HYDROILEX

Groundwater Geosciences

REPORT

GROUNDWATER MONITORING BORE CONSTRUCTION & WATER ANALYSES

GMB 1 "KYEEMA", GUNDAROO

LOTS 1 & 2 DP 850916
GUNDAROO ROAD,
GUNDAROO, NSW, 2620

PREPARED FOR:	**AP & MP CARMODY AND MJ & CA HEFFERNAN**
REPORT NUMBER:	**HG14.9.8CA**
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1.0 INTRODUCTION

Hydroilex was engaged in May 2014 by the *Client* to manage the construction and associated hydrogeological requirements for a groundwater monitoring bore at "Kyeema", Gundaroo. A site inspection was conducted on 28th May 2014 following a review of the local hydrogeological setting and requirements required by the *NSW Office of Water (NOW).*

NOW has set rigid requirements for *Council* where developers, particularly in upzoning proposals, meet strict groundwater monitoring that ensures protection of groundwater quality. In compliance of an eventual Development Application approval that will include onsite effluent disposal, a groundwater monitoring bore was constructed on the western margin of the site. The bore location was specified by *NOW* at a down-gradient location, to be drilled to a minimum depth of 10 metres. The purpose of the bore is to provide baseline water quality data of specific analytes that will eventually be sampled bi-annually (summer and winter). A more extensive suite of water analyses were conducted in view of assessing the groundwater chemistry, and possible eventual use for groundwater reticulation, if required.

The site is defined at Lots 1 & 2 DP 850916, at 4056/4078 Gundaroo Road, Gundaroo. 2620, as shown in **Figure1.** The groundwater monitoring bore (MB1) is constructed in Lot 2.

This report summarises the local hydrogeological setting, construction and water chemistry of the groundwater monitoring bore.

2.0 DEVELOPMENT PROPOSAL SITE LAYOUT

A planning proposal has been lodged by AP & MP Carmody consistent with provisions of the *Yass Valley Council* LEP. The proposal requires the rezoning of rural land located on the northern side of the village of Gundaroo for subdivision into 2,100m^2 to 12,000m^2 blocks by the creation of both RU5 (Village) and E3 (Environmental Management). A staged development is proposed, where Stage 1 proposes the creation of 21 blocks. Landuse zone E3 has been dedicated to the creation of an environmental corridor along McLeod's Creek. The proposed subdivision plan is shown in **Figure 2**. A public exhibition of the proposal has been made available by Council.

Lot 1 DP 850916 is owned by AP & MP Carmody, and Lot 2 DP 850916 by CA & MJ Heffernan. The total land area subject to the proposal is approximately 41 hectares out of the total 62.7 hectare area of Lots 1 & 2.

The site is located on the northern side of the village, within the corridor of McLeod's Creek. The development has been proposed in two stages. It includes significant renewable energy concepts, rainwater harvesting and water reuse.

3.0 LOCAL HYDROGEOLOGY AND GEOGRAPHIC SETTING

The regional geological setting is shown in **Figure 3**. The key elements of the geology are:

- Site Location on the margin of alluvial deposits associated with the Yass River;
- Site bedrock (East of Yass River) located within undifferentiated Ordovician sediments comprised of greywacke, shale, slate and mixed fine grained low grade metamorphic rocks;
- Quaternary sediments in the valley floor, principally associated with the Yass River and Back Creek valleys;
- Northerly-trending faults which likely control the incised valley; northerly-trending geology, steeply inclined to the east?
- Ordovician-aged Pittman Formation (shale, sandstone, mudstone) exposed on the western side of the valley;

At a local scale, the site topography is defined clearly by aerial imagery and topographic maps, as shown in **Figures 1 &4**. The following is apparent:

1. A large dam on McLeod's Creek that is located within the proposed "Kyeema" subdivision;
2. A meandering stream pattern, particularly across the alluvial flat to the west of the subject land;
3. Rocky outcrop on the eastern margins of the dam;
4. Incised streambed east of the subject land;
5. Gentle gradient towards the Yass River;

A review of the local hydrogeology has been undertaken, where it is apparent from the local topography and geology that the predictive hydraulic gradient is westwards from the site, towards the Yass River as identified in **Figure 5**. The following is apparent from *NOW* registered data:

- The site is notably down-gradient of aquifers associated with water supplies in the township and consequently discharge of any water into the water table from the project will not impact on groundwater abstraction by existing users;
- The location of the new groundwater monitoring bore is well positioned to monitor the water quality of site run-off and any effluent irrigation, being situated in the migration pathway towards McLeod's Creek;
- Two bores in the vicinity of the project area are noted – GW402903 is a 'stock & domestic' licensed bore at 'Kyeema', located up-gradient; GW402728 is a bore located ~500m down-gradient. It is licensed for 'stock, domestic & irrigation', and extracts water from the fractured bedrock. Neither groundwater extraction or discharge from the project site is considered to have any effect on the quality of these water supplies;

4.0 LOCATION AND CONSTRUCTION OF GROUNDWATER MONITORING BORE

The siting of the monitoring bore was located for the purpose of monitoring water quality within the shallow groundwater system at a down-gradient location. The site, as shown in the attached maps will effectively:

1. Intercept the migration pathway of surface water from the site that may enter the shallow ground water system;
2. Monitor variation of water chemistry from a set of baseline water analyses;
3. Comply with bore construction, sampling regimes and analytical requirements, as specified by *Council*;

Bore construction was conducted consistent with the issue of Bore Licence 40BL192627. Drilling and bore construction was conducted by *Bungendore Water Bore* on 13.8.14.

Figure 6 provides a detailed bore construction diagram. The following provides a brief summary of the drilling results:

- Cemented hard gravels were encountered at ~1-2m depth; also recognised in the bank of McLeod's Creek;
- Clay deposits encountered to a depth of 6m, overlying slate and phyllite;
- Very slight dampness encountered below 3m (approximately equivalent to the water level in the adjacent creek), and significant aquifer in the bedrock below ~8m, that yields ~1.5 L/s;
- The bore has been constructed with a screen at 8.5-1.5m, and bentonite seals, as shown;
- A Form 'A' registration report for the bore has been prepared for lodgment with *NOW*;
- The bore was sterilized with liquid chlorine upon completion;
- Bore construction has been consistent with *Council / NOW* requirements for the drilling to a minimum depth of 10m;

Images of the borehole monument and completion structure are provided in **Figure 7**.

5.0 WATER SAMPLING AND ANALYSIS

Water samples were collected from the bore consistent with standard practice that required:

1. Allowance of sufficient time (~1 week) for the groundwater to stabilize after drilling and prior to sampling; sampling conducted on 19.8.14;
2. Collection of samples after the removal of 3 casing volumes from the bore;
3. Sterile collection of samples;
4. Direct delivery of samples to the laboratory;
5. Measurement of SWL;
6. Analyses that included the following minimum requirements:
    - Biological oxygen demand (*BOD*)
    - Chemical oxygen demand (*COD*)
    - Dissolved oxygen (*DO*)

- Nitrates
- E.coli, faecal coliforms
- pH and *EC*

A more comprehensive suite of analyses were conducted to characterise the groundwater chemistry. Data is summarised in **Table 1**, where water chemistry is compared to various water quality standards. The certified analyses are provided in **Appendix 1**. The following is noted:

1. Water quality is characterised by low salinity, low hardness and major ion chemistry that would satisfy potable requirements, subject to more extensive testing for trace metal concentrations;
2. pH is close to neutral;
3. *BOD,COD & DO* are all within the normal range;
4. Nitrate concentrations are 'low'; water is not contaminated by agricultural fertilizers;
5. Coliform and *E.coli* levels <2 were recorded, not considered significant;
6. Based on the major ion chemistry, the water is hydrochemically classified as a *chloride-sodium* water;
7. Low chloride concentrations, together with low total salinity and low SAR provides evidence that groundwater associated with the local fractured bedrock is of excellent quality that would satisfy a secondary water supply for domestic purposes if required in the future;
8. Static water level (SWL) is 4.65m bgl (5.20m below top of casing);

6.0 SUMMARY & RECOMMENDATIONS

The following summarises the findings of this study:

- Construction of a groundwater monitoring has been constructed consistent with Council requirements;
- A review of the local hydrogeological setting and distribution of bores has concluded that the monitoring bore is well-located to satisfy its purpose for the monitoring of groundwater quality and protection of the environment and existing groundwater users;
- The groundwater chemistry is considered to meet requirements for 'baseline' data *prior* to development;
- Water analyses reveal that the local groundwater is of 'excellent' quality;

* * *

7.0 REFERENCES

Agriculture and Resource Management Council of Australia and New Zealand, 2003. Minimum Construction Requirements for Water Bores in Australia. Edition 2, Sept. 2003.

ANZECC (2001) Australian New Zealand Guidelines For Fresh And Marine Water Quality. National Water Quality Management Strategy. Australian And New Zealand Environment Conservation Council.

Australian Bottled Water Institute Inc. (2005) Model Code.

Australian Government, 2004. Australian Drinking Water Guidelines 6. National Water Quality Management Strategy. Natural Resource Management Ministerial Council. National Health and Medical Research Council.

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 3, Primary Industries - Rationale and Background Information (Chapter 9).

Domenico P.A. and Schwartz F.W. 1997. Physical and Chemical Hydrogeology. Second Ed. John Wiley & Sons, Inc. pp. 145

Freeze R.A. and Cherry J.A. 1997. Groundwater. Prentice-Hall, Inc.

TABLES

Table 1 Summary of Water Analyses in Comparison with Various Standards

TABLE 1

'Kyeema', Gundaroo

Summary of Water Analyses in Comparison with Various Standards

Meth	Test	Units	BORE 1	ABWI Limit[1]	FSANZ limit[2]	NHMRC1996	Comments
	Test Date		**19.8.14**			**'Health'**	
	pH	pH units	**6.80**	++	++	++	*
	Sp.Conductance (EC)	υS/cm	**420**	++	++	++	*
	T Diss Salt - TDS	mg/L	**272**	250	++	++	*
	Total Hardness	mg/L	**87**				
	Sodium Absorption Ratio (SAR)	1.93					
	Anions						
	Bicarbonate	mg/L	**73.20**	++	++	++	*
	Carbonate	mg/L	**0**	++	++		*
	Fluoride	mg/L	**0.3**	1.5	2	1.5	
	Chloride	mg/L	**72.8**	250	++	++	*
	Bromide	mg/L	**<0.4**				*
	Sulphate	mg/L	**12.4**				*
	Nitrate (as N)	mg/L	**0.1**	10.0	45 (as NO3) -11.3 as N	10	*
	Nitrite (as N)	mg/L	**<0.05**	1.0	0.005 (as NO2) ??	1	*
	Nitrite + Nitrate (as N)	mg/L	**0.10**				
	Phosphate (as P)	mg/L	**<0.04**				
	Anions						
	Diss Calcium	mg/L	**10.2**	++	++	++	*
	Diss Magnesium	mg/L	**14.9**	++	++	++	*
	Diss Potassium	mg/L	**2.0**	++	++	++	*
	Diss Sodium	mg/L	**41.5**	++	++	++	* 180 aesthetic
	Dissolved Ox (DO)	mg/L	**7.2**		>5 [4]		*
	Chem Ox Demand (COD)	mg/L	**18**	++	<40 [4]	++	*
	Biochemical Oxy Demand (BOD)	mg/L	**<2**		<15 [4]		
	Coliforms & E.coli			-	-		*
	Faecal coliforms	CFU/100mL	**<2**	0	0	0	trace
	E.coli	CFU/100mL	**<2**	0	0	0	trace

1. Australian Bottled Water Institute (Model Code, June 2004)

2. Food Standards Australia and New Zealand (Standard 2.6.2)

3. NHMRC 1996 National Health and Medical Association

4. National Water Quality Management Strategy,Guidelines for fresh and Marine Water Quality,Paper N0.4 (2000)

Note: mg/L Milligrams per litre

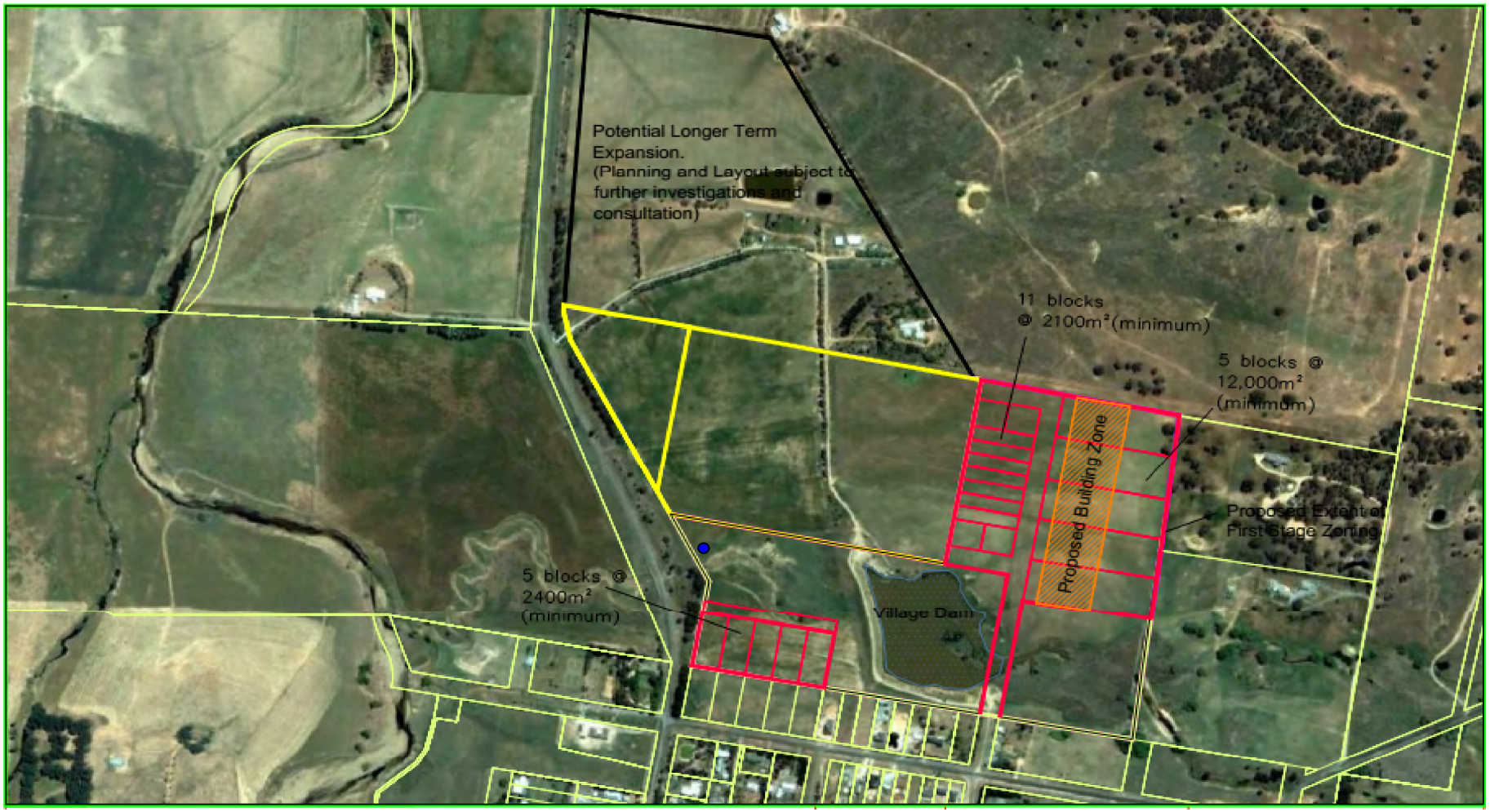
++ no health-based guideline is necessary

* high quality, pass on all relevent standards

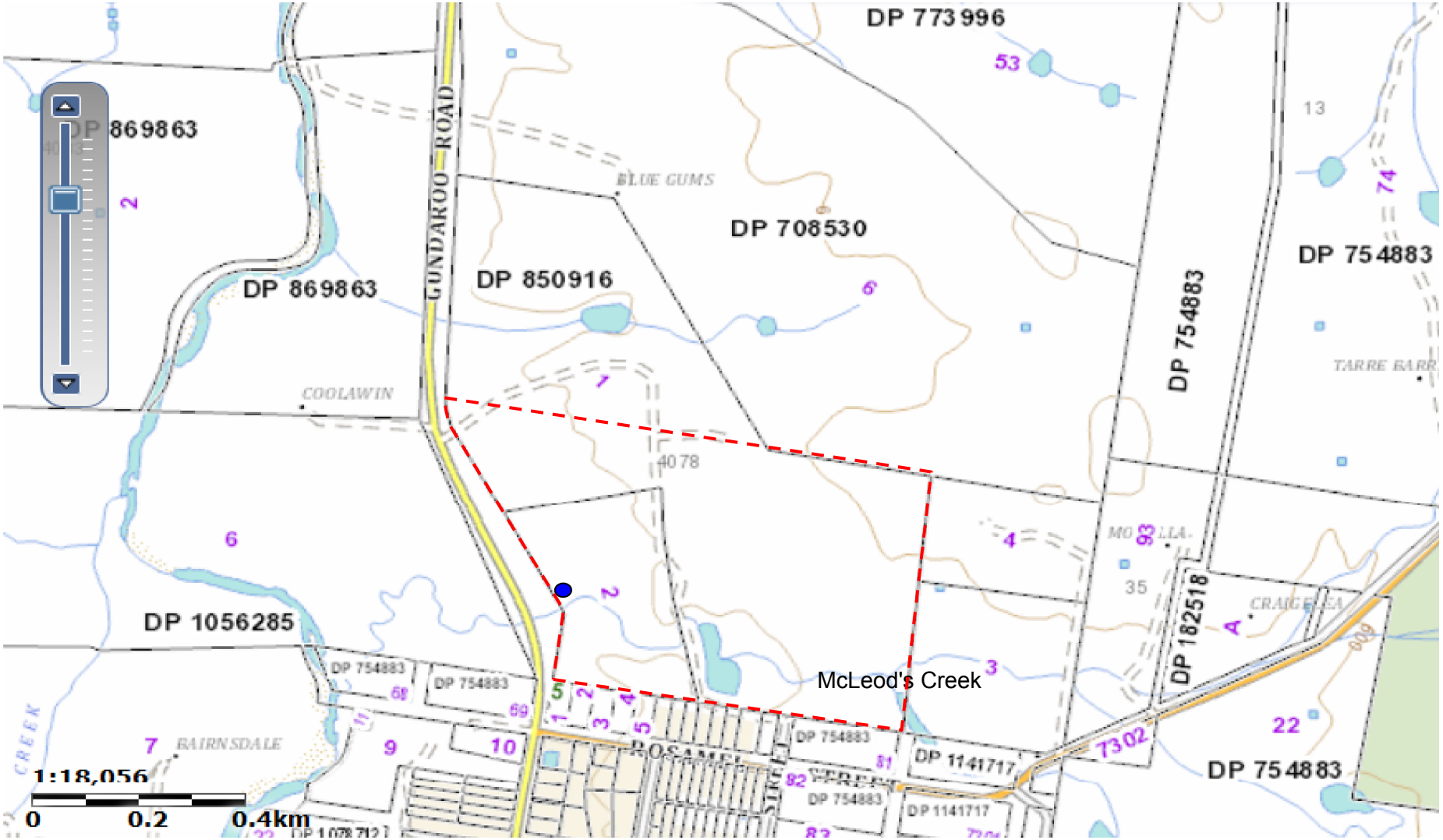
Ionic balance 1.02

Hydrochemical Classification : *chloride - sodium water*

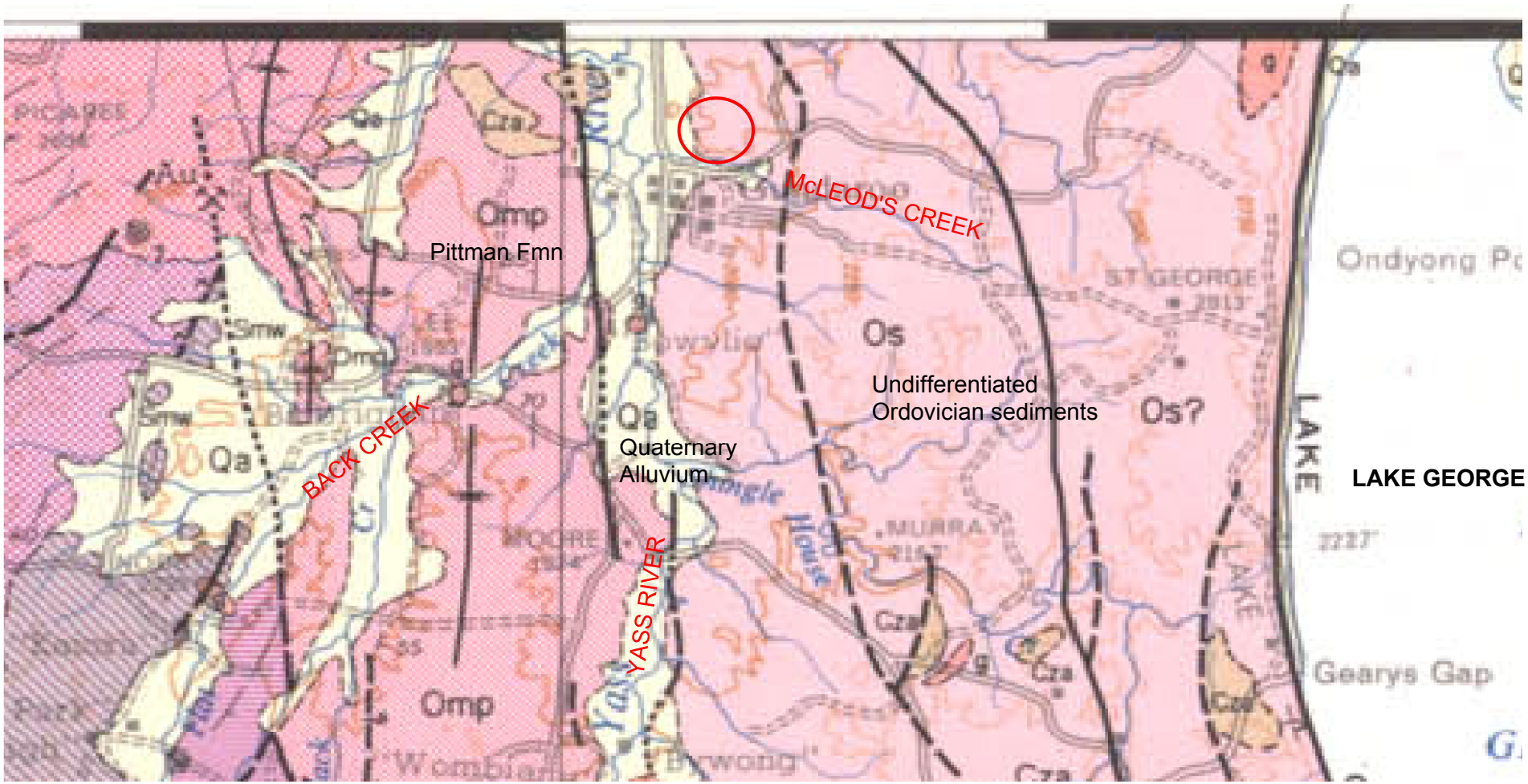
FIGURES



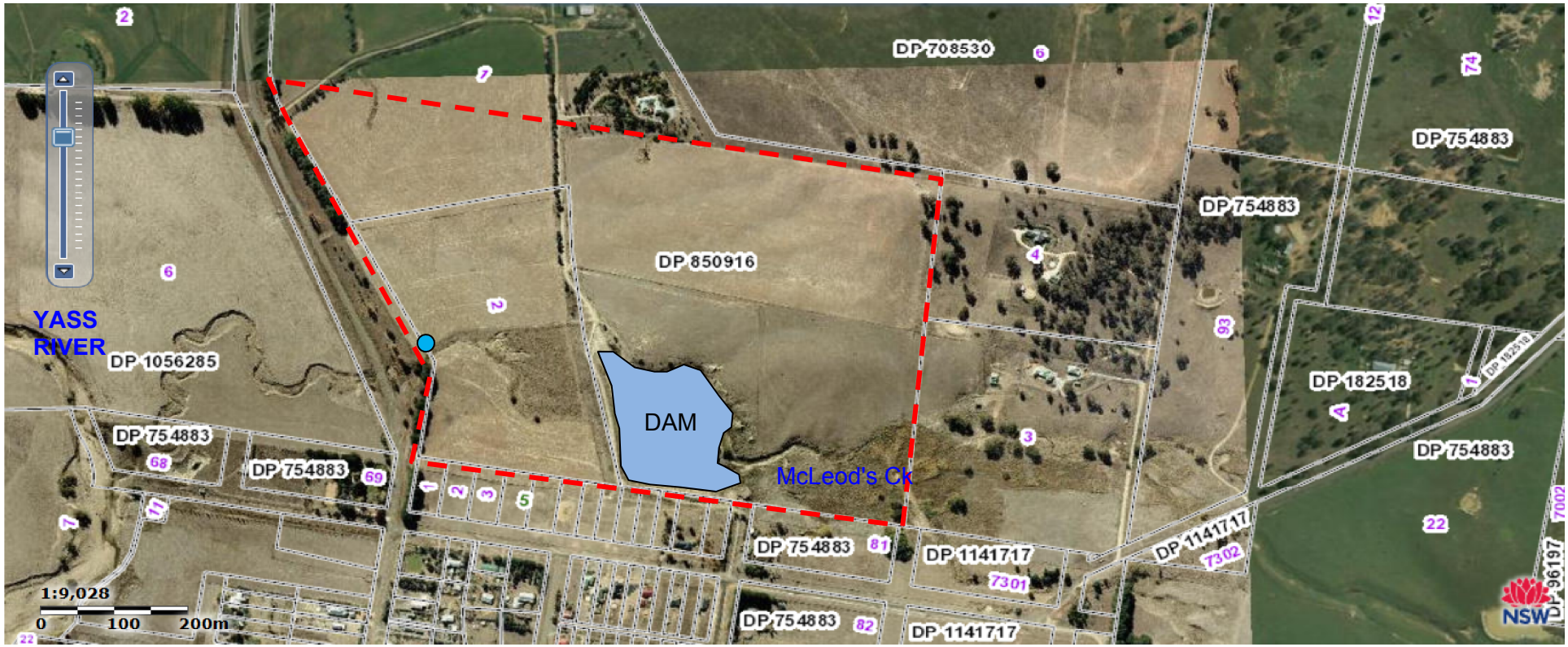
Hydroilex Pty Ltd www.hydroilex.com.au	UTM: - Date: Sept 2014 Drawn: RJL Approved: RJL	**Proposed Kyeema Subdivision** **Location of Monitoring Bore in Relation to Subdivision Plan**	**Figure: 1**



Hydroilex Pty Ltd www.hydroilex.com.au	UTM: - Date: Sept 2014 Drawn: RJL Approved: RJL	**Proposed Kyeema Subdivision** **Location of Groundwater Monitoring Bore**	**Figure: 2**



Hydroilex Pty Ltd www.hydroilex.com.au	UTM: - Date: Sept 2014 Drawn: RJL Approved: RJL	**Proposed Kyeema Subdivision** **Regional Geological Setting**	**Figure: 3**

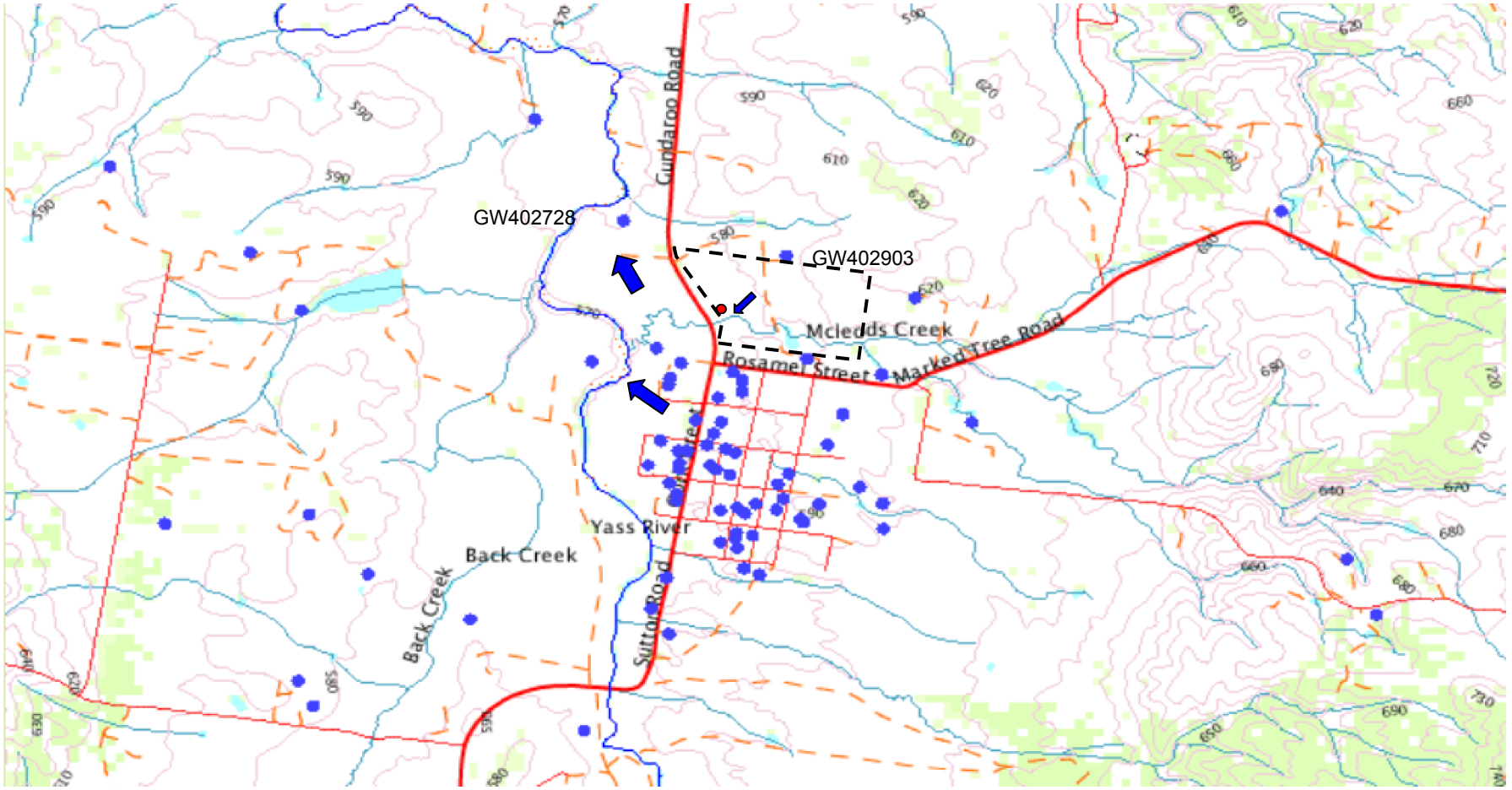


LEGEND

'Kyeema' land subject to re-zoning (Lot 2 DP 850916 & part Lot 1 DP850916)
MB1

N

Hydroilex Pty Ltd www.hydroilex.com.au	UTM: - Date: Sept 2014 Drawn: RJL Approved: RJL	**Proposed Kyeema Subdivision** **Site Aerial Image**	**Figure: 4**



LEGEND

Kyeema Subdivision

Predicted hydraulic gradient

Registered bores

Kyeemah MB1

GW402903 (96m deep bore at Kyeeema, 0.85 L/s - stock/domestic)

GW402728 (66m deep bore at Coolawin, 4.0 L/s - irrig./stock in bedrock)

500m

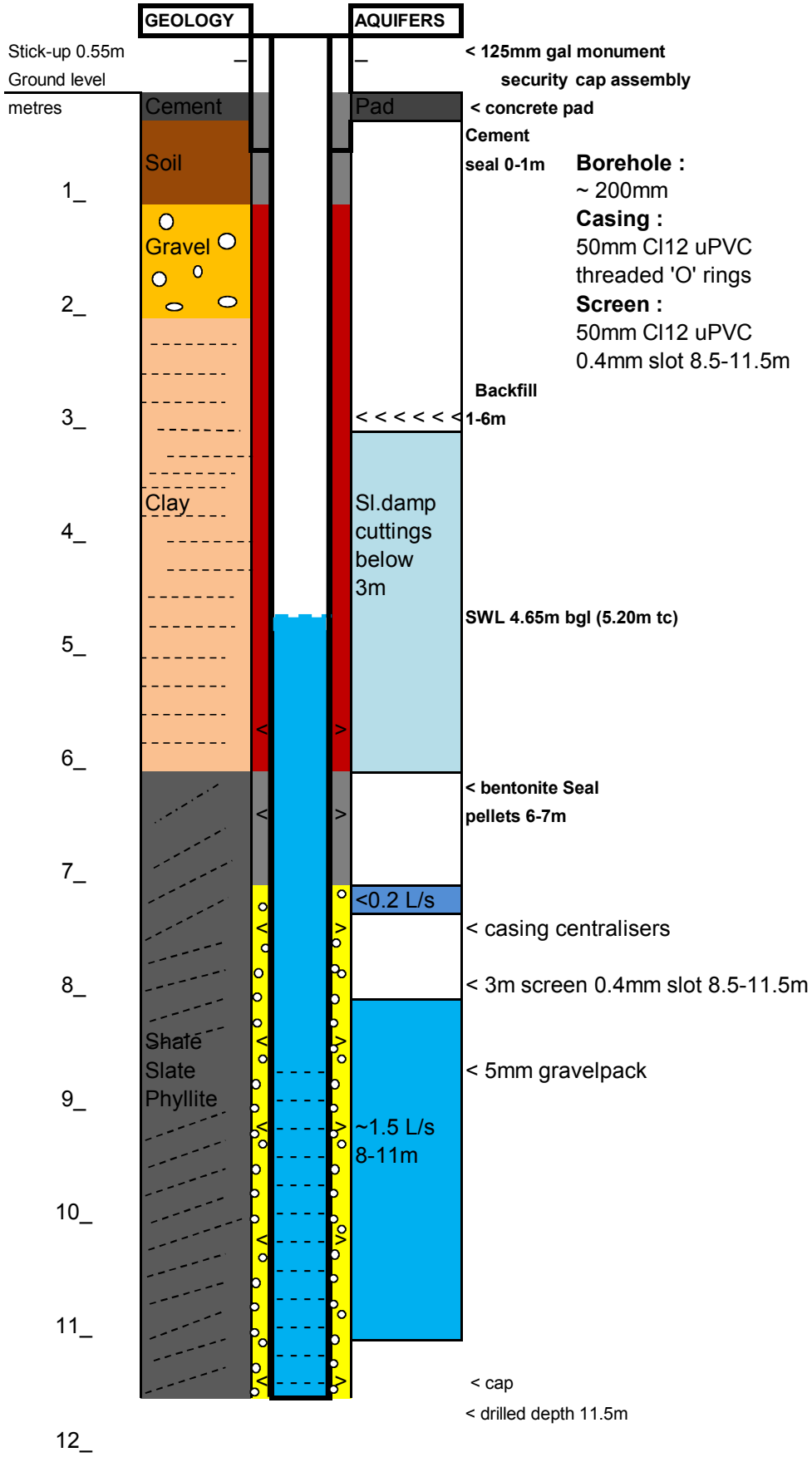
N

Hydroilex Pty Ltd www.hydroilex.com.au	UTM: -	**Proposed Kyeema Subdivision**	**Figure: 5**
	Date: Sept 2014		
	Drawn: RJL	**Location of NOW Registered Bores**	
	Approved: RJL		

FIGURE 6 BORE CONSTRUCTION DIAGRAM

KYEEMA GROUNDWATER MONITORING BORE 1

LOCATION
mga 706867E 6122588N
Licence: 40BL192627



BOREHOLE CONSTRUCTION DIAGRAM
Kyeema Groundwater Monitoring Bore 1

Scale: diagramatic

FIGURE 6

FIGURE 7 Bore Construction and Security Monument

Appendix

Appendix 1 Laboratory Certificates of Analysis

ALS Environmental

(Water Resources Group)

CERTIFICATE OF ANALYSIS

Work Order	: **CA1402461**	Page	: 1 of 5
Client	: **Hydroilex**	Laboratory	: ALS Water Resources Group
Contact	: Mr John Lee	Contact	: Client Services
Address	: 5 - 7 William Street Molong NSW 2866	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
E-mail	: johnlee@hydrolex.com.au	E-mail	: ecowisecustomerservice@alsglobal.com
Telephone	: 02 6366 8877	Telephone	: +61 2 6202 5404
Facsimile	: ----	Facsimile	:
Project	: Kyeemah, Gundaroo	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 19-Aug-2014 11:45
Sampler	: ----	Issue Date	: 05-Sep-2014 16:24
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

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
Amanda Gonzalez	Technical Officer	Inorganics
Chau Lethitran	Technical Officer	Inorganics
Geetha Ramasundara	Teamleader Wet Chem	Inorganics
Namal Gamage	Technical Officer	Microbiology / Biology
Terry OBrien	Teamleader Nutrients	Inorganics
Titus Vimalasiri	Teamleader Metals	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.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MB1 Bore Water	----	----	----	----
			Client sampling date / time	19-Aug-2014 08:45	----	----	----	----
Compound	CAS Number	LOR	Unit	CA1402461-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EA005: pH								
pH	----	0.01	pH Unit	**6.80**	----	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	2	µS/cm	**420**	----	----	----	----
EA015: Total Dissolved Solids								
^ Total Dissolved Solids	----	10	mg/L	**272**	----	----	----	----
ED009: Anions								
Chloride	16887-00-6	0.1	mg/L	**72.8**	----	----	----	----
Bromide	24959-67-9	0.4	mg/L	<0.4	----	----	----	----
Sulfate	14808-79-8	0.4	mg/L	**12.4**	----	----	----	----
Fluoride	16984-48-8	0.1	mg/L	**0.3**	----	----	----	----
Nitrate as N	14797-55-8	0.1	mg/L	**0.1**	----	----	----	----
Nitrite as N	----	0.05	mg/L	<0.05	----	----	----	----
Phosphate as P	14265-44-2	0.4	mg/L	<0.4	----	----	----	----
EG005F: Dissolved Metals by ICP-OES								
Calcium	7440-70-2	0.05	mg/L	**10.2**	----	----	----	----
Magnesium	7439-95-4	0.05	mg/L	**14.9**	----	----	----	----
Potassium	7440-09-7	0.1	mg/L	**2.0**	----	----	----	----
Sodium	7440-23-5	0.1	mg/L	**41.5**	----	----	----	----
EK057: Nitrite as N								
Nitrite as N	----	0.01	mg/L	<0.01	----	----	----	----
EK058: Nitrate as N								
^ Nitrate as N	14797-55-8	0.01	mg/L	**0.10**	----	----	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N	----	0.05	mg/L	**0.10**	----	----	----	----
EP025: Oxygen - Dissolved (DO)								
Dissolved Oxygen	----	0.5	mg/L	**7.2**	----	----	----	----
EP026: Chemical Oxygen Demand (COD)								
Chemical Oxygen Demand	----	1	mg/L	**18**	----	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	----	----	----	----
MW006: Faecal coliforms & E. coli by MF								
Thermotolerant Faecal Coliforms (Presumptive)	----	1	CFU/100mL	<2	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MB1 Bore Water	----	----	----	----
				Client sampling date / time	19-Aug-2014 08:45	----	----	----	----
Compound	CAS Number	LOR	Unit		CA1402461-001	--------	--------	--------	--------
					Result	Result	Result	Result	Result
MW006: Faecal coliforms & E. coli by MF - Continued									
Thermotolerant Faecal Coliforms (Confirmed)	----	1	CFU/100mL		<2	----	----	----	----
E. coli (Confirmed)	----	1	CFU/100mL		<2	----	----	----	----