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AQUATIC SCIENCE AND MANAGEMENT

Lot 2 Phillip Drive South West Rocks

Final Groundwater Monitoring Report

Report Prepared for:

Rise Projects Pty Ltd

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Prepared By:

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Document History

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1 Introduction

1.1 Introduction and Background

Rise Projects Pty Ltd propose a mixed-use development at Lot 2 DP1091323, located off Phillip Drive South West Rocks. Due to the potential for interaction with a shallow water table at the site a Groundwater Assessment Methodology (GAM) has been prepared (Australasian Groundwater and Environmental Consultants Pty Ltd 2021). It includes a field characterisation stage that involves construction of 7 groundwater monitoring bores and groundwater level and quality assessments. A further (eighth) bore was constructed near the southwestern margin of the site and has been added to the monitoring program.

This report aims to address aspects of the field characterisation stage of the groundwater assessment methodology. It provides a summary of the groundwater monitoring activities and data collected between September 2022 and March 2023.

1.1.1 Aims and Objectives

The objective of groundwater monitoring is to assess the variability in groundwater level and quality across the site and over time.

The aim of this report is to provide a summary of groundwater monitoring activities and results collected, and to comply with the requirements of the GAM.

1.2 Water Quality Guidelines and Objectives

There are a variety of guidelines available for the comparison and assessment of results obtained from surface water and groundwater sampling. Choosing appropriate guidelines to assess water quality depends on the environmental values of the site, human uses, the objectives for water quality, the level of protection required for the site and the issues and associated risks present.

Most often, guidelines are derived from the Australian and New Zealand Environment Conservation Council (ANZECC) Guidelines for Water Quality (ANZECC 2000), The

Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2013) and the Guidelines for Managing Risks in Recreational Waters (NHMRC 2011).

In the case of large datasets collected regularly over time and with an appropriate sampling design the ANZECC Guidelines suggest the use of median and 80th percentile (P80) concentrations from the gathered data. The SWMP and the GWMP employ a before/after, control/impact (BACI) sampling design to assess the impact of the highway upgrade on water quality. They recommend the use of the median values from the impact (downstream) sites and the P80 values from the control (upstream) sites for assessing impacts with the intention of informing ongoing management of water quality.

The ANZECC guidelines prescribe default guideline values for many water quality parameters. The individual values depend on the desired use of the water, perceived values of the water and the level of protection required. The default guideline values are intended to trigger further water quality investigations and to be used where there is an absence of locally derived guideline values. The ANZECC default guideline concentrations will be used in this report for providing context. The relevant ANZECC guideline concentrations are presented in **Table 1.1**.

The Australian Drinking Water Guidelines (ADWG, NHMRC 2013) provide guideline values for many water quality parameters that have potential impacts upon human health. In accordance with the Guidelines for the Assessment and Management of Groundwater Contamination (DEC 2007) both the ADWG guidelines and the relevant ANZECC guidelines (default guidelines for Freshwater Aquatic Ecosystem Protection for 95% of species) to provide quantitative context. Importantly, results that exceed the ANZECC and ADWG guidelines are not necessarily an indication of poor water quality. The relevant ADWG concentrations are presented in **Table 1.1**.

Table 1.1 Available ANZECC and ADWG guideline concentrations for relevant parameters

Parameter	***ANZECC Guideline Concentrations for Aquatic Ecosystem Protection (95% of spp.) in moderately disturbed ecosystems***		***ADWG Concentrations***
	Freshwater	***Marine***	
Silver (µg/L)	0.05	1.4	100
Aluminium (µg/L)	55	0.5[a]	200[b]
Antimony (µg/L)	9	270	3
Arsenic (V) (µg/L)	13	4.5[a]	10
Cadmium (µg/L)	0.2	5.5	2
Chromium (VI) (µg/L)	1.0	4.4	50
Copper (µg/L)	1.4	1.3	2000
Iron (µg/L)	-	-	300[b]
Manganese (µg/L)	1900	-	500

Parameter	*ANZECC Guideline Concentrations for Aquatic Ecosystem Protection (95% of spp.) in moderately disturbed ecosystems*		*ADWG Concentrations*
	Freshwater	*Marine*	
Nickel (µg/L)	11	7	20
Lead (µg/L)	3.4	4.4	10
Selenium (µg/L)	5	-	10
Zinc (µg/L)	8.0	15	300[b]
Mercury (µg/L)	0.05	0.1	1
Chloride, Cl (mg/L)	-	-	250[b]
Sulphate, SO4 (mg/L)	-	-	250[b]
Bicarbonate Alkalinity as CaCO3 (mg/L)	-	-	-
Sodium – Dissolved (mg/L)	-	-	180b
Potassium – Dissolved (mg/L)	-	-	-
Calcium – Dissolved (mg/L)	-	-	-
Magnesium – Dissolved (mg/L)	-	-	-
Hydroxide Alkalinity (OH-) as CaCO3 (mg/L)	-	-	-
Carbonate Alkalinity as CaCO3 (mg/L)	-	-	200[b]
Total Alkalinity as CaCO3 (mg/L)	-	-	-
Total Dissolved Solids (mg/L)	-	-	600[b]
pH	6.5 – 8.0	7.0 – 8.5	6.5 – 8.5
Conductivity (mS/cm)	0.125 – 2.2	-	-

a – ANZECC low reliability trigger

b – No health-based guideline value, aesthetic value applied.

2 Methods

2.1 Locations

2.1.1 Groundwater Monitoring Bores

The GAM specifies the locations of 7 monitoring bores. A map of bore locations is presented in **Illustration 2.1.** Coordinates for each of the bores are presented in **Table 3.1**. The locations of two bores were adjusted slightly from the proposed layout in the GAM to account for future construction works. An eighth bore was included to assist with site characterisation.

Illustration 2.1 Groundwater well locations in relation to the property boundary

2.2 Monitoring Tasks

2.2.1 Slug Tests

Slug tests were undertaken after well construction and development to provide an indication of the hydraulic conductivity of the soils. HOBO level dataloggers were used to measure changes in the water level at one second intervals. The tests involved:

- Insertion of a solid into the well, allow 2 minutes for the level to settle.
- Removal of the solid from the well, allow 2 minutes for the water level to settle.
- Remove one bailer of water from the well, allow 2 minutes for the water level to settle.

Slug tests were performed on 22 September 2022 and the data presented in the first monitoring report.

2.2.2 Groundwater Quality Monitoring

The GAM outlines the parameters required for groundwater quality monitoring. The parameters monitored were metals, major ions, pH and electrical conductivity. Electrical conductivity (EC) and pH were measured on site using a calibrated and regularly serviced HORIBA U52 multiparameter water quality meter. The other parameters were analysed by Envirolab Pty Ltd.

At each monitoring bore the groundwater monitoring tasks were as follows:

- Collect groundwater using a low flow peristaltic pump system with the pump inlet placed within the screened section of the monitoring bore. Filter and acid-fix the sample on site for metals analysis.
- Measure pH and EC in a flow cell.

Six sets of groundwater monitoring samples were collected between September 2022 and March 2023. The dates of sample collection were as follows:

- 21-22/09/2022
- 25/10/2022
- 23/11/2022
- 25/01/2023
- 27/02/2023
- 28/03/2023

Samples were couriered in a chilled esky to Envirolab at the first possible opportunity after collection, typically on the day of collection.

2.2.3 Groundwater Level Monitoring

Groundwater level monitoring was undertaken using HOBO water level loggers, one in each monitoring bore set just above the bottom of the bore. Barometric pressure fluctuations were offset by readings from another HOBO located on site. The HOBOs were set to monitor groundwater level changes at 15-minute intervals and were checked monthly, with one exception. The dates of checks were the same as those listed for groundwater quality monitoring in **Section 2.2.2**.

Manual groundwater level measurements to the nearest centimetre are collected during each site visit using a Heron instruments Dipper T.

Water levels are reported to mAHD using the surveyed natural ground levels provided by Rise Projects Pty Ltd and manual measurements of monitoring well neck height and groundwater level collected during the site visits.

The total depths of the wells were measured during each of the site inspections.

3 Results and Discussion

3.1 Groundwater Level

The logged groundwater levels at each site are displayed in **Figures 1** to **3**. Summary statistics are displayed in **Table 3.2** and in **Figures 4** to **6**.

The logged levels at sites GW3 and GW7 show that the piezometers at these sites became dry as monitoring continued, first at GW3 in mid-November 2022 and then at GW7 in mid-January 2023.

Logged water levels (**Figures 1** to **3**) show a range of less than 2 m at all sites in response to the conditions experienced over the first six months of monitoring. There is significant fall in the groundwater level across the site, most notable between sites GW5 and GW7, in short higher at the south and lower at the north. There also appears to be a notable variability in the response of groundwater to wet and dry conditions across the site from east to west.

The results displayed in **Figures 1** to **3** show that groundwater levels respond differently to wet and dry weather across the site but that there are distinct patterns among some groups of sites. The sensitivity of the piezometers at GW1, GW2 and GW3 were very similar (**Figure 1**) as were those at GW6, GW7 and GW8 (**Figure 3**). The piezometers at GW4 and GW5 responded uniquely to wet and dry weather in the context of the site (**Figure 2**).

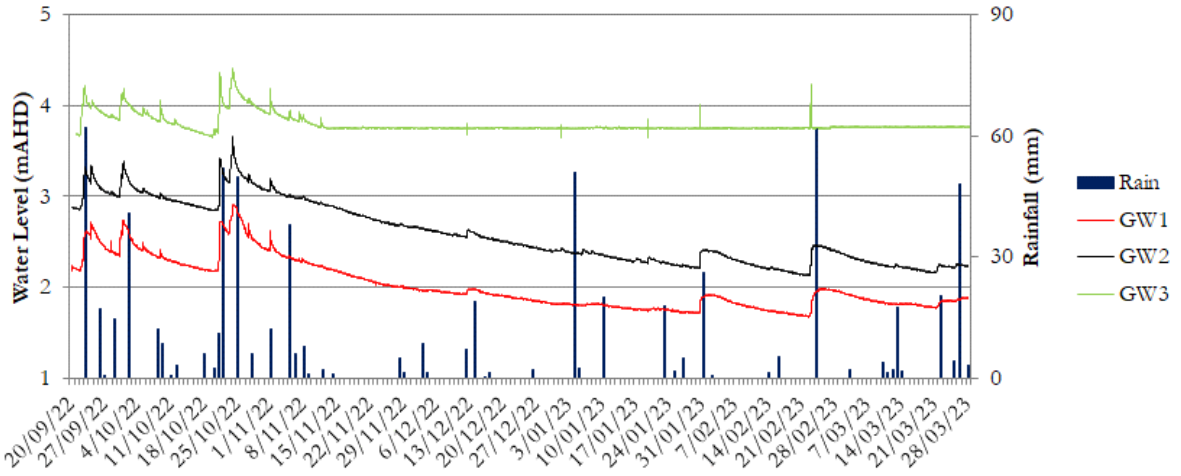

Figure 1 Groundwater levels from GW1, GW2 and GW3 plotted against rainfall

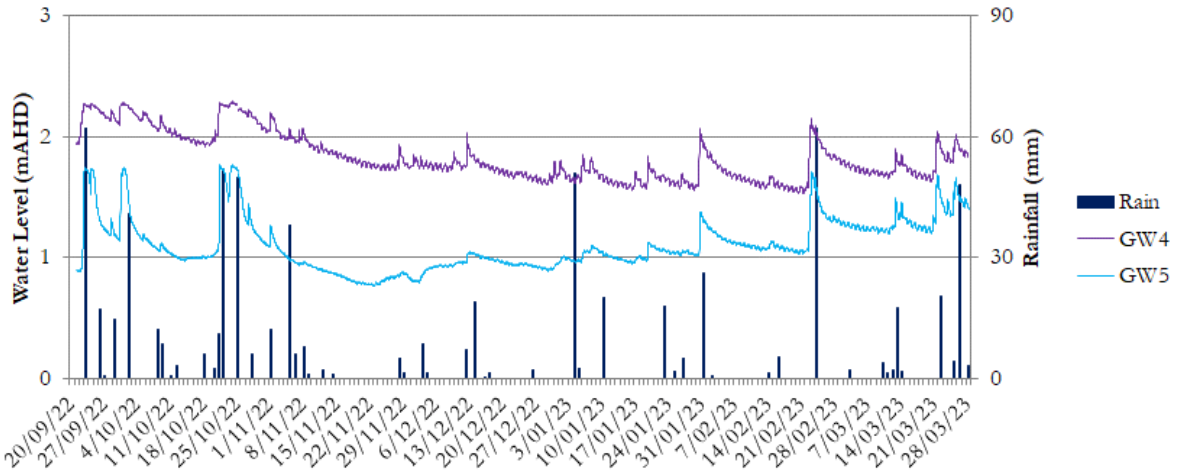

Figure 2 Groundwater levels from GW4 and GW5 plotted against rainfall

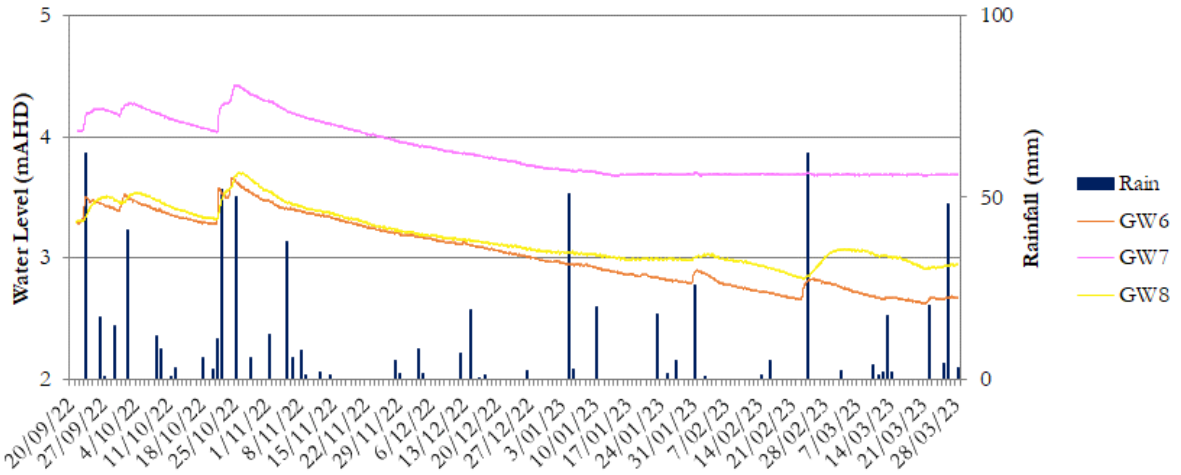

Figure 3 Groundwater levels from GW6, GW7 and GW8 plotted against rainfall

Table 3.1 Summary statistics from logged groundwater levels

Site	*Position (East)*	*Position (North)*	*Elevation (Ground, mAHD)*	*Average Level (mAHD)*	*Median Level (mAHD)*	*Max Level (mAHD)*	*Range (m)*
GW1	505570	6582508	2.79	2.02	1.93	2.92	1.24
GW2	505587	6582471	3.76	2.59	2.47	3.66	1.53
GW3	505642	6582420	5.52	3.80	3.76	4.42	0.77*
GW4	505686	6582518	1.98	1.83	1.77	2.29	0.77
GW5	505792	6582515	1.75	1.10	1.05	1.78	1.01
GW6	505795	6582445	4.55	3.06	3.03	3.67	1.05
GW7	505786	6582400	6.27	3.89	3.79	4.43	0.76*
GW8	505873	6582438	5.23	3.17	3.09	3.71	0.88

*** Not likely to represent total range, piezometer dry at lower levels**

The direction of fall in the groundwater levels across the site is clearly in a north south direction. Regression analysis using the maximum, mean and median water levels at each monitoring site

demonstrates this clearly . **Figures 4** through **6** show that the north south position of the site is the feature that most influences the maximum, mean and median groundwater levels.

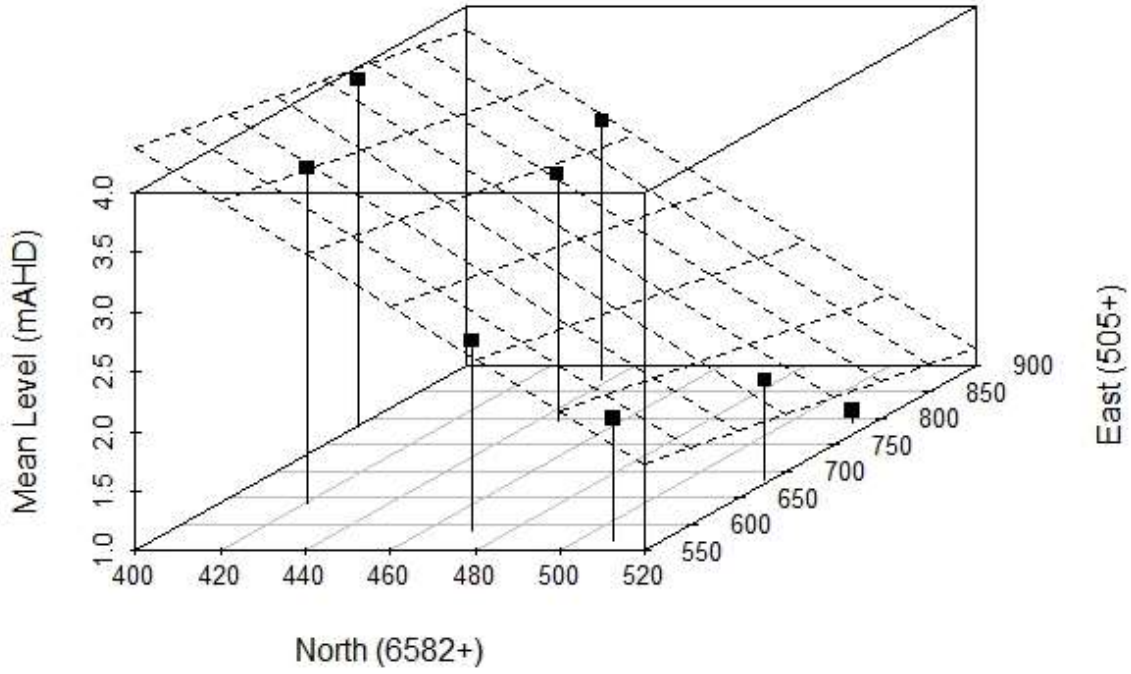

Figure 4 3D plot of mean water level against northern and eastern coordinates with a linear regression plane (Adjusted R^2 = 0.9448)

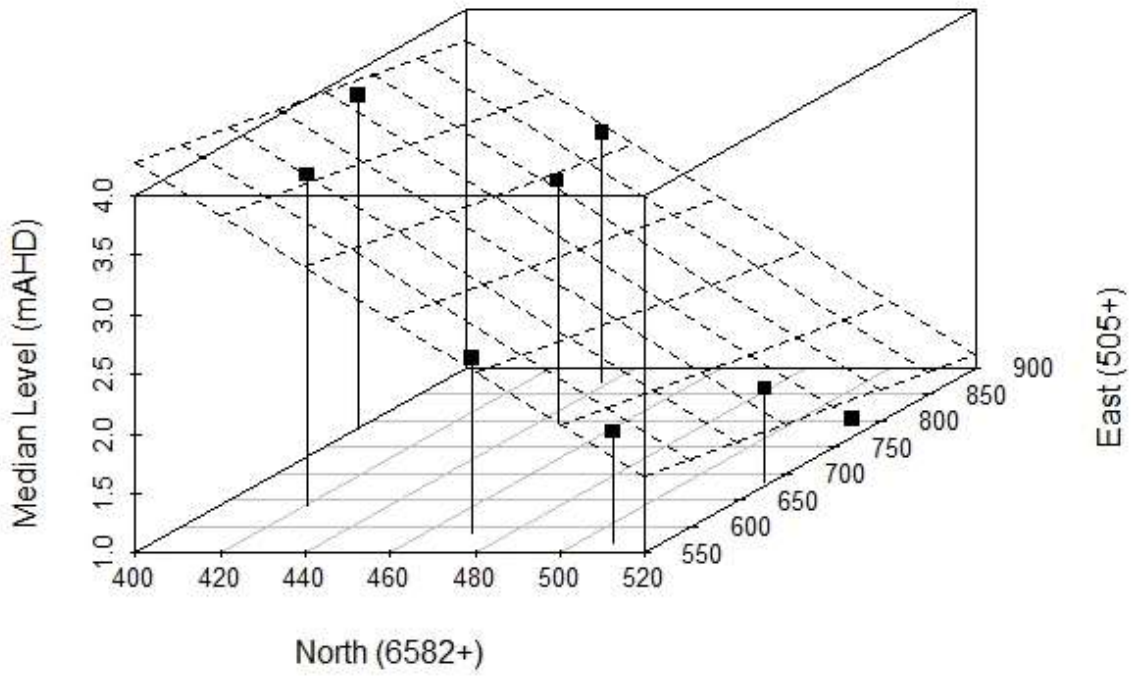

Figure 5 3D plot of median water level against northern and eastern coordinates with a linear regression plane (Adjusted R^2 = 0.9402)

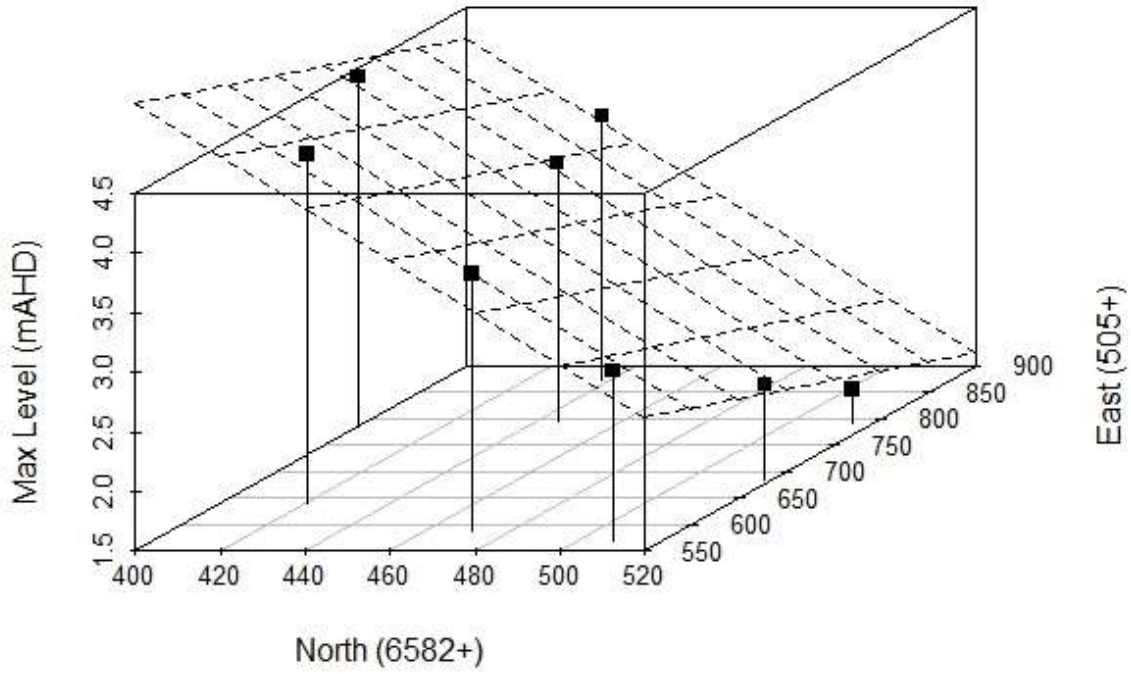

Figure 6 3D plot of maximum water level against northern and eastern coordinates with a linear regression plane (Adjusted R^2 = 0.9615)

The maximum groundwater level was the statistic that provided the most accurate linear regression plane (R^2 = 0.9615). This result is somewhat intuitive because the mean and median statistics from GW3 and GW7 are compromised by the lack of resolution when groundwater levels fell below the bottom of the piezometers at these two sites, which they did for much of the monitoring period. The maximum groundwater levels indicate that there is a small degree of fall from west to east in the groundwater levels across the site (approximately 1 m fall over 500 m) but still indicate that most of the fall is in the south to north direction (approximately 2.5 m fall over 120 m).

3.2 Groundwater Quality

Summary groundwater quality information is displayed in **Table 3.3**.

Table 3.2 Median groundwater quality results from all sites

Parameter	*Guidelines*		*Site*							
			GW1	*GW2*	*GW3*	*GW4*	*GW5*	*GW6*	*GW7*	*GW8*
	Freshwater ANZECC	*ADWG*	*Median*	*Median*	*Median*	*Median*	*Median*	*Median*	*Median*	*Median*
Number of Samples	-	-	6	6	1	6	6	6	2	6
Silver (µg/L)	0.5	100	1	1	1	1	1	1	1	1
Aluminium (µg/L)	55	200	**355**	**215**	**1400**	**270**	**420**	**1550**	**1285**	**1550**
Arsenic (V) (µg/L)	13	10	1	1	1	1	2	1	1	1
Cadmium (µg/L)	0.2	2	0.1	0.1	0.1	0.1	0.1	0.1	**0.25**	0.1
Chromium (VI) (µg/L)	1	50	1	1	1	1	1	1	1	1
Copper (µg/L)	1.4	2000	1	1	**4**	**2**	1	1	**4**	**2.5**
Iron (µg/L)	-	300	**360**	**655**	150	125	160	**920**	**1275**	**975**
Manganese (µg/L)	1900	500	52	50	5	5	5	8	12	5
Nickel (µg/L)	11	20	1	1	1	1	1	1	2	1
Lead (µg/L)	3.4	10	1	1	1	1	1	1	1	1
Selenium (µg/L)	5	10	1	1	1	1	1	1	1	1
Zinc (µg/L)	8	300	5	**9**	**11**	**18**	**18**	**12**	**55**	**18**
Mercury (µg/L)	0.05	1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calcium – Dissolved (mg/L)	-	-	8.3	4.5	2.0	6.3	0.5	3	2.3	2.5
Potassium – Dissolved (mg/L)	-	-	0.5	0.8	0.9	2.0	0.8	1	1.5	2
Sodium – Dissolved (mg/L)	-	180	7.9	6.7	14.0	11.9	9.4	12.5	9.6	13
Magnesium – Dissolved (mg/L)	-	-	2	1	1	2	1	3	3	2
Hydroxide Alkalinity (OH-) as CaCO3 (mg/L)	-	-	5	5	5	5	5	5	5	5
Bicarbonate Alkalinity as CaCO3 (mg/L)	-	-	25	14	38	30	7	5	5	6
Carbonate Alkalinity as CaCO3 (mg/L)	-	200	5	5	5	5	5	5	5	5
Total Alkalinity as CaCO3 (mg/L)	-	-	25	14	38	30	7	5	5	6
Sulphate, SO4 (mg/L)	-	250	4	3	2	4	2	1	7	2
Chloride, Cl (mg/L)	-	250	12	10	2	13	12	28	18	20
Ionic Balance	-	-	-3	-4	-9	1	0	10	5	12
Total Dissolved Solids (mg/L)	-	600	59	44	38	83	39	175	62	134
pH	6.5 – 8.0	6.5 – 8.5	**5.53**	**5.54**	-	**5.74**	**5.46**	**5.37**	**4.99**	**4.71**
Conductivity (mS/cm)	0.125 – 2.2	-	**0.102**	**0.073**	-	**0.089**	**0.062**	**0.119**	**0.077**	**0.106**

Results in **RED** exceed a guideline value

Several median results exceeded the relevant default guideline values. This included:

- All of the median dissolved aluminium, pH and electrical conductivity measurements.
- Median dissolved zinc concentrations at all sites except GW1.
- Median dissolved iron concentrations at all sites except GW3, GW4 and GW5.
- Median dissolved copper concentrations at GW3, GW4, GW7 and GW8.
- The median cadmium concentration at GW7.

These results are of interest but do not necessarily indicate a pollution event or an abnormality. Of the median results that exceeded the relevant default guidelines (results of interest), some are of little relevance. For example, the median copper concentrations at sites GW3, GW4, GW7 and GW8 and the median cadmium concentration at GW7 only slightly exceed the relevant ANZECC guideline concentration.

Box plots of these parameters (**Figures 7 - 12**) indicate that, in general, but with some minor exceptions, dissolved metals concentrations increased across the site in an east to west direction and pH decreased across the site in an east to west direction. This basic trend indicates that pH may be the key factor driving metals concentrations on site, as the solubility of most metals in water increases in relation to decreasing pH.

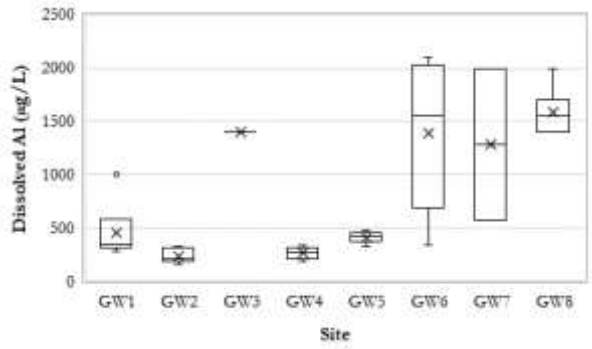

Figure 7 Box plots of dissolved aluminium at all sites

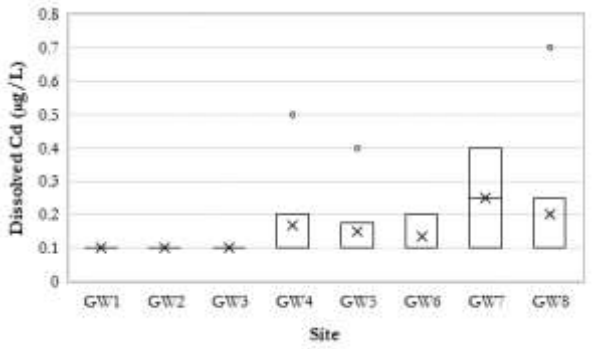

Figure 8 Box plots of dissolved cadmium at all sites

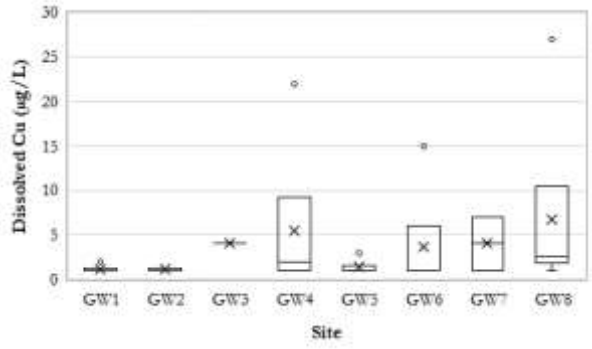

Figure 9 Box plots of dissolved copper at all sites

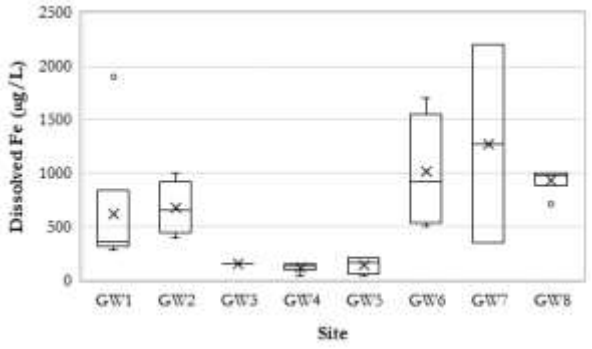

Figure 10 Box plots of dissolved iron at all sites

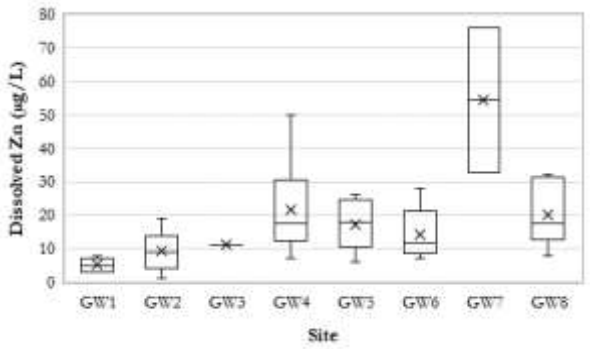

Figure 11 Box plots of dissolved zinc at all sites

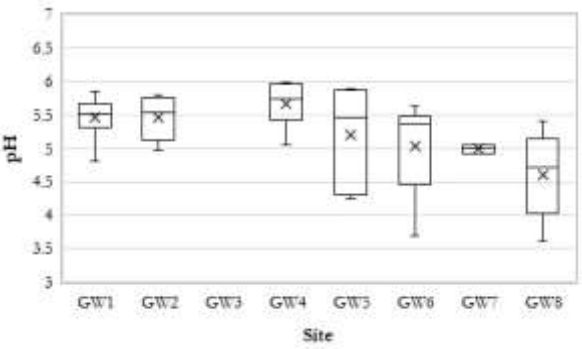

Figure 12 Box plots of pH at all sites

The low pH and conductivity results from across the site are likely to result from natural features associated with the biogeography of the site and surrounds. This is also the case with the elevated iron and aluminium concentrations from many of the sites. All of these results are likely to result from shallow potential acid sulfate soils under and around the site (**Illustration 3.1**).

Imagery: NSW Dept Customer Service. Data: NSW DFSI Spatial Services, ASM

Illustration 3.1 Acid sulfate soil risk in the study area

Pearson's correlation analysis of the collected results was undertaken to assess the potential for relationships (such as those between pH and dissolved metals) between the various parameters. The results of the correlation analysis are displayed in **Table 3.4**.

Table 3.3 Pearson's correlation coefficients (r) for all water quality parameters

Variable	*As*	*Cd*	*Cr*	*Cu*	*Fe*	*Mn*	*Ni*	*Zn*	*pH*	*Ca*	*K*	*Na*	*Mg*	*Alkalinity*	*SO4*	*Cl*	*Ionic Balance*	*TDS*	*EC*
Al	-0.23	0.35	0	0.07	0.75	-0.34	0.07	0.38	-0.32	-0.39	0.42	0.48	0.69	-0.49	0.11	0.75	0.56	0.53	0.24
As		-0.14	0.1	-0.01	-0.26	-0.06	-0.11	-0.01	0.16	-0.1	-0.14	0	-0.09	-0.03	0.24	-0.19	-0.12	-0.09	-0.03
Cd			-0.14	-0.13	0.17	-0.2	0.4	0.3	0.1	-0.2	0.23	0.32	0.12	0	0.07	0.16	0.02	-0.08	-0.23
Cr				0.24	0.23	0.01	-0.09	0.02	0.14	0.28	-0.01	0.1	0.19	0.39	0.02	-0.14	-0.09	-0.07	0.12
Cu					-0.02	-0.2	-0.01	0.12	-0.23	0	0.4	0.44	0.12	0.08	-0.03	0.23	0.18	0.12	0.35
Fe						0.02	0.21	0.29	-0.19	-0.16	0.17	0.14	0.61	-0.31	0.09	0.48	0.37	0.38	0.05
Mn							0.08	-0.35	0.17	0.56	-0.47	-0.53	-0.31	0.31	0.05	-0.36	-0.37	-0.16	-0.06
Ni								0.21	0.2	0.02	0.18	0.12	0.02	0.18	0.12	-0.03	-0.2	-0.06	-0.12
Zn									-0.12	-0.21	0.48	0.37	0.37	-0.1	0.47	0.27	0.11	0.17	0.18
pH										0.31	-0.04	-0.24	-0.11	0.39	0.3	-0.32	-0.61	-0.13	-0.1
Ca											0.02	-0.09	-0.02	0.85	0.2	-0.34	-0.19	0.07	0.42
K												0.67	0.4	0.09	0.4	0.47	0.26	0.54	0.52
Na													0.61	0.09	0.2	0.64	0.47	0.63	0.63
Mg														-0.12	0.35	0.78	0.44	0.71	0.57
Alkalinity															0.13	-0.45	-0.35	-0.1	0.31
SO4																0.12	-0.16	0.33	0.23
Cl																	0.45	0.75	0.54
Ionic Balance																		0.46	0.25
TDS																			0.71

Most variables showed little ($|r| < 0.3$) or weak ($0.3 < |r| < 0.5$) linear associations. Seventeen paired variables showed moderate ($0.5 < |r| < 0.7$) linear associations, and a five showed strong ($|r| > 0.7$) linear associations. Those showing moderate or strong linear associations were

- Calcium ions and magnesium ions (mod).
- Sodium ions and dissolved manganese (mod) and potassium ions (mod).
- Magnesium ions and dissolved aluminium (mod), dissolved iron (mod) and sodium ions (mod).
- Alkalinity and calcium ions (str).
- Chloride ions and dissolved aluminium (mod), sodium ions (mod) and magnesium ions (str).
- Ionic balance and dissolved aluminium (mod) and pH (mod).
- TDS and dissolved aluminium (mod), potassium ions (mod), sodium ions (mod), magnesium ions (str) and chloride ions (str).
- Electrical conductivity and potassium ions (mod), sodium ions (mod), magnesium ions (mod), chloride ions (mod) and TDS (str).

Many of the linear associations detected result from basic water chemistry, such as the associations between ions and measures of salinity (EC and/or TDS). The indications of a relationship between pH and dissolved metals were not supported by the results of the correlation analysis.

Scatterplot matrices showing the distributions pf key related variables and the metals that exceeded default guideline values are presented in **Figures 13** to **16**.

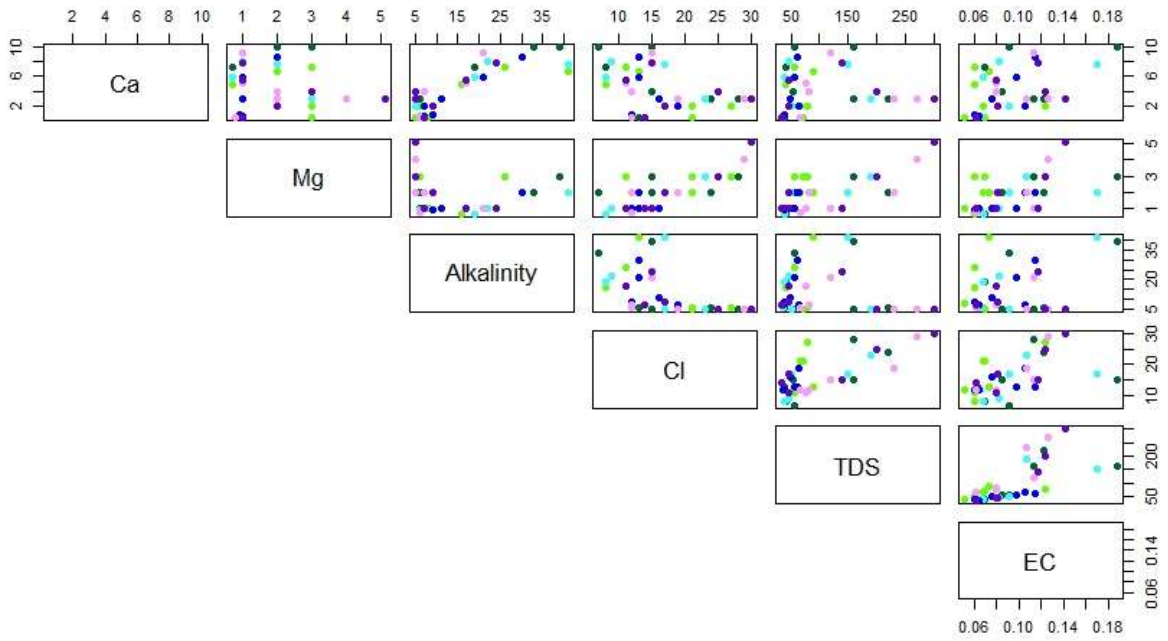

Figure 13 Scatterplot matrix of related ion concentrations presented by date collected

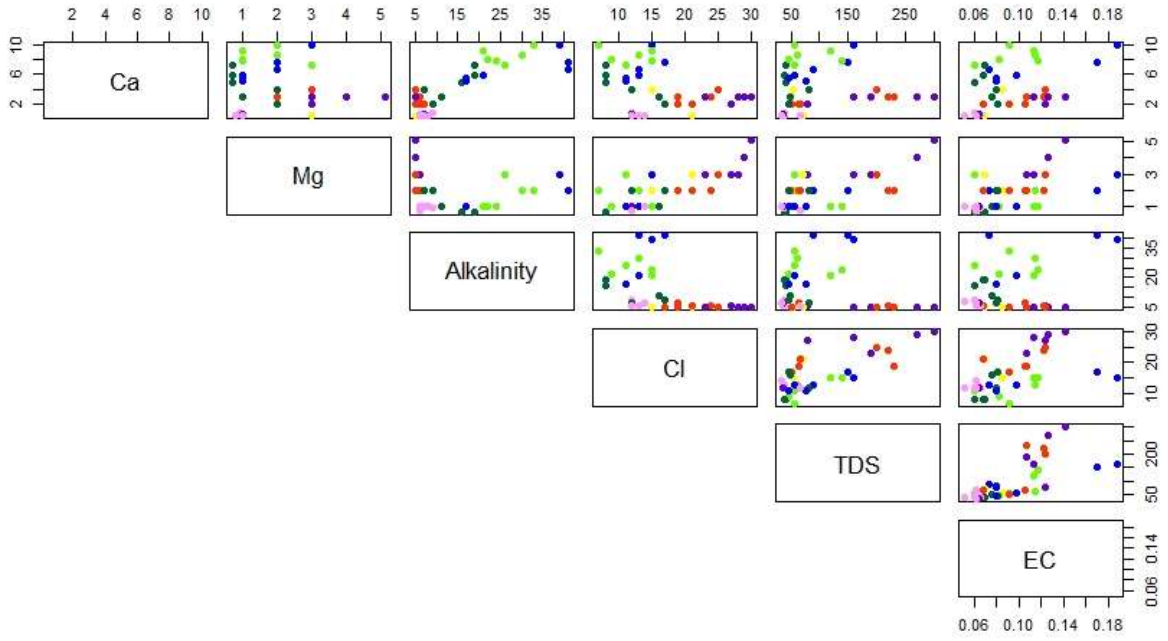

Figure 14 Scatterplot matrix of ion concentrations presented by site collected

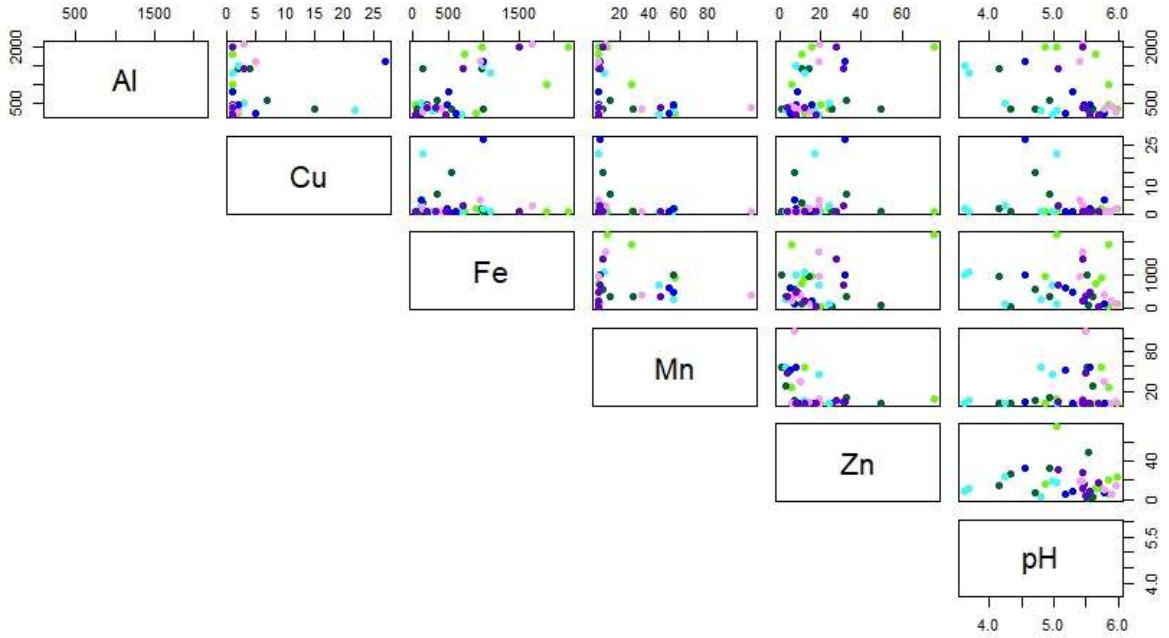

Figure 15 Scatterplot matrix of key dissolved metals concentrations presented by date collected

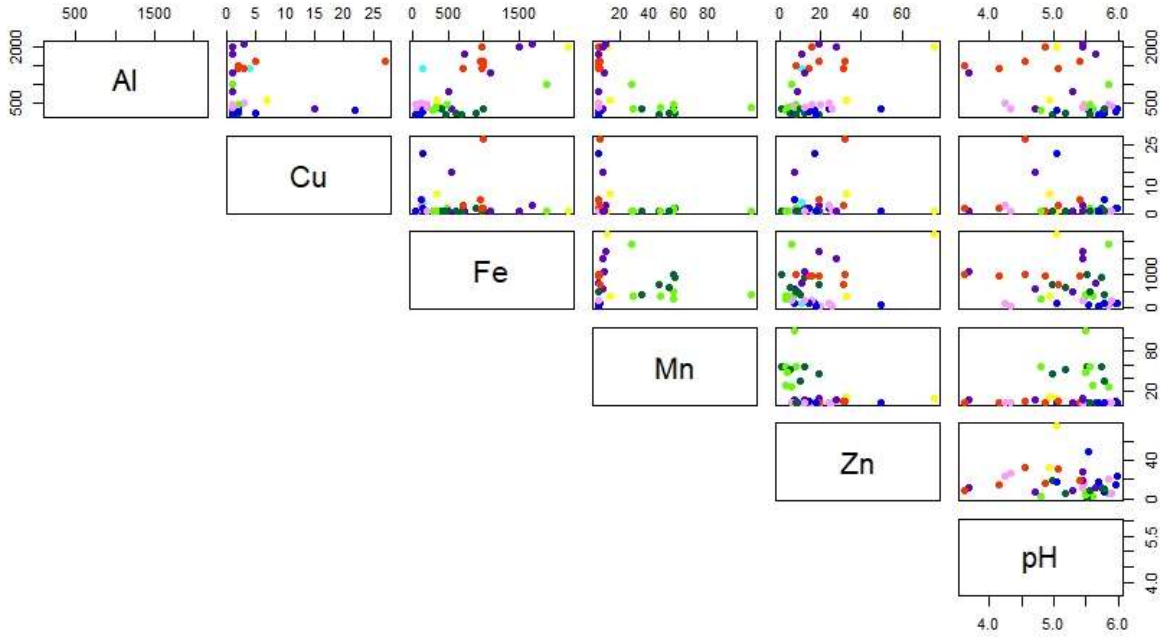

Figure 16 Scatterplot matrix of key dissolved metals concentrations presented by site collected

The scatterplot matrices presented in **Figures 13** to **16** indicate that, in general, much of the variation in the major ions dataset is explained by site. Although TDS and EC showed a tendency to group by date collected, the major ions did not appear to group by date collected in any sense. On the other hand, there is apparent grouping by site in the case of all the major ions displayed. The dissolved metals concentrations show a similar but more definite trend, with little grouping by date collected displayed. The conclusion arising from this observation is that groundwater quality in the study area is more likely to be influenced by site than by weather conditions or season.

3.3 Slug Tests

Slug tests were performed in all wells. However, the water levels in GW3 and GW7 were so close to the bottom of the wells that the slug test results are erroneous. Graphs of all other tests are presented in **Figures 17** to **22**. The graphs show a rapid response of the groundwater levels in all wells, indicating very high hydraulic conductivity of the soils throughout the site. In general, the hydraulic conductivity reduces slightly at the more westward sites.

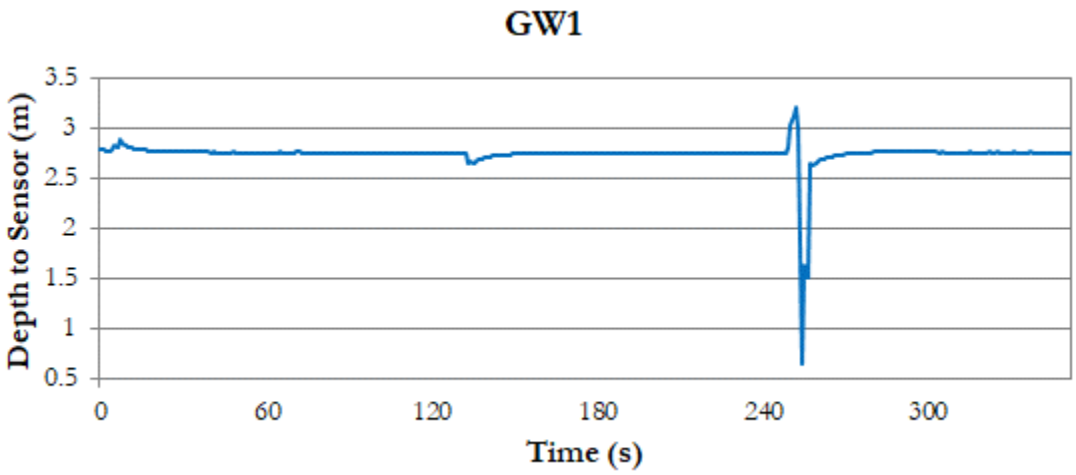

Figure 17 Slug test results from GW1

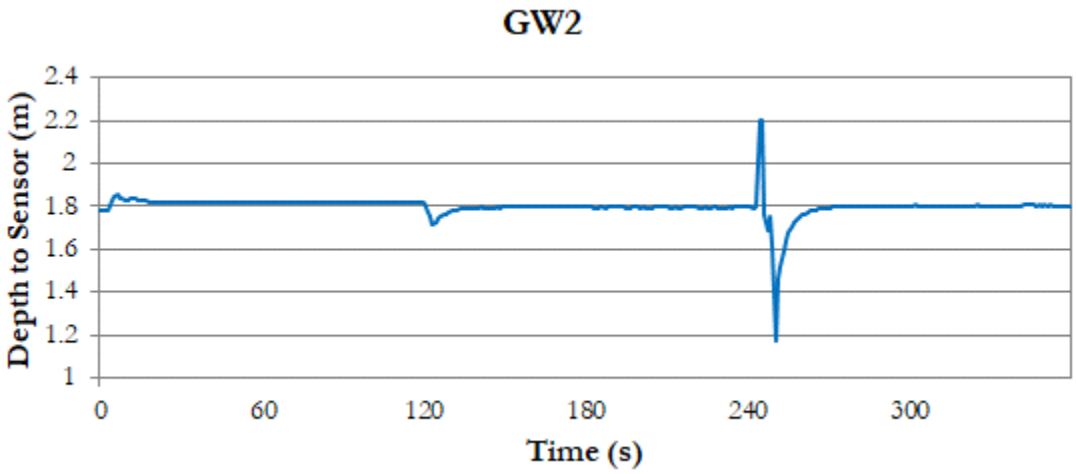

Figure 18 Slug test results from GW2

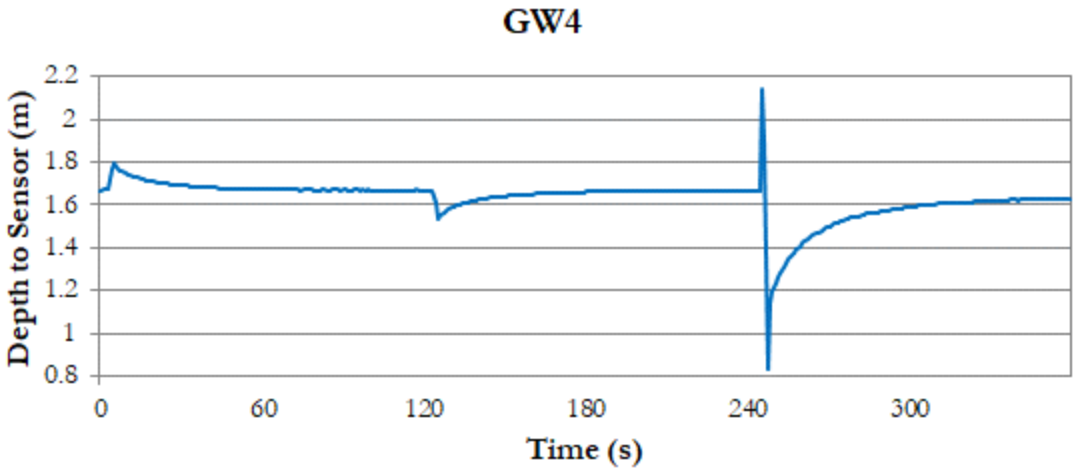

Figure 19 Slug test results from GW4

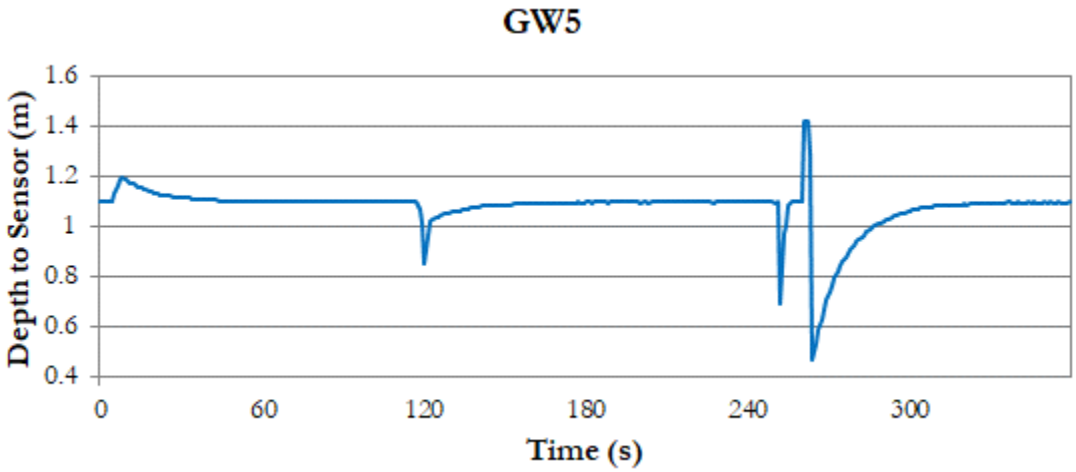

Figure 20 Slug test results from GW5

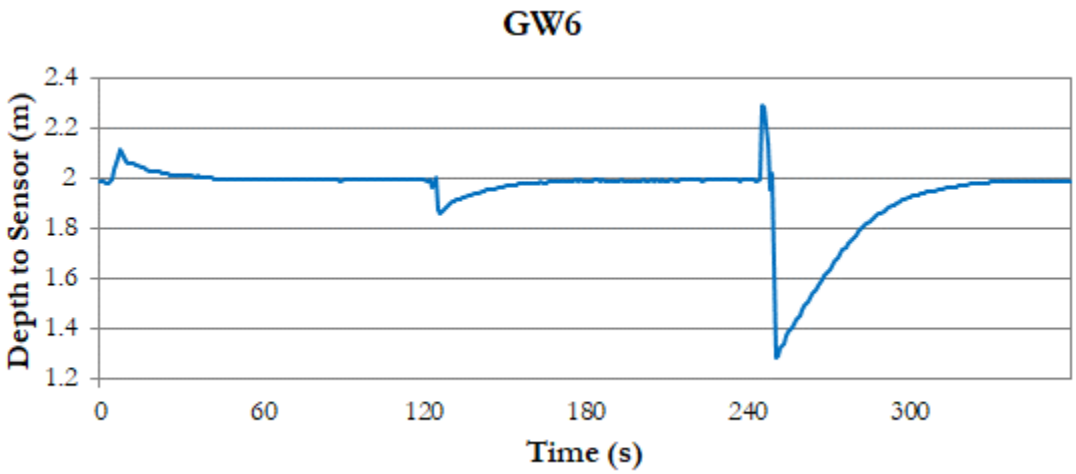

Figure 21 Slug test results from GW6

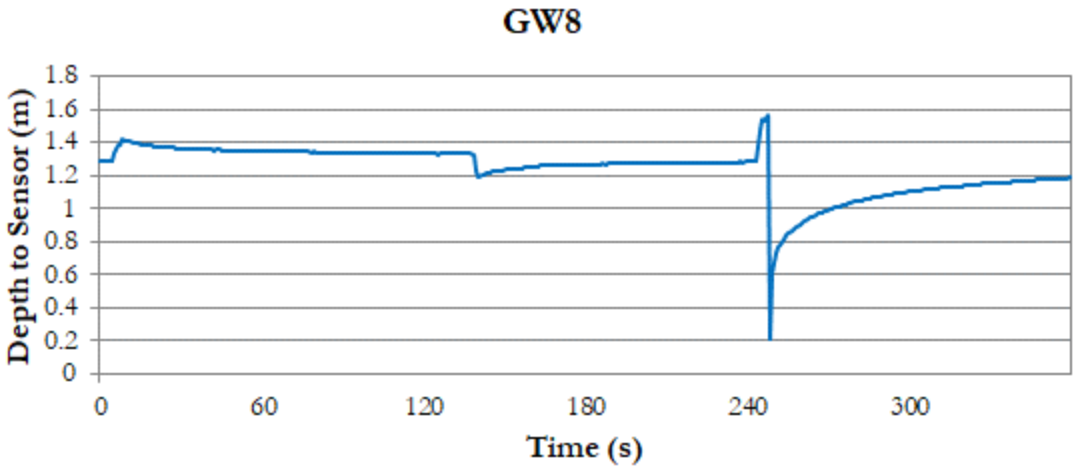

Figure 22 Slug test results from GW8

Hydraulic conductivity (K) and transmissivity (T) were estimated using the Bauwer and Rice method applied to the rising head slug tests from the bailed water part of the tests only. The Bauwer and Rice method was applied to the data using the spreadsheet and assumptions from the US Geological Survey (Halford and Kuniansky 2002). The results are presented in **Table 3.4**.

Table 3.4 Hydraulic conductivity (K) and transmissivity (T) for each site

Site	***K (m/s)***	***T(m2/s)***	***t 90% recovery(s)***
GW1	Error	Error	Error
GW2	0.000073	0.000071	10
GW3	N/A	N/A	N/A
GW4	0.000027	0.000020	47
GW5	0.000024	0.000023	30
GW6	0.000018	0.000016	40
GW7	N/A	N/A	N/A
GW8	0.000012	0.000008	78

4 Conclusions

Monitoring of the groundwater at the Phillip Drive site was undertaken according to the requirements of the GAM. This is the final monitoring report and presents all six months of groundwater level and groundwater quality measurements in addition to the results of slug tests.

The data presented provides an indication of significant short-term variability in groundwater level and quality. The data also provides an indication of some spatial variability in hydraulic conductivity, groundwater levels and groundwater quality across the site. Groundwater levels decreased fairly consistently across the site in a mostly south to north direction. Hydraulic conductivity, which was very high towards the eastern end of the site, tended to reduce somewhat inconsistently in a westerly direction. Groundwater quality appears to be influenced more by location than by weather or season, although at most sites there was some variability within the parameters measured. Although median concentrations of some of the parameters were above relevant default guideline values there is no evidence of groundwater pollution among the parameters measured. High measurements are considered likely to result from the natural biogeographical features of the site and surrounds.

References

Australasian Groundwater and Environmental Consultants Pty Ltd (2021) Proposed development at Lot 2 Phillip Drive, South West Rocks – Groundwater Assessment Methodology. Memo to Rise Projects Pty Ltd dated 8 March 2021

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

Halford, K. & Kuniansky, E. (2002) *Documentation of Spreadsheets for the Analysis of Aquifer-Test and Slug-Test Data*. US Geological Survey, Carson City.

NHMRC (2011) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy.* National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

Appendix A

Lab Reports

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CERTIFICATE OF ANALYSIS 306649

Client Details

Client	Aquatic Science and Management
Attention	Mathew Birch
Address	PO Box 214, Bellingen, NSW, 2454

Sample Details

Your Reference	**Phillip Drive Groundwater**
Number of Samples	7 Water
Date samples received	27/09/2022
Date completed instructions received	27/09/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	05/10/2022
Date of Issue	05/10/2022

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Results Approved By
Giovanni Agosti, Group Technical Manager
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

HM in water - dissolved						
Our Reference		306649-1	306649-2	306649-3	306649-4	306649-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Date Sampled		21/09/2022	21/09/2022	21/09/2022	21/09/2022	21/09/2022
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/09/2022	28/09/2022	28/09/2022	28/09/2022	28/09/2022
Date analysed	-	28/09/2022	28/09/2022	28/09/2022	28/09/2022	28/09/2022
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Aluminium-Dissolved	µg/L	1,000	210	310	440	1,800
Arsenic-Dissolved	µg/L	<1	<1	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	0.5	0.4	0.2
Chromium-Dissolved	µg/L	4	<1	1	<1	1
Copper-Dissolved	µg/L	1	2	2	<1	<1
Iron-Dissolved	µg/L	1,900	900	130	40	740
Manganese-Dissolved	µg/L	28	57	<5	<5	<5
Nickel-Dissolved	µg/L	<1	6	4	<1	2
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	6	12	24	20	11
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05

HM in water - dissolved			
Our Reference		306649-6	306649-7
Your Reference	UNITS	GW7	GW8
Date Sampled		21/09/2022	21/09/2022
Type of sample		Water	Water
Date prepared	-	28/09/2022	28/09/2022
Date analysed	-	28/09/2022	28/09/2022
Silver-Dissolved	µg/L	<1	<1
Aluminium-Dissolved	µg/L	2,000	2,000
Arsenic-Dissolved	µg/L	<1	<1
Cadmium-Dissolved	µg/L	0.4	0.7
Chromium-Dissolved	µg/L	1	1
Copper-Dissolved	µg/L	<1	<1
Iron-Dissolved	µg/L	2,200	970
Manganese-Dissolved	µg/L	11	<5
Nickel-Dissolved	µg/L	3	2
Lead-Dissolved	µg/L	<1	<1
Selenium-Dissolved	µg/L	<1	<1
Zinc-Dissolved	µg/L	76	16
Mercury-Dissolved	µg/L	<0.05	<0.05

Ion Balance						
Our Reference		306649-1	306649-2	306649-3	306649-4	306649-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Date Sampled		21/09/2022	21/09/2022	21/09/2022	21/09/2022	21/09/2022
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/09/2022	28/09/2022	28/09/2022	28/09/2022	28/09/2022
Date analysed	-	28/09/2022	28/09/2022	28/09/2022	28/09/2022	28/09/2022
Calcium - Dissolved	mg/L	7.2	5	6.6	<0.5	2
Potassium - Dissolved	mg/L	0.6	0.9	2	0.6	0.9
Sodium - Dissolved	mg/L	7.9	5.4	17	9.1	11
Magnesium - Dissolved	mg/L	3	0.7	2	1	3
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	26	16	41	8	6
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	26	16	41	8	6
Sulphate, SO4	mg/L	4	3	9	3	<1
Chloride, Cl	mg/L	11	8	13	12	27
Ionic Balance	%	1.0	-6.0	-5.0	-5.0	-4.0

Ion Balance			
Our Reference		306649-6	306649-7
Your Reference	UNITS	GW7	GW8
Date Sampled		21/09/2022	21/09/2022
Type of sample		Water	Water
Date prepared	-	28/09/2022	28/09/2022
Date analysed	-	28/09/2022	28/09/2022
Calcium - Dissolved	mg/L	0.6	2
Potassium - Dissolved	mg/L	2	2
Sodium - Dissolved	mg/L	10	14
Magnesium - Dissolved	mg/L	3	2
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	<5	6
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	<5	6
Sulphate, SO4	mg/L	8	1
Chloride, Cl	mg/L	21	21
Ionic Balance	%	0	13

Miscellaneous Inorganics						
Our Reference		306649-1	306649-2	306649-3	306649-4	306649-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Date Sampled		21/09/2022	21/09/2022	21/09/2022	21/09/2022	21/09/2022
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/09/2022	28/09/2022	28/09/2022	28/09/2022	28/09/2022
Date analysed	-	28/09/2022	28/09/2022	28/09/2022	28/09/2022	28/09/2022
Total Dissolved Solids (grav)	mg/L	57	40	89	39	79

Miscellaneous Inorganics			
Our Reference		306649-6	306649-7
Your Reference	UNITS	GW7	GW8
Date Sampled		21/09/2022	21/09/2022
Type of sample		Water	Water
Date prepared	-	28/09/2022	28/09/2022
Date analysed	-	28/09/2022	28/09/2022
Total Dissolved Solids (grav)	mg/L	70	67

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	306649-2
Date prepared	-			28/09/2022	1	28/09/2022	28/09/2022		28/09/2022	28/09/2022
Date analysed	-			28/09/2022	1	28/09/2022	28/09/2022		28/09/2022	28/09/2022
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	89	[NT]
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	1000	1000	0	110	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	98	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	97	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	4	5	22	97	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	1	<1	0	95	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	1	1900	1900	0	97	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	28	29	4	97	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	1	0	96	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	91	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	95	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	6	6	0	98	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	109	118

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	306649-2
Date prepared	-			28/09/2022	1	28/09/2022	28/09/2022		28/09/2022	28/09/2022
Date analysed	-			28/09/2022	1	28/09/2022	28/09/2022		28/09/2022	28/09/2022
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	7.2	7.2	0	92	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	0.6	0.6	0	92	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	7.9	7.9	0	97	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	3	3	0	94	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	26	24	8	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	26	24	8	109	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	4	4	0	83	81
Chloride, Cl	mg/L	1	Inorg-081	<1	1	11	11	0	94	95
Ionic Balance	%		Inorg-040	[NT]	1	1.0	2.0	67	[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date prepared	-			28/09/2022	1	28/09/2022	28/09/2022		28/09/2022	[NT]
Date analysed	-			28/09/2022	1	28/09/2022	28/09/2022		28/09/2022	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	1	57	57	0	100	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

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CERTIFICATE OF ANALYSIS 309095

Client Details

Client	Aquatic Science and Management
Attention	Mathew Birch
Address	PO Box 214, Bellingen, NSW, 2454

Sample Details

Your Reference	**Phillip Drive Groundwater**
Number of Samples	8 Water
Date samples received	27/10/2022
Date completed instructions received	27/10/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	03/11/2022
Date of Issue	03/11/2022

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Results Approved By
Diego Bigolin, Inorganics Supervisor
Giovanni Agosti, Group Technical Manager

Authorised By

Nancy Zhang, Laboratory Manager

HM in water - dissolved						
Our Reference		309095-1	309095-2	309095-3	309095-4	309095-5
Your Reference	UNITS	GW1	GW2	GW3	GW4	GW5
Date Sampled		25/10/2022	25/10/2022	25/10/2022	25/10/2022	25/10/2022
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	31/10/2022	31/10/2022	31/10/2022	31/10/2022	31/10/2022
Date analysed	-	31/10/2022	31/10/2022	31/10/2022	31/10/2022	31/10/2022
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Aluminium-Dissolved	µg/L	320	310	1,400	340	330
Arsenic-Dissolved	µg/L	<1	<1	<1	2	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	1	2	1
Copper-Dissolved	µg/L	<1	<1	4	1	1
Iron-Dissolved	µg/L	330	1,000	150	110	60
Manganese-Dissolved	µg/L	29	56	<5	<5	<5
Nickel-Dissolved	µg/L	<1	1	<1	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	3	1	11	50	26
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05

HM in water - dissolved				
Our Reference		309095-6	309095-7	309095-8
Your Reference	UNITS	GW6	GW7	GW8
Date Sampled		25/10/2022	25/10/2022	25/10/2022
Type of sample		Water	Water	Water
Date prepared	-	31/10/2022	31/10/2022	31/10/2022
Date analysed	-	31/10/2022	31/10/2022	31/10/2022
Silver-Dissolved	µg/L	<1	<1	<1
Aluminium-Dissolved	µg/L	340	570	1,400
Arsenic-Dissolved	µg/L	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	1
Copper-Dissolved	µg/L	15	7	2
Iron-Dissolved	µg/L	550	350	980
Manganese-Dissolved	µg/L	8	13	<5
Nickel-Dissolved	µg/L	<1	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1
Zinc-Dissolved	µg/L	7	33	14
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05

Ion Balance						
Our Reference		309095-1	309095-2	309095-3	309095-4	309095-5
Your Reference	UNITS	GW1	GW2	GW3	GW4	GW5
Date Sampled		25/10/2022	25/10/2022	25/10/2022	25/10/2022	25/10/2022
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	27/10/2022	27/10/2022	27/10/2022	27/10/2022	27/10/2022
Date analysed	-	27/10/2022	27/10/2022	27/10/2022	27/10/2022	27/10/2022
Calcium - Dissolved	mg/L	10	7.3	2	10	0.5
Potassium - Dissolved	mg/L	<0.5	0.8	0.9	2	<0.5
Sodium - Dissolved	mg/L	8.2	5.8	14	16	9.9
Magnesium - Dissolved	mg/L	2	0.7	<0.5	3	1
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	33	19	38	39	6
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	33	19	38	39	6
Sulphate, SO4	mg/L	<1	2	2	6	<1
Chloride, Cl	mg/L	7	8	2	15	13
Ionic Balance	%	9.0	4.0	-9.0	5.0	7.0

Ion Balance				
Our Reference		309095-6	309095-7	309095-8
Your Reference	UNITS	GW6	GW7	GW8
Date Sampled		25/10/2022	25/10/2022	25/10/2022
Type of sample		Water	Water	Water
Date prepared	-	27/10/2022	27/10/2022	27/10/2022
Date analysed	-	27/10/2022	27/10/2022	27/10/2022
Calcium - Dissolved	mg/L	3	4	3
Potassium - Dissolved	mg/L	1	1	2
Sodium - Dissolved	mg/L	13	9.2	13
Magnesium - Dissolved	mg/L	3	2	2
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	<5	5	6
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	<5	5	6
Sulphate, SO4	mg/L	<1	6	<1
Chloride, Cl	mg/L	28	15	24
Ionic Balance	%	12	9.0	11

Miscellaneous Inorganics						
Our Reference		309095-1	309095-2	309095-3	309095-4	309095-5
Your Reference	UNITS	GW1	GW2	GW3	GW4	GW5
Date Sampled		25/10/2022	25/10/2022	25/10/2022	25/10/2022	25/10/2022
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	02/11/2022	02/11/2022	02/11/2022	02/11/2022	02/11/2022
Date analysed	-	02/11/2022	02/11/2022	02/11/2022	02/11/2022	02/11/2022
Total Dissolved Solids (grav)	mg/L	55	42	38	160	39

Miscellaneous Inorganics				
Our Reference		309095-6	309095-7	309095-8
Your Reference	UNITS	GW6	GW7	GW8
Date Sampled		25/10/2022	25/10/2022	25/10/2022
Type of sample		Water	Water	Water
Date prepared	-	02/11/2022	27/10/2022	27/10/2022
Date analysed	-	02/11/2022	27/10/2022	02/11/2022
Total Dissolved Solids (grav)	mg/L	160	54	220

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date prepared	-			31/10/2022	1	31/10/2022	31/10/2022		31/10/2022	[NT]
Date analysed	-			31/10/2022	1	31/10/2022	31/10/2022		31/10/2022	[NT]
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	107	[NT]
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	320	320	0	93	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	95	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	97	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	94	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	96	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	1	330	320	3	93	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	29	28	4	93	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	94	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	102	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	99	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	3	3	0	95	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	[NT]		105	[NT]

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	7	31/10/2022	31/10/2022		[NT]	[NT]
Date analysed	-			[NT]	7	31/10/2022	31/10/2022		[NT]	[NT]
Silver-Dissolved	µg/L	1	Metals-022	[NT]	7	<1	[NT]		[NT]	[NT]
Aluminium-Dissolved	µg/L	10	Metals-022	[NT]	7	570	[NT]		[NT]	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	[NT]	7	<1	[NT]		[NT]	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	[NT]	7	<0.1	[NT]		[NT]	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	[NT]	7	<1	[NT]		[NT]	[NT]
Copper-Dissolved	µg/L	1	Metals-022	[NT]	7	7	[NT]		[NT]	[NT]
Iron-Dissolved	µg/L	10	Metals-022	[NT]	7	350	[NT]		[NT]	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	[NT]	7	13	[NT]		[NT]	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	[NT]	7	<1	[NT]		[NT]	[NT]
Lead-Dissolved	µg/L	1	Metals-022	[NT]	7	<1	[NT]		[NT]	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	[NT]	7	<1	[NT]		[NT]	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	[NT]	7	33	[NT]		[NT]	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	[NT]	7	<0.05	<0.05	0	[NT]	[NT]

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	309095-2
Date prepared	-			27/10/2022	1	27/10/2022	27/10/2022		27/10/2022	27/10/2022
Date analysed	-			27/10/2022	1	27/10/2022	27/10/2022		27/10/2022	27/10/2022
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	10	10	0	103	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	<0.5	<0.5	0	99	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	8.2	8.0	2	105	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	2	2	0	105	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	33	31	6	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	33	31	6	104	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	<1	2	67	97	95
Chloride, Cl	mg/L	1	Inorg-081	<1	1	7	7	0	102	94
Ionic Balance	%		Inorg-040	[NT]	1	9.0	8.0	12	[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			02/11/2022	[NT]	[NT]	[NT]	[NT]	02/11/2022	[NT]
Date analysed	-			02/11/2022	[NT]	[NT]	[NT]	[NT]	02/11/2022	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	[NT]	[NT]	[NT]	[NT]	92	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

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CERTIFICATE OF ANALYSIS 311632

Client Details

Client	Aquatic Science and Management
Attention	Mathew Birch
Address	PO Box 214, Bellingen, NSW, 2454

Sample Details

Your Reference	**Phillip Drive Groundwater**
Number of Samples	6 Water
Date samples received	25/11/2022
Date completed instructions received	25/11/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	02/12/2022
Date of Issue	01/12/2022

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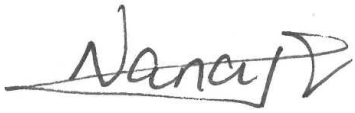
Results Approved By
Diego Bigolin, Inorganics Supervisor
Giovanni Agosti, Group Technical Manager

Authorised By



Nancy Zhang, Laboratory Manager

HM in water - dissolved						
Our Reference		311632-1	311632-2	311632-3	311632-4	311632-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/11/2022	28/11/2022	28/11/2022	28/11/2022	28/11/2022
Date analysed	-	28/11/2022	28/11/2022	28/11/2022	28/11/2022	28/11/2022
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Aluminium-Dissolved	µg/L	280	160	290	480	1,300
Arsenic-Dissolved	µg/L	<1	<1	2	2	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	0.1	<0.1
Chromium-Dissolved	µg/L	1	<1	2	1	1
Copper-Dissolved	µg/L	<1	<1	22	3	<1
Iron-Dissolved	µg/L	280	690	150	120	1,100
Manganese-Dissolved	µg/L	56	47	<5	<5	9
Nickel-Dissolved	µg/L	<1	1	2	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	3	19	17	24	12
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05

HM in water - dissolved		
Our Reference		311632-6
Your Reference	UNITS	GW8
Type of sample		Water
Date prepared	-	28/11/2022
Date analysed	-	28/11/2022
Silver-Dissolved	µg/L	<1
Aluminium-Dissolved	µg/L	1,500
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	1
Copper-Dissolved	µg/L	2
Iron-Dissolved	µg/L	1,000
Manganese-Dissolved	µg/L	<5
Nickel-Dissolved	µg/L	<1
Lead-Dissolved	µg/L	<1
Selenium-Dissolved	µg/L	<1
Zinc-Dissolved	µg/L	8
Mercury-Dissolved	µg/L	<0.05

Ion Balance						
Our Reference		311632-1	311632-2	311632-3	311632-4	311632-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	25/11/2022	25/11/2022	25/11/2022	25/11/2022	25/11/2022
Date analysed	-	25/11/2022	25/11/2022	25/11/2022	25/11/2022	25/11/2022
Calcium - Dissolved	mg/L	8.0	5.9	7.7	0.7	3
Potassium - Dissolved	mg/L	<0.5	0.7	3	1	1
Sodium - Dissolved	mg/L	5.3	5.1	19	9.9	12
Magnesium - Dissolved	mg/L	1	0.7	2	0.9	3
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	22	19	41	6	5
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	22	19	41	6	5
Sulphate, SO4	mg/L	4	2	4	3	<1
Chloride, Cl	mg/L	9	8	17	12	23
Ionic Balance	%	-2.0	-4.0	1.0	5.0	12

Ion Balance		
Our Reference		311632-6
Your Reference	UNITS	GW8
Type of sample		Water
Date prepared	-	25/11/2022
Date analysed	-	25/11/2022
Calcium - Dissolved	mg/L	2
Potassium - Dissolved	mg/L	1
Sodium - Dissolved	mg/L	12
Magnesium - Dissolved	mg/L	2
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	<5
Carbonate Alkalinity as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	<5
Sulphate, SO4	mg/L	<1
Chloride, Cl	mg/L	17
Ionic Balance	%	24

Miscellaneous Inorganics						
Our Reference		311632-1	311632-2	311632-3	311632-4	311632-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	30/11/2022	30/11/2022	30/11/2022	30/11/2022	30/11/2022
Date analysed	-	30/11/2022	30/11/2022	30/11/2022	30/11/2022	30/11/2022
Total Dissolved Solids (grav)	mg/L	46	39	150	37	190

Miscellaneous Inorganics		
Our Reference		311632-6
Your Reference	UNITS	GW8
Type of sample		Water
Date prepared	-	30/11/2022
Date analysed	-	30/11/2022
Total Dissolved Solids (grav)	mg/L	52

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C.
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	311632-2
Date prepared	-			28/11/2022	1	28/11/2022	28/11/2022		28/11/2022	28/11/2022
Date analysed	-			28/11/2022	1	28/11/2022	28/11/2022		28/11/2022	28/11/2022
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	92	[NT]
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	280	270	4	99	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	96	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	97	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	1	1	0	96	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	94	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	1	280	280	0	99	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	56	55	2	100	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	95	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	98	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	98	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	3	3	0	98	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	113	114

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	311632-2
Date prepared	-			25/11/2022	1	25/11/2022	25/11/2022		25/11/2022	25/11/2022
Date analysed	-			25/11/2022	1	25/11/2022	25/11/2022		25/11/2022	25/11/2022
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	8.0	7.9	1	96	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	<0.5	<0.5	0	97	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	5.3	5.4	2	96	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	1	1	0	100	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	22	22	0	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	22	22	0	100	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	4	3	29	91	86
Chloride, Cl	mg/L	1	Inorg-081	<1	1	9	9	0	94	95
Ionic Balance	%		Inorg-040	[NT]	1	-2.0	-1.0	-67	[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			30/11/2022	[NT]	[NT]	[NT]	[NT]	30/11/2022	[NT]
Date analysed	-			30/11/2022	[NT]	[NT]	[NT]	[NT]	30/11/2022	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	[NT]	[NT]	[NT]	[NT]	108	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

The mass inbalance may be caused by other ions that have not been measured.

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CERTIFICATE OF ANALYSIS 315276

Client Details

Client	Aquatic Science and Management
Attention	Mathew Birch
Address	PO Box 214, Bellingen, NSW, 2454

Sample Details

Your Reference	**Phillip Drive Groundwater**
Number of Samples	6 Water
Date samples received	27/01/2023
Date completed instructions received	27/01/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	03/02/2023
Date of Issue	03/02/2023

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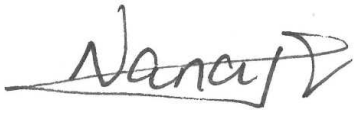
Results Approved By
Loren Bardwell, Development Chemist
Nick Sarlamis, Assistant Operation Manager

Authorised By



Nancy Zhang, Laboratory Manager

HM in water - dissolved						
Our Reference		315276-1	315276-2	315276-3	315276-4	315276-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Depth		Surface	Surface	Surface	Surface	Surface
Date Sampled		25/01/2023	25/01/2023	25/01/2023	25/01/2023	25/01/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	30/01/2023	30/01/2023	30/01/2023	30/01/2023	30/01/2023
Date analysed	-	30/01/2023	30/01/2023	30/01/2023	30/01/2023	30/01/2023
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Aluminium-Dissolved	µg/L	440	220	220	430	800
Arsenic-Dissolved	µg/L	<1	<1	1	3	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	2	<1	1	2	1
Copper-Dissolved	µg/L	2	<1	5	1	<1
Iron-Dissolved	µg/L	480	620	120	210	500
Manganese-Dissolved	µg/L	56	53	<5	<5	<5
Nickel-Dissolved	µg/L	1	1	<1	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	8	5	7	16	9
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05

HM in water - dissolved		
Our Reference		315276-6
Your Reference	UNITS	GW8
Depth		Surface
Date Sampled		25/01/2023
Type of sample		Water
Date prepared	-	30/01/2023
Date analysed	-	30/01/2023
Silver-Dissolved	µg/L	<1
Aluminium-Dissolved	µg/L	1,600
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	2
Copper-Dissolved	µg/L	27
Iron-Dissolved	µg/L	1,000
Manganese-Dissolved	µg/L	6
Nickel-Dissolved	µg/L	1
Lead-Dissolved	µg/L	<1
Selenium-Dissolved	µg/L	<1
Zinc-Dissolved	µg/L	32
Mercury-Dissolved	µg/L	<0.05

Ion Balance						
Our Reference		315276-1	315276-2	315276-3	315276-4	315276-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Depth		Surface	Surface	Surface	Surface	Surface
Date Sampled		25/01/2023	25/01/2023	25/01/2023	25/01/2023	25/01/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	27/01/2023	27/01/2023	27/01/2023	27/01/2023	27/01/2023
Date analysed	-	27/01/2023	27/01/2023	27/01/2023	27/01/2023	27/01/2023
Calcium - Dissolved	mg/L	8.5	3	5.9	1	0.8
Potassium - Dissolved	mg/L	0.5	0.9	2	0.7	0.7
Sodium - Dissolved	mg/L	7.4	8.0	7.8	9.2	7.7
Magnesium - Dissolved	mg/L	2	1	1	0.9	1
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	30	11	21	9	7
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	30	11	21	9	7
Sulphate, SO4	mg/L	4	2	3	2	<1
Chloride, Cl	mg/L	13	16	13	12	12
Ionic Balance	%	-8.0	-5.0	-4.0	0	1.0

Ion Balance		
Our Reference		315276-6
Your Reference	UNITS	GW8
Depth		Surface
Date Sampled		25/01/2023
Type of sample		Water
Date prepared	-	27/01/2023
Date analysed	-	27/01/2023
Calcium - Dissolved	mg/L	2
Potassium - Dissolved	mg/L	2
Sodium - Dissolved	mg/L	13
Magnesium - Dissolved	mg/L	2
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	7
Carbonate Alkalinity as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	7
Sulphate, SO4	mg/L	3
Chloride, Cl	mg/L	19
Ionic Balance	%	6.0

Miscellaneous Inorganics						
Our Reference		315276-1	315276-2	315276-3	315276-4	315276-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Depth		Surface	Surface	Surface	Surface	Surface
Date Sampled		25/01/2023	25/01/2023	25/01/2023	25/01/2023	25/01/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	02/02/2023	02/02/2023	02/02/2023	02/02/2023	02/02/2023
Date analysed	-	02/02/2023	02/02/2023	02/02/2023	02/02/2023	02/02/2023
Total Dissolved Solids (grav)	mg/L	60	48	56	38	36

Miscellaneous Inorganics		
Our Reference		315276-6
Your Reference	UNITS	GW8
Depth		Surface
Date Sampled		25/01/2023
Type of sample		Water
Date prepared	-	02/02/2023
Date analysed	-	02/02/2023
Total Dissolved Solids (grav)	mg/L	64

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C. NOTE: Where the EC of the sample is <100µS/cm, the TDS will typically be below 70mg/L (as the sample is very likely to be at least drinking water quality). Therefore to ensure data quality for TDS, the TDS is typically calculated as per the equation below:- TDS = EC * 0.6
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	315276-2
Date prepared	-			30/01/2023	1	30/01/2023	30/01/2023		30/01/2023	30/01/2023
Date analysed	-			30/01/2023	1	30/01/2023	30/01/2023		30/01/2023	30/01/2023
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		99	[NT]
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	440	[NT]		120	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		106	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	[NT]		102	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	2	[NT]		110	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	2	[NT]		109	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	1	480	[NT]		109	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	56	[NT]		113	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	1	[NT]		110	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		100	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		102	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	8	[NT]		109	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	117	121

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	315276-2
Date prepared	-			27/01/2023	1	27/01/2023	27/01/2023		27/01/2023	27/01/2023
Date analysed	-			27/01/2023	1	27/01/2023	27/01/2023		27/01/2023	27/01/2023
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	8.5	[NT]		90	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	0.5	[NT]		94	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	7.4	[NT]		98	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	2	[NT]		89	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	30	28	7	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	30	28	7	94	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	4	4	0	112	109
Chloride, Cl	mg/L	1	Inorg-081	<1	1	13	13	0	108	107
Ionic Balance	%		Inorg-040	[NT]	1	-8.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			02/02/2023	1	02/02/2023	02/02/2023		02/02/2023	[NT]
Date analysed	-			02/02/2023	1	02/02/2023	02/02/2023		02/02/2023	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	1	60	60	0	97	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

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CERTIFICATE OF ANALYSIS 317514

Client Details

Client	Aquatic Science and Management
Attention	Mathew Birch
Address	PO Box 214, Bellingen, NSW, 2454

Sample Details

Your Reference	**Phillip Drive Groundwater**
Number of Samples	6 Water
Date samples received	28/02/2023
Date completed instructions received	28/02/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	07/03/2023
Date of Issue	07/03/2023

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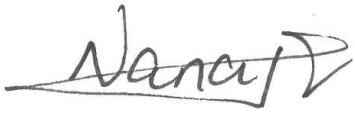
Results Approved By
Hannah Nguyen, Metals Supervisor
Priya Samarawickrama, Senior Chemist

Authorised By



Nancy Zhang, Laboratory Manager

HM in water - dissolved						
Our Reference		317514-1	317514-2	317514-3	317514-4	317514-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Depth		Surface	Surface	Surface	Surface	Surface
Date Sampled		27/02/2023	27/02/2023	27/02/2023	27/02/2023	27/02/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	01/03/2023	01/03/2023	01/03/2023	01/03/2023	01/03/2023
Date analysed	-	01/03/2023	01/03/2023	01/03/2023	01/03/2023	01/03/2023
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Aluminium-Dissolved	µg/L	360	330	250	410	2,100
Arsenic-Dissolved	µg/L	<1	5	<1	2	<1
Cadmium-Dissolved	µg/L	0.1	<0.1	<0.1	<0.1	0.2
Chromium-Dissolved	µg/L	<1	<1	<1	1	1
Copper-Dissolved	µg/L	<1	<1	2	<1	3
Iron-Dissolved	µg/L	390	400	150	200	1,700
Manganese-Dissolved	µg/L	110	35	6	<5	10
Nickel-Dissolved	µg/L	<1	1	<1	<1	2
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	7	10	14	6	19
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05

HM in water - dissolved		
Our Reference		317514-6
Your Reference	UNITS	GW8
Depth		Surface
Date Sampled		27/02/2023
Type of sample		Water
Date prepared	-	01/03/2023
Date analysed	-	01/03/2023
Silver-Dissolved	µg/L	<1
Aluminium-Dissolved	µg/L	1,600
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	1
Copper-Dissolved	µg/L	5
Iron-Dissolved	µg/L	950
Manganese-Dissolved	µg/L	<5
Nickel-Dissolved	µg/L	<1
Lead-Dissolved	µg/L	<1
Selenium-Dissolved	µg/L	<1
Zinc-Dissolved	µg/L	19
Mercury-Dissolved	µg/L	<0.05

Ion Balance						
Our Reference		317514-1	317514-2	317514-3	317514-4	317514-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Depth		Surface	Surface	Surface	Surface	Surface
Date Sampled		27/02/2023	27/02/2023	27/02/2023	27/02/2023	27/02/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	28/02/2023	28/02/2023	28/02/2023	28/02/2023	28/02/2023
Date analysed	-	28/02/2023	28/02/2023	28/02/2023	28/02/2023	28/02/2023
Calcium - Dissolved	mg/L	9.1	4	5.1	<0.5	3
Potassium - Dissolved	mg/L	<0.5	<0.5	2	0.8	2
Sodium - Dissolved	mg/L	7.8	7.6	7.6	9.5	15
Magnesium - Dissolved	mg/L	1	2	1	0.8	4
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	21	7	17	6	<5
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	21	7	17	6	<5
Sulphate, SO4	mg/L	6	10	4	2	<1
Chloride, Cl	mg/L	15	12	11	12	29
Ionic Balance	%	-4.0	0	1.0	0	16

Ion Balance		
Our Reference		317514-6
Your Reference	UNITS	GW8
Depth		Surface
Date Sampled		27/02/2023
Type of sample		Water
Date prepared	-	28/02/2023
Date analysed	-	28/02/2023
Calcium - Dissolved	mg/L	3
Potassium - Dissolved	mg/L	2
Sodium - Dissolved	mg/L	13
Magnesium - Dissolved	mg/L	2
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	<5
Carbonate Alkalinity as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	<5
Sulphate, SO4	mg/L	7
Chloride, Cl	mg/L	19
Ionic Balance	%	13

Miscellaneous Inorganics						
Our Reference		317514-1	317514-2	317514-3	317514-4	317514-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Depth		Surface	Surface	Surface	Surface	Surface
Date Sampled		27/02/2023	27/02/2023	27/02/2023	27/02/2023	27/02/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	03/03/2023	03/03/2023	03/03/2023	03/03/2023	03/03/2023
Date analysed	-	03/03/2023	03/03/2023	03/03/2023	03/03/2023	03/03/2023
Total Dissolved Solids (grav)	mg/L	120	82	77	67	270

Miscellaneous Inorganics		
Our Reference		317514-6
Your Reference	UNITS	GW8
Depth		Surface
Date Sampled		27/02/2023
Type of sample		Water
Date prepared	-	03/03/2023
Date analysed	-	03/03/2023
Total Dissolved Solids (grav)	mg/L	230

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C. NOTE: Where the EC of the sample is <100µS/cm, the TDS will typically be below 70mg/L (as the sample is very likely to be at least drinking water quality). Therefore to ensure data quality for TDS, the TDS is typically calculated as per the equation below:- TDS = EC * 0.6
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	317514-2
Date prepared	-			01/03/2023	1	01/03/2023	01/03/2023		01/03/2023	01/03/2023
Date analysed	-			01/03/2023	1	01/03/2023	01/03/2023		01/03/2023	01/03/2023
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	108	102
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	360	350	3	91	#
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	95	96
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	0.1	0.1	0	93	97
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	96	96
Copper-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	99	97
Iron-Dissolved	µg/L	10	Metals-022	<10	1	390	370	5	97	#
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	110	110	0	95	97
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	98	97
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	87	88
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	92	95
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	7	7	0	97	98
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	111	111

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	317514-2
Date prepared	-			28/02/2023	1	28/02/2023	28/02/2023		28/02/2023	28/02/2023
Date analysed	-			28/02/2023	1	28/02/2023	28/02/2023		28/02/2023	28/02/2023
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	9.1	9.2	1	88	82
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	<0.5	<0.5	0	88	83
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	7.8	7.9	1	94	85
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	1	1	0	89	84
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	[NT]		[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	21	[NT]		[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	[NT]		[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	21	[NT]		97	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	6	6	0	109	111
Chloride, Cl	mg/L	1	Inorg-081	<1	1	15	15	0	109	108
Ionic Balance	%		Inorg-040	[NT]	1	-4.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	5	28/02/2023	28/02/2023		[NT]	[NT]
Date analysed	-			[NT]	5	28/02/2023	28/02/2023		[NT]	[NT]
Calcium - Dissolved	mg/L	0.5	Metals-020	[NT]	5	3	[NT]		[NT]	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	[NT]	5	2	[NT]		[NT]	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	[NT]	5	15	[NT]		[NT]	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	[NT]	5	4	[NT]		[NT]	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	[NT]	5	<5	[NT]		[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	[NT]	5	<5	[NT]		[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	[NT]	5	<5	[NT]		[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	[NT]	5	<5	[NT]		[NT]	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	[NT]	5	<1	<1	0	[NT]	[NT]
Chloride, Cl	mg/L	1	Inorg-081	[NT]	5	29	27	7	[NT]	[NT]
Ionic Balance	%		Inorg-040	[NT]	5	16	[NT]		[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			03/03/2023	[NT]	[NT]	[NT]	[NT]	03/03/2023	[NT]
Date analysed	-			03/03/2023	[NT]	[NT]	[NT]	[NT]	03/03/2023	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	[NT]	[NT]	[NT]	[NT]	98	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

8 HM in water - dissolved - # Percent recovery is not applicable due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

TDS values may be exagerated due to colloidal matter passing through the filter.

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CERTIFICATE OF ANALYSIS 319869

Client Details

Client	Aquatic Science and Management
Attention	Mathew Birch
Address	PO Box 214, Bellingen, NSW, 2454

Sample Details

Your Reference	**Phillip Drive Groundwater**
Number of Samples	6 Water
Date samples received	30/03/2023
Date completed instructions received	30/03/2023

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	06/04/2023
Date of Issue	24/04/2023
Reissue Details	This report replaces R00 created on 06/04/2023 due to: revised report with additional results (Al, Fe & Ag).

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Results Approved By
Diego Bigolin, Inorganics Supervisor
Hannah Nguyen, Metals Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

HM in water - dissolved						
Our Reference		319869-1	319869-2	319869-3	319869-4	319869-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Date Sampled		28/03/2023	28/03/2023	28/03/2023	28/03/2023	28/03/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	03/04/2023	03/04/2023	03/04/2023	03/04/2023	03/04/2023
Date analysed	-	03/04/2023	03/04/2023	03/04/2023	03/04/2023	03/04/2023
Arsenic-Dissolved	µg/L	<1	<1	<1	2	<1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	<1	<1
Copper-Dissolved	µg/L	<1	1	<1	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	4	8	18	12	28
Barium-Dissolved	µg/L	15	5	1	1	12
Beryllium-Dissolved	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt-Dissolved	µg/L	<1	1	<1	<1	1
Manganese-Dissolved	µg/L	48	5	<5	<5	8
Selenium-Dissolved	µg/L	<1	<1	<1	<1	<1
Iron-Dissolved	µg/L	330	460	40	210	1,500
Aluminium-Dissolved	µg/L	350	190	190	380	2,000
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1

HM in water - dissolved		
Our Reference		319869-6
Your Reference	UNITS	GW8
Date Sampled		28/03/2023
Type of sample		Water
Date prepared	-	03/04/2023
Date analysed	-	03/04/2023
Arsenic-Dissolved	µg/L	<1
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	<1
Copper-Dissolved	µg/L	3
Lead-Dissolved	µg/L	<1
Mercury-Dissolved	µg/L	<0.05
Nickel-Dissolved	µg/L	<1
Zinc-Dissolved	µg/L	31
Barium-Dissolved	µg/L	8
Beryllium-Dissolved	µg/L	<0.5
Cobalt-Dissolved	µg/L	<1
Manganese-Dissolved	µg/L	6
Selenium-Dissolved	µg/L	<1
Iron-Dissolved	µg/L	710
Aluminium-Dissolved	µg/L	1,400
Silver-Dissolved	µg/L	<1

Miscellaneous Inorganics						
Our Reference		319869-1	319869-2	319869-3	319869-4	319869-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Date Sampled		28/03/2023	28/03/2023	28/03/2023	28/03/2023	28/03/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	30/03/2023	30/03/2023	30/03/2023	30/03/2023	30/03/2023
Date analysed	-	30/03/2023	30/03/2023	30/03/2023	30/03/2023	30/03/2023
Total Dissolved Solids (grav)	mg/L	140	45	45	34	300

Miscellaneous Inorganics		
Our Reference		319869-6
Your Reference	UNITS	GW8
Date Sampled		28/03/2023
Type of sample		Water
Date prepared	-	30/03/2023
Date analysed	-	30/03/2023
Total Dissolved Solids (grav)	mg/L	200

Ion Balance						
Our Reference		319869-1	319869-2	319869-3	319869-4	319869-5
Your Reference	UNITS	GW1	GW2	GW4	GW5	GW6
Date Sampled		28/03/2023	28/03/2023	28/03/2023	28/03/2023	28/03/2023
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	30/03/2023	30/03/2023	30/03/2023	30/03/2023	30/03/2023
Date analysed	-	30/03/2023	30/03/2023	30/03/2023	30/03/2023	30/03/2023
Calcium - Dissolved	mg/L	7.9	2	5.6	<0.5	3
Potassium - Dissolved	mg/L	0.8	0.8	2	0.8	2
Sodium - Dissolved	mg/L	8.9	8.8	6.1	8.5	14
Magnesium - Dissolved	mg/L	1	2	1	1	5.1
Hardness	mgCaCO 3 /L	25	13	20	4.1	29
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	24	9	17	7	<5
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	24	9	17	7	<5
Sulphate, SO4	mg/L	3	3	4	2	10
Chloride, Cl	mg/L	15	17	11	14	30
Ionic Balance	%	-3.0	-4.0	0	-9.0	8.0

Ion Balance		
Our Reference		319869-6
Your Reference	UNITS	GW8
Date Sampled		28/03/2023
Type of sample		Water
Date prepared	-	30/03/2023
Date analysed	-	30/03/2023
Calcium - Dissolved	mg/L	4
Potassium - Dissolved	mg/L	3
Sodium - Dissolved	mg/L	13
Magnesium - Dissolved	mg/L	3
Hardness	mgCaCO 3 /L	21
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	<5
Carbonate Alkalinity as $CaCO_3$	mg/L	<5
Total Alkalinity as $CaCO_3$	mg/L	<5
Sulphate, SO4	mg/L	12
Chloride, Cl	mg/L	25
Ionic Balance	%	3.0

Method ID	Methodology Summary
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-10°C. NOTE: Where the EC of the sample is <100µS/cm, the TDS will typically be below 70mg/L (as the sample is very likely to be at least drinking water quality). Therefore to ensure data quality for TDS, the TDS is typically calculated as per the equation below:- TDS = EC * 0.6
Inorg-040	The concentrations of the major ions (mg/L) are converted to milliequivalents and summed. The ionic balance should be within +/- 15% ie total anions = total cations +/-15%.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W5	319869-2
Date prepared	-			03/04/2023	1	03/04/2023	03/04/2023		03/04/2023	03/04/2023
Date analysed	-			03/04/2023	1	03/04/2023	03/04/2023		03/04/2023	03/04/2023
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	91	87
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	100	103
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	86	84
Copper-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	87	83
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	109	107
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	106	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	87	84
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	4	4	0	92	85
Barium-Dissolved	µg/L	1	Metals-022	<1	1	15	16	6	91	89
Beryllium-Dissolved	µg/L	0.5	Metals-022	<0.5	1	<0.5	<0.5	0	112	113
Cobalt-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	88	85
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	48	49	2	91	87
Selenium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	88	78
Iron-Dissolved	µg/L	10	Metals-022	<10	1	330	330	0	91	#
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	350	350	0	89	#
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	95	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			04/04/2023	6	30/03/2023	30/03/2023		04/04/2023	[NT]
Date analysed	-			04/04/2023	6	30/03/2023	30/03/2023		04/04/2023	[NT]
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	6	200	190	5	105	[NT]

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	319869-2
Date prepared	-			30/03/2023	1	30/03/2023	30/03/2023		30/03/2023	30/03/2023
Date analysed	-			30/03/2023	1	30/03/2023	30/03/2023		30/03/2023	30/03/2023
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	7.9	7.8	1	105	117
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	0.8	0.8	0	103	112
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	8.9	8.9	0	88	92
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	1	1	1	0	108	121
Hardness	mgCaCO 3 /L	3	Metals-020	[NT]	1	25	25	0	[NT]	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	24	24	0	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	<5	<5	0	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	1	24	24	0	94	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	1	3	3	0	118	107
Chloride, Cl	mg/L	1	Inorg-081	<1	1	15	15	0	107	103
Ionic Balance	%		Inorg-040	[NT]	1	-3.0	-3.0	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

8 HM in water - dissolved - # Percent recovery is not applicable due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Appendix B

Well Construction Report

Aquatic Science and Management

Groundwater Well Installation – Factual Report

Lot 2 DP1091323 – Phillip Drive, South West Rocks

Report No. RGS21305.1-AB

6 October 2022

REGIONAL GEOTECHNICAL SOLUTIONS

REGIONAL GEOTECHNICAL SOLUTIONS

Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS21305.1-AB

6 October 2022

Aquatic Science and Management
PO Box 214
BELLGINGEN NSW 2454

Attention: Mathew Birch

Dear Mathew,

RE: Proposed – Lot 2 DP1091323 – Phillip Drive, South West Rocks
Groundwater Well Installation – Factual Report

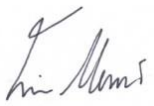
As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has installed seven groundwater monitoring wells at nominated locations at Lot 2 DP1091323, Phillip Drive, South West Rocks. An additional well was installed at the direction of the site project manager during fieldwork.

Well details are presented in the attached report.

If you have any questions regarding this project, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by



Tim Morris

Principal Engineering Geologist

Regional Geotechnical Solutions Pty Ltd
ABN 51141848820

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Ph. (02) 6553 5641

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Appendices

1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has installed seven groundwater monitoring wells at nominated locations at Lot 2 DP1091323, Phillip Drive, South West Rocks. An additional groundwater monitoring well was installed as directed by the site project manager and details of the well are included in this report.

The work was commissioned by Mathew Birch on behalf of Aquatic Science and Management Pty Ltd and was undertaken in accordance with proposal number RGS21305.1-AA, dated 27 June 2022.

2 METHODOLOGY

Field work for the assessment was undertaken on 5 and 6 September 2022 and was undertaken by a Geotechnical Engineer from RGS and included:

- Observation of site features and surrounding features relevant to the geotechnical conditions of the site;
- Eight boreholes undertaken by a track mounted drilling rig using a combination of push tube sampling and augering methods to depths of between 4.2m and 5.0m;
- Collection of samples for subsequent laboratory testing; and
- Installation of groundwater monitoring wells to variable depths in each borehole.

Engineering logs of the borehole presented in Appendix A. Investigation locations are shown on the attached Figure 1 and were staked and surveyed before and after the investigation. Survey coordinates and reduced levels of investigation locations were provided and are presented in Figure 2.

The monitoring wells were constructed with 50mm diameter Class 18 PVC casing and machine slotted well screen intervals with screw-threaded joints. The annulus between the monitoring wells and the borehole was backfilled with clean sand cuttings and 5mm filter gravel to the top of well screen. A 0.75m to 1.0m thick bentonite seal was installed above the filter gravel in each well, with the remaining annulus backfilled with gravel and cuttings. Each well was finished with approximately 900mm PVC casing stick up with a cement plug and covered with a lockable steel monument. The well construction details for each monitoring well are summarised in Table 1 and presented in Appendix A.

Table 1: Summary of Groundwater Monitoring Well Construction Details

Detail	BH101	BH102	BH103	BH104	BH105	BH106	BH107	BH108
Ground Level	RL2.79m	RL3.76m	RL5.52m	RL4.55m	RL5.23m	RL1.75m	RL1.98m	RL6.27m
Bentonite Seal Thickness (m Below ground level (mbgl))	0.25 – 1.0	0.25 – 1.0	0.5 – 1.5	0.25 – 1.0	0.5 – 1.2	0.25 – 1.0	0.25 – 1.0	0.5 – 1.3
Screen Interval (mbgl)	1.0 – 4.75	1.0 – 4.1	1.5 – 4.5	1.0 – 4.2	1.2 – 4.2	1.0 – 4.0	1.0 – 2.5	1.3 – 4.3
Bottom of Well (mbgl and RL)	4.75 RL-1.96m	4.1 RL-0.34m	4.5 RL-1.02m	4.2 RL0.35m	4.2 RL1.03m	4.0 RL-2.25m	2.5 RL-0.52m	4.3 RL1.97m
Groundwater inflow during drilling (mbgl and RL)	1.2 RL1.59m	1.9 RL1.86m	1.6 RL3.92m	1.2 RL3.35m	1.3 RL3.93m	0.4 RL1.35m	0.3 RL1.68m	2.2 RL4.07m

Groundwater inflows were observed within the boreholes at the levels shown in Table 1. It should be noted that fluctuations in groundwater levels can occur as a result of seasonal variations, temperature, rainfall, tidal influences, and other similar factors, the influence of which may not have been apparent at the time of the assessment.

3 SITE CONDITIONS

3.1 Surface Conditions

The site is located to the north of Phillip Drive in an area of gently undulating topography with surface elevations of less than 10m AHD.

Undulating sand dune deposits with elevations of between 3m and 8m AHD were present in the south of the site and had been partially cleared of trees in the west. A low lying area with surface elevations <3m AHD was present to the north of the sand dune deposits and had been cleared of trees.

Drainage of the site is via a combination of overland flow to the north and surface infiltration into the sand soils. An area of surface water seepage was observed near the northern toe of the sand dune as shown on Figure 1.

A satellite image that shows the location of the site and the site setting is reproduced in Plate 1.

Plate 1: *Satellite image dated 2022 obtained from the NSW Government 'Minview' website that illustrates the site location and setting. The approximate site boundaries are outlined in red.*

Selected images from the investigation are presented below.

Looking south across the elevated sand dune deposits from near BH101 towards the existing houses on Phillip Drive.

Installed groundwater monitoring well with steel monument.

3.2 Subsurface Conditions

The Kempsey 1:25,000 Coastal Quaternary Geology Map indicates the site is underlain by Holocene age inter-barrier deposits comprising marine sand, silt, clay and peat in the northern low-lying area of the site and Pleistocene dune deposits comprising aeolian and marine sand and indurated sand in the elevated areas in the south of the site.

The materials encountered during the investigation are summarised in Table 2. Further details are presented on the engineering logs presented in Appendix A.

Table 2: Summary of Subsurface Materials

Material Unit	Material Description	Depth to Base of Material Layer (m)							
		BH101	BH102	BH103	BH104	BH105	BH106	BH107	BH108
TOPSOIL	Silty SAND, fine to medium grained, dark grey-grey, low plasticity silt, with grass rootlets	0.1	0.2	0.25	0.25	0.1	0.40	0.2	0.25
AEOLIAN	SAND, fine to medium grained, pale grey	2.6	2.0	2.0	1.8	1.8	--	--	3.50
MARINE	SAND, fine to medium grained, grey-brown, with low plasticity silt	--	--	--	--	--	≥5.0	2.5	--
MARINE – INDURATED	SAND, fine to medium grained, grey-dark grey, with indurated layers of weakly to moderately cemented sand	≥4.75	≥4.75	≥4.50	≥4.20	≥4.20	--	≥4.50	≥5.0

Table Notes: ≥ *Indicates that base of material layer was not encountered*
-- *Indicates that the material was not encountered at the test location*

4 LIMITATIONS

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

Tim Morris

Associate Engineering Geologist

Figures

REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	AQUATIC SCIENCE AND MANAGEMENT	Job No.	RGS21305.1
	Project:	GROUNDWATER WELL INSTALLATION LOT 2 DP1091323, PHILLIP DRIVE, SOUTH WEST ROCKS	Drawn By:	DS
			Scale:	NTS
			Date:	28-Sep-22
	Title:	INVESTIGATION LOCATION PLAN	Figure No.	**1**

(A) DP 244025 - EASEMENT TO DRAIN WATER 1.83 WIDE
(B) Y718759 & DP 777845 - EASEMENT FOR RISING MAIN 5 WIDE & 10 WIDE
(C) AQ309102 - EASEMENT FOR ASSET PROTECTION ZONE 33.15 WIDE

All COORDINATES GROUND DISTANCE FROM PM 42312

7045 / 1120753

7017 / 1056214

10 / 530207

2

(A)

(B)

(C)

BH101
TOP WELL RL 3.58
NATURAL SURFACE RL 2.79
E 505569.9
N 6582507.5

BH102
TOP WELL RL 4.57
NATURAL SURFACE RL 3.76
E 505587.0
N 6582470.5

BH103
TOP WELL RL 6.38
NATURAL SURFACE RL 5.52
E 505642.0
N 6582420.2

BH107
TOP WELL RL 2.79
NATURAL SURFACE RL 1.98
E 505686.0
N 6582517.8

TOP WELL RL 5.17
NATURAL SURFACE RL 4.79
E 505770.5
N 6582435.2

BH106
TOP WELL RL 2.38 - PVC
NATURAL SURFACE RL 1.75
E 505792.2
N 6582515.0

BH104
TOP WELL RL 5.18
NATURAL SURFACE RL 4.55
E 505794.6
N 6582445.4

BH105
TOP WELL RL 6.09
NATURAL SURFACE RL 5.23
E 505873.1
N 6582437.8

BH108
TOP WELL RL 7.06
NATURAL SURFACE RL 6.27
E 505785.8
N 6582400.3

PHILLIP DRIVE

PM 42312
E 505795.639
N 6582370.768
RL 7.98 AHD
GDA2020
MGA - Z56

APPROX. TRUE NORTH
APPROX. MAGNETIC NORTH

Based on supplied drawing titled " PLAN OF LOT 2 DP 1091323 PHILLIP DRIVE SOUTH WEST ROCKS "

REGIONAL GEOTECHNICAL SOLUTIONS	**Client:**	AQUATIC SCIENCE AND MANAGEMENT	Job No.	RGS21305.1
	Project:	GROUNDWATER WELL INSTALLATION LOT 2 DP1091323, PHILLIP DRIVE, SOUTH WEST ROCKS	Drawn By:	DS
			Scale:	NTS
			Date:	28-Sep-22
	Title:	INVESTIGATION SURVEY PLAN	Figure No.	**2**

Appendix A

Results of Field Investigations

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH101

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 5/9/22

DRILL TYPE: Geoprobe
EASTING: 505570 m
SURFACE RL: 2.8 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582508 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT	5/9/2022	0.10m	2.0	1.0		SM SP	0.10m **TOPSOIL:** Silty SAND, fine to medium grained, dark grey-grey, low plasticity silt, with grass rootlets **SAND:** Fine to medium grained, grey	M				TOPSOIL AEOLIAN
		B										
		1.50m	1.0	2.0				W				
		B					Becoming pale grey-white					
		2.35m										
		2.50m D										
		2.60m	0.0	3.0		SP	2.60m **SAND:** Fine to coarse grained, dark grey-black, weakly cemented With layers of moderately cemented indurated sand amongst non-cemented layers of sand					MARINE-INDURATED
		2.85m D										
		3.00m										
		B										
		4.00m	-1.0	4.0								
			-2.0	5.0			4.75m Hole Terminated at 4.75 m Well Installed					
			-3.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH102

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 5/9/22

DRILL TYPE: Geoprobe
EASTING: 505587 m
SURFACE RL: 3.8 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582471 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT	5/9/2022	0.20m	3.0	1.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, low plasticity silt, with grass rootlets (0.20m)	M				TOPSOIL
		B				SP	**SAND:** Fine to medium grained, pale grey					AEOLIAN
		1.50m	2.0	2.0				W				
		2.00m										MARINE-INDURATED Inner pushtube casing jammed within outer casing No sample or cutting recovered
		B	1.0	3.0								
		3.00m										
			0.0	4.0								Increased drilling resistance
			-1.0				(4.75m)					
				5.0			Hole Terminated at 4.75 m Well Installed					
			-2.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH103

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 5/9/22

DRILL TYPE: Geoprobe
EASTING: 505642 m
SURFACE RL: 5.5 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582420 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT	5/9/2022		5.0	0.25m		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, low plasticity silt, with grass roots	M				TOPSOIL
						SP	**SAND:** Fine to medium grained, grey					AEOLIAN
			4.0	1.0								
			3.0	2.0								
			2.0	2.00m		SP	**SAND:** Fine to medium grained, grey-dark grey, with indurated layers of weakly to moderately cemented sand					MARINE-INDURATED
			1.0	3.0								
			0.0	4.0								
				4.50m			Hole Terminated at 4.50 m Well Installed					
				5.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH104

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 6/9/22

DRILL TYPE: Geoprobe
EASTING: 505795 m
SURFACE RL: 4.6 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582495 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT	5/9/2022	0.30m ES 0.50m	4.0	1.0		SP	**TOPSOIL:** SAND, fine to medium grained, dark grey, with rootlets, trace silt 0.25m	M				TOPSOIL
		1.00m ES 1.60m	3.0	2.0		SP	**SAND:** Fine to medium grained, pale grey	W				AEOLIAN
		1.80m ES 2.20m	2.0	3.0		SP	1.80m **SAND:** Fine to medium grained, dark grey-dark brown, weakly cemented					MARINE-INDURATED
			1.0	4.0			4.20m					Reduced drilling resistance
			0.0	5.0			Hole Terminated at 4.20 m					
			-1.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH105

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 6/9/22

DRILL TYPE: Geoprobe
EASTING: 505873 m
SURFACE RL: 5.2 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582438 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT		0.20m	5.0			SP	0.10m **TOPSOIL:** SAND, fine to medium grained, grey, white, rootlets	M				TOPSOIL
						SP	**SAND:** Fine to medium grained, pale grey-white					AEOLIAN
		ES		1.0								
		1.20m	4.0									
		1.50m										
		ES					1.80m					
		1.80m		2.0		SP	**SAND:** Fine to medium grained, grey to pale brown, weakly to moderately cemented					MARINE-INDURATED
		ES										
		2.20m	3.0									
				3.0								Reduced drilling resistance
			2.0									
				4.0								
			1.0				4.20m					
							Hole Terminated at 4.20 m					
				5.0								
			0.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH106

CLIENT: Aquatic Science & Management
PROJECT NAME: Proposed Groundwater Wells
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
TEST LOCATION: Refer to Survey

PAGE: 1 of 1
JOB NO: RGS21305.1
LOGGED BY: DS
DATE: 5/9/22

DRILL TYPE: Geoprobe
BOREHOLE DIAMETER:
INCLINATION: 90°
EASTING: 505792 m
NORTHING: 6582515 m
SURFACE RL: 1.8 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT			1.8	0.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, low plasticity silt, with rootlets					TOPSOIL
	▶	0.40m					0.40m					
						SP	**SAND:** Fine to medium grained, grey	M				MARINE
								W				
		ES	1.0	1.0								
		1.20m										
		1.80m	0.0	2.0								
		ES										
		2.20m										
			-1.0	3.0								
			-2.0	4.0								
			-3.0	5.0			5.00m					
							Hole Terminated at 5.00 m Hole collapse to 3m, well installed to 4m					
			-4.0									

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH107

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 5/9/22

DRILL TYPE: Geoprobe
EASTING: 505686 m
SURFACE RL: 2.0 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582518 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT	5/9/2022	0.30m				SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, with rootlets	M				TOPSOIL
							0.30m					
						SP	**SAND:** Fine to medium grained, grey-brown, with low plasticity silt, with humus	W				MARINE
		ES	1.0	1.0								
		1.20m										
		ES										
			0.0	2.0								
		2.20m										
							2.50m					
						SP	**SAND:** Fine to medium grained, dark grey-black, moderately cemented					MARINE-INDURATED
			-1.0	3.0								
							3.50m					
						SP	**SAND:** Fine to medium grained, dark grey-grey					
			-2.0	4.0								Increased ground water inflow
							4.50m					
							Hole Terminated at 4.50 m					
			-3.0	5.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: BH108

CLIENT: Aquatic Science & Management
PAGE: 1 of 1
PROJECT NAME: Proposed Groundwater Wells
JOB NO: RGS21305.1
SITE LOCATION: Lot 2 DP1091323 Phillip Drive, SWR
LOGGED BY: DS
TEST LOCATION: Refer to Survey
DATE: 5/9/22

DRILL TYPE: Geoprobe
EASTING: 505786 m
SURFACE RL: 6.3 m
BOREHOLE DIAMETER:
INCLINATION: 90°
NORTHING: 6582400 m
DATUM: AHD

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
PT		0.30m	6.0			SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, with rootlets	M				TOPSOIL
							0.28m					
						SP	**SAND:** Fine to medium grained, pale grey-white					AEOLIAN
		ES		1.0								
		1.20m	5.0									
		ES		2.0								
	5/9/2022	2.20m	4.0									
		ES		3.0								
		3.20m	3.0									
							3.50m					
AD/T						SP	**SAND:** Fine to medium grained, dark brown-black, moderately cemented					MARINE-INDURATED
				4.0								
			2.0				Weakly cemented					
				5.0			5.00m					
			1.0				Hole Terminated at 5.00 m Well Installed to 4.3m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample
ASS	Acid Sulfate Soil Sample
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH101

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505569.9, N: 6582507.5 (MGA2020 Zone 56) SURFACE ELEVATION : 2.79 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 5/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level BH101 / Standpipe / 0.90 m 1.89 m AHD / 4.75 m -1.96 m AHD
PT		05/09/22	0.0		SM	0.10m **TOPSOIL:** Silty SAND, fine to medium grained, dark grey-grey, low plasticity silt, with grass rootlets **SAND:** Fine to medium grained, grey	No Surface Completion Concrete
			0.5				Bentonite
			1.0		SP		1.00 m 1.00 m
			1.5				
			2.0			Becoming pale grey-white	
			2.5			2.60m **SAND:** Fine to coarse grained, dark grey-black, weakly cemented	
			3.0			With layers of moderately cemented indurated sand amongst non-cemented layers of sand	Sand ID: BH101 PVC TYPE: Threaded & machine slotted ID/OD: 112/125 mm DESCRIPTION OF SLOTS: Machine slotted SAND PACK: 2.36-4.75 mm STICKUP: 0.90 m RL: 3.69 m AHD
			3.5		SP		
			4.0				
			4.5			4.75m Hole Terminated at 4.75 m Well Installed	4.75 m 4.75 m
			5.0				

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH102

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505587.0, N: 6582470.5 (MGA2020 Zone 56) SURFACE ELEVATION : 3.76 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 5/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level
PT		05/09/22	0.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, low plasticity silt, with grass rootlets	BH102 Standpipe 0.90 m 2.86 m AHD 4.10 m -0.34 m AHD
						0.20m **SAND:** Fine to medium grained, pale grey	No Surface Completion Concrete Bentonite
			0.5				
			1.0				1.00 m 1.00 m
			1.5				
			2.0				
			2.5		SP		Sand ID: BH102 PVC TYPE: Threaded & machine slotted ID/OD: 112/125 mm DESCRIPTION OF SLOTS: Machine slotted SAND PACK: 2.36-4.75 mm STICKUP: 0.90 m RL: 4.66 m AHD
			3.0				
			3.5				
			4.0				4.10 m 4.10 m
			4.5			4.75m Hole Terminated at 4.75 m Well Installed	
			5.0				

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH103

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505642.0, N: 6582420.2 (MGA2020 Zone 56) SURFACE ELEVATION : 5.52 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 5/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level
			0.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, low plasticity silt, with grass roots	ID: BH103 Type: Standpipe Stick Up & RL: 0.90 m 4.62 m AHD Tip Depth & RL: 4.50 m 1.02 m AHD
			0.25m			**SAND:** Fine to medium grained, grey	
			0.5				
			1.0		SP		
		05/09/22	1.5				1.50 m 1.50 m
			2.0				
			2.00m			**SAND:** Fine to medium grained, grey-dark grey, with indurated layers of weakly to moderately cemented sand	
			2.5				
			3.0		SP		
			3.5				
			4.0				
PT			4.5				4.50 m 4.50 m
			4.50m			Hole Terminated at 4.50 m Well Installed	

BH103

No Surface Completion

Concrete

Bentonite

Sand

ID: BH103 PVC TYPE: Threaded & machine slotted
ID/OD: 112/125 mm
DESCRIPTION OF SLOTS: Machine slotted
SAND PACK: 2.36-4.75 mm
STICKUP: 0.90 m RL: 6.42 m AHD

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH104

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505794.6, N: 6582495.4 (MGA2020 Zone 56) SURFACE ELEVATION : 4.55 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 6/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level BH104 / Standpipe / 0.90 m 3.65 m AHD / 4.20 m 0.35 m AHD
			0.0		SP	**TOPSOIL:** SAND, fine to medium grained, dark grey, with rootlets, trace silt	No Surface Completion Concrete
						0.25m **SAND:** Fine to medium grained, pale grey	
			0.5				Bentonite
			1.0		SP		1.00 m 1.00 m
		05/09/22	1.5				
						1.80m **SAND:** Fine to medium grained, dark grey-dark brown, weakly cemented	
PT			2.0				
			2.5				Sand ID: BH104 PVC TYPE: Threaded & machine slotted ID/OD: 112/125 mm DESCRIPTION OF SLOTS: Machine slotted SAND PACK: 2.36-4.75 mm STICKUP: 0.90 m RL: 5.45 m AHD
			3.0		SP		
			3.5				
			4.0			4.20m Hole Terminated at 4.20 m	4.20 m 4.20 m
			4.5				

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH105

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505873.1, N: 6582437.8 (MGA2020 Zone 56) SURFACE ELEVATION : 5.23 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 6/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level
			0.0		SP	**TOPSOIL:** SAND, fine to medium grained, grey, white, rootlets	ID: BH105 Type: Standpipe Stick Up & RL: 0.90 m 4.33 m AHD Tip Depth & RL: 4.20 m 1.03 m AHD
						0.10m **SAND:** Fine to medium grained, pale grey-white	No Surface Completion
			0.5				Concrete
							Bentonite
			1.0		SP		1.20 m
							1.20 m
			1.5			1.80m **SAND:** Fine to medium grained, grey to pale brown, weakly to moderately cemented	
PT			2.0				
			2.5				Sand
			3.0		SP		ID: BH105 PVC TYPE: Threaded & machine slotted ID/OD: 112/125 mm DESCRIPTION OF SLOTS: Machine slotted SAND PACK: 2.36-4.75 mm STICKUP: 0.90 m RL: 6.13 m AHD
			3.5				
			4.0			4.20m Hole Terminated at 4.20 m	4.20 m 4.20 m
			4.5				

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH106

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505792.2, N: 6582515.0 (MGA2020 Zone 56) SURFACE ELEVATION : 1.75 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 5/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level BH106 / Standpipe / 0.90 m 0.85 m AHD / 4.00 m -2.25 m AHD
PT			0.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, low plasticity silt, with rootlets	No Surface Completion Concrete
						0.40m **SAND:** Fine to medium grained, grey	Bentonite
			0.5				
			1.0				1.00 m 1.00 m
			1.5				
			2.0				
			2.5		SP		Sand ID: BH106 PVC TYPE: Threaded & machine slotted ID/OD: 112/125 mm DESCRIPTION OF SLOTS: Machine slotted SAND PACK: 2.36-4.75 mm STICKUP: 0.90 m RL: 2.65 m AHD
			3.0				
			3.5				
			4.0				4.00 m 4.00 m
			4.5				
			5.0			5.00m Hole Terminated at 5.00 m Hole collapse to 3m, well installed to 4m	
			5.5				

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH107

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

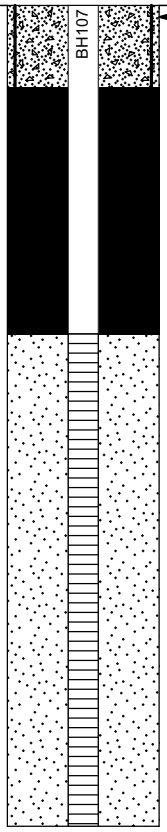
FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505686.0, N: 6582517.8 (MGA2020 Zone 56) SURFACE ELEVATION : 1.98 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 5/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	ID / Type / Stick Up & RL / Tip Depth & RL / Installation Date / Static Water Level
			0.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, with rootlets	ID: BH107 Type: Standpipe Stick Up & RL: 0.90 m 1.08 m AHD Tip Depth & RL: 2.50 m -0.52 m AHD
		05/09/22	0.30m			**SAND:** Fine to medium grained, grey-brown, with low plasticity silt, with humus	
			0.5				
			1.0		SP		1.00 m 1.00 m
			1.5				
			2.0				
PT			2.50m			**SAND:** Fine to medium grained, dark grey-black, moderately cemented	2.50 m 2.50 m
			2.5				
			3.0		SP		
			3.50m			**SAND:** Fine to medium grained, dark grey-grey	
			3.5				
			4.0		SP		
			4.50m			Hole Terminated at 4.50 m	
			4.5				



No Surface Completion
Concrete
Bentonite
Sand

ID: BH107 PVC TYPE: Threaded & machine slotted
ID/OD: 112/125 mm
DESCRIPTION OF SLOTS: Machine slotted
SAND PACK: 2.36-4.75 mm
STICKUP: 0.90 m RL: 2.88 m AHD

See Explanatory Notes for details of abbreviations & basis of descriptions.

REGIONAL GEOTECHNICAL SOLUTIONS

HOLE NO : BH108

CLIENT : Aquatic Science & Management PROJECT : Proposed Groundwater Wells
LOCATION : Refer to Survey

FILE / JOB NO : RGS21305.1
SHEET : 1 OF 1

POSITION : E: 505785.8, N: 6582400.3 (MGA2020 Zone 56) SURFACE ELEVATION : 6.27 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : Geoprobe MOUNTING : CONTRACTOR :

DATE STARTED : 5/9/2022 DATE COMPLETED : DATE LOGGED : LOGGED BY : DS CHECKED BY :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	
PT		05/09/22	0.0		SM	**TOPSOIL:** Silty SAND, fine to medium grained, dark grey, with rootlets	
						0.28m **SAND:** Fine to medium grained, pale grey-white	
			0.5				
			1.0				
			1.5		SP		
			2.0				
			2.5				
			3.0				
			3.5			3.50m **SAND:** Fine to medium grained, dark brown-black, moderately cemented	
AD/T			4.0		SP		
			4.5			Weakly cemented	
			5.0			5.00m Hole Terminated at 5.00 m Well Installed to 4.3m	
			5.5				

ID: BH108 Type: Standpipe Stick Up & RL: 0.90 m 5.37 m AHD Tip Depth & RL: 4.30 m 1.97 m AHD Installation Date: Static Water Level:

BH108

No Surface Completion

Concrete

Bentonite

1.30 m
1.30 m

4.30 m
4.30 m

Sand

ID: BH108 PVC TYPE: Threaded & machine slotted
ID/OD: 112/125 mm
DESCRIPTION OF SLOTS: Machine slotted
SAND PACK: 2.36-4.75 mm
STICKUP: 0.90 m RL: 7.17 m AHD

See Explanatory Notes for details of abbreviations & basis of descriptions.