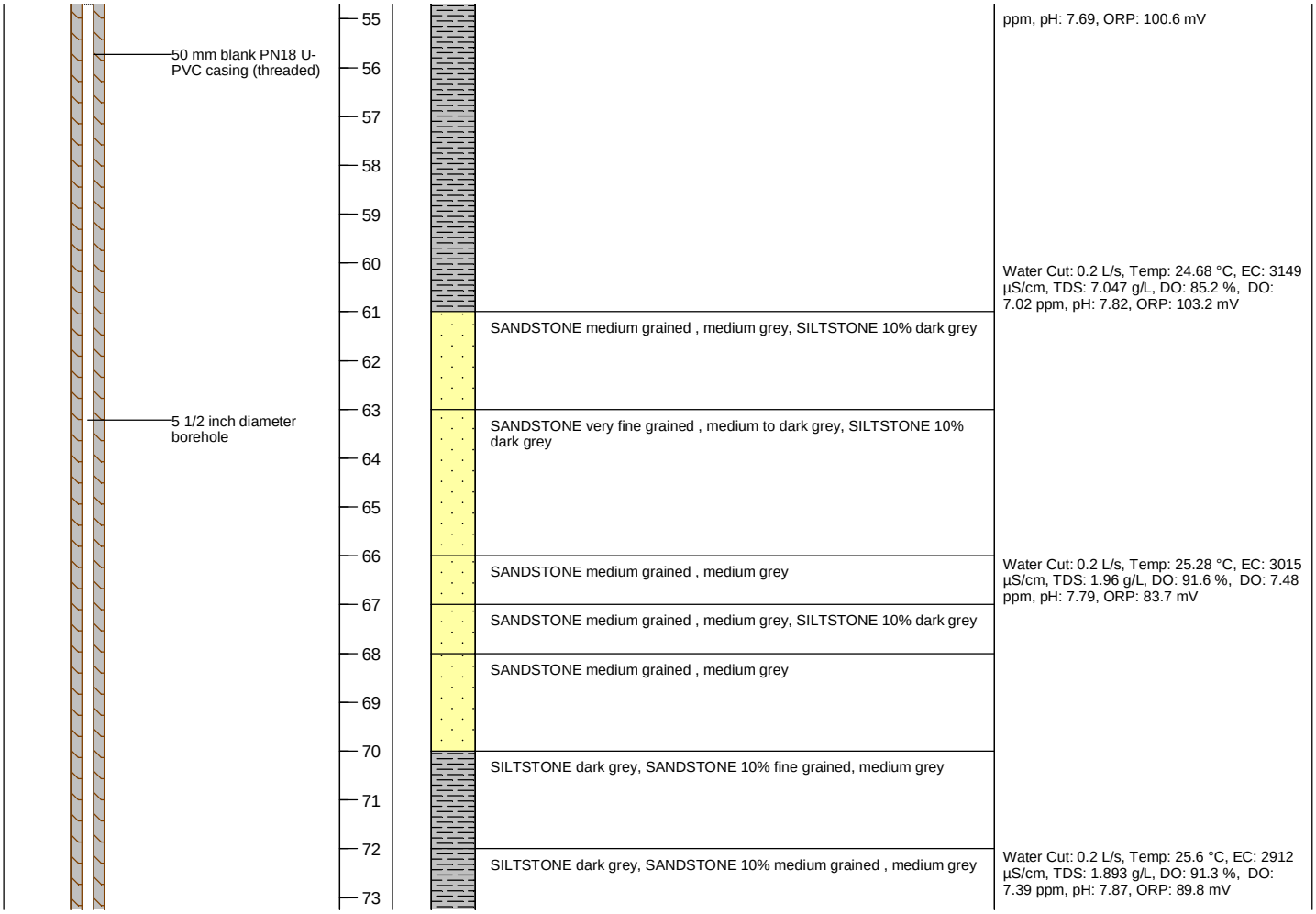
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.:	WRMB01C - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY / GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	74			
	75			
	76			
	77			
	78			
	79			
	80		SANDSTONE fine grained, medium grey, SILTSTONE 5% dark grey	
	81			
	82			
	83			
	84			Water Cut: 0.2 L/s, Temp: 23.46 °C, EC: 2881 µS/cm, TDS: 1.872 g/L, DO: 86.7 %, DO: 7.31 ppm, pH: 7.79, ORP: 75.3 mV
	85		SANDSTONE medium grained , medium grey, SILTSTONE 15% dark grey	
	86			
	87			
	88			
	89			
	90		SANDSTONE fine grained, medium grey, COAL 5% black, SILTSTONE 5% dark grey	Water Cut: 0.2 L/s, Temp: 24.04 °C, EC: 2712 µS/cm, TDS: 1.762 g/L, DO: 76.5 %, DO: 6.49 ppm, pH: 7.86, ORP: 71.5 mV
	91		SANDSTONE fine grained, medium grey, SILTSTONE 10% dark grey	
	92			

PARSONS BRINCKERHOFF

Drawing No.:	WRMB01C - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

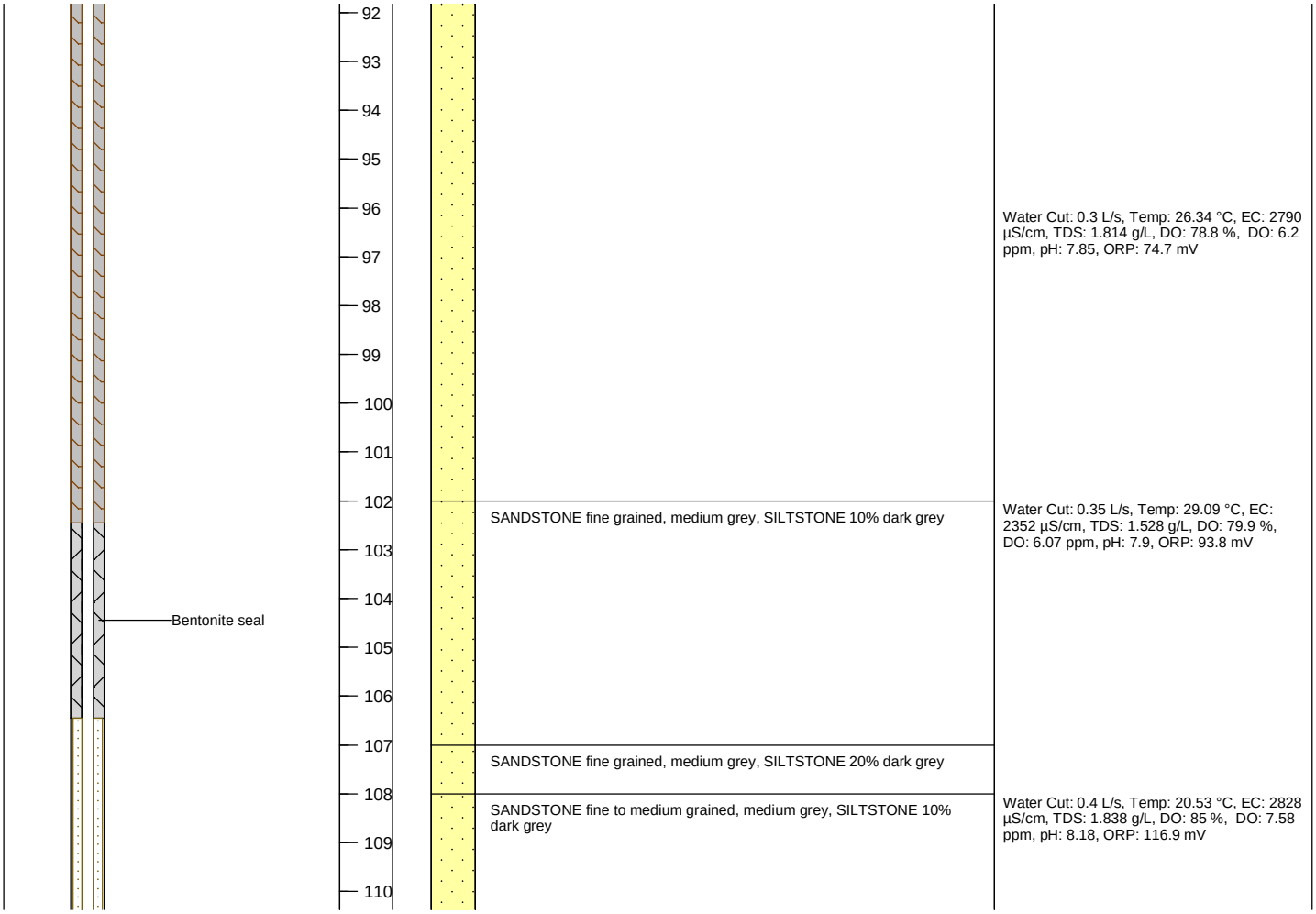
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.: WRMB01C - Bore Construction	
Revision: A	Date drawn: 10/7/14
Drawn by: K. Maher	Checked by: E. Kwantes
Project No. 2193324A	

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01C

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400584.81 **Northing:** 6437858.50
Top of casing elevation: 89.99 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.58 m

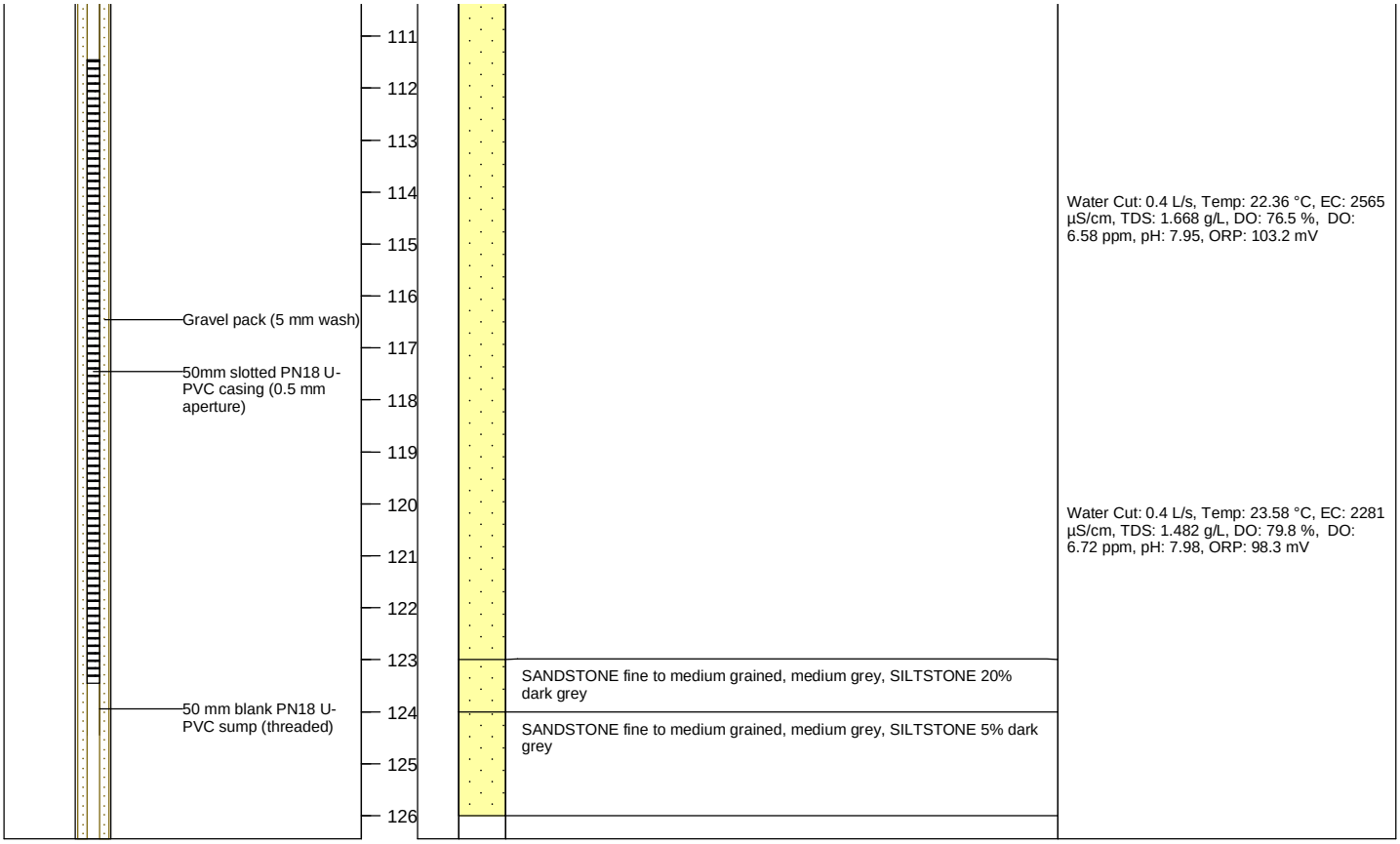
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 20
Drilling method: Rotary air **Total drilled depth:** 126.46 m

Borehole diameter:	205.0	0 - 5.5 m	**Bit:** Blade
Borehole diameter:	139.0	5.5 - 126.45 m	**Bit:** DHH

Purpose of bore: Monitoring stand pipe
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 21/11/13
Completion date: 22/11/13

Static WL: 40.51 mAHD 49.85 mbtoc
Water level date: 2/12/13

Plain casing: 0-1114.45 m: CLASS 18 50 mm PVC
Screen: 111.45-123.45: 50 mm PVC Class 18 (0.5 mm slot)
Sump: 123.45-126.45 m: 50 mm PVC Class 18
Cement grout: 0-23.45 m; 60.45-102.45 m: 0.78 m3
Gravel backfill: NA
Bentonite seal: 102.45-106.45 m
Gravel pack: 106.45-126.45 m: 5 mm washed gravel
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.:	WRMB01C - Bore Construction		
Revision:	A	Date drawn:	10/7/14
Drawn by:	K. Maher	Checked by:	E. Kwantes
Project No.	2193324A		

AGL

AGL Upstream Investments Pty Ltd
WRMB01C

BORE COMPLETION REPORT - WRMB01D

Project: AGL Gloucester Gas Project
Location: Wards River
Easting: 400570.97 **Northing:** 6437838.17
Top of casing elevation: 90.1 mAHD
Grid system: MGA 94 Zone 56 **Stick-up height:** 0.62 m

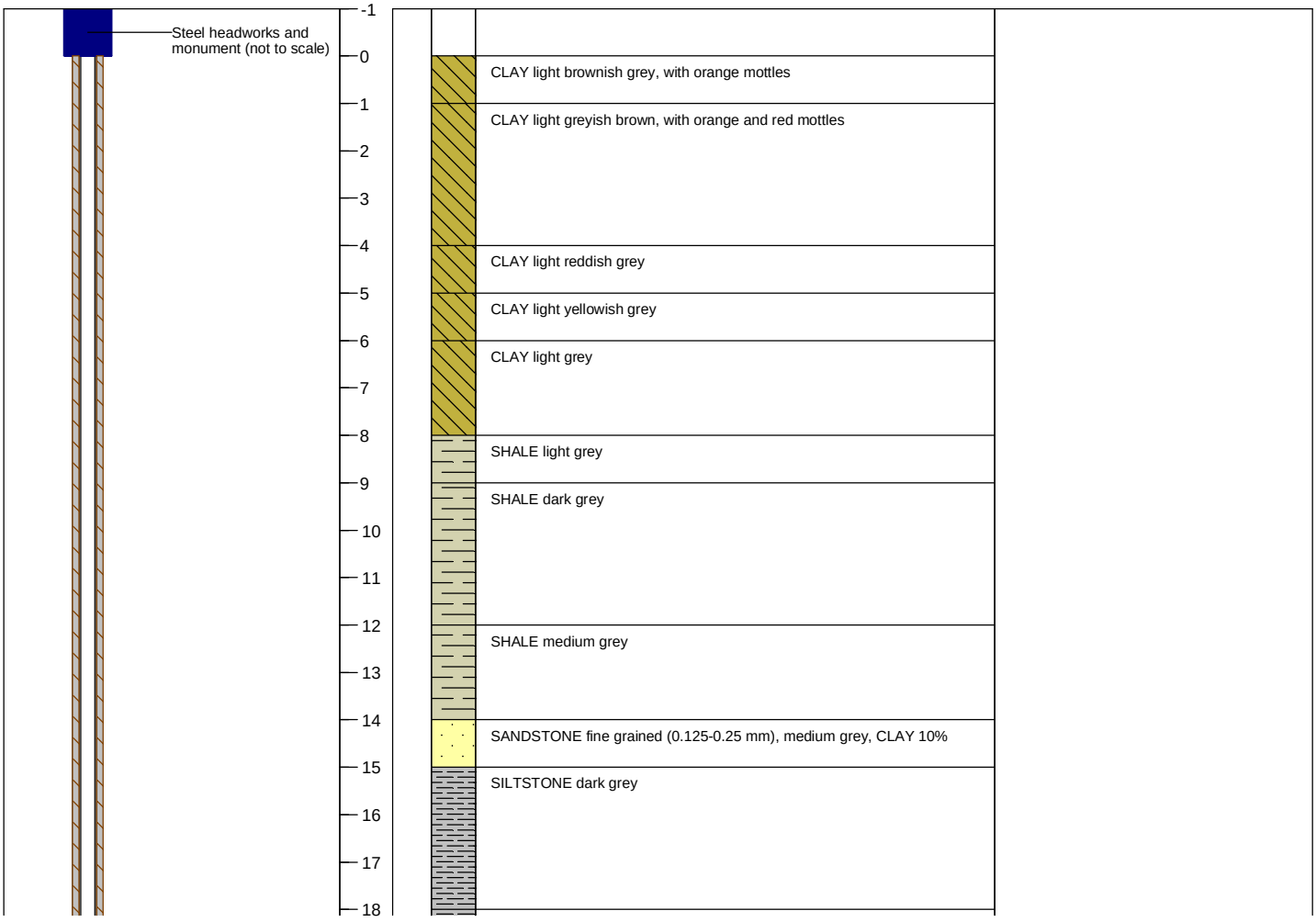
Drilling contractor: Highland Drilling
Driller: I. Palk **Rig:** Rig 12
Drilling method: PCD with mud **Total drilled depth:** 199 m

Borehole diameter:	205	0 - 32 m	**Bit:** DHH
Borehole diameter:	127	32 - 199 m	**Bit:** PCD

Purpose of bore: Groundwater monitoring bore
Screened Formation: Jilleon Formation
Logged by: K. Maher
Start date: 11/6/14
Completion date: 18/6/14

Static WL: NA NA
Water level date: 17/10/13

Plain casing: 0-178 m: 73 mm threaded steel
Screen: 178-184 m: Perforated Steel
Sump: 184-193 m: 73 mm threaded steel
Cement grout: 0-199m: 2.5m3
Gravel backfill: NA
Bentonite seal: NA
Gravel pack: NA
Bentonite plug: NA



PARSONS BRINCKERHOFF

Drawing No.: WRMB01 - Bore Construction	
Revision: A	Date drawn: 10/7/14
Drawn by: K Maher	Checked by: E. Kwantes
Project No. 2193324A	

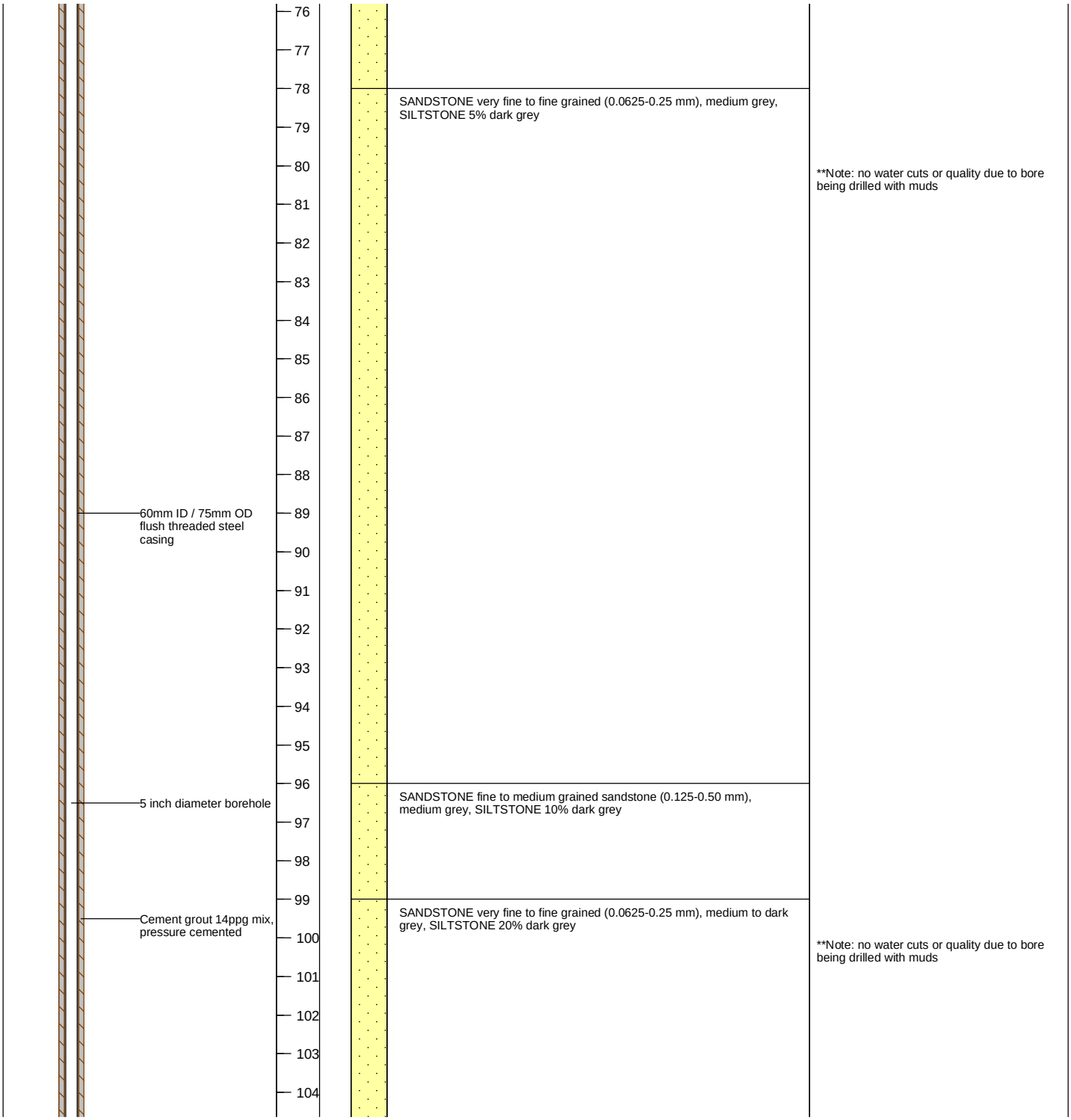
AGL

AGL Upstream Investments Pty Ltd
WRMB01D

Phase 2 Groundwater Investigation

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	18			SILTSTONE medium to dark grey	
	19				
	20				**Note: no water cuts or quality due to bore being drilled with muds
	21				
	22			SANDSTONE fine grained (0.125-0.25 mm), medium grey	
	23			SILTSTONE dark grey	
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32			SANDSTONE fine grained (0.125-0.25 mm), medium grey, SILTSTONE 20% dark grey	
	33				
	34				
	35			SANDSTONE fine grained (0.125-0.25 mm), medium grey, SILTSTONE 20% dark grey, rare coaly whisps	
	36			SANDSTONE fine grained (0.125-0.25 mm), medium grey	
	37				
	38				
	39				
	40			SANDSTONE fine grained (0.125-0.25 mm), medium grey, SILTSTONE 20% dark grey	**Note: no water cuts or quality due to bore being drilled with muds
	41				
	42				
	43				
	44				
	45				
	46			SILTSTONE dark grey, SANDSTONE 10% fine to medium grained sandstone (0.125-0.50 mm), light to medium grey	
	47				

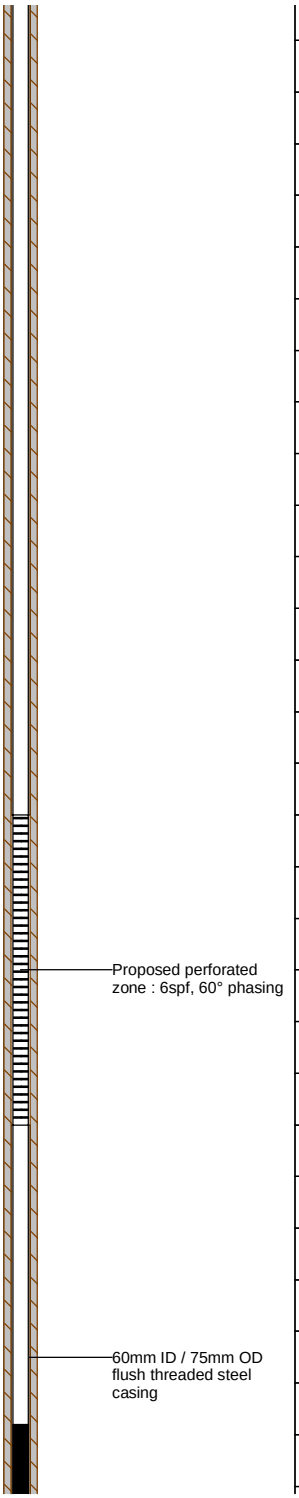
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	47				
	48				
	49				
	50				
	51				
	52				
	53				
	54				
	55			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 30% medium to dark grey	
	56				
	57				
	58				
	59				
	60			SILTSTONE dark grey, minor black COAL	**Note: no water cuts or quality due to bore being drilled with muds
	61			SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium to dark grey, SILTSTONE 5% dark grey	
	62			SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 5% dark grey	
	63				
	64				
	65				
	66			SILTSTONE medium to dark grey, SANDSTONE 10% very fine to fine grained (0.0625-0.25 mm), medium grey	
	67				
	68				
	69				
	70				
	71				
	72				
	73				
	74				
	75			SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 10% dark grey, minor black COAL	



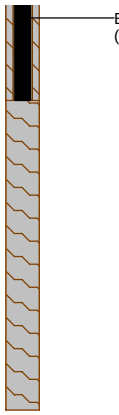
PARSONS BRINCKERHOFF	Drawing No.: WRMB01 - Bore Construction		AGL Upstream Investments Pty Ltd WRMB01D Phase 2 Groundwater Investigation
	Revision: A	Date drawn: 10/7/14	
	Drawn by: K Maher	Checked by: E. Kwantes	
	Project No. 2193324A		

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	105				
	106				
	107				
	108				
	109				
	110				
	111				
	112				
	113				
	114			SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 5% dark grey	
	115				
	116				
	117				
	118				
	119				
	120				**Note: no water cuts or quality due to bore being drilled with muds
	121				
	122				
	123				
	124				
	125				
	126				
	127				
	128				
	129				
	130				
	131				
	132				
	133				

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	134				
	135			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, CLAY 10% light grey	
	136			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 20% dark grey, CLAY 20% light grey	
	137				
	138				
	139				
	140				**Note: no water cuts or quality due to bore being drilled with muds
	141				
	142			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 20% dark grey, CLAY 10% light grey	
	143				
	144			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey	
	145				
	146				
	147			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), light to medium grey, SILTSTONE 5% dark grey	
	148				
	149				
	150				
	151				
	152				
	153				
	154				
	155				
	156			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 5% dark grey	
	157				
	158			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 20% dark grey	
	159			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 10% dark grey	
	160				**Note: no water cuts or quality due to bore being drilled with muds
	161			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 25% dark grey	
	162				

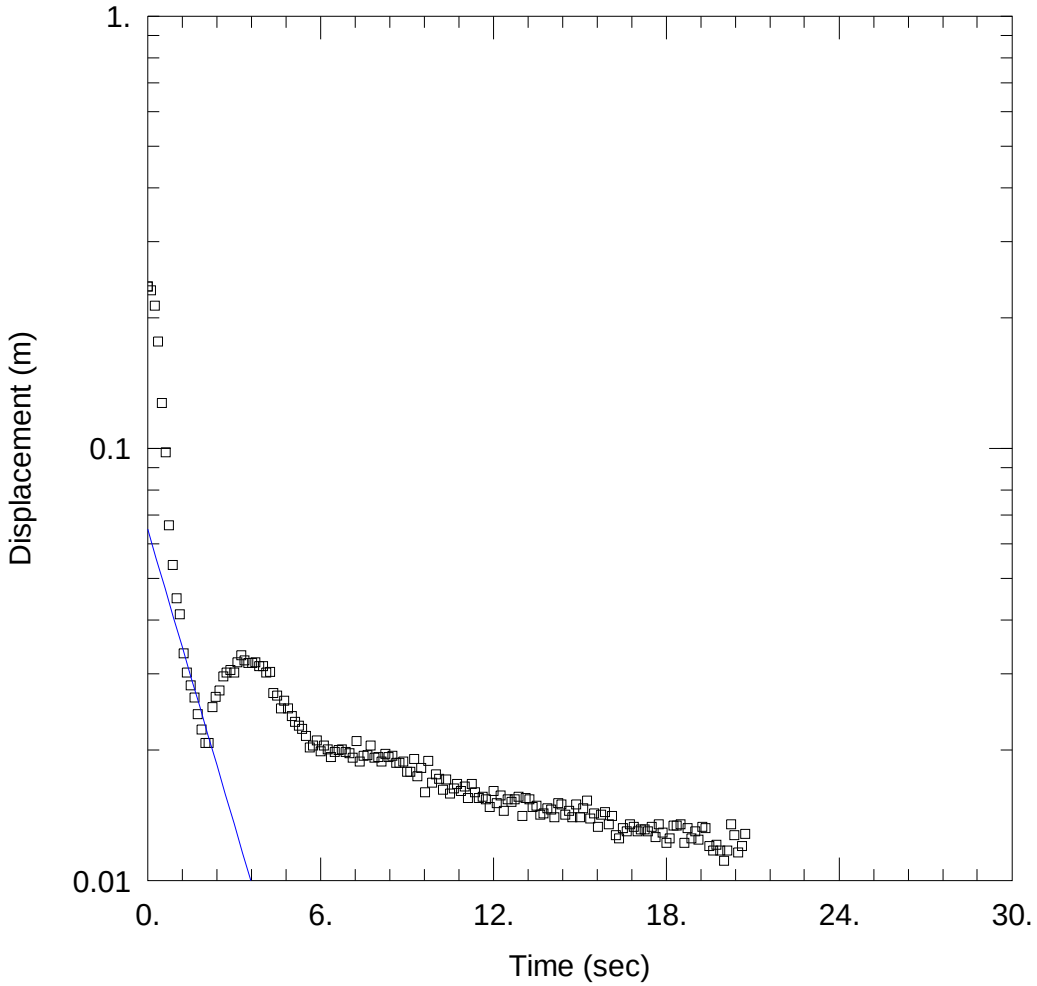
BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
	163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191			SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium grey, SILTSTONE 10% dark grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 5% dark grey SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), medium greenish grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), light greyish brown, SILTSTONE 5% dark grey SILTSTONE dark grey, SANDSTONE 30% very fine to fine grained (0.0625-0.25 mm), medium greenish grey SILTSTONE dark grey, SANDSTONE 5% very fine to fine grained (0.0625-0.25 mm), medium grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), light to medium greenish grey, SILTSTONE 10% dark grey SILTSTONE dark grey, SANDSTONE 20% very fine to fine grained (0.0625-0.25 mm), medium grey, minor carbonaceous fragments SILTSTONE dark grey, SANDSTONE 50% very fine to fine grained (0.0625-0.25 mm), medium grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium to dark grey, SILTSTONE 5% dark grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium greenish grey, SILTSTONE 30% dark grey	**Note: no water cuts or quality due to bore being drilled with muds

BORE COMPLETION REPORT - WRMB01D

BORE CONSTRUCTION	DEPTH (m)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	WATER QUALITY
 Borehole Obstruction (189.8 - 193mbgl)	191 192 193 194 195 196 197 198 199 200			SANDSTONE fine to medium grained sandstone (0.125-0.50 mm), medium greenish grey, SILTSTONE 10% dark grey SANDSTONE very fine to fine grained (0.0625-0.25 mm), medium grey, SILTSTONE 30% dark grey	

Appendix C

Hydraulic conductivity reports



WELL TEST ANALYSIS

Data Set: \...\WRMB01A TEST1.aqt
Date: 10/27/14 Time: 16:04:02

PROJECT INFORMATION

Company: Parsons Brinckerhoff
Client: AGL
Project: 2193324A
Test Well: WRMB01A
Test Date: 4/9/14

AQUIFER DATA

Saturated Thickness: 3.52 m Anisotropy Ratio (Kz/Kr): 1.

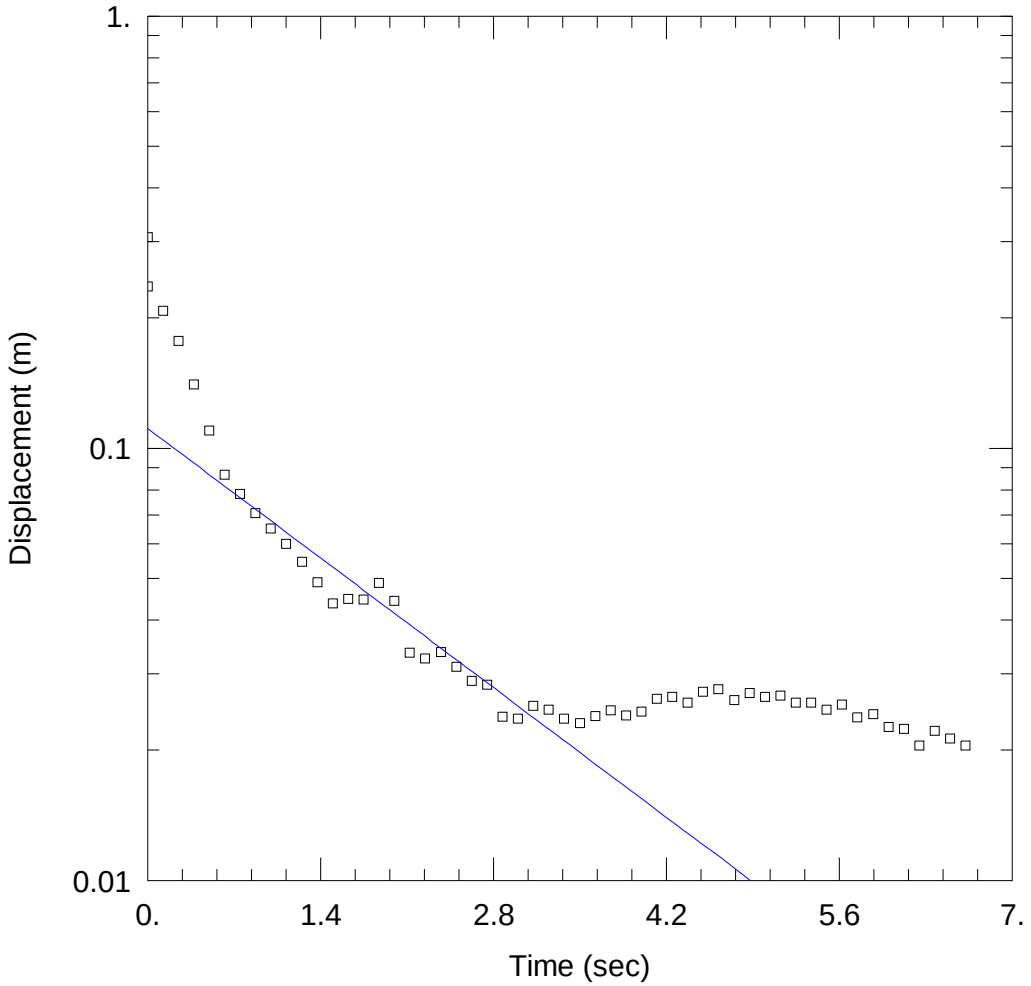
WELL DATA (WRMB01A)

Initial Displacement: 0.237 m
Total Well Penetration Depth: 6.5 m
Casing Radius: 0.025 m
Static Water Column Height: 0.2242 m
Screen Length: 2.5 m
Well Radius: 0.025 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 23.44 m/day y0 = 0.06505 m



WELL TEST ANALYSIS

Data Set: \...\WRMB01A TEST2.aqt
Date: 10/27/14 Time: 16:04:42

PROJECT INFORMATION

Company: Parsons Brinckerhoff
Client: AGL
Project: 2193324A
Test Well: WRMB01A
Test Date: 4/9/14

AQUIFER DATA

Saturated Thickness: 3.52 m Anisotropy Ratio (Kz/Kr): 1.

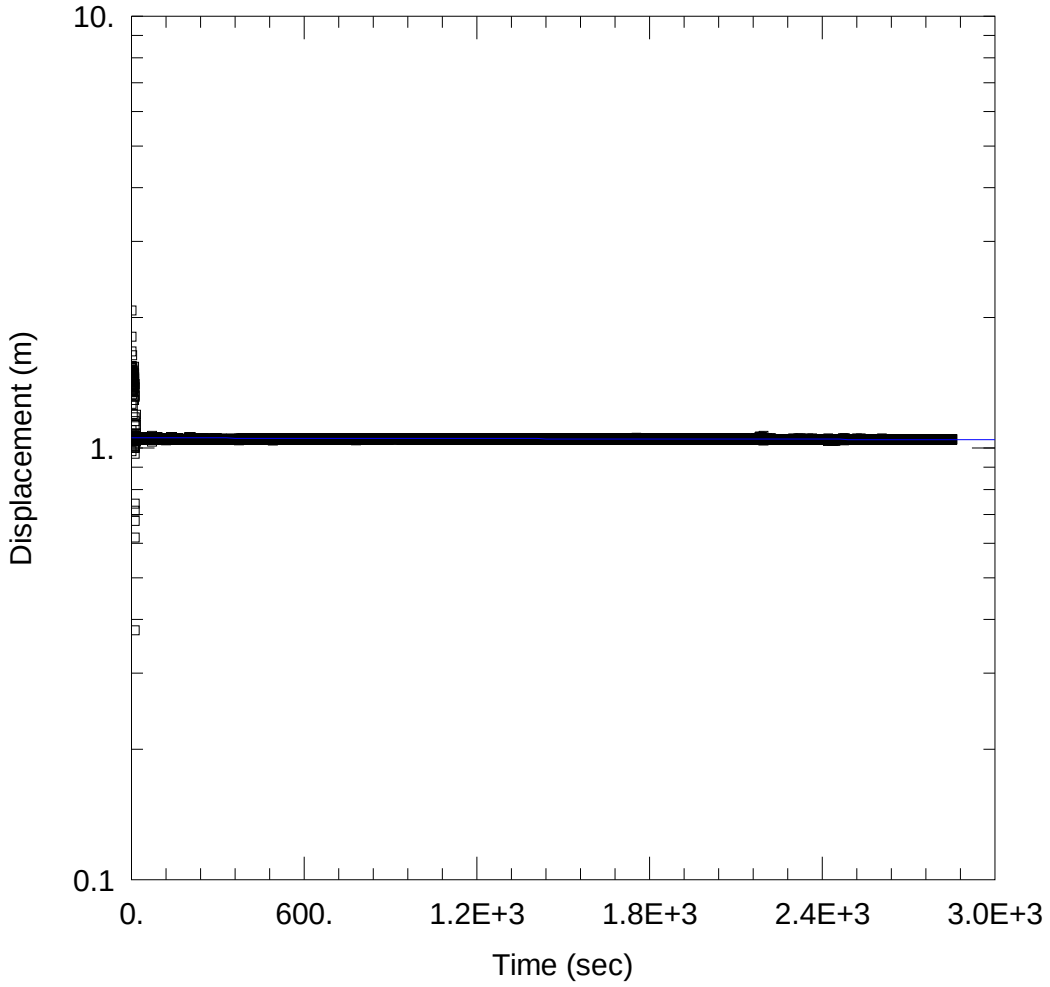
WELL DATA (WRMB01A)

Initial Displacement: 0.237 m
Total Well Penetration Depth: 6.5 m
Casing Radius: 0.025 m
Static Water Column Height: 3.52 m
Screen Length: 2.5 m
Well Radius: 0.025 m
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 22.08 m/day y0 = 0.1111 m



WELL TEST ANALYSIS

Data Set: \...\WRMB01B TEST1.aqt
Date: 02/12/16 Time: 11:40:53

PROJECT INFORMATION

Company: Parsons Brinckerhoff
Project: 2193324A
Location: Ward's River
Test Well: WRMB01B
Test Date: 03/09/2014

AQUIFER DATA

Saturated Thickness: 14. m Anisotropy Ratio (Kz/Kr): 1.

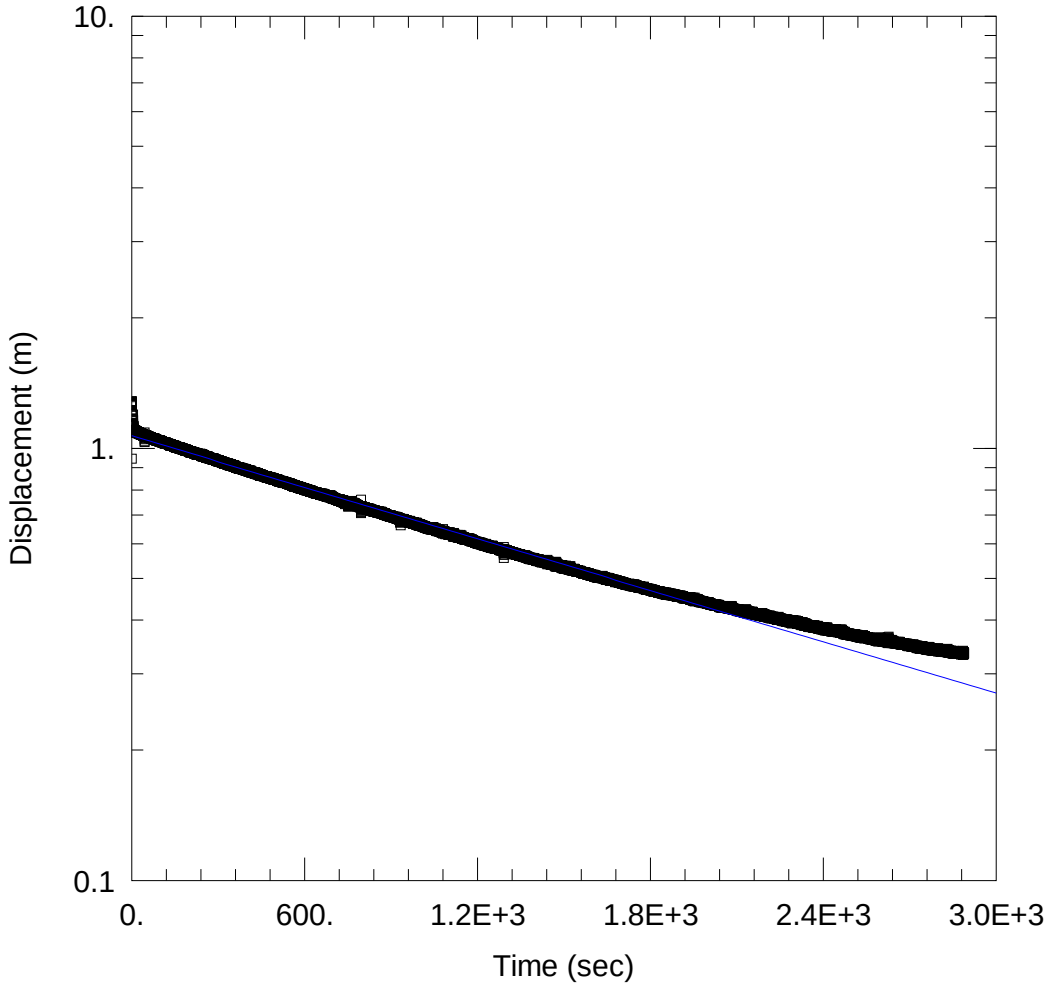
WELL DATA (New Well)

Initial Displacement: 1.05 m
Static Water Column Height: 48.8 m
Total Well Penetration Depth: 12. m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 7.964E-5 m/day
y0 = 1.054 m



WELL TEST ANALYSIS

Data Set: \...\WRMC01C TEST2.aqt
Date: 10/27/14 Time: 16:05:00

PROJECT INFORMATION

Company: Parsons Brinckerhoff
Client: AGL
Project: 2193324A
Test Well: WRMB01C
Test Date: 3/9/14

AQUIFER DATA

Saturated Thickness: 82.99 m Anisotropy Ratio (Kz/Kr): 1.

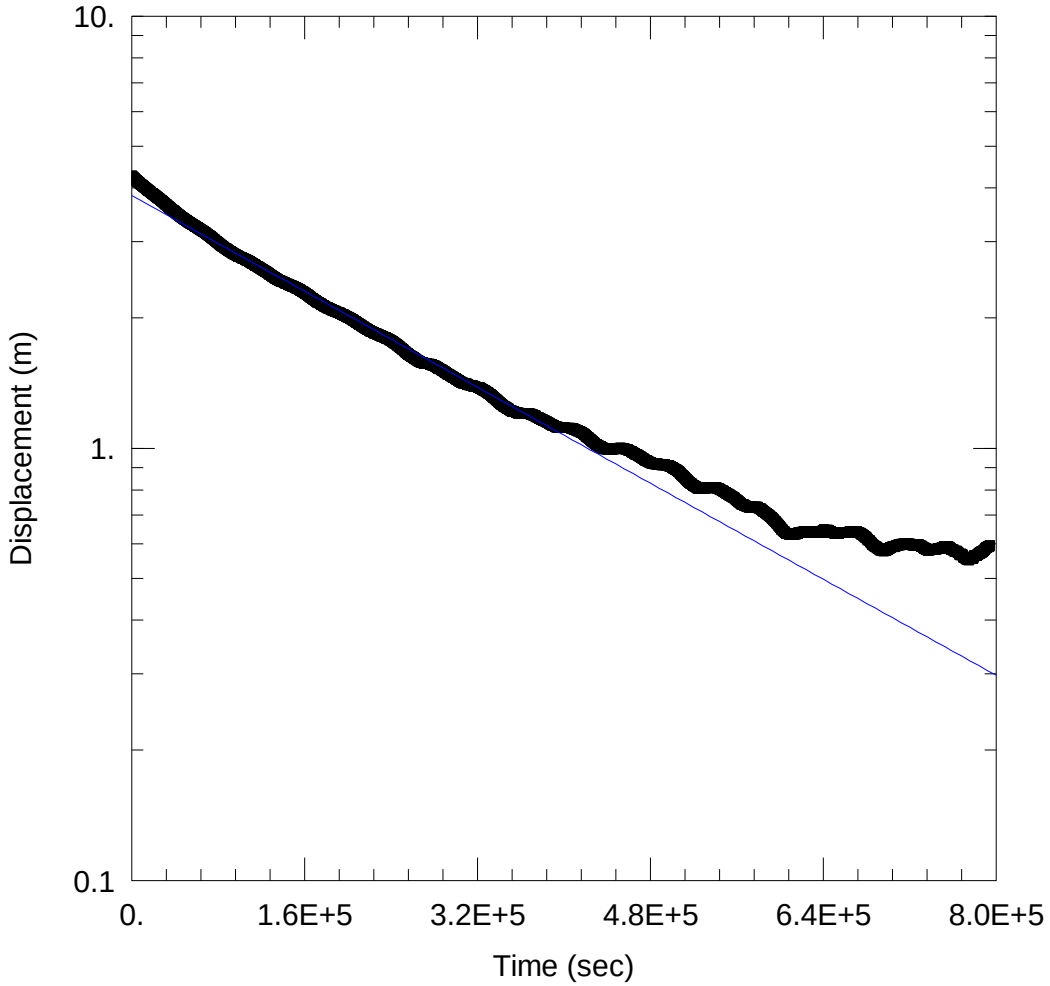
WELL DATA (WRMB01C)

Initial Displacement: 0.9453 m
Static Water Column Height: 82.99 m
Total Well Penetration Depth: 123.5 m
Screen Length: 12. m
Casing Radius: 0.025 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.007066 m/day
y0 = 1.068 m



WELL TEST ANALYSIS

Data Set: \...\WRMB01D_FH1.aqt
Date: 02/11/16 Time: 15:40:17

PROJECT INFORMATION

Company: Parsons Brinckerhoff
Project: 2193324A
Location: Ward's River
Test Well: WRMB01D
Test Date: 01/09/2015

AQUIFER DATA

Saturated Thickness: 19. m Anisotropy Ratio (Kz/Kr): 1.

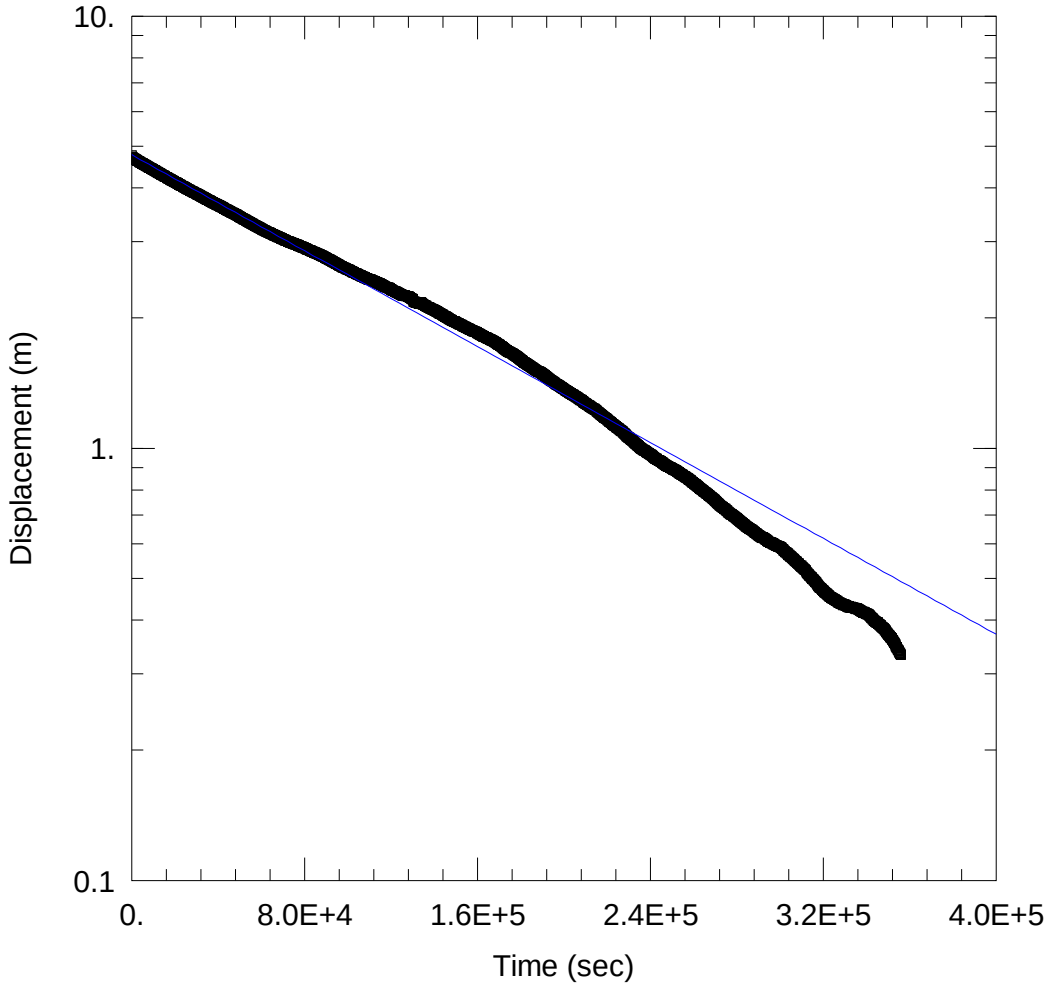
WELL DATA (WRMB01D)

Initial Displacement: 4.237 m
Total Well Penetration Depth: 7. m
Casing Radius: 0.035 m
Static Water Column Height: 156.5 m
Screen Length: 6. m
Well Radius: 0.035 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.0001451 m/day
y0 = 3.847 m



WELL TEST ANALYSIS

Data Set: \...\WRMB01D_RH1.aqt
Date: 02/11/16 Time: 15:41:08

PROJECT INFORMATION

Company: Parsons Brinckerhoff
Project: 2193324A
Location: Ward's River
Test Well: WRMB01D
Test Date: 01/09/2015

AQUIFER DATA

Saturated Thickness: 19. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (WRMB01D)

Initial Displacement: 4.761 m
Total Well Penetration Depth: 7. m
Casing Radius: 0.035 m
Static Water Column Height: 156.3 m
Screen Length: 6. m
Well Radius: 0.035 m

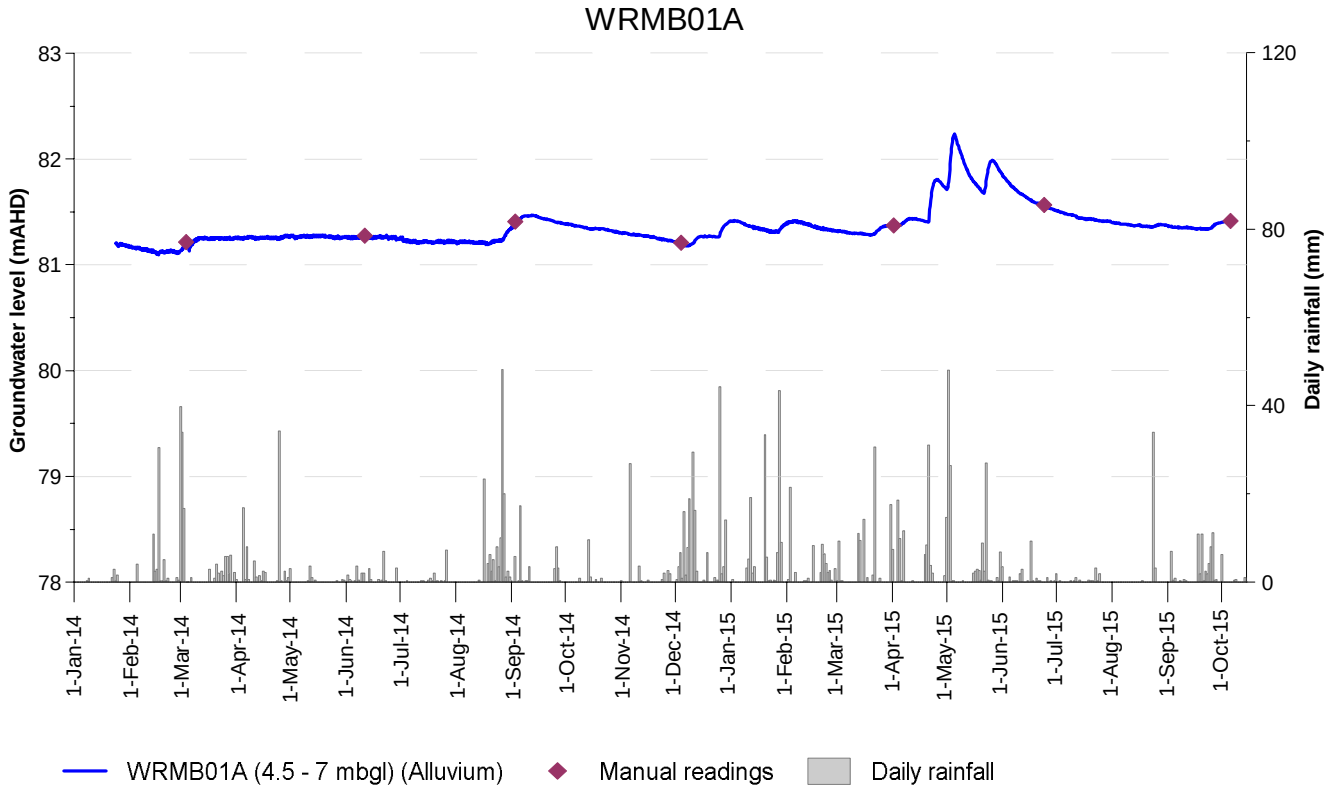
SOLUTION

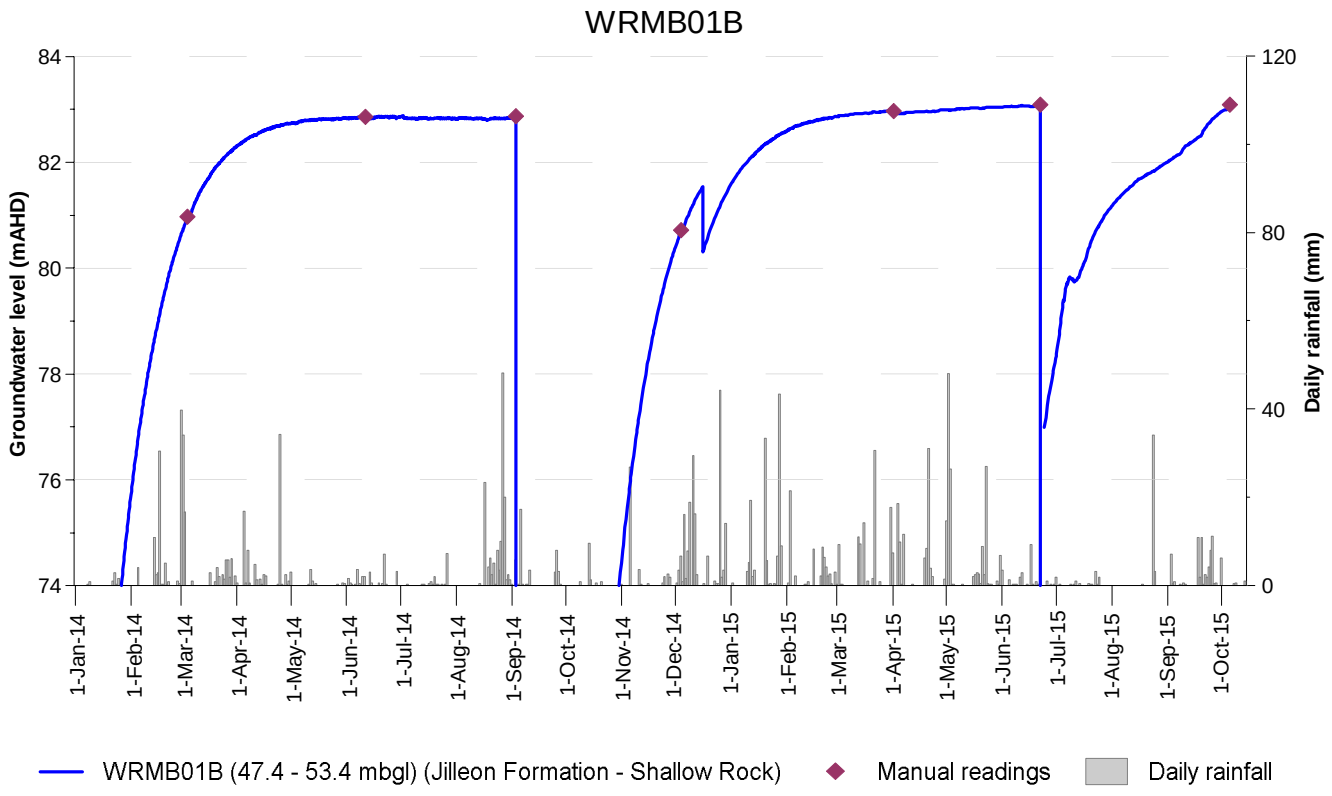
Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.0002898 m/day
y0 = 4.775 m

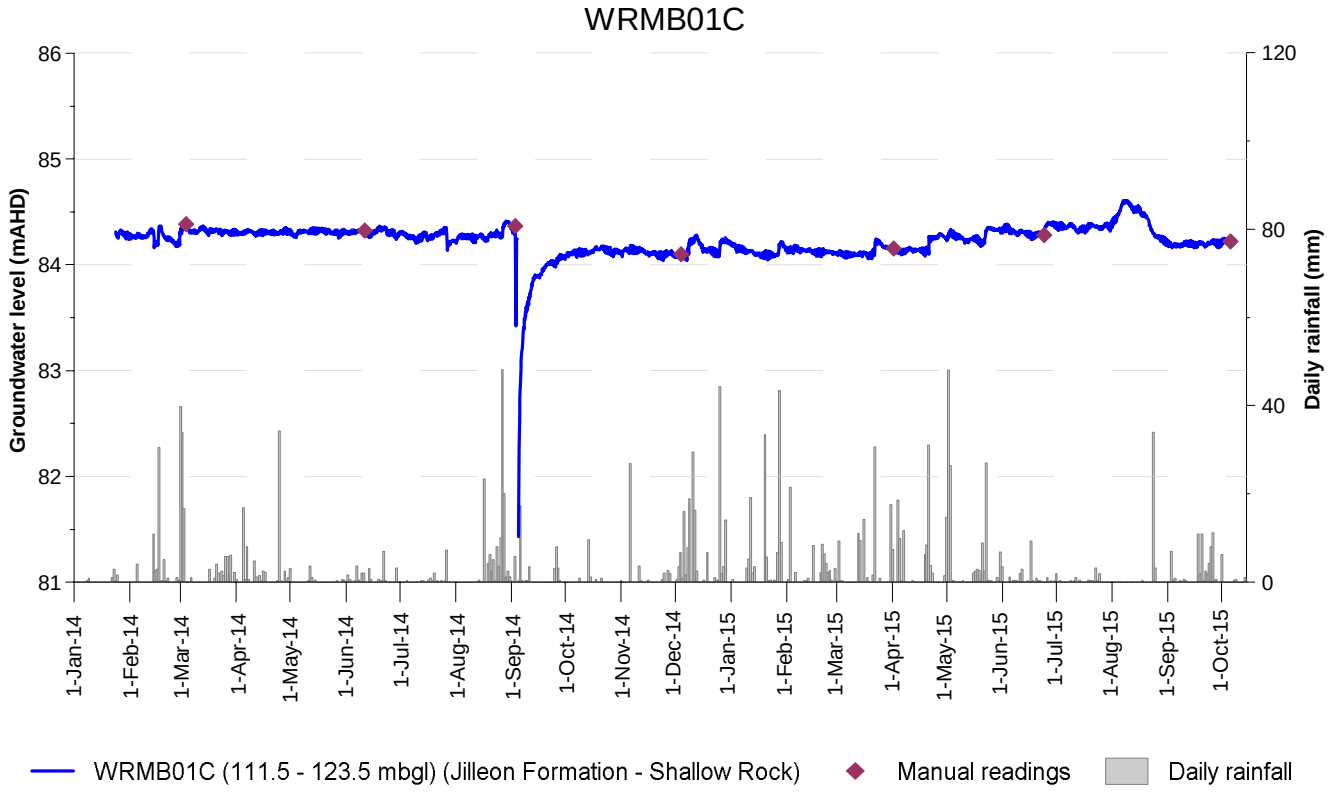
Appendix D

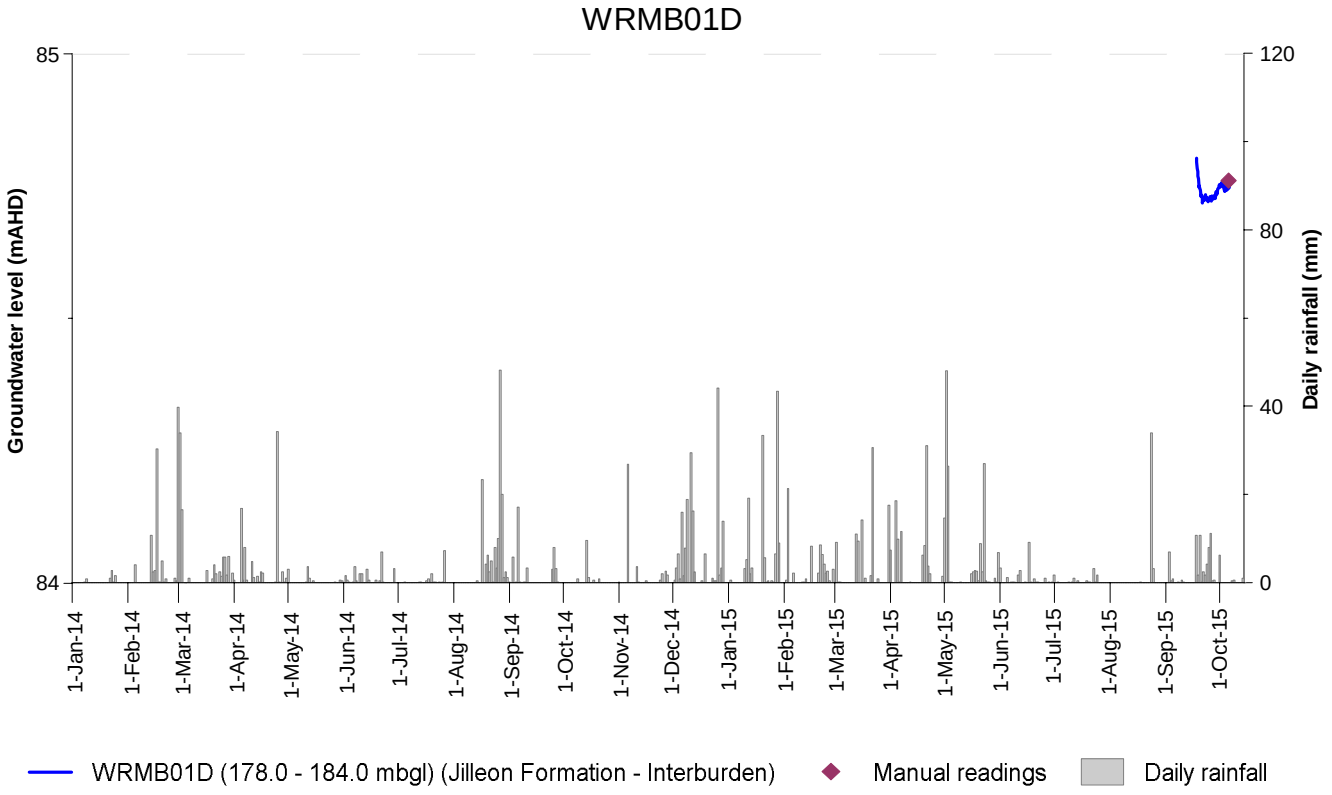
Hydrographs





WRMB01A and WRMB01B monitoring bores





WRMB01C and WRMB01D monitoring bores

Appendix E

Water quality summary table

WATER QUALITY RESULTS - Wards River monitoring bores

Analyte	Units	LOR	WRMB01A	WRMB01B	WRMB01C	WRMB01D
Sample date			4/09/2014	17/09/2014	4/09/2014	9/10/2015
Screened formation			Alluvium	Jilleon Formation	Jilleon Formation	Jilleon Formation
General parameters						
Conductivity (Field)	uS/cm		1417	3032	3371	2841
pH (Field)	-		6.4	7.8	7.91	9.02
TDS (Field)	mg/L		921	1969	2192	1843
DO % (Field)	%		24.4	28.1	12.2	4.5
DO mg/L (Field)	mg/L		2.17	2.49	1.05	0.41
Redox (Field)	mV		-71.2	96	-81.9	-201.2
Temperature (Field)	°C		20.77	20.6	22.73	20.3
Conductivity @ 25 C	µS/cm	1	1410	3040	3450	2900
pH (Lab)	pH_Units	0.01	6.9	8.09	8.33	9.1
TDS	mg/L	10	884	1550	1880	1470
Chloride	mg/L	0.1	315	468	572	614 - 617
Sulfate as SO4 - Turbidimetric (Filtered)	mg/L	1	2	65	<1	3
Bicarbonate Alkalinity-mg CaCO3/L	mg/L	1	144	738	650	440
Carbonate Alkalinity-mg CaCO3/L	mg/L	1	<1	<1	22	114
Alkalinity (Hydroxide) as CaCO3	mg/L	1	<1	<1	<1	<1
Alkalinity (total) as CaCO3	mg/L	1	144	738	672	554
Calcium (Filtered)	mg/L	1	71	6	5	6
Magnesium (Filtered)	mg/L	1	20	1	<1	1
Potassium (Filtered)	mg/L	1	4	4	3	11
Sodium (Filtered)	mg/L	1	157	605	727	734
Fluoride	mg/L	0.1	<0.1	0.4	0.2	0.1
Bromine (Filtered)	mg/L	0.1	0.8	1	1	0.7
Ionic Balance	%	0.01	1.32	4.5	3.84	6.59
Reactive Silica	mg/L	0.05	N/A	N/A	N/A	2.28
Silicon as SiO2 (Filtered)	mg/L	0.1	32.9	12.8	11.6	N/A
Phosphorus	mg/L	0.01	0.25	0.18	0.02	0.01
Ammonia as N	mg/L	0.01	0.65	0.98	1	1.4
Nitrate (as N)	mg/L	0.01	0.08	<0.01	0.09	<0.01
Nitrite (as N)	mg/L	0.01	<0.01	0.07	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	0.01	0.08	0.07	0.09	<0.01
Reactive Phosphorus as P	mg/L	0.01	<0.01	0.05	0.01	<0.01
Total Organic Carbon	mg/L	1	5	7	1	10
Butane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Butene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Ethane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Ethene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Methane	mg/L	0.01	2.64	6.84	17.8	29.7
Propane	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Propene	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Boron (Filtered)	mg/L	0.05	<0.05	0.05	<0.05	<0.05
Aluminium (Filtered)	mg/L	0.01	0.09	0.08	0.04	<0.01
Arsenic (Filtered)	mg/L	0.001	0.001	0.005	<0.001	<0.001
Barium (Filtered)	mg/L	0.001	0.801	1.09	0.806	0.213
Berryllium (Filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium (Filtered)	mg/L	0.0001	<0.0001	0.0002	<0.0001	<0.0001
Chromium (Filtered)	mg/L	0.001	<0.0001	<0.0001	0.0001	<0.001
Cobalt (Filtered)	mg/L	0.001	0.002	<0.001	<0.001	<0.001
Copper (Filtered)	mg/L	0.001	0.001	0.002	0.001	0.033
Iron (Filtered)	mg/L	0.05	17.3	0.09	0.05	<0.05
Lead (Filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (Filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Zinc (Filtered)	mg/L	0.005	0.180	0.063	0.008	<0.005
Manganese (Filtered)	mg/L	0.001	0.300	0.041	0.024	0.009
Molybdenum (Filtered)	mg/L	0.001	<0.001	0.008	<0.001	0.008
Nickel (Filtered)	mg/L	0.001	0.002	0.006	0.002	0.002
Selenium (Filtered)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Strontium (Filtered)	mg/L	0.001	2.08	2.46	1.38	0.698
Tin (Filtered)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Uranium (Filtered)	mg/L	0.001	<0.001	0.004	<0.001	<0.001
Oil and Grease	mg/L	5	<5	<5	<5	<5
2,4,5-trichlorophenol	µg/L	1	<1	<1	<1	<1
2.4.6-Trichlorophenol	µg/L	1	<1	<1	<1	<1
2,4-dichlorophenol	µg/L	1	<1	<1	<1	<1
2,4-dimethylphenol	µg/L	1	<1	<1	<1	<1
2,6-dichlorophenol	µg/L	1	<1	<1	<1	<1
2-chlorophenol	µg/L	1	<1	<1	<1	<1
2-methylphenol	µg/L	1	<1	<1	<1	<1
2-nitrophenol	µg/L	1	<1	<1	<1	<1
3-&4-methylphenol	µg/L	2	<2	<2	<2	<2
4-chloro-3-methylphenol	µg/L	1	<1	<1	<1	<1
Pentachlorophenol	µg/L	2	<2	<2	<2	<2
Phenol	µg/L	1	<1	<1	<1	2.3
Acenaphthene	µg/L	1	<1	<1	<1	<1
Acenaphthylene	µg/L	1	<1	<1	<1	<1
Anthracene	µg/L	1	<1	<1	<1	<1
Benz(a)anthracene	µg/L	1	<1	<1	<1	<1
Benzo(a) pyrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b)fluoranthene	µg/L	1	<1	<1	<1	<1
Benzo(g,h,i)perylene	µg/L	1	<1	<1	<1	<1
Benzo(k)fluoranthene	µg/L	1	<1	<1	<1	<1
Benzo(a)pyrene TEQ (zero)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Chrysene	µg/L	1	<1	<1	<1	<1
Dibenz(a,h)anthracene	µg/L	1	<1	<1	<1	<1
Fluoranthene	µg/L	1	<1	<1	<1	<1
Fluorene	µg/L	1	<1	<1	<1	<1
Indeno(1,2,3-c,d)pyrene	µg/L	1	<1	<1	<1	<1
Phenanthrene	µg/L	1	<1	<1	<1	<1
Pyrene	µg/L	1	<1	<1	<1	<1
Polycylic aromatic hydrocarbons EPA448	ug/L	0.5	<0.5	<0.5	<0.5	<0.5
TPH C6-C10	µg/L	20	<20	<20	30	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
C10 - C40 Fraction (Sum)	µg/L	100	<100	<100	<100	<100
TRH >C10-C16 less Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
C6 - C9 Fraction	µg/L	20	<20	<20	20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29-C36 Fraction	µg/L	50	<50	<50	<50	<50
+C10 - C36 (Sum of total)	µg/L	50	<50	<50	<50	<50
Benzene	µg/L	1	<1	<1	<1	8
Toluene	µg/L	2	<2	<2	11	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2	<2	<2	<2	<2
Xylene (o)	µg/L	2	<2	<2	<2	<2
Xylene Total	µg/L	2	<2	<2	<2	<2
Total BTEX	µg/L	1	<1	<1	11	8
Naphthalene	µg/L	1	<1	<1	<1	<1
Oxygen-18	‰	0.01	-3.68	-4.92	-5.5	-5.3
Deuterium	‰	0.1	-21.5	-28.2	-31.5	-26.1
Tritium	TU	0.001	0.845 ± 0.024	0.052 ± 0.013	-0.010 ± 0.012	0.011 ± 0.015
Radiocarbon	pMC	0.1	87.37 ± 0.18	10.3 ± 0.19	0.54 ± 0.21	1.13 ± 0.22
Radiocarbon age (uncorrected)	yrs BP	1	1,022 ± 17	18,194 ±151	41,825 ± 3,034	35,958 ± 1,564
Radiocarbon age (corrected)	yrs BP	1	Modern	16,350	37,250	33,300
Carbon-13 in methane	VPDB	0.01	-50.87	-49.1	-49.17	-48.63
Deuterium in methane	VSMOW	0.01	606	2321.1	2103.2	-210.6
Carbon-13 of dissolved inorganic carbon	VPDB	0.01	-14.09	-18.75	-15.18	-13.46

N/A = not analysed

Appendix F

ALS results

CERTIFICATE OF ANALYSIS

Work Order	: **ES1419893**	Page	: 1 of 8
Amendment	: **2**		
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Client Services
Address	: PO BOX 1162 NEWCASTLE NSW, AUSTRALIA 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: sydney@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 4929 7299	Facsimile	: +61-2-8784 8500
Project	: 2193324A	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 05-SEP-2014
Sampler	: AM	Issue Date	: 18-FEB-2016
Site	: ----		
		No. of samples received	: 3
Quote number	: EN/008/14	No. of samples analysed	: 3

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
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.

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **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.**
- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**
- **EP033: Poor matrix spike recovery due to sample matrix interference. Confirmed by re-analysis.**
- **This report has been amended and re-released to allow the reporting of additional analytical data.(SB, CR,MN, HG added on 12/2/16)**
- **This report has been amended following the request to link analysis to another container**

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: -	WRMB01A	WRMB01C	----	----
				Client sampling date / time: 04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	----	----
				ES1419893-001	ES1419893-002	ES1419893-003	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	----	**6.90**	**8.33**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	**1410**	**3450**	----	----
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	----	10	mg/L	----	**884**	**1880**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	**22**	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	**144**	**650**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	----	**144**	**672**	----	----
ED040F: Dissolved Major Anions								
Silicon as SiO2	14464-46-1	0.1	mg/L	----	**32.9**	**11.6**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	**2**	<1	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	----	**315**	**572**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	----	**71**	**5**	----	----
Magnesium	7439-95-4	1	mg/L	----	**20**	<1	----	----
Sodium	7440-23-5	1	mg/L	----	**157**	**727**	----	----
Potassium	7440-09-7	1	mg/L	----	**4**	**3**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	----	**0.09**	**0.04**	----	----
Antimony	7440-36-0	0.001	mg/L	----	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	----	**0.001**	<0.001	----	----
Beryllium	7440-41-7	0.001	mg/L	----	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	----	**0.801**	**0.806**	----	----
Cadmium	7440-43-9	0.0001	mg/L	----	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	----	<0.001	**0.001**	----	----
Cobalt	7440-48-4	0.001	mg/L	----	**0.002**	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	----	**0.001**	**0.001**	----	----
Lead	7439-92-1	0.001	mg/L	----	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	----	**0.300**	**0.024**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	-	WRMB01A	WRMB01C	-----	-----
				Client sampling date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	----	----
Compound	CAS Number	LOR	Unit		ES1419893-001	ES1419893-002	ES1419893-003	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Molybdenum	7439-98-7	0.001	mg/L		----	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L		----	**0.002**	**0.002**	----	----
Selenium	7782-49-2	0.01	mg/L		----	<0.01	<0.01	----	----
Strontium	7440-24-6	0.001	mg/L		----	**2.08**	**1.38**	----	----
Tin	7440-31-5	0.001	mg/L		----	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L		----	<0.001	<0.001	----	----
Vanadium	7440-62-2	0.01	mg/L		----	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L		----	**0.180**	**0.008**	----	----
Boron	7440-42-8	0.05	mg/L		----	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L		----	**17.3**	**0.05**	----	----
Bromine	7726-95-6	0.1	mg/L		----	**0.8**	**1.0**	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	-	-		----	**Not Authorised**	**Not Authorised**	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	<0.1	**0.2**	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	**0.65**	**1.00**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		----	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	**0.08**	**0.09**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		----	**0.08**	**0.09**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		----	**0.25**	**0.02**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		----	<0.01	**0.01**	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	**11.8**	**29.6**	----	----
Total Cations	----	0.01	meq/L		----	**12.1**	**32.0**	----	----
Ionic Balance	----	0.01	%		----	**1.32**	**3.84**	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		----	**5**	**1**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	-	WRMB01A	WRMB01C	----	----
				Client sampling date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	----	----
Compound	CAS Number	LOR	Unit		ES1419893-001	ES1419893-002	ES1419893-003	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		----	<5	<5	----	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		----	**2640**	**17800**	----	----
Ethene	74-85-1	10	µg/L		----	<10	<10	----	----
Ethane	74-84-0	10	µg/L		----	<10	<10	----	----
Propene	115-07-1	10	µg/L		----	<10	<10	----	----
Propane	74-98-6	10	µg/L		----	<10	<10	----	----
Butene	25167-67-3	10	µg/L		----	<10	<10	----	----
Butane	106-97-8	10	µg/L		----	<10	<10	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		----	<1.0	<1.0	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		----	<1.0	<1.0	----	----
2-Methylphenol	95-48-7	1.0	µg/L		----	<1.0	<1.0	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		----	<2.0	<2.0	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		----	<1.0	<1.0	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		----	<1.0	<1.0	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		----	<1.0	<1.0	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L		----	<1.0	<1.0	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		----	<1.0	<1.0	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		----	<1.0	<1.0	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		----	<1.0	<1.0	----	----
Pentachlorophenol	87-86-5	2.0	µg/L		----	<2.0	<2.0	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		----	<1.0	<1.0	----	----
Acenaphthylene	208-96-8	1.0	µg/L		----	<1.0	<1.0	----	----
Acenaphthene	83-32-9	1.0	µg/L		----	<1.0	<1.0	----	----
Fluorene	86-73-7	1.0	µg/L		----	<1.0	<1.0	----	----
Phenanthrene	85-01-8	1.0	µg/L		----	<1.0	<1.0	----	----
Anthracene	120-12-7	1.0	µg/L		----	<1.0	<1.0	----	----
Fluoranthene	206-44-0	1.0	µg/L		----	<1.0	<1.0	----	----
Pyrene	129-00-0	1.0	µg/L		----	<1.0	<1.0	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		----	<1.0	<1.0	----	----
Chrysene	218-01-9	1.0	µg/L		----	<1.0	<1.0	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	-	WRMB01A	WRMB01C	-----	-----
				Client sampling date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	----	----
Compound	CAS Number	LOR	Unit		ES1419893-001	ES1419893-002	ES1419893-003	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		----	<1.0	<1.0	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		----	<1.0	<1.0	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		----	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		----	<1.0	<1.0	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		----	<1.0	<1.0	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		----	<1.0	<1.0	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		----	<0.5	<0.5	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		----	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		----	<20	**20**	----	----
C10 - C14 Fraction	----	50	µg/L		----	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L		----	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		----	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		----	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		----	<20	**30**	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		----	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		----	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		----	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		----	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		----	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		----	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		----	<1	<1	----	----
Toluene	108-88-3	2	µg/L		----	<2	**11**	----	----
Ethylbenzene	100-41-4	2	µg/L		----	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		----	<2	<2	----	----
^ Total Xylenes	1330-20-7	2	µg/L		----	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		----	<1	**11**	----	----
Naphthalene	91-20-3	5	µg/L		----	<5	<5	----	----
EP075(SIM)S: Phenolic Compound Surrogates									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	-	WRMB01A	WRMB01C	----	----
			Client sampling date / time	04-SEP-2014 15:00	04-SEP-2014 00:00	04-SEP-2014 15:00	----	----
Compound	CAS Number	LOR	Unit	ES1419893-001	ES1419893-002	ES1419893-003	----	----
EP075(SIM)S: Phenolic Compound Surrogates - Continued								
Phenol-d6	13127-88-3	0.1	%	----	18.0	25.4	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%	----	29.8	52.4	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%	----	41.8	61.8	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	----	46.4	72.1	----	----
Anthracene-d10	1719-06-8	0.1	%	----	56.4	78.5	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	----	56.4	79.3	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	93.5	95.3	----	----
Toluene-D8	2037-26-5	0.1	%	----	106	107	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	----	107	105	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	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	27.4	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	: **ES1421004**	Page	: 1 of 8
Amendment	: **1**		
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MS ANDREA MADDEN	Contact	: Loren Schiavon
Address	: PO BOX 1162 NEWCASTLE NSW, AUSTRALIA 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amadden@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5127	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 4929 7299	Facsimile	: +61 2 8784 8500
Project	: 2193324A	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 18-SEP-2014
Sampler	: AM	Issue Date	: 18-FEB-2016
Site	: ----		
		No. of samples received	: 1
Quote number	: EN/008/14	No. of samples analysed	: 1

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

General Comments

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

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **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.**
- **EG020: 'Bromine/Iodine' quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**
- **This report has been amended and re-released to allow the reporting of additional analytical data. (Sb, Cr, and Mn added on 12/02/16)**

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao	Inorganic Chemist	Sydney Inorganics
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01B	----	----	----	----
				Client sampling date / time	17-SEP-2014 15:15	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1421004-001	----	----	----	----
EA005: pH									
pH Value	----	0.01	pH Unit		**8.09**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**3040**	----	----	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**1550**	----	----	----	----
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		**738**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**738**	----	----	----	----
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L		**12.8**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**65**	----	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**468**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**6**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**1**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**605**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**4**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.08**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		**0.001**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.005**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**1.09**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.002**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.041**	----	----	----	----

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: WRMB01B	----	----	----	----
				Client sampling date / time: 17-SEP-2014 15:15	----	----	----	----
				ES1421004-001	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Molybdenum	7439-98-7	0.001	mg/L	**0.008**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.006**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**2.46**	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L	**0.004**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.063**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.05**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.09**	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	**1.0**	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.98**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.07**	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.07**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.18**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.05**	----	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**29.3**	----	----	----	----
Total Cations	----	0.01	meq/L	**26.8**	----	----	----	----
Ionic Balance	----	0.01	%	**4.50**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**7**	----	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01B	----	----	----	----
				Client sampling date / time	17-SEP-2014 15:15	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1421004-001	----	----	----	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**6840**	----	----	----	----
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	1.0	µg/L		<1.0	----	----	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	----	----	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	----	----	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	----	----	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	----	----	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	----	----	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	----	----	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	----	----	----	----
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	----	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	----	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01B	----	----	----	----
				Client sampling date / time	17-SEP-2014 15:15	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1421004-001	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	----	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	----	----	----	----
^ 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	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.1	%		**20.8**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%		**46.6**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%		**67.0**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01B	----	----	----	----
				Client sampling date / time	17-SEP-2014 15:15	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1421004-001	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates - Continued									
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		**71.1**	----	----	----	----
Anthracene-d10	1719-06-8	0.1	%		**64.0**	----	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%		**57.2**	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**95.2**	----	----	----	----
Toluene-D8	2037-26-5	0.1	%		**102**	----	----	----	----
4-Bromofluorobenzene	460-00-4	0.1	%		**101**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	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	27.4	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

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1533252**	Page	: 1 of 9
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MR ANGUS MCFARLANE	Contact	: Loren Schiavon
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: amcfarlane@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5100	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 9272 5101	Facsimile	: +61-2-8784 8500
Project	: 2193324A	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 09-Oct-2015 14:30
C-O-C number	: ----	Date Analysis Commenced	: 09-Oct-2015
Sampler	: ANDREW FARINA, ANGUS MCFARLANE	Issue Date	: 16-Oct-2015 17:30
Site	: ----		
		No. of samples received	: 1
Quote number	: ----	No. of samples analysed	: 1

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
Merrin Avery	Supervisor - Inorganic	Newcastle - Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Phalak Inthakesone	Laboratory Manager - Organics	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.
- EG020: Poor matrix spike recovery was obtained for many elements on sample ES1533149-002. Results have been confirmed by re-analysis.
- 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	WRMB01D	----	----	----	----
			Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1533252-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EA005: pH								
pH Value	----	0.01	pH Unit	**9.10**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2900**	----	----	----	----
EA015: Total Dissolved Solids								
^ **Total Dissolved Solids @180°C**	----	10	mg/L	**1470**	----	----	----	----
EA025: Suspended Solids								
^ **Suspended Solids (SS)**	----	5	mg/L	<5	----	----	----	----
ED009: Anions								
Chloride	16887-00-6	0.1	mg/L	**614**	----	----	----	----
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	**114**	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**440**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**554**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**3**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**617**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**6**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**1**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**734**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**11**	----	----	----	----
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	**0.698**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.213**	----	----	----	----
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	WRMB01D	----	----	----	----
				Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1533252-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.033**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.009**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.008**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.002**	----	----	----	----
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	----	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
Bromine	7726-95-6	0.1	mg/L		**0.7**	----	----	----	----
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		**2.28**	----	----	----	----
EK010/011: Chlorine									
Chlorine - Free	----	0.2	mg/L		<0.2	----	----	----	----
Chlorine - Total Residual	----	0.2	mg/L		<0.2	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**1.40**	----	----	----	----
EK055G-NH4: Ammonium as N by DA									
^ Ammonium as N	14798-03-9_N	0.01	mg/L		**0.98**	----	----	----	----
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		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.9**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01D	----	----	----	----
				Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1533252-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.9**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	----	----	----	----
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		**28.5**	----	----	----	----
^ **Total Cations**	----	0.01	meq/L		**32.6**	----	----	----	----
^ **Ionic Balance**	----	0.01	%		**6.59**	----	----	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**10**	----	----	----	----
EP020: Oil and Grease (O&G)									
^ **Oil & Grease**	----	5	mg/L		<5	----	----	----	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**29700**	----	----	----	----
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	----	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		<5	----	----	----	----
Isopropylbenzene	98-82-8	5	µg/L		<5	----	----	----	----
n-Propylbenzene	103-65-1	5	µg/L		<5	----	----	----	----
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	----	----	----	----
sec-Butylbenzene	135-98-8	5	µg/L		<5	----	----	----	----
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	----	----	----	----
tert-Butylbenzene	98-06-6	5	µg/L		<5	----	----	----	----
p-Isopropyltoluene	99-87-6	5	µg/L		<5	----	----	----	----
n-Butylbenzene	104-51-8	5	µg/L		<5	----	----	----	----
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	----	----	----	----
2-Butanone (MEK)	78-93-3	50	µg/L		<50	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01D	----	----	----	----
				Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1533252-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EP074B: Oxygenated Compounds - Continued									
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	----	----	----	----
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	----	----	----	----
EP074C: Sulfonated Compounds									
Carbon disulfide	75-15-0	5	µg/L		<5	----	----	----	----
EP074D: Fumigants									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	----	----	----	----
1.2-Dichloropropane	78-87-5	5	µg/L		<5	----	----	----	----
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	----	----	----	----
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	----	----	----	----
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	----	----	----	----
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	----	----	----	----
Chloromethane	74-87-3	50	µg/L		<50	----	----	----	----
Vinyl chloride	75-01-4	50	µg/L		<50	----	----	----	----
Bromomethane	74-83-9	50	µg/L		<50	----	----	----	----
Chloroethane	75-00-3	50	µg/L		<50	----	----	----	----
Trichlorofluoromethane	75-69-4	50	µg/L		<50	----	----	----	----
1.1-Dichloroethene	75-35-4	5	µg/L		<5	----	----	----	----
Iodomethane	74-88-4	5	µg/L		<5	----	----	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	----	----	----	----
1.1-Dichloroethane	75-34-3	5	µg/L		<5	----	----	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	----	----	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	----	----	----	----
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	----	----	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	----	----	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	----	----	----	----
Trichloroethene	79-01-6	5	µg/L		<5	----	----	----	----
Dibromomethane	74-95-3	5	µg/L		<5	----	----	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	----	----	----	----
1.3-Dichloropropane	142-28-9	5	µg/L		<5	----	----	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	----	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	----	----	----	----
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	----	----	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01D	----	----	----	----
				Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1533252-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EP074E: Halogenated Aliphatic Compounds - Continued									
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	----	----	----	----
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	----	----	----	----
Pentachloroethane	76-01-7	5	µg/L		<5	----	----	----	----
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	----	----	----	----
Hexachlorobutadiene	87-68-3	5	µg/L		<5	----	----	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	----	----	----	----
Bromobenzene	108-86-1	5	µg/L		<5	----	----	----	----
2-Chlorotoluene	95-49-8	5	µg/L		<5	----	----	----	----
4-Chlorotoluene	106-43-4	5	µg/L		<5	----	----	----	----
1.3-Dichlorobenzene	541-73-1	5	µg/L		<5	----	----	----	----
1.4-Dichlorobenzene	106-46-7	5	µg/L		<5	----	----	----	----
1.2-Dichlorobenzene	95-50-1	5	µg/L		<5	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		<5	----	----	----	----
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	----	----	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	----	----	----	----
Bromodichloromethane	75-27-4	5	µg/L		<5	----	----	----	----
Dibromochloromethane	124-48-1	5	µg/L		<5	----	----	----	----
Bromoform	75-25-2	5	µg/L		<5	----	----	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1	µg/L		**2.3**	----	----	----	----
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									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01D	----	----	----	----
				Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1533252-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
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		<1.0	----	----	----	----
Fluorene	86-73-7	1	µg/L		<1.0	----	----	----	----
Phenanthrene	85-01-8	1	µg/L		<1.0	----	----	----	----
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	----	----	----	----
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		<0.5	----	----	----	----
^ 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	>C10_C16	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									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WRMB01D	----	----	----	----
				Client sampling date / time	09-Oct-2015 12:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1533252-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EP080: BTEXN - Continued									
Benzene	71-43-2	1	µg/L		8	----	----	----	----
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		8	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP262: Ethanolamines									
Ethanolamine	141-43-5	1	µg/L		<1	----	----	----	----
Diethanolamine	111-42-2	1	µg/L		<1	----	----	----	----
Methyl diethanolamine (MDEA)	105-59-9	1	µg/L		<1	----	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		114	----	----	----	----
Toluene-D8	2037-26-5	5	%		123	----	----	----	----
4-Bromofluorobenzene	460-00-4	5	%		104	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1	%		24.2	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1	%		39.5	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1	%		35.1	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1	%		71.8	----	----	----	----
Anthracene-d10	1719-06-8	1	%		60.3	----	----	----	----
4-Terphenyl-d14	1718-51-0	1	%		84.6	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		117	----	----	----	----
Toluene-D8	2037-26-5	2	%		120	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		105	----	----	----	----