ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

30 August 2019

Dunmore Sand & Soil Pty Ltd
C/- Boral Quarries
38 Tabbitta Road
Dunmore NSW 2529

Attention: **Ben Williams**
Environmental Coordinator

Dear Ben

Annual report on groundwater monitoring at 38 Tabbitta Road, Dunmore, NSW: May 2018 – May 2019

Please find enclosed a copy of our report entitled as above. Thank you for the opportunity to undertake this work

1 Introduction

Environmental Earth Sciences NSW was engaged by Dunmore Sand & Soil Pty Ltd (DSS) to monitor groundwater levels and quality at the Dunmore Lakes Sand Project (Stages 2 – 4) at 38 Tabbitta Road, Dunmore, NSW (the 'site') between May 2018 and May 2019. Refer to Figure 1 for the site's locality.

The Dunmore Lakes Sand Project (Stages 2 – 4) has been approved for the extraction and processing of approximately eight million tonnes of sand under Development Consent 195-8-2004 (2004), issued on 29 June 2005 per the Environmental Planning and Assessment (EP&A) Act 1979. It is recognised that the operation of the Dunmore Lakes Sand Project has the potential to influence groundwater beneath the site.

To manage the potential impact on groundwater, DSS has implemented a groundwater monitoring and management program in line with the Development Consents for Stage 2 – 4 as per the following plans:

- Environmental Management Plan (EMP) (DS&S, 2006);
- Water Management Plan (WMP) (Arcadis, 2016); and
- Groundwater Monitoring and Management Plan (GMMP) (Environmental Earth Sciences, 2018b).

In addition, DSS is seeking to modify the current Project Approval (DA 195-8-2004) under Section 75W of the EP&A Act 1979 to provide for an additional extraction area (Stage 5) on adjoining private land, encompassing two separate extraction areas, Stage 5A located at 471 Riverside Drive, and Stage 5B located at 69 Fig Hill Lane, Dunmore. An Environmental

Assessment (EA) was submitted to NSW Department of Planning, Industry & Environment (DPIE) in support of the modification proposal, for review and public exhibition in February 2019.

Quarterly monitoring of the Stage 5 area was undertaken in May 2019, at the same time as the most recent monitoring at 'Stages 2- 4' in order to provide further background information prior to development. However, this data has not been included within this letter report and has been reported under a separate email memo report, dated 18 July 2019.

The objective of this report is to assess whether former and on-going sand extraction activities are impacting groundwater levels and quality in accordance with the aforementioned Development Consents and management plans pertaining to the site.

The scope of works undertaken to achieve this objective included:

- Downloading data from water level loggers;
- Manual water level measurement to calibrate water levels;
- Review water level data from data loggers in the vicinity of Swamp Road Quarry and the Stage 3 sand dredging area; and
- Review the groundwater quality data collected by Environmental Earth Sciences during the monitoring period.

2 Fieldworks and data download

The groundwater monitoring network established for the site is illustrated in Figure 2 with details summarised in Table 1. Water level data from each active monitoring location (bores DG5, DG6, DG17, DG21, DG31, DG35, DG36, DG59, DG60 as well as at Lower Dam and Rocklow Creek) was downloaded from pressure transducer data loggers ('divers') at quarterly intervals by Environmental Earth Sciences personnel in August 2018, November 2018, February 2019 and May 2019.

Replacement bores (DG7, DG17, DG21 and DG31) were added to the network as a result of the expansion of Stage 3 dredge pond and up-gradient of Stage 2, following recommendations made in the DSS Annual Report 2018 (Environmental Earth Sciences 2018a). Replacement of faulty divers and installation of divers within new bores were also installed in the DS&S and Quarry network during November 2018.

Water level data from May 2018 to May 2019 for all bores in the active network have been compared to rainfall totals in Appendix A, Chart 1 and to tidal data in Appendix A, Chart 2.

Water quality monitoring of the active groundwater network was undertaken at quarterly intervals by Environmental Earth Sciences personnel in August 2018, November 2018, February 2019 and May 2019. Data was compared against trigger levels outlined in the GMMP (Environmental Earth Sciences, 2018b) for the purposes of this Annual Report.

Table 1: Monitoring bore network

Bore ID	Easting	Northing	Elevation (mAHD)	Depth (m)	Screen interval (mBGL)	Status	Diver installed	Comments
BHA	301383	616892	2.225	5.2	2.2-5.2	Destroyed	-	
BHB	301450	6167890	-	5.1	2.1-5.1	Destroyed	-	Decommissioned in November 2016 due to Stage 3 dredge pond expansion.
BHC	301531	6167902	-	5.2	2.2-5.2	Destroyed	-	Decommissioned in November 2016 due to Stage 3 dredge pond expansion.
BHD	301620	6167901	1.760	5.1	2.1-5.1	Destroyed	-	Decommissioned in May 2018.
BHE	301595	6167932	-	5.1	2.1-5.1	Destroyed	-	Decommissioned in November 206 due to Stage 3 dredge pond expansion.
BHF	301505	6167931	2.225	5.2	2.2-5.2	Destroyed	-	Decommissioned in February 2018.
DG1	301665	6167434	2.225	-	-	-	-	May 2018 annual report recommended installation to monitor background water levels.
DG2	301665	6167434	2.598	-	-	Inactive		Monitoring ceased due to completion of Stage 1 area.
DG3	302005	6167259	1.866	-	-	Inactive	-	2015-16 Annual rRview recommended that monitoring cease due to completion of Stage 1 (Environmental Earth Sciences, 2016)
DG4	301966	6167408	2.083	-	-	Inaccessible	-	No longer accessible. Removed from monitoring network.
DG5	301883	6167521	1.717	-	-	**Active**	Yes	Nested well; deep well contains diver.
DG6	301844	6167628	1.647	-	-	**Active**	Yes	Nested well; shallow well contains diver.
DG7	276637	6203886	2.35	-	-	**Active**	Yes	Installed November 2018.

Bore ID	Easting	Northing	Elevation (mAHD)	Depth (m)	Screen interval (mBGL)	Status	Diver installed	Comments
DG17	275757	6203448	3.49	-	-	**Active**	Yes	Installed November 2018.
DG21	276480	6203877	2.12		-	**Active**	Yes	Re-installed in November 2018 as bore had been damaged (June 2017).
DG31	276186	6203803	3.05		-	**Active**	Yes	Re-installed in November 2018 as bore had been damaged (June 2017). Diver replaced in August 2018 as faulty.
DG35	276088	6204430	3.84	8.0	4.0 – 8.0	**Active**	-	Bore installed August 2018. No diver
DG36	275982	6204182	2.31	8.0	5.0 – 8.0	**Active**	-	Bore installed August 2018. Diver installed November 2018
DG54	301403	6167969	2.311	11.5	-	Decommissioned	-	Decommissioned in 2017 / 2018 due to Stage 3 dredge pond expansion.
DG56	301639	6168017	1.369	10.5	-	Decommissioned	-	Decommissioned in 2017 /2018 due to Stage 3 dredge pond expansion.
DG59	301125	6167718	1.763	8.69	-	**Active**	Yes	-
DG60	301275	6167683	1.501	1.9	-	**Active**	No	Location is often dry during monitoring.
Lower Dam				-	-	**Active**	Yes	
Rocklow Creek				-	-	**Active**	Yes	
Middle Dam				-	-	Inactive	-	Recommend reinstallation as diver had been removed and location damaged.

2.1 Water level calibration

Standing water levels (SWL) are manually measured from the top of casing (TOC) of each monitoring bore with the TOCs surveyed to Australian Height Datum (mAHD). To assess groundwater levels these measurements from TOC are converted into relative levels to calibrate datalogger measurements. Subtracting the bore dip from the surveyed TOC level provides a water level in mAHD that can be used to calibrate the datalogger pressure reading. Table 2 below summarizes the SWL for bores generally obtained during the May 2018 – May 2019 monitoring period.

Table 2: Standing water levels across the monitoring network May 2017 – May 2018

Location	Trigger Value[1]		May 2018	Aug 2018	Nov 2018	Feb 2019	May 2019
	Upper Limit	Lower Limit					
DG5 (shallow)	-	-	1.18	1.005	-	-	1.12
DG5 (deep)	0.19	1.55	1.23	1.07	1.25	1.11	1.12
DG6 (shallow)	-	-	1.13	0.97	0.99	1.03	0.97
DG6 (deep)	-	-	1.19	1.03	-	-	1.04
DG17			-	-	2.48	2.53	2.665
DG7					2.255	2.215	2.155
DG21			-	-	2.24	2.2	2.034
DG31	-	-	2.90	Damaged	3.02	2.805	2.835
DG35			-	-	2.48	2.53	2.210
DG36			-	-	1.44	1.33	1.360
DG59	-	-	1.675	1.65	1.485	1.53	1.51
DG60	-	-	Dry (1.75)	Dry	1.56	1.58	Dry (1.75)
Rocklow Creek			0.383	0.325	0.25	0.3	0.3
Lower Dam			4.832	4.47	3.44	2.92	3.75

Notes:

1. Trigger values taken from Table 5: Physical Triggers – Groundwater Levels of the GMMP (Environmental Earth Sciences, 2018b) have been converted from mAHD to mBTOC for comparison to SWL.
2. – no information available or not applicable
3. All measurements in mBTOC – metres Below Top Of Casing

The data logging of the piezometric pressure (water pressure) in the monitoring bores containing divers was undertaken at 60 minute intervals, with readings compensated for barometric changes. The data from the loggers is downloaded quarterly at each location and used to compare the piezometric head with tidal influence and rainfall. No measurements obtained from the diver data or SWL readings exceeded the trigger values outlined in the GMMP (Environmental Earth Sciences, 2018b).

2.2 Rainfall data

Local daily rainfall data was obtained from the Bureau of Meteorology (BOM) weather station 068242 located at Kiama (Bombo Headland) approximately 4.6 km from site. The majority of rainfall during both 2018 and 2019 occurred over summer. Two significant summer rainfall events totalling 84 mm (December 2018) and 74 mm (January 2019) were recorded.

Rainfall during the monitoring period was lower compared to previous years, which historically recorded rainfall events in excess of 150 mm. Rainfall totals compared to water level data at DS&S are presented in Appendix A, Chart 1.

2.3 Tidal data

Tidal data from the Minnamurra River tidal monitoring station (214442) was purchased from Manly Hydraulics Laboratory for the period between 2 June 2018 and 2 June 2019, in addition to data from BOM for the purpose of comparing the water level data to tidal movements (Appendix A, Chart 2).

2.4 Water quality data

Full laboratory transcripts are included in Appendix C – Laboratory Transcripts.

Bores west of the Princes Highway (ID: DG17, DG21, DG31, DG35, DG36 and DG59) and bores east of the Princes Highway (ID: DG5, DG6 and DG7) are presented separately due the strong tidal influence on easterly bores.

Table 3 of the Tables Appendix summarizes quarterly data for the western bores (ID: DG17, DG21, DG31, DG35, DG36 and DG59). The following were identified as exceeding GMMP Trigger Values:

- Elevated EC above the trigger value of 1500 µS/cm on all occasions at bores DH17, DG31 and DG59, on two occasions at bore DG21, and in August 2018 in bore DG36;
- Elevated sodium (Na) in February (565 mg/L) and May (630 mg/L) 2019 in bore DG31;
- Bores DG17 and DG31 recorded consistently elevated values of magnesium (Mg) between November 2018 and May 2019;
- Bores DG35 and DG59 reported elevated ammonia (NH_3N) in May 2019;
- Iron (Fe) above the trigger value of 3 mg/L was recorded in August 2018, November 2018 and May 2019 in bore DG35 (upgradient bore); and

- Bores DG59 and DG17 had bicarbonate (HCO_3) in excess of trigger values for at least three consecutive monitoring events (August 2018, November 2018, February 2019 and May 2019).

Table 4 of the Tables Appendix summarizes quarterly data for the eastern bores (ID: DG5-S, DG5-D, DG6-S and DG6-D). The following were identified as exceeding site specific GMMP Trigger Values:

- Bore DG6-D reported elevated potassium (K), magnesium (Mg), chloride (Cl) and bicarbonate (HCO_3) consistently between May 2018 and May 2019, and elevated sulfate (SO_4) in May and August 2018;
- Bore DG5-D reported elevated potassium (K) in May 2018 and May 2019, and bore DG6-S was elevated in May 2018;
- Elevated magnesium (Mg) was reported in bores DG5-D and DG6-S in May and August 2018, and in May 2019 at bore DG5-D;
- Elevated chloride (Cl) was recorded on two occasions (August 2018 and May 2019) at bore DG5-D;
- Bore DG5-D also reported elevated ammonia (NH_3N) in May and August 2018, and in May 2019; and
- Bore DG6-D reported elevated dissolved iron (Fe) concentrations in May 2018.

These results are discussed in more detail in Section 3.4.

3 Data interpretation and discussion

A review of the water level data collected during the 2018/ 2019 monitoring period indicates no observable impact on local groundwater from dewatering or extraction activities undertaken at DSS.

3.1 Groundwater level response and rainfall analysis

The aquifer beneath site has historically responded rapidly to local rainfall events (Environmental Earth Sciences 2009-2018), a trend which was repeated during 2018/ 2019 monitoring period at all locations (Appendix A, Chart 1).

Only one rainfall event during the May 2018 – May 2019 monitoring period exceeded 80 mm in a single event. Historically, several rainfall events >150 mm were generally recorded across the monitoring period. The reduced recharge of the aquifer via rainfall was evidenced in the downward trend in groundwater levels across the site.

Bore DG59 displayed a particularly variable SWL and these fluctuations are attributed to the encroachment of the dredge pond and other disturbances associated with sand dredging activities at Stage 3.

Water levels up-gradient (DG36) reported a downward trend over the summer of 2018, which recovered from March 2019 onwards, indicative of background aquifer behaviour, which is less influenced by tidal impacts and direct rainfall recharge.

Water levels at bores DG31 and DG59 report a slight downward trend that Chart 1 illustrates is more associated with lower rainfall in the region than site activities.

The groundwater in bores DG21 and DG31 although affected by rainfall appear to have a dampened response (lower overall fluctuations) during 2018-19 when compared to the other bores on site. This is likely as result of a reduced sensitivity to rainfall totals <20 mm, reduced tidal influences and being located further up the catchment and closer to the edge of the aquifer/ unconsolidated sediments (Appendix A, Chart 1). Data gaps (DG31) result from diver malfunction.

Bores DG17 and DG7 appear to be influenced both by rainwater recharge and also upstream tidal influences of Rocklow Creek and Dunmore Creek respectively.

Bores down-gradient (DG5 and DG6) have generally remained consistent as these are more influenced by tidal fluctuations (Appendix A, Chart 2).

Bore DG59 exhibited a rapid rainfall response pattern and appeared to be more easily influenced by rainfall events (Appendix A, Chart 1). Fluctuations in the water-table level up to half a metre AHD can be seen during significant rainfall events or periods of extended rainfall over several days. This observation fits the conceptual site model (CSM) of the aquifer's effective porosity being close to 30% and recharge from rainfall being close to 100% of total recharge at the water-table level (Environmental Earth Sciences, 2013b).

3.2 Groundwater level response and tide analysis

The unconfined aquifer which is intercepted by all bore locations is susceptible to tidal influences, however at relatively low amplitudes. Tidal characteristics of the aquifer are shown in Appendix A, Chart 2.

Groundwater fluctuations in response to tidal influxes in bores DG5 and DG6 have historically been larger, while the tidal amplitudes at bores DG59, DG31 and DG21 show dampened responses. Bores DG7 and DG17 also show dampened responses, but appear to be impacted by fluctuations in Rocklow Creek and Dunmore Creek ,respectively. This indicates a reduced tidal impact on groundwater levels further up the Rocklow Creek catchment.

3.3 Hydraulic gradient and groundwater flow direction

The groundwater hydraulic gradient at each location is determined by comparing the average standing water level (SWL, converted to mAHD) in the unconfined aquifer at each location to down-gradient bore DG5. The inferred groundwater contours (Figure 3 and 4) indicate that groundwater flow is influenced by both tidal movements and localised dredging activities in Stage 3, but showed a consistent south easterly pressure gradient towards Rocklow Creek, the Minnamurra River and the coast.

3.4 Groundwater quality

In general, groundwater did not exceed the site-specific trigger levels outlined in the GMMP (Environmental Earth Sciences, 2018b) across the monitoring period.

Due to tidal/ estuarine influences, bores east of the Princes Highway consistently reported greater EC and cation/ anion concentrations than those west of the Princes Highway. The bores screened in the deeper portion of the aquifer (DG5-D and DG6-D) exhibited greater EC and cation/ anion concentrations than those screened in the shallow aquifer (DG5-S and DG5-D and DG-7).

It was noted that bore DG59 reported elevated EC as well and bicarbonate (HCO_3) concentrations. This is considered a result of the proximity of the bore to the dredge pond causing interference.

Ammonia (NH_4N) concentrations in both the west and the east of the site were reported as elevated to the trigger levels at various times. As the natural environment surrounding the site contains numerous wetlands and swamps, the presence of elevated concentrations of ammonia and other nitrogenous compounds is not unexpected and considered to be due to the natural breakdown of organic material.

Electrical conductivity (EC) above trigger values in the bores west of the Princes Highway will continue to be monitored. Analytes reported above the trigger values will continue to be monitored as per the contingency plan in the GMMP (Environmental Earth Sciences, 2018b), with consideration to current site operations and climate.

3.5 Recommendations for future monitoring

Quarterly groundwater level and quality monitoring should continue in line with the Development Consents for Stage 2 – 4 as well as the EMP (DSS, 2006), WMP (Arcadis, 2016) and GMMP (Environmental Earth Sciences, 2018b). It is understood that DSS ceased Stage 1 dredging activities at the Swamp Road site in March 2009, and the site is currently a rehabilitated pond. Sand dredging of Stage 2 is complete and dredging operations within Stage 3 are approaching capacity.

Based on a review of the 2018/ 2019 monitoring data the following adjustments are recommended to the program:

- monitoring of representative onsite diver locations should continue at quarterly intervals as indicated on Figure 2 by the active monitoring network;
- monitoring of onsite bore DG59 (southern edge of Stage 3) can cease, as the dredge area has advanced to the south west;
- bore DG1 should be included within the active monitoring network, be monitored at quarterly intervals and be installed with a diver; and
- inclusion of monitoring of bores within Stage 5 at quarterly intervals.

4 Conclusions

The data obtained from the data loggers installed in bores DG5, DG6, DG7, DG17, DG21, DG31, DG35, DG36, and DG59 indicates that over the past monitoring year natural fluctuations in water levels were occurring in response to rainfall and tide as illustrated in Appendix A, Charts 1 and 2. This is consistent with previous findings dating back to 2003 (Environmental Earth Sciences 2009, 2010, 2011, 2012, 2013a, 2014, 2015, 2016a, 2017 and 2018a).

All data obtained from the bores monitored strongly indicates the following:

- that influences on groundwater levels are related to recharge from rainfall and more minor tidal influx (this finding is supported by chemical monitoring of tidal seawater intrusion from Rocklow Creek);
- reductions in groundwater levels are related to periods of low rainfall (i.e. not to minor recharge) where the aquifer is slowly draining from Rocklow Creek and the south-east aquifer boundary; and
- water-table fluctuations are therefore naturally occurring and cannot be seen to be impacted by dredging activities in the area, except in immediate proximity to the dredge pond.

5 Limitations

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from Dunmore Sand & Soil Pty Ltd;
2. The specific scope of works set out in PO118204 and confirmed in variation 1 dated 12 April 2019;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at 38 Tabbita Road, Dunmore, NSW, 2529 (“the site”);
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;

8. Our General Limitations set out at the back of the body of this report.

Should you have any queries, please do not hesitate to contact us on (02) 9922 1777.

For and on behalf of
Environmental Earth Sciences NSW

Project Manager
Elin Griffiths
Associate Environmental Scientist

Project Director / Internal Reviewer
Mark Stuckey
Senior Principal Soil Scientist,
Hydrogeologist & Risk Assessor

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Attachments

Environmental Earth Sciences General Limitations

Figures

Tables

Appendix A: Hydrographs

Appendix B: Schoeller Plots

Appendix C: Laboratory Transcripts

6 References

Arcadis (2016) Dunmore Sand and Soil Project – *Water Management Plan*. Report to Boral date 26 August 2016.

Dunmore Sand and Soil (DS&S) (2006) *Dunmore Lakes Sand Project Stages 2, 3 and 4 – Environmental Management Plan.* Compiled by R.W. Corkery & Co. Ref. No. 478/08, dated August 2006.

Environmental Earth Sciences (2009) G*roundwater Level Monitoring June 2008 to May 2009 – Swamp Road Sand Quarry*, Dunmore, NSW. Report No. 109031

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Environmental Earth Sciences (2013a) *Groundwater Level Monitoring May 2012 to May 2013 – Swamp Road Sand Quarry*, Dunmore, NSW. Report No. 112084

Environmental Earth Sciences (2013b) *Hydrogeological assessment for Lot 21 DP653009, Dunmore Recycling and Waste Disposal Depot, Dunmore, NSW*. Report No. 113057_Hydrogeology for Hyder Consulting Pty Ltd

Environmental Earth Sciences (2014) *Groundwater Level Monitoring May 2013 to May 2014 – Swamp Road Sand Quarry, Dunmore, NSW*. Report No. 114019

Environmental Earth Sciences (2015) *Groundwater Level Monitoring May 2014 to May 2015 – Swamp Road Sand Quarry, Dunmore, NSW*. Report No. 114061

Environmental Earth Sciences (2016a) *Groundwater Level Monitoring May 2015 to May 2016 – Swamp Road Sand Quarry, Dunmore*, NSW. Report No. 115069

Environmental Earth Sciences (2016b) *Annual Monitoring Report at 38 Tabbitta Road, Dunmore, NSW*. Report No. 116083

Environmental Earth Sciences (2017) *Annual report on groundwater level monitoring at the Swamp Road Sand Quarry, Dunmore, NSW - May 2016 to May 2017*. Report No. 116085

Environmental Earth Sciences (2018a) *Annual report on groundwater level monitoring at 38 Tabbitta Road, Dunmore NSW – May 2017 to May 2018*. Report No.117053

Environmental Earth Sciences (2018b) *Groundwater monitoring and management plan for 38 Tabbitta Road, Dunmore, NSW*. Report No. 118076

7 Glossary of terms

The following descriptions are of terms used in the text of this report.

Anaerobic. Reducing or without oxygen.

Aquifer. A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, confined. An aquifer that is overlain by a confining bed with significantly lower hydraulic conductivity than the aquifer.

Aquifer, perched. A region in the unsaturated zone where the soil is locally saturated because it overlies soil or rock of low permeability.

Background. The natural level of a property.

Baseline. An initial value of a measure.

Bore. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface.

Borehole. An uncased well drill hole.

Confined Aquifer. An aquifer that is confined between two low-permeability aquitards. The groundwater in these aquifers is usually under hydraulic pressure, i.e. its hydraulic head is above the top of the aquifer.

Confining layer. A layer with low vertical hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. A confining layer is an aquitard. It may lie above or below the aquifer.

Diffusion. A process by which species in solution move, driven by concentration gradients (from high to low).

Dissolved Oxygen (DO). Oxygen in the gaseous phase dissolved in water. Measured either as a concentration in mg/L or as a percentage of the theoretical saturation point, which is inversely related to temperature. At 19, 20 and 21 degrees Celsius, the oxygen concentrations in mg/L corresponding to 100% saturation are 9.4, 9.2 and 9.0 respectively.

Electrical Conductivity (EC). The EC of water is a measure of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration. An estimate of TDS in fresh water can be obtained by multiplying EC by 0.65.

Flow path. The direction in which groundwater is moving.

Fluvial. A material deposited by, or in transit, in streams or watercourses.

Gradient. The rate of inclination of a slope. The degree of deviation from the horizontal; also refers to pressure.

Groundwater. The water held in the pores in the ground below the water table.

Groundwater Elevation. The elevation of the groundwater surface measured relative to a specified datum such as the Australian Height Datum (mAHD) or an arbitrary survey datum onsite, or “reduced level” (mRL).

Heterogeneous. A condition of having different characteristics in proximate locations. Non-uniform. (Opposite of homogeneous).

Hydraulic Conductivity (K). A coefficient describing the rate at which water can move through a permeable medium. It has units of length per time. The units for hydraulic conductivity are typically m3/day/m2 or m/day.

Hydraulic Gradient (i). The rate of change in total head per unit of distance of flow in a given direction – the direction is that which yields a maximum rate of decrease in head. Hydraulic Gradient is unit less.

Hydraulic Head (h). The sum of the elevation head and the pressure head at a point in an aquifer. This is typically reported as an elevation above a fixed datum, such as sea level.

Infiltration. The passage of water, under the influence of gravity, from the land surface into the subsurface.

Ionic Exchange. Adsorption occurs when a particle with a charge imbalance, neutralises this charge by the attraction (and subsequent adherence of) ions of opposite charge from solution. There are two types of such a charge: pH dependent; and pH independent or crystalline charge. Metal hydroxides and oxy-hydroxides represent examples of the former type, whilst clay minerals are representative of the latter and are normally associated with cation exchange.

Ions. An ion is a charged element or compound as a result of an excess or deficit of electrons. Positively charged ions are called cations, whilst negatively charged ions are called anions. Cations are written with superscript +, whilst anions use - as the superscript. The major aqueous ions are those that dominate total dissolved solids (TDS). These ions include: Cl^-, SO_4^{2-}, HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}, K^+, NH_4^+, NO_3^-, NO_2^-, F^-, PO_4^{3-} and the heavy metals.

Organics. Chemical compounds comprising atoms of carbon, hydrogen and others (commonly oxygen, nitrogen, phosphorous, sulfur). Opposite is inorganic, referring to chemical species not containing carbon.

Permeability (k). Property of porous medium relating to its ability to transmit or conduct liquid (usually water) under the influence of a driving force. Where water is the fluid, this is effectively the hydraulic conductivity. A function of the connectivity of pore spaces.

Piezometric or Potentiometric Surface. A surface that represents the level to which water will rise in cased bores. The water table is the potentiometric surface in an unconfined aquifer.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Recharge Area. Location of the replenishment of an aquifer by a natural process such as addition of water at the ground surface, or by an artificial system such as addition through a well

Recovery. The rate at which a water level in a well rises after pumping ceases.

Redox. REDuction-OXidation state of a chemical or solution.

Redox potential (Eh). The oxidation/reduction potential of the soil or water measured as milli-volt.

Reducing Conditions. Can be simply expressed as the absence of oxygen, though chemically the meaning is more complex. For more details refer to OXIDATION.

Standing Water Level (SWL). The depth to the groundwater surface in a well or bore measured below a specific reference point – usually recorded as metres below the top of the well casing or below the ground surface.

Total Dissolved Salts (TDS). The total dissolved salts comprise dissociated compounds and undissociated compounds, but not suspended material, colloids or dissolved gases.

Unsaturated Zone. The zone between the land surface and the water table, in which the rock or soil pores contain both air and water (water in the unsaturated zone is present at less than atmospheric pressure). It includes the root zone, intermediate zone and capillary fringe. Saturated bodies such as perched groundwater may exist in the unsaturated zone. Also referred to as the Vadose Zone.

Water table. Interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

Well. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a Bore.

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ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES

Source: Google Maps

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

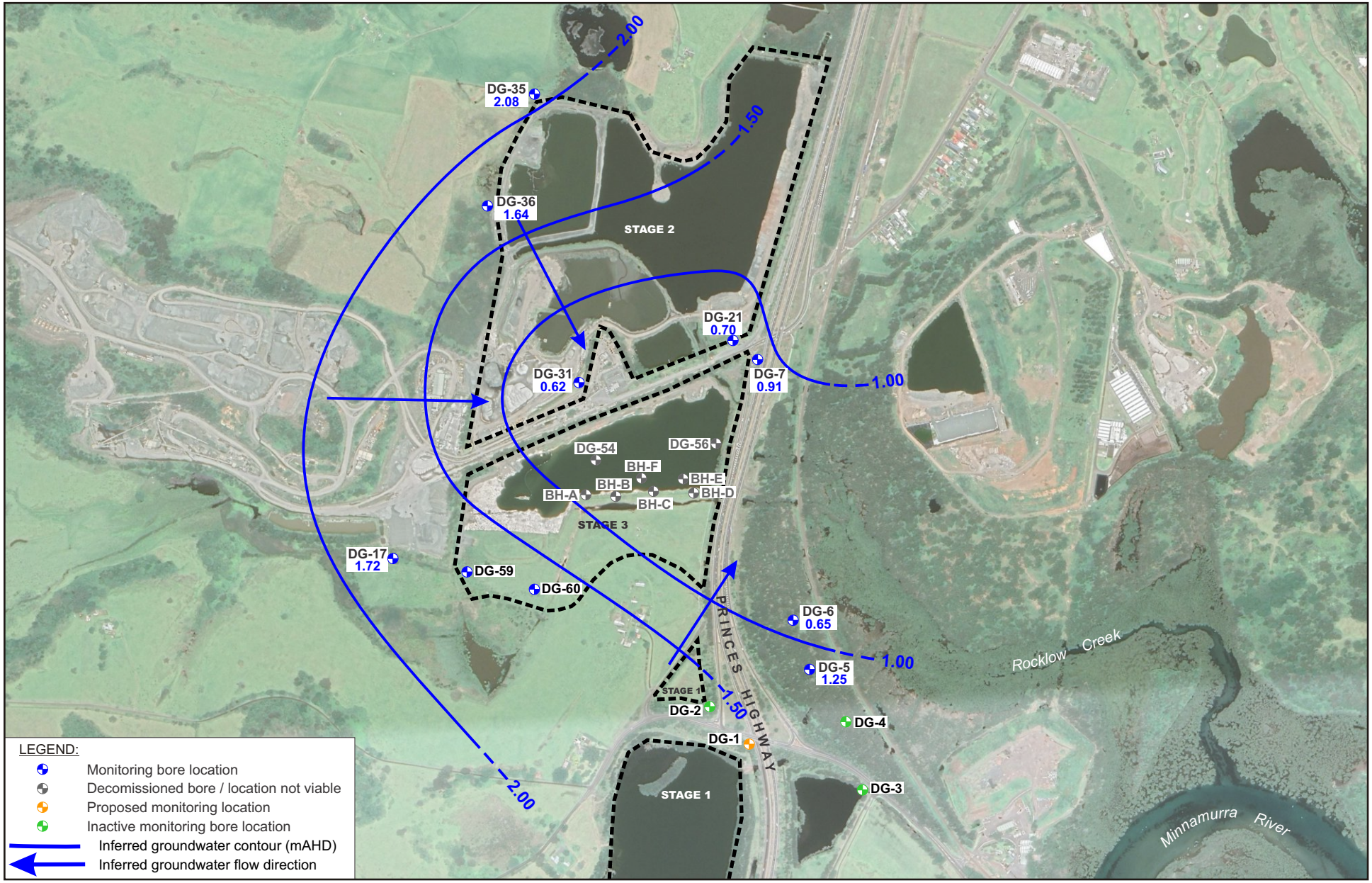
Title:	**Site Locality Map**
Location:	**Dunmore, NSW**
Client: **Dunmore Sand and Soil Pty Ltd**	Job No: **118117**
Project Man: **EG**	Scale: **As Shown**
Drawn By: **LB**	Date: **September 2019**
	Figure 1

Source: © Google Earth Pro - Imagery date 23.12.2018

0 100 200 300 400 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Site Layout and Borehole Locations**
Location:	**Dunmore, NSW**
Client: **Dunmore Sand and Soil Pty Ltd**	Job No: **118117**
Project Man: **EG**	Scale: **As Shown**
Drawn By: **LB**	Date: **September 2019**
	Figure 2

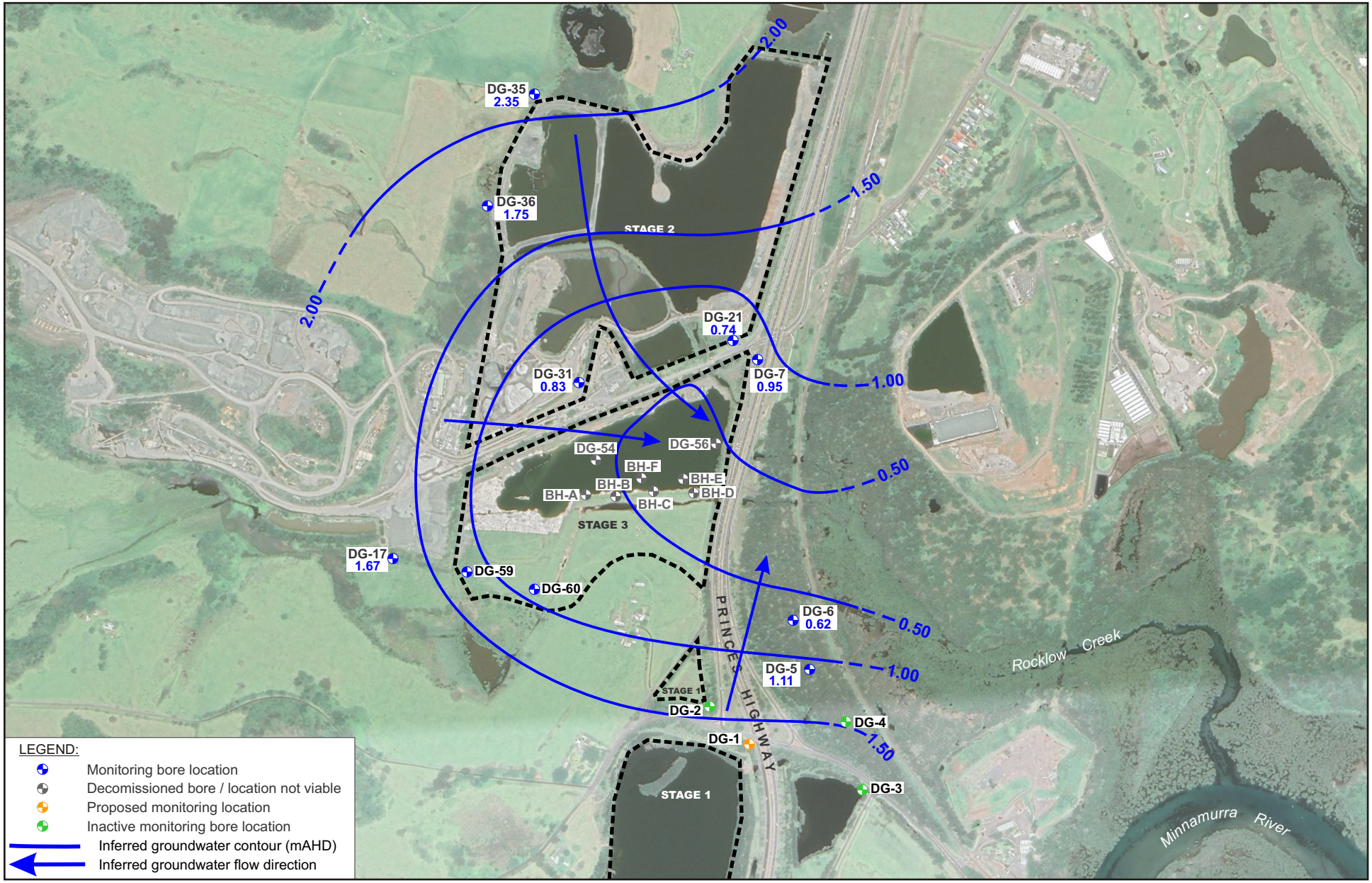


Source: © Google Earth Pro - Imagery date 23.12.2018

0 100 200 300 400 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Inferred Groundwater Contours - November 2018**
Location:	**Dunmore, NSW**
Client:	**Dunmore Sand and Soil Pty Ltd**
Job No:	**118117**
Project Man:	**EG**
Scale:	**As Shown**
Drawn By:	**LB**
Date:	**September 2019**
Figure	**3**



Source: © Google Earth Pro - Imagery date 23.12.2018

0 100 200 300 400 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Inferred Groundwater Contours - February 2019**
Location:	**Dunmore, NSW**
Client:	**Dunmore Sand and Soil Pty Ltd**
Job No:	**118117**
Project Man:	**EG**
Scale:	**As Shown**
Drawn By:	**LB**
Date:	**September 2019**
Figure	**4**

TABLES

Table 3: Results for bores west of the Princes Highway (ID: DG17, DG21, DG31, DG35, DG36, DG59) between May 2018 - Present

Analyte[1]	Units	Trigger Value		DG59				DG35				DG36				DG31			DG17			DG21		
		DA[2]	GMMP[3]	Aug-18	Nov-18	Feb-19	May-19	Aug-18	Nov-18	Feb-19	May-19	Aug-18	Nov-18	Feb-19	May-19	Nov-18	Feb-19	May-19	Nov-18	Feb-19	May-19	Nov-18	Feb-19	May-19
pH	-	6.5 – 8.5	**6.5 – 8.5**	7.0	6.8	7.1	7	6.7	6.6	6.9	6.6	6.8	6.9	7.0	6.8	6.7	6.9	6.6	7	7.2	6.9	6.3	7.2	6.3
EC	µS/cm	<1,500	**1,500**	**2,770**	**3,110**	**3,050**	**2,242**	940	925	895	1,011	**1,970**	1,030	1,080	1,089	**3,870**	**4,060**	**4,529**	**2,950**	**2,830**	**2,430**	1,280	**1,810**	**1,740**
TDS	mg/L	-	**-**	1,710	1,940	1,860	1,910	570	565	550	590	1,240	630	0	685	2,420	2,490	2,790	1,870	1,740	1,620	760	1,130	1,040
Total N	mg/L	100 – 500	**-**	2.3	1.8	1.7	2.3	1.5	1.8	4	1.9	0.6	0.3	0.2	0.1	1.4	0.6	1.3	1.8	1.6	1.5	1	1.1	0.9
Na	mg/L	400	**560**	400	385	370	405	86	82	75	91	230	125	125	130	540	**565**	**630**	440	405	365	185	260	250
K	mg/L	50	**50**	22	21	26	18	9.8	8.6	9.0	8.2	18	13	15	13	34	39	32	35	40	32	12	14	13
Mg	mg/L	50	**90**	63	72	75	72	37	33	29	33	60	29	31	35	**93**	**91**	**100**	**120**	**110**	**100**	40	64	42
Cl	mg/L	300	**1,400**	475	610	560	545	60	64	58	61	260	110	110	130	1050	1,020	1,150	540	495	420	320	530	460
Ca	mg/L	-	**-**	140	200	200	185	66	66	62	67	93	56	61	64	170	170	210	77	83	79	39	62	48
F	mg/L	-	**-**	0.51	0.39	0.45	0.51	0.20	0.16	0.19	0.16	0.35	0.4	0.17	0.41	<0.1	0.31	<0.1	0.65	0.16	0.66	0.1	0.18	0.12
Fe	mg/L	6	**3**	0.52	0.53	0.13	0.1	**26**	**20**	0.23	**13**	0.56	0.4	0.40	0.37	0.29	<0.1	0.79	0.02	0.7	0.1	1	0.1	0.7
NO_3	mg/L			<0.1	<0.1	245	0.1	<0.1	<0.1	1.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SO_4	mg/L	250	**300**	175	270	245	280	120	175	185	190	**390**	140	150	165	**490**	**490**	**610**	25	19	22	120	145	135
PO_4[5]	mg/L	5 – 50	**4**	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	0	0.12	<0.1	<0.1	<0.1	<0.1	**9.9**	**6.6**	2.1	0.58	0.13	0.13
HCO_3[6]	mg/L	750	**400**	**775**	**690**	**720**	**765**	360	260	230	265	300	295	300	320	130	130	140	**1,180**	**1,090**	**1,060**	90	98	115
NH_3N[7]	mg/L	20	**1**	<0.1	<0.1	<0.1	**1.1**	<0.1	<0.1	<0.1	**1.8**	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.3	<0.1	<0.1	0.8	<0.1	<0.1	0.3

Notes:

1. EC = Electrical Conductivity; TDS = Total Dissolved Solids; PO4 = Phosphorous; Total N = Total Nitrogen; Na = Sodium; K = Potassium; Mg = Magnesium; Cl = Chloride; Ca = Calcium; F = Fluoride; SO4 = Sulfate; HCO3 = Bicarbonate; Fe = Dissolved Iron; NH3N = Ammonia
2. DA Criteria is not site specific and outlined under Development Consent 195-8-2004 (2004), issued on 29 June 2005 for The Dunmore Lakes Sand Project (Stages 2 – 4).
3. GMMP Criteria are site-specific criteria for groundwater quality and a sub-plan to the WMP (Arcadis, 2016).
4. Elevated concentrations to site-specific GMMP criteria are **shaded and bold.**
5. Reported as Total Phosphorous in Nov '17 and Feb '18 hence not included
6. Reported as mg$CaCO_3$/L in Nov '17 and Feb '18. These results were converted to HCO_3 by multiplying mg$CaCO_3$/L by 1.219
7. Divided by 1.2 when reported as Ammonia Total to get NH_3N

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Table 4: Results for bores east of the Princes Highway (ID: DG5-S, DG5-D, DG6-S, DG6-D and DG7) between May 2018 - Present

Analyte[1]	Units	Trigger Value		DG5-S			DG5-D					DG6-S					DG6-D			DG7		
		DA[2]	GMMP[3]	May-18	Aug-18	May-19	May-18	Aug-18	Nov-18	Feb-19	May-19	May-18	Aug-18	Nov-18	Feb-19	May-19	May-18	Aug-18	May-19	Nov-18	Feb-19	May-19
pH	-	6.5 – 8.5	**6.5 – 8.5**	7.40	7.30	7.20	7.40	7.20	7.20	6.90	7.20	6.70	6.50	6.50	6.70	6.50	6.90	6.70	6.80	6.80	7.30	7.00
EC	µS/cm	<1,500	**33,000**	980	990	11020	18300	23800	17700	17000	19609	16800	16600	17500	16200	16240	25900	26100	21880	415	315	175
TDS	mg/L	-	**-**	620	630	710	11600	14900	11200	10600	13400	10300	10400	10900	10100	10800	16100	16300	15400	255	185	98
Total N	mg/L	100 – 500	**-**	<0.1	2	0.8	<0.1	6.7	1.9	2.1	3.6	<0.1	2.3	2.1	2	2.5	<0.1	2	1.2	0.9	1.1	1.3
Na	mg/L	400	**5,500**	75	88	120	2950	4280	3380	3210	3740	2500	3050	3140	3080	3270	3950	4710	4610	40	24	17
K	mg/L	50	**170**	11	7.5	10	**240**	170	140	150	**185**	**210**	135	145	155	155	**350**	**185**	**220**	6.5	3.3	3.1
Mg	mg/L	50	**420**	17	18	18	**610**	**630**	345	330	**470**	**530**	**440**	410	390	390	**960**	**655**	**550**	0.5	10	4.6
Cl	mg/L	300	**6,900**	145	170	195	6550	**8430**	6120	5610	**7240**	5550	5640	5920	5450	5750	**9180**	**8960**	**8280**	62	29	21
Ca	Ca-	-	**-**	-	120	115	-	375	200	195	280	-	200	210	200	195	-	390	300	38	28	12
F	mg/L	-	**-**	-	0.22	0.28	-	0.34	0.43	0.02	0.41	-	0.41	0.39	0.58	0.44	-	0.29	0.34	0.26	0.33	0.39
PO_4	mg/L	5 – 50	**0.7**	<0.1	<0.1	0.15	0.15	<0.1	0.12	0.41	<0.1	0.18	<0.1	<0.1	0.39	<0.1	<0.1	<0.1	<0.1	0.12	0.21	0.28
NO_3	mg/L	-	**-**	-	0.62	0.22	-	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	-	<0.1	0.71	<0.1	<0.1	<0.1
SO_4	mg/L	250	**1,170**	96	100	92	870	1010	720	750	880	650	695	690	700	740	**1320**	**1330**	1130	36	22	10
HCO_3[6]	mg/L	750	**420**	280	275	305	295	405	250	0.11	350	420	375	365	0.1	375	**440**	**465**	**435**	140	125	63
Fe	mg/L	6	**4**	0.02	0.28	0.1	0.02	0.05	0.05	0.02	0.12	1.2	1.4	1.3	0.58	0.75	**16**	4	0.13	0.1	1.1	0.31
NH_3N[7]	mg/L	20	**3**	0.33	<0.1	0.3	**3.25**	**5**	<0.1	<0.1	**3.5**	1.2	1	<0.1	<0.1	1	1.25	<0.1	0.4	<0.1	<0.1	0.3

Notes:

1. EC = Electrical Conductivity; TDS = Total Dissolved Solids; PO4 = Phosphorous; Total N = Total Nitrogen; Na = Sodium; K = Potassium; Mg = Magnesium; Cl = Chloride; Ca = Calcium; F = Fluoride; SO4 = Sulfate; HCO3 = Bicarbonate; Fe = Dissolved Iron; NH3N = Ammonia
2. DA Criteria is not site specific and outlined under Development Consent 195-8-2004 (2004), issued on 29 June 2005 for The Dunmore Lakes Sand Project (Stages 2 – 4).
3. GMMP Criteria are site-specific criteria for groundwater quality and a sub-plan to the WMP (Arcadis, 2016).
4. Elevated concentrations to site-specific criteria are **shaded and bold.**
6. Reported as mg/$CaCO_3$/L in Aug '17, Nov '17 and Feb '18. These results were converted to HCO_3 by multiplying mg/$CaCO_3$/L by 1.219
7. Divided by 1.2 when reported as Ammonia Total to get NH_3N

APPENDIX A: HYDROGRAPHS

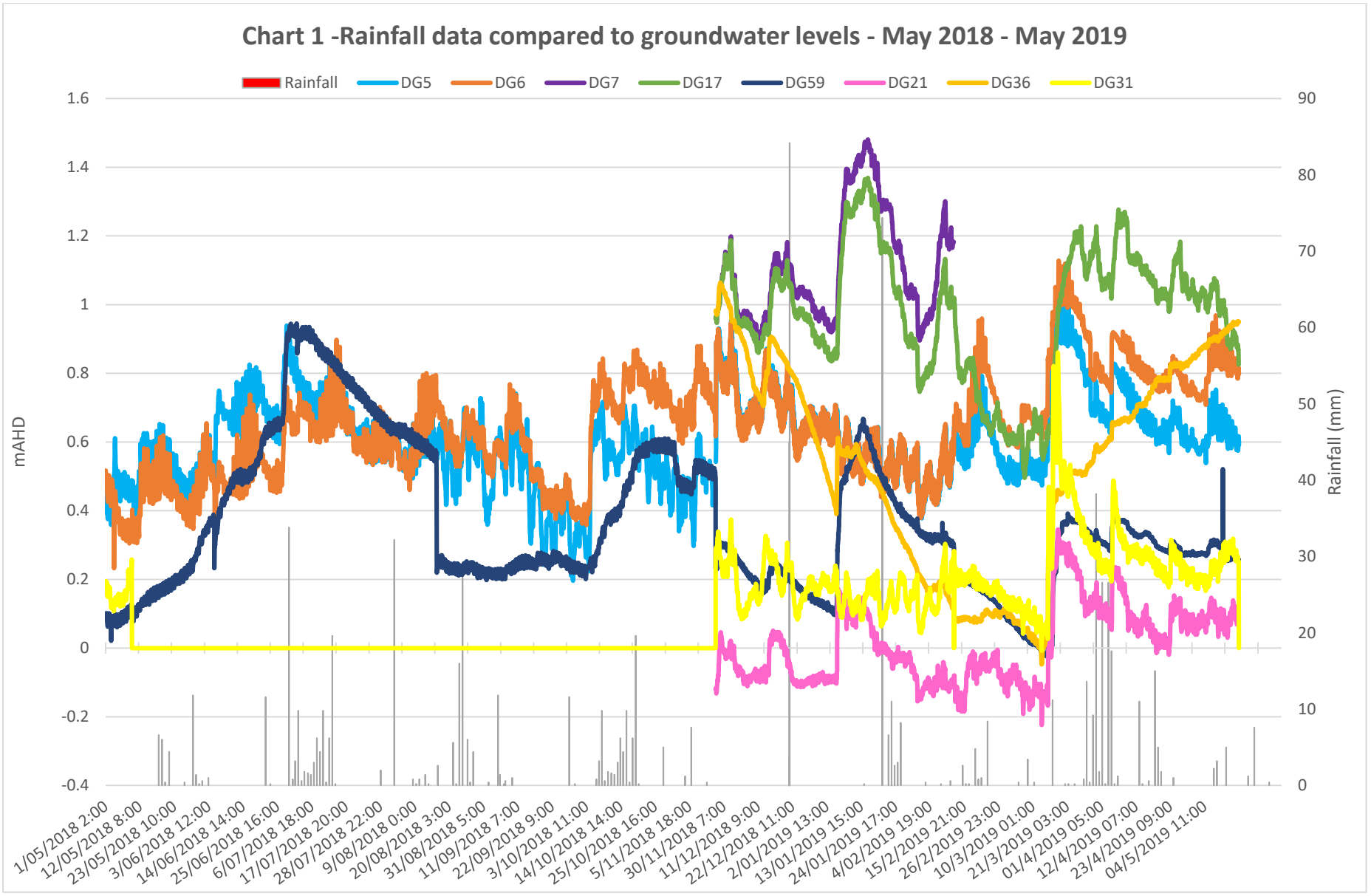
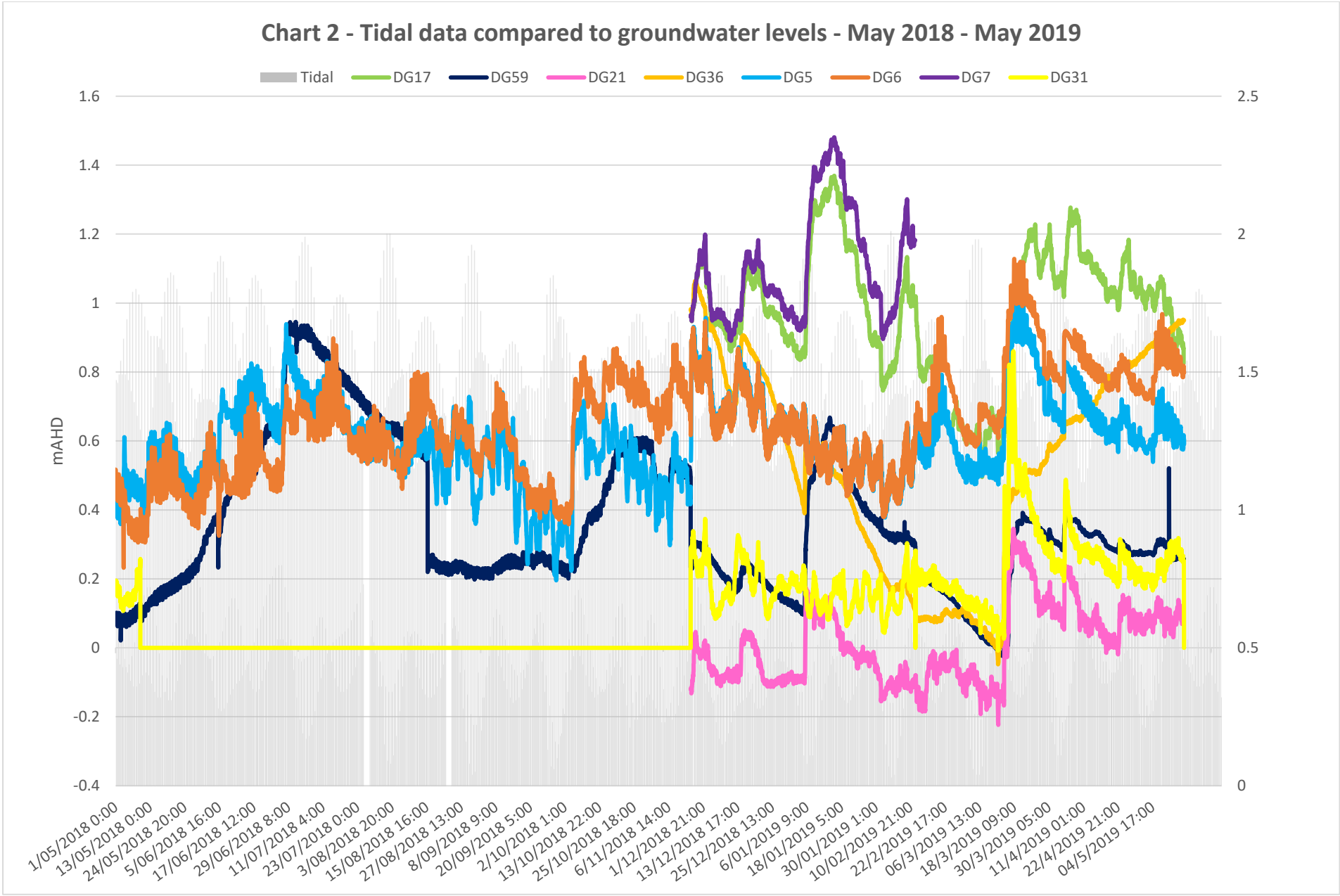


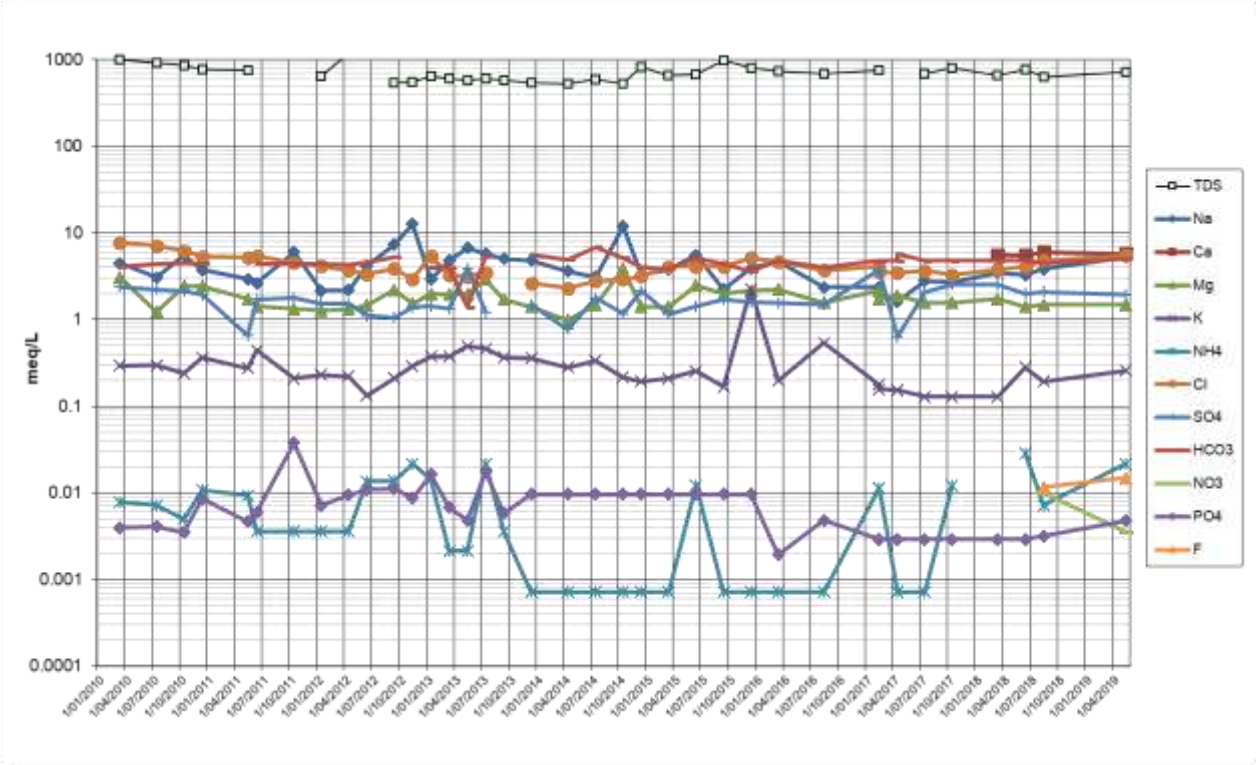
Chart 1 -Rainfall data compared to groundwater levels - May 2018 - May 2019
Rainfall
DG5
DG6
DG7
DG17
DG59
DG21
DG36
DG31
mAHD
Rainfall (mm)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
90
80
70
60
50
40
30
20
10
0
1/05/2018 2:00
12/05/2018 8:00
23/05/2018 10:00
3/06/2018 12:00
14/06/2018 14:00
25/06/2018 16:00
6/07/2018 18:00
17/07/2018 20:00
28/07/2018 22:00
9/08/2018 0:00
20/08/2018 3:00
31/08/2018 5:00
11/09/2018 7:00
22/09/2018 9:00
3/10/2018 11:00
14/10/2018 14:00
25/10/2018 16:00
5/11/2018 18:00
30/11/2018 7:00
11/12/2018 9:00
22/12/2018 11:00
2/01/2019 13:00
13/01/2019 15:00
24/01/2019 17:00
4/02/2019 19:00
15/2/2019 21:00
26/2/2019 23:00
10/3/2019 01:00
21/3/2019 03:00
01/4/2019 05:00
12/4/2019 07:00
23/4/2019 09:00
04/5/2019 11:00

Chart 2 - Tidal data compared to groundwater levels - May 2018 - May 2019

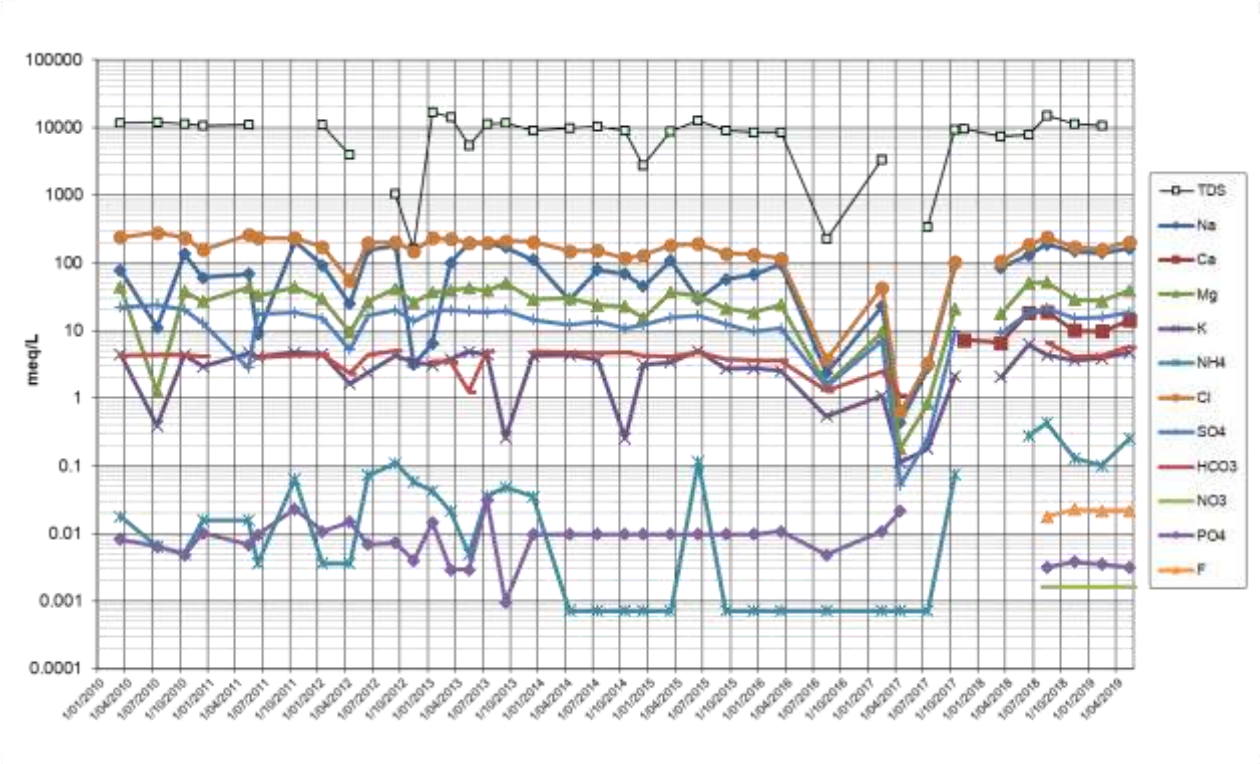


APPENDIX B: SCHOELLER PLOTS

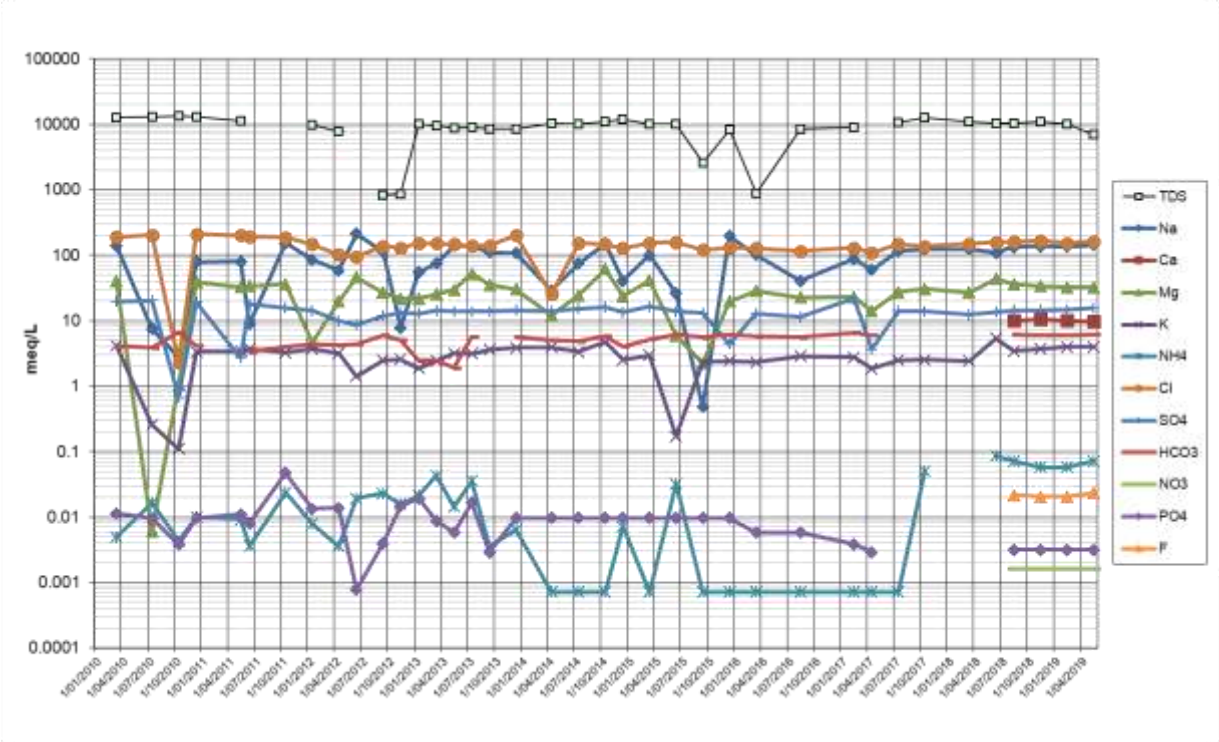
Schoeller Plot - DG-5S



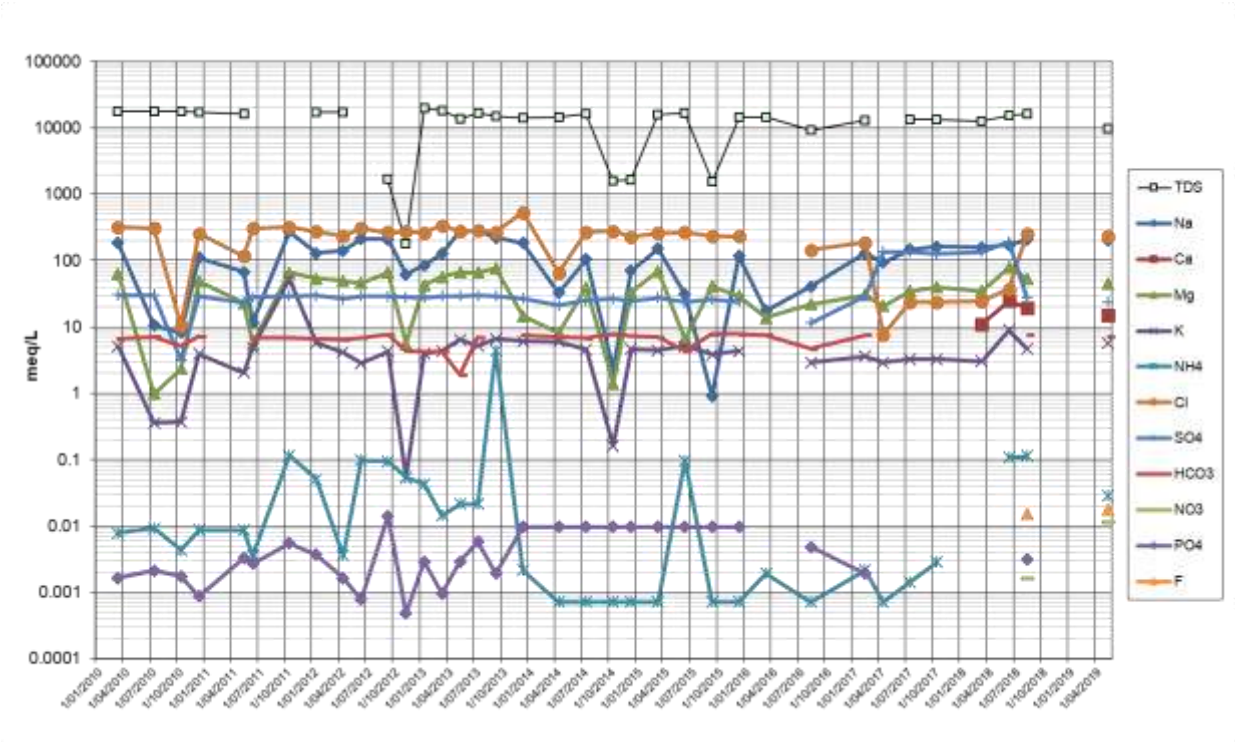
Schoeller Plot - DG-5D



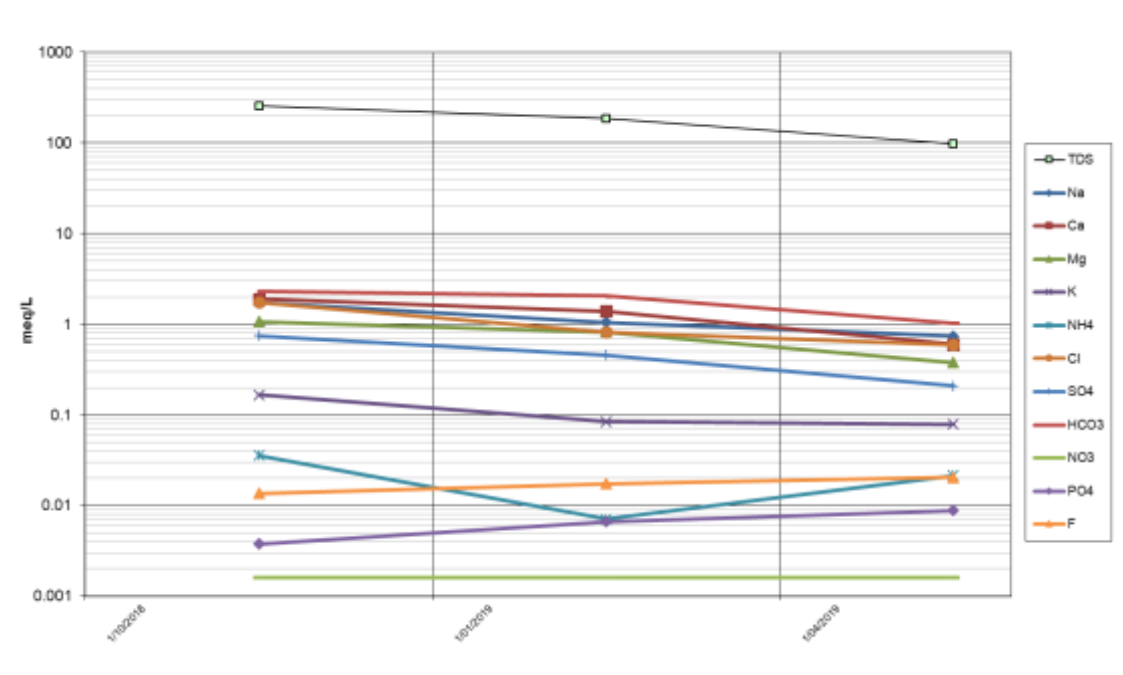
Schoeller Plot - DG-6S



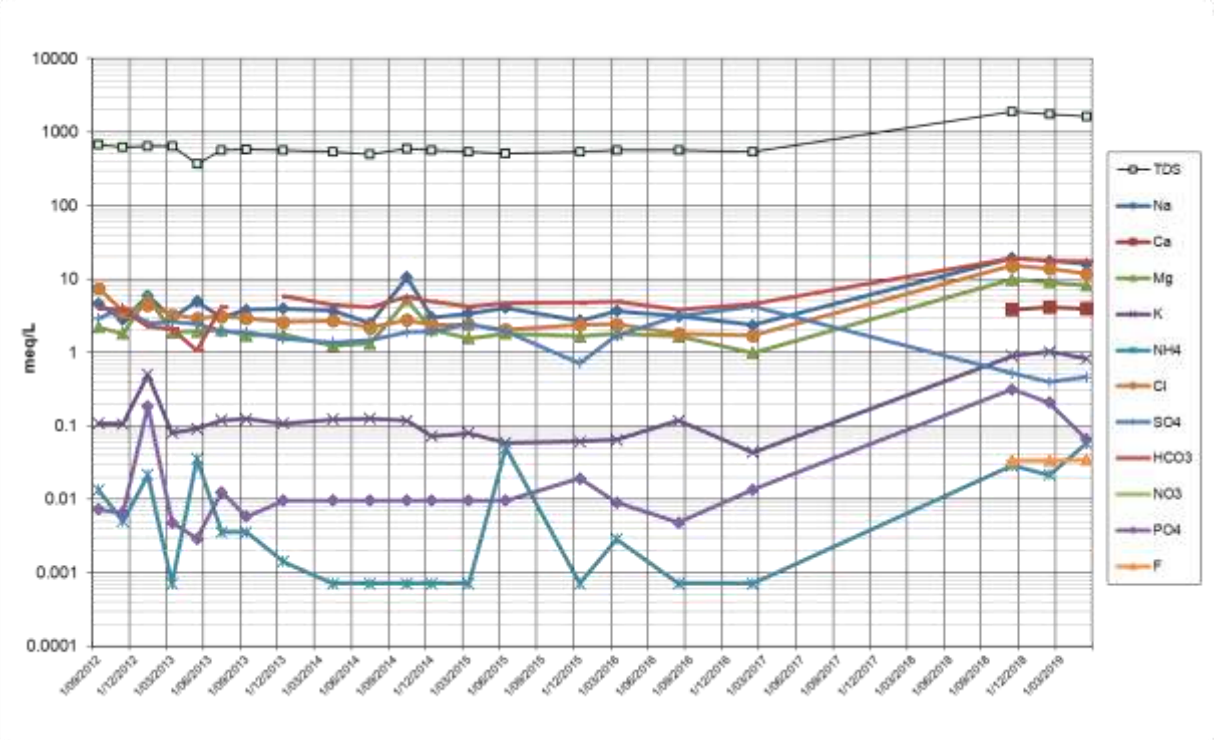
Schoeller Plot - DG-6D



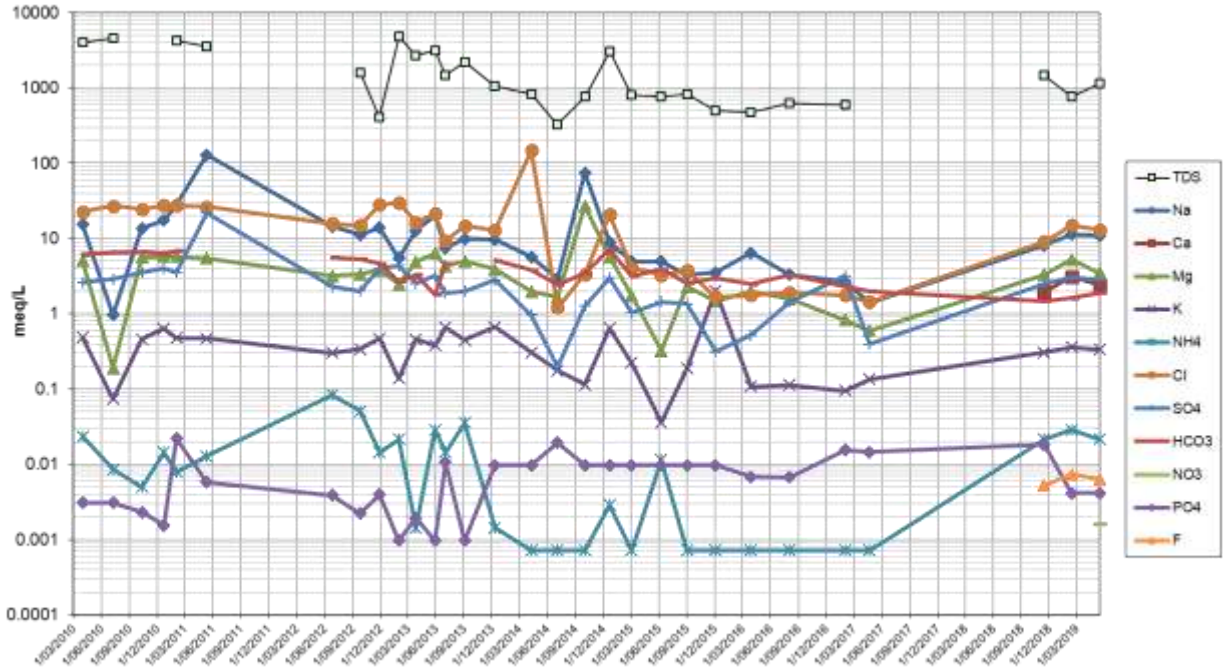
Schoeller Plot - DG-7



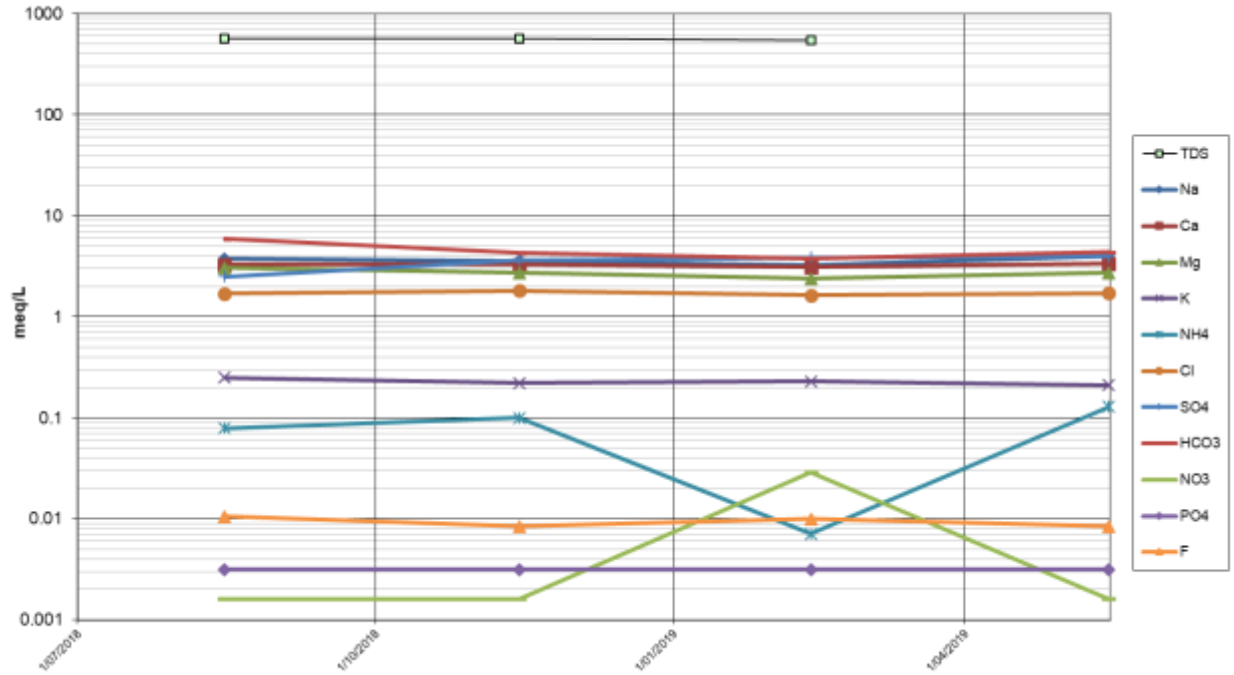
Schoeller Plot - DG-17



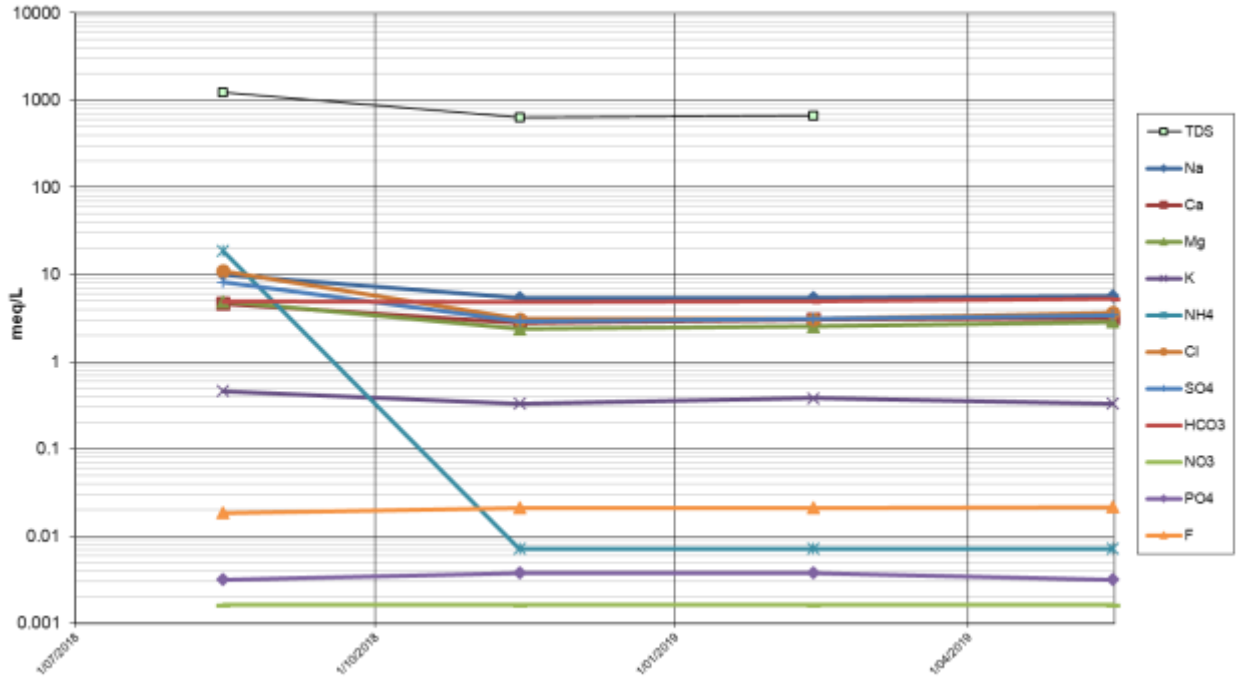
Schoeller Plot - DG-21



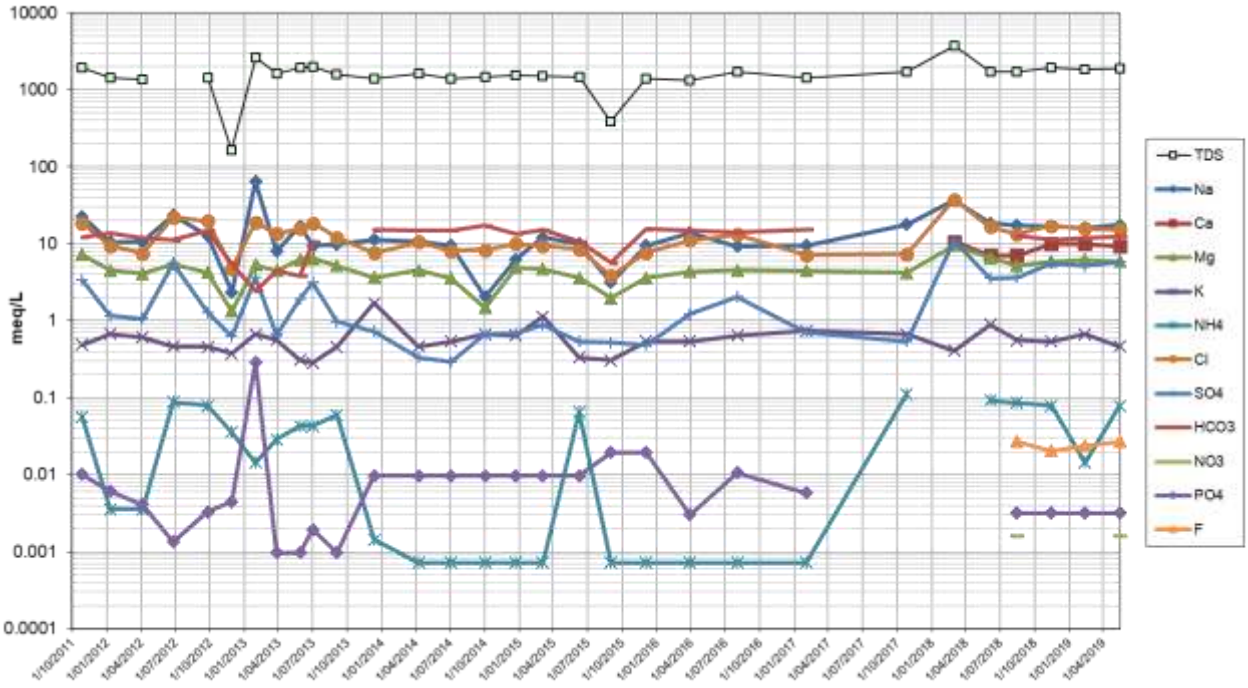
Schoeller Plot - DG-35



Schoeller Plot - DG-36



Schoeller Plot - DG-59



APPENDIX C: LABORATORY TRANSCRIPTS

SYDNEY
ANALYTICAL
LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: L.VISINTIN

JOB NO: SAL26772

CLIENT ORDER: 117053

DATE RECEIVED: 09/05/18

DATE COMPLETED: 25/05/18

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 8

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 25/05/18
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		DG5-S	DG5-D
pH		7.4	7.4
Total Dissolved Solids	mg/L	620	11600
Total Nitrogen	mg/L	2.7	4.0
Conductivity	uS/cm	980	18300
Iron (Dissolved)	mg/L	0.02	0.02

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	75	3.263	2950	128.325
Calcium Ca++	110	5.489	365	18.214
Potassium K+	11	0.282	240	6.144
Magnesium Mg++	17	1.399	610	50.203
Ammonia (Total)	0.4	0.029	3.9	0.278
TOTAL CATIONS		10.462		203.164
Chloride Cl-	145	4.089	6550	184.710
Fluoride F-	<0.1		<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	96	1.997	870	18.096
Bicarbonate HCO3-	280	4.592	295	4.838
Phosphate PO4---	<0.1		0.15	0.005
TOTAL ANIONS		10.678		207.649

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		DG6-S	DG6-D
pH		6.7	6.9
Total Dissolved Solids	mg/L	10300	16100
Total Nitrogen	mg/L	2.3	7.4
Conductivity	uS/cm	16800	25900
Iron (Dissolved)	mg/L	1.2	16

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	2500	108.750	3950	171.825
Calcium Ca++	290	14.471	495	24.701
Potassium K+	210	5.376	350	8.960
Magnesium Mg++	530	43.619	960	79.008
Ammonia (Total)	1.2	0.086	1.5	0.107
TOTAL CATIONS		172.302		284.601
Chloride Cl-	5550	156.510	9180	258.876
Fluoride F-	0.10	0.005	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	650	13.520	1320	27.456
Bicarbonate HCO3-	420	6.888	440	7.216
Phosphate PO4---	0.18	0.006	<0.1	
TOTAL ANIONS		176.929		293.548

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		BHA	DG55/BHD
pH		6.0	6.9
Total Dissolved Solids	mg/L	1220	8360
Total Nitrogen	mg/L	0.4	1.1
Conductivity	uS/cm	2060	13500
Iron (Dissolved)	mg/L	2.7	0.15

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	280	12.180	2050	89.175
Calcium Ca++	86	4.291	165	8.233
Potassium K+	17	0.435	220	5.632
Magnesium Mg++	47	3.868	435	35.801
Ammonia (Total)	0.2	0.014	0.4	0.029
TOTAL CATIONS		20.788		138.870
Chloride Cl-	590	16.638	4520	127.464
Fluoride F-	<0.1		0.13	0.007
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	150	3.120	710	14.768
Bicarbonate HCO3-	100	1.640	110	1.804
Phosphate PO4---	<0.1		0.18	0.006
TOTAL ANIONS		21.398		144.049

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18	09/05/18
SAMPLES		DG31-S	DG59
pH		6.9	7.2
Total Dissolved Solids	mg/L	1740	1920
Total Nitrogen	mg/L	4.0	2.9
Conductivity	uS/cm	2840	3000
Iron (Dissolved)	mg/L	2.1	0.04

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	330	14.355	425	18.488
Calcium Ca++	180	8.982	140	6.986
Potassium K+	24	0.614	35	0.896
Magnesium Mg++	78	6.419	80	6.584
Ammonia (Total)	2.4	0.171	1.3	0.093
TOTAL CATIONS		30.541		33.047
Chloride Cl-	620	17.484	585	16.497
Fluoride F-	<0.1		0.11	0.006
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	260	5.408	170	3.536
Bicarbonate HCO3-	430	7.052	825	13.530
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		29.944		33.569

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION		09/05/18
SAMPLES		BLANK
pH		7.1
Total Dissolved Solids	mg/L	<1
Total Nitrogen	mg/L	<0.1
Conductivity	uS/cm	0.9
Iron (Dissolved)	mg/L	<0.01

	mg/L	meq/L
Sodium Na+	<0.1	
Calcium Ca++	<0.1	
Potassium K+	<0.1	
Magnesium Mg++	<0.1	
Ammonia (Total)	<0.1	
TOTAL CATIONS		
Chloride Cl-	<1	
Fluoride F-	<0.1	
Nitrate NO3-	<0.1	
Sulphate SO4--	<2	
Bicarbonate HCO3-	<1	
Phosphate PO4---	<0.1	
TOTAL ANIONS		

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
4500B	Total Nitrogen
2510B	Conductivity
3111B	Iron (Dissolved)

SYDNEY
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A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: M.NARRACOTT

JOB NO: SAL26998

CLIENT ORDER: 118117

DATE RECEIVED: 15/11/18

DATE COMPLETED: 28/11/18

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 10

NATA Accredited for compliance with ISO/IEC 17025 Testing

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Issued on 28/11/18
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		14/11/18	14/11/18
SAMPLES		DG5-D	DG6-S
pH		7.2	6.5
Total Dissolved Solids	mg/L	11200	10900
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.9	2.1
Iron (Dissolved)	mg/L	0.05	1.3
Conductivity	uS/cm	17700	17500

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3380	147.030	3140	136.590
Calcium Ca++	200	9.980	210	10.479
Potassium K+	140	3.584	145	3.712
Magnesium Mg++	345	28.394	410	33.743
Ammonia (Total)	1.8	0.129	0.8	0.057
TOTAL CATIONS		189.117		184.581
Chloride Cl-	6120	172.584	5920	166.944
Fluoride F-	0.43	0.023	0.39	0.021
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	720	14.976	690	14.352
Bicarbonate HCO3-	250	4.100	365	5.986
Phosphate PO4---	0.12	0.004	<0.1	
TOTAL ANIONS		191.687		187.303

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		14/11/18	14/11/18
SAMPLES		DG-35	DG-36
pH		6.6	6.9
Total Dissolved Solids	mg/L	565	630
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.8	0.3
Iron (Dissolved)	mg/L	20	0.44
Conductivity	uS/cm	925	1030

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	82	3.567	125	5.438
Calcium Ca++	66	3.293	56	2.794
Potassium K+	8.6	0.220	13	0.333
Magnesium Mg++	33	2.716	29	2.387
Ammonia (Total)	1.4	0.100	<0.1	
TOTAL CATIONS		9.896		10.952
Chloride Cl-	64	1.805	110	3.102
Fluoride F-	0.16	0.008	0.40	0.021
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	175	3.640	140	2.912
Bicarbonate HCO3-	260	4.264	295	4.838
Phosphate PO4---	<0.1		0.12	0.004
TOTAL ANIONS		9.717		10.877

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		14/11/18	14/11/18
SAMPLES		DG-59	DG-7
pH		6.8	6.8
Total Dissolved Solids	mg/L	1940	255
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.8	0.9
Iron (Dissolved)	mg/L	0.53	0.10
Conductivity	uS/cm	3110	415

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	385	16.748	40	1.740
Calcium Ca++	200	9.980	38	1.896
Potassium K+	21	0.538	6.5	0.166
Magnesium Mg++	72	5.926	13	1.070
Ammonia (Total)	1.1	0.079	0.5	0.036
TOTAL CATIONS		33.271		4.908
Chloride Cl-	610	17.202	62	1.748
Fluoride F-	0.39	0.021	0.26	0.014
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	270	5.616	36	0.749
Bicarbonate HCO3-	690	11.316	140	2.296
Phosphate PO4---	<0.1		0.12	0.004
TOTAL ANIONS		34.155		4.811

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		14/11/18	15/11/18
SAMPLES		DG-17	DG-21
pH		7.0	6.3
Total Dissolved Solids	mg/L	1870	760
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.8	1.0
Iron (Dissolved)	mg/L	0.02	0.63
Conductivity	uS/cm	2950	1280

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	440	19.140	185	8.047
Calcium Ca++	77	3.842	39	1.946
Potassium K+	35	0.896	12	0.307
Magnesium Mg++	120	9.876	40	3.292
Ammonia (Total)	0.4	0.029	0.3	0.021
TOTAL CATIONS		33.783		13.613
Chloride Cl-	540	15.228	320	9.024
Fluoride F-	0.65	0.034	0.10	0.005
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	25	0.520	120	2.496
Bicarbonate HCO3-	1180	19.352	90	1.476
Phosphate PO4---	9.9	0.313	0.58	0.018
TOTAL ANIONS		35.447		13.019

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		15/11/18	15/11/18
SAMPLES		DG-31	FD1
pH		6.7	6.3
Total Dissolved Solids	mg/L	2420	780
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.4	1.0
Iron (Dissolved)	mg/L	0.29	0.65
Conductivity	uS/cm	3870	1290

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	540	23.490	190	8.265
Calcium Ca++	170	8.483	40	1.996
Potassium K+	34	0.870	12	0.307
Magnesium Mg++	93	7.654	39	3.210
Ammonia (Total)	<0.1		0.3	0.021
TOTAL CATIONS		40.497		13.799
Chloride Cl-	1050	29.610	320	9.024
Fluoride F-	<0.1		<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	490	10.192	125	2.600
Bicarbonate HCO3-	130	2.132	91	1.492
Phosphate PO4---	<0.1		0.54	0.017
TOTAL ANIONS		41.934		13.133

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		15/11/18	15/11/18
SAMPLES		DG-7 DUP	BLANK
pH		6.8	7.2
Total Dissolved Solids	mg/L	250	<1
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.1	<0.1
Iron (Dissolved)	mg/L	0.10	<0.01
Conductivity	uS/cm	420	1.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	38	1.653	<0.1	
Calcium Ca++	38	1.896	<0.1	
Potassium K+	6.2	0.159	<0.1	
Magnesium Mg++	13	1.070	<0.1	
Ammonia (Total)	0.5	0.036	<0.1	
TOTAL CATIONS		4.814		
Chloride Cl-	62	1.748	<1	
Fluoride F-	0.26	0.014	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	37	0.770	<2	
Bicarbonate HCO3-	135	2.214	<1	
Phosphate PO4---	0.14	0.004	<0.1	
TOTAL ANIONS		4.750		

LABORATORY DUPLICATE REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-7	pH		0.1	6.8	6.8	0
DG-7	TDS	mg/L	1	255	250	2
DG-7	Sodium	mg/L	0.1	40	38	5
DG-7	Calcium	mg/L	0.1	38	38	0
DG-7	Potassium	mg/L	0.1	6.5	6.2	5
DG-7	Magnesium	mg/L	0.1	13	13	0
DG-7	Chloride	mg/L	1	62	62	0
DG-7	Fluoride	mg/L	0.1	0.26	0.26	0
DG-7	Nitrate	mg/L	0.1	<0.1	<0.1	0
DG-7	Sulphate	mg/L	2	36	37	3
DG-7	Bicarbonate	mg/L	1	140	135	4
DG-7	Phosphate	mg/L	0.1	0.12	0.14	15
DG-7	Ammonia	mg/L	0.1	0.5	0.5	0
DG-7	Ammonia	mg/L	0.1	<0.1	<0.1	0
DG-7	Total Nitrogen	mg/L	0.1	0.9	1.1	20
DG-7	Fe Dissolved	mg/L	0.01	0.10	0.10	0
DG-7	Conductivity	uS/cm	0.1	415	420	1

Acceptance criteria:

RPD <50% for low level (<10xMDL)
RPD <20% for medium level (10-50xMDL)
RPD <10% for high level (>50xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
CALC.	Ammonia NH3-N
4500B	Total Nitrogen
3111B	Iron (Dissolved)
2510B	Conductivity

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NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: E.GRIFFITHS

JOB NO:	SAL27115
CLIENT ORDER:	118117
DATE RECEIVED:	14/02/19
DATE COMPLETED:	05/03/19
TYPE OF SAMPLES:	WATERS
NO OF SAMPLES:	10

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 05/03/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION		12/02/19	12/02/19
SAMPLES		DG5-D	DG6-S
pH		6.9	6.7
Total Dissolved Solids	mg/L	10600	10100
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	2.1	2.0
Iron (Dissolved)	mg/L	0.02	0.58
Conductivity	uS/cm	17000	16200

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3210	139.635	3080	133.980
Calcium Ca++	195	9.730	200	9.980
Potassium K+	150	3.840	155	3.968
Magnesium Mg++	330	27.159	390	32.097
Ammonia (Total)	1.4	0.100	0.8	0.057
TOTAL CATIONS		180.464		180.082
Chloride Cl-	5610	158.202	5450	153.690
Fluoride F-	0.41	0.022	0.39	0.021
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	750	15.600	700	14.560
Bicarbonate HCO3-	255	4.182	365	5.986
Phosphate PO4---	0.11	0.003	0.10	0.003
TOTAL ANIONS		178.009		174.260

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION		12/02/19	12/02/19
SAMPLES		DG-35	DG-36
pH		6.9	7.0
Total Dissolved Solids	mg/L	550	660
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	4.0	0.2
Iron (Dissolved)	mg/L	0.23	0.17
Conductivity	uS/cm	895	1080

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	75	3.263	125	5.438
Calcium Ca++	62	3.094	61	3.044
Potassium K+	9.0	0.230	15	0.384
Magnesium Mg++	29	2.387	31	2.551
Ammonia (Total)	<0.1		<0.1	
TOTAL CATIONS		8.974		11.417
Chloride Cl-	58	1.636	110	3.102
Fluoride F-	0.19	0.010	0.40	0.021
Nitrate NO3-	1.8	0.029	<0.1	
Sulphate SO4--	185	3.848	150	3.120
Bicarbonate HCO3-	230	3.772	300	4.920
Phosphate PO4---	<0.1		0.12	0.004
TOTAL ANIONS		9.295		11.167

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION		12/02/19	12/02/19
SAMPLES		DG-59	DG-7
pH		7.1	7.3
Total Dissolved Solids	mg/L	1860	185
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.7	1.1
Iron (Dissolved)	mg/L	0.13	1.1
Conductivity	uS/cm	3050	315

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	370	16.095	24	1.044
Calcium Ca++	200	9.980	28	1.397
Potassium K+	26	0.666	3.3	0.084
Magnesium Mg++	75	6.172	10	0.823
Ammonia (Total)	0.2	0.014	<0.1	
TOTAL CATIONS		32.927		3.348
Chloride Cl-	560	15.792	29	0.818
Fluoride F-	0.45	0.024	0.33	0.017
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	245	5.096	22	0.458
Bicarbonate HCO3-	720	11.808	125	2.050
Phosphate PO4---	<0.1		0.21	0.007
TOTAL ANIONS		32.720		3.350

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION		12/02/19	12/02/19
SAMPLES		DG-17	DG-21
pH		7.2	7.2
Total Dissolved Solids	mg/L	1740	1130
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.6	1.1
Iron (Dissolved)	mg/L	0.16	0.18
Conductivity	uS/cm	2830	1810

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	405	17.618	260	11.310
Calcium Ca++	83	4.142	62	3.094
Potassium K+	40	1.024	14	0.358
Magnesium Mg++	110	9.053	64	5.267
Ammonia (Total)	0.3	0.021	0.4	0.029
TOTAL CATIONS		31.858		20.058
Chloride Cl-	495	13.959	530	14.946
Fluoride F-	0.65	0.034	0.14	0.007
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	19	0.395	145	3.016
Bicarbonate HCO3-	1090	17.876	98	1.607
Phosphate PO4---	6.6	0.209	0.13	0.004
TOTAL ANIONS		32.473		19.580

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION		12/02/19	12/02/19
SAMPLES		DG-31	FD1
pH		6.9	7.3
Total Dissolved Solids	mg/L	2490	1730
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	0.6	1.8
Iron (Dissolved)	mg/L	0.31	0.14
Conductivity	uS/cm	4060	2820

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	565	24.578	400	17.400
Calcium Ca++	170	8.483	81	4.042
Potassium K+	39	0.998	42	1.075
Magnesium Mg++	91	7.489	115	9.464
Ammonia (Total)	<0.1		0.3	0.021
TOTAL CATIONS		41.548		32.002
Chloride Cl-	1020	28.764	490	13.818
Fluoride F-	<0.1		0.62	0.033
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	490	10.192	17	0.354
Bicarbonate HCO3-	130	2.132	1120	18.368
Phosphate PO4---	<0.1		7.0	0.221
TOTAL ANIONS		41.088		32.794

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION		12/02/19	12/02/19
SAMPLES		DG-31 DUP	BLANK
pH		7.0	7.2
Total Dissolved Solids	mg/L	2460	<1
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	0.5	<0.1
Iron (Dissolved)	mg/L	0.33	<0.01
Conductivity	uS/cm	4080	1.2

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	555	24.143	<0.1	
Calcium Ca++	175	8.733	<0.1	
Potassium K+	38	0.973	<0.1	
Magnesium Mg++	90	7.407	<0.1	
Ammonia (Total)	<0.1		<0.1	
TOTAL CATIONS		41.256		
Chloride Cl-	1010	28.482	<1	
Fluoride F-	<0.1		<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	500	10.400	<2	
Bicarbonate HCO3-	125	2.050	<1	
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		40.932		

SYDNEY ANALYTICAL LABORATORIES

LABORATORY DUPLICATE REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-31	pH		0.1	6.9	7.0	1
DG-31	TDS	mg/L	1	2490	2460	1
DG-31	Sodium	mg/L	0.1	565	555	2
DG-31	Calcium	mg/L	0.1	170	175	3
DG-31	Potassium	mg/L	0.1	39	38	3
DG-31	Magnesium	mg/L	0.1	91	90	1
DG-31	Chloride	mg/L	1	1020	1010	1
DG-31	Fluoride	mg/L	0.1	<0.1	<0.1	0
DG-31	Nitrate	mg/L	0.1	<0.1	<0.1	0
DG-31	Sulphate	mg/L	2	490	500	2
DG-31	Bicarbonate	mg/L	1	130	125	4
DG-31	Phosphate	mg/L	0.1	<0.1	<0.1	0
DG-31	Ammonia	mg/L	0.1	<0.1	<0.1	0
DG-31	Ammonia	mg/L	0.1	<0.1	<0.1	0
DG-31	Total Nitrogen	mg/L	0.1	0.6	0.5	17
DG-31	Fe Dissolved	mg/L	0.01	0.31	0.33	6
DG-31	Conductivity	uS/cm	0.1	4060	4080	0

Acceptance criteria:

RPD <50% for low level (<10xMDL)
RPD <20% for medium level (10-50xMDL)
RPD <10% for high level (>50xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
CALC.	Ammonia NH3-N
4500B	Total Nitrogen
3111B	Iron (Dissolved)
2510B	Conductivity

SYDNEY
ANALYTICAL
LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
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A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: E.GRIFFITHS

JOB NO:	SAL27215
CLIENT ORDER:	119037
DATE RECEIVED:	17/05/19
DATE COMPLETED:	31/05/19
TYPE OF SAMPLES:	WATERS
NO OF SAMPLES:	17

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 31/05/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG5-S	DG5-D
pH		7.2	7.2
Total Dissolved Solids	mg/L	710	13400
Total Nitrogen	mg/L	0.8	3.6
Iron	mg/L	0.10	0.12
Manganese	mg/L	0.18	0.32
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	120	5.220	3740	162.690
Calcium Ca++	115	5.739	280	13.972
Potassium K+	10	0.256	185	4.736
Magnesium Mg++	18	1.481	470	38.681
Ammonia (Total)	0.3	0.021	3.5	0.250
TOTAL CATIONS		12.717		220.329
Chloride Cl-	195	5.499	7240	204.168
Fluoride F-	0.28	0.015	0.41	0.022
Nitrate NO3-	0.22	0.004	<0.1	
Sulphate SO4--	92	1.914	880	18.304
Bicarbonate HCO3-	305	5.002	350	5.740
Phosphate PO4---	0.15	0.005	<0.1	
TOTAL ANIONS		12.439		228.234

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG6-S	DG6-D
pH		6.5	6.8
Total Dissolved Solids	mg/L	10800	15400
Total Nitrogen	mg/L	2.5	1.2
Iron	mg/L	0.75	0.13
Manganese	mg/L	0.56	1.1
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3270	142.245	4610	200.535
Calcium Ca++	195	9.730	300	14.970
Potassium K+	155	3.968	220	5.632
Magnesium Mg++	390	32.097	550	45.265
Ammonia (Total)	1.0	0.071	0.4	0.029
TOTAL CATIONS		188.111		266.431
Chloride Cl-	5750	162.150	8280	233.496
Fluoride F-	0.44	0.023	0.34	0.018
Nitrate NO3-	<0.1		0.71	0.011
Sulphate SO4--	740	15.392	1130	23.504
Bicarbonate HCO3-	375	6.150	435	7.134
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		183.715		264.163

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG-7	DG-17
pH		7.0	6.9
Total Dissolved Solids	mg/L	98	1620
Total Nitrogen	mg/L	1.3	1.5
Iron	mg/L	0.31	0.11
Manganese	mg/L	0.13	0.70
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	17	0.739	365	15.878
Calcium Ca++	12	0.599	79	3.942
Potassium K+	3.1	0.079	32	0.819
Magnesium Mg++	4.6	0.379	100	8.230
Ammonia (Total)	0.3	0.021	0.8	0.057
TOTAL CATIONS		1.817		28.926
Chloride Cl-	21	0.592	420	11.844
Fluoride F-	0.39	0.021	0.66	0.035
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	10	0.208	22	0.458
Bicarbonate HCO3-	63	1.033	1060	17.384
Phosphate PO4---	0.28	0.009	2.1	0.066
TOTAL ANIONS		1.863		29.787

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG-21	DG-31
pH		6.3	6.6
Total Dissolved Solids	mg/L	1040	2790
Total Nitrogen	mg/L	0.9	1.3
Iron	mg/L	0.67	0.79
Manganese	mg/L	1.4	0.03
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	250	10.875	630	27.405
Calcium Ca++	48	2.395	210	10.479
Potassium K+	13	0.333	32	0.819
Magnesium Mg++	42	3.457	100	8.230
Ammonia (Total)	0.3	0.021	0.3	0.021
TOTAL CATIONS		17.081		46.954
Chloride Cl-	460	12.972	1150	32.430
Fluoride F-	0.12	0.006	<0.1	
Nitrate NO3-	<0.1		0.18	0.003
Sulphate SO4--	135	2.808	610	12.688
Bicarbonate HCO3-	115	1.886	140	2.296
Phosphate PO4---	0.13	0.004	<0.1	
TOTAL ANIONS		17.676		47.417

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG-35	DG-36
pH		6.6	6.8
Total Dissolved Solids	mg/L	590	685
Total Nitrogen	mg/L	1.9	0.1
Iron	mg/L	13	0.37
Manganese	mg/L	1.4	0.55
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	91	3.959	130	5.655
Calcium Ca++	67	3.343	64	3.194
Potassium K+	8.2	0.210	13	0.333
Magnesium Mg++	33	2.716	35	2.881
Ammonia (Total)	1.8	0.129	0.1	0.007
TOTAL CATIONS		10.357		12.070
Chloride Cl-	61	1.720	130	3.666
Fluoride F-	0.16	0.008	0.41	0.022
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	190	3.952	165	3.432
Bicarbonate HCO3-	265	4.346	320	5.248
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		10.026		12.368

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG-36 DUP	DG-59
pH		6.8	7.0
Total Dissolved Solids	mg/L	700	1910
Total Nitrogen	mg/L	0.2	2.3
Iron	mg/L	0.35	0.10
Manganese	mg/L	0.52	0.55
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	135	5.873	405	17.618
Calcium Ca++	64	3.194	185	9.232
Potassium K+	12	0.307	18	0.461
Magnesium Mg++	34	2.798	72	5.926
Ammonia (Total)	0.1	0.007	1.1	0.079
TOTAL CATIONS		12.179		33.316
Chloride Cl-	135	3.807	545	15.369
Fluoride F-	0.41	0.022	0.51	0.027
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	160	3.328	280	5.824
Bicarbonate HCO3-	325	5.330	765	12.546
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		12.487		33.766

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		FD2	MW5A1
pH		6.5	6.2
Total Dissolved Solids	mg/L	11000	115
Total Nitrogen	mg/L	2.1	3.2
Iron	mg/L	0.78	0.24
Manganese	mg/L	0.54	<0.01
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3300	143.550	11	0.479
Calcium Ca++	200	9.980	20	0.998
Potassium K+	155	3.968	2.9	0.074
Magnesium Mg++	380	31.274	4.3	0.354
Ammonia (Total)	1.0	0.071	<0.1	
TOTAL CATIONS		188.843		1.905
Chloride Cl-	5840	164.688	29	0.818
Fluoride F-	0.44	0.023	<0.1	
Nitrate NO3-	<0.1		11	0.177
Sulphate SO4--	750	15.600	14	0.291
Bicarbonate HCO3-	375	6.150	36	0.590
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		186.461		1.876

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		MW5A3	MW5B2-S
pH		6.7	7.3
Total Dissolved Solids	mg/L	660	450
Total Nitrogen	mg/L	2.3	1.4
Iron	mg/L	6.0	0.65
Manganese	mg/L	0.17	0.10
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	130	5.655	52	2.262
Calcium Ca++	81	4.042	94	4.691
Potassium K+	4.8	0.123	3.3	0.084
Magnesium Mg++	17	1.399	12	0.988
Ammonia (Total)	1.1	0.079	0.4	0.029
TOTAL CATIONS		11.298		8.054
Chloride Cl-	295	8.319	50	1.410
Fluoride F-	0.18	0.009	0.18	0.009
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	16	0.333	42	0.874
Bicarbonate HCO3-	185	3.034	360	5.904
Phosphate PO4---	0.18	0.006	<0.1	
TOTAL ANIONS		11.701		8.197

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		MW5B2-D	MW5B4
pH		7.4	7.4
Total Dissolved Solids	mg/L	360	460
Total Nitrogen	mg/L	0.8	1.8
Iron	mg/L	0.10	0.21
Manganese	mg/L	0.09	0.06
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	38	1.653	45	1.958
Calcium Ca++	75	3.743	110	5.489
Potassium K+	3.6	0.092	2.7	0.069
Magnesium Mg++	13	1.070	10	0.823
Ammonia (Total)	0.6	0.043	0.1	0.007
TOTAL CATIONS		6.601		8.346
Chloride Cl-	52	1.466	36	1.015
Fluoride F-	0.17	0.009	0.23	0.012
Nitrate NO3-	<0.1		0.18	0.003
Sulphate SO4--	13	0.270	10	0.208
Bicarbonate HCO3-	300	4.920	450	7.380
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		6.665		8.618

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		MW5B4 DUP	BLANK
pH		7.4	7.3
Total Dissolved Solids	mg/L	450	<1
Total Nitrogen	mg/L	1.8	<0.1
Iron	mg/L	0.20	<0.01
Manganese	mg/L	0.07	<0.01
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	48	2.088	<0.1	
Calcium Ca++	105	5.240	<0.1	
Potassium K+	3.0	0.077	<0.1	
Magnesium Mg++	9.6	0.790	<0.1	
Ammonia (Total)	0.1	0.007	<0.1	
TOTAL CATIONS		8.202		
Chloride Cl-	36	1.015	<1	
Fluoride F-	0.22	0.012	<0.1	
Nitrate NO3-	0.18	0.003	<0.1	
Sulphate SO4--	9	0.187	<2	
Bicarbonate HCO3-	445	7.298	<1	
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		8.515		

LABORATORY DUPLICATE REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-36	pH		0.1	6.8	6.8	0
MW5B4	pH		0.1	7.4	7.4	0
DG-36	TDS	mg/L	1	685	700	2
MW5B4	TDS	mg/L	1	460	450	2
DG-36	Sodium	mg/L	0.1	130	135	4
MW5B4	Sodium	mg/L	0.1	45	48	6
DG-36	Calcium	mg/L	0.1	64	64	0
MW5B4	Calcium	mg/L	0.1	110	105	5
DG-36	Potassium	mg/L	0.1	13	12	8
MW5B4	Potassium	mg/L	0.1	2.7	3.0	10
DG-36	Magnesium	mg/L	0.1	35	34	3
MW5B4	Magnesium	mg/L	0.1	10	9.6	4
DG-36	Chloride	mg/L	1	130	135	4
MW5B4	Chloride	mg/L	1	36	36	0
DG-36	Fluoride	mg/L	0.1	0.41	0.41	0
MW5B4	Fluoride	mg/L	0.1	0.23	0.22	4
DG-36	Nitrate	mg/L	0.1	<0.1	<0.1	0
MW5B4	Nitrate	mg/L	0.1	0.18	0.18	0
DG-36	Sulphate	mg/L	2	165	160	3
MW5B4	Sulphate	mg/L	2	10	9	10
DG-36	Bicarbonate	mg/L	1	320	325	2
MW5B4	Bicarbonate	mg/L	1	450	445	1
DG-36	Phosphate	mg/L	0.1	<0.1	<0.1	0
MW5B4	Phosphate	mg/L	0.1	<0.1	<0.1	0
DG-36	Ammonia	mg/L	0.1	0.1	0.1	0
MW5B4	Ammonia	mg/L	0.1	0.1	0.1	0
DG-36	Total Nitrogen	mg/L	0.1	0.1	0.2	50
MW5B4	Total Nitrogen	mg/L	0.1	1.8	1.8	0
DG-36	Iron	mg/L	0.01	0.37	0.35	6
MW5B4	Iron	mg/L	0.01	0.21	0.20	5

LABORATORY DUPLICATE REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-36	Manganese	mg/L	0.01	0.55	0.52	6
MW5B4	Manganese	mg/L	0.01	0.06	0.07	14
DG-36	Aluminium	mg/L	0.1	<0.1	<0.1	0
MW5B4	Aluminium	mg/L	0.1	<0.1	<0.1	0

Acceptance criteria:

RPD <50% for low level (<10xMDL)
RPD <20% for medium level (10-50xMDL)
RPD <10% for high level (>50xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
4500B	Total Nitrogen
3111B	Iron
3111B	Manganese
3111D	Aluminium