



REPORT

HYDROGEOLOGICAL

ASSESSMENT

**27782 HUME HIGHWAY, BOWNING, NSW,
LOT 172 DEPOSITED PLAN 649063**

Prepared For: **Barker Group**
Project Number: **ENRS0978**
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EXECUTIVE SUMMARY

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent groundwater consultants in March 2018 to prepare a hydrogeological assessment (HA) at Lot 172 DP 649063, 27782 Hume Highway, Bowning, NSW, 2582 (herein referred to as the Site).

ENRS understand this HA is required to document the groundwater supply at the Site in anticipation of development of a Road Side Service Centre. The Centre will not be connected to the Yass Shire reticulation system. The proposal is to utilise groundwater at the Site to meet the design peak daily demand of approximately 20 Kilolitres per day.

Test drilling during the scope of work culminated in the construction and airlift testing of one (1) proposed production bore. The bore has intersected fractured and porous rock aquifers at depths between 48 and 115 metres with a cumulative yield up to 1.7 L/s, which exceeds the project requirements. The proposal is to licence the bore for domestic, commercial and industrial purposes.

This report documents the findings of a hydrogeological assessment incorporating aquifer testing (drillers airlift) in general accordance with requirements for water bores outlined by the *NSW Office of Water (NOW)* and consistent with the spirit and principles of the *NSW State Groundwater Policy Framework Document* (NSW Government 1997), the *NSW State Groundwater Quality Protection Policy* (NSW Government 1998) and the *NSW State Groundwater Dependent Ecosystems Policy* (NSW Government 2002).

The project objectives were to prepare a site specific hydrogeological assessment to document the hydrogeological setting and aquifer properties, and provide an assessment if the test bore is capable of meeting the project water supply requirements water Provide recommendations on potential yields, sustainable pumping regimes and assess potential impacts in support the proposed development.

A hydrogeological assessment was conducted for the site by undertaking the following scope of work:

- Pre-commencement groundwater target study - desktop review of available site data including; previous reports (if any); aerial photographs; geological and topographic maps; registered bore records;
- Review of the site proposal, water demand and operational requirements;
- Site inspection, check licensing requirements for distance setbacks and peg drilling targets;
- Prepare and lodge test bore drilling licences with NOW;
- Drill and construct test bore by licensed driller. Log cuttings and record details of aquifer intercepts. Conduct a minimum two (2) hour airlift to measure cumulative bore yield;

- Collect representative water samples upon completion of air lifting and submit samples for NATA accredited laboratory analysis. Tabulate and compare the laboratory results against the Australian Drinking Water Guidelines (ADWG);
- Review the drilling results and hydrogeological setting. Identify any potential impacts from the proposed bore operations on existing bores, groundwater users (if any) and groundwater dependent ecosystems (GDEs), if any; and
- Compile the investigation results, prepare a hydrogeological report including recommendations for bore licensing, groundwater management, and pumping regimes.

Based on the findings obtained during the scope of work the following conclusions and recommendations may be made:

- The subject bore was drilled and constructed by *Bungendore Water Bores* in April 2018. The bore was drilled to a depth of 120 m with a 5 metres clay sanitary seal at the surfaces to prevent ingress of any shallow soil water. The bore was completed with slotted PVC casing and gravel packed in general accordance with the *Minimum Construction Requirements for Water Bores in Australia – 3rd Edition* (2012). A summary of the bore construction, aquifer intercepts and drillers airlift is provided in **Table 6**;
- The bore was subject to a three (3) hour airlift test to assess the capable yield and meet NOW testing requirements for water bores. The results indicate the subject bore is capable of sustaining the following yield and recommended pumping regime:
 - **Bore 1** - up to 1.5 L/s; 10hrs Pumping; 14hrs Recovery; 20 ML per year at 40% duty. A higher pump duty may be realised supported by monitoring of pumping performance and recovery rates.
- The proposal is to convert the test bore to a production bore with a commercial, industrial and domestic groundwater access licence with an entitlement of **20ML** to facilitate the proposed development and anticipated demand. ENRS understands a contract has been approved for the purchase of a 20ML Water Access Licence (WAL) within the Goulburn Fractured Rock Groundwater source;
- Based on the capable yield the recommended pumping regime is considered low risk for groundwater impacts. No registered water bores are present within a 1 km radius of the site and similarly no GDEs were identified at the Site area. Hence, it is assessed that under the proposed operating regimes the bores will have no significant measurable impact on the groundwater environment and existing users in the area;
- The NATA accredited laboratory CoA provided in Appendix B documents the groundwater bore quality is suitable for the proposed use with salinity measured as TDS 392 mg/L which is low and within the drinking water guidelines;

- This hydrogeological assessment concludes the bore has a capable yield of 20 ML operating at 40% pump duty, supported by significant fractured rock and regional scale aquifers with an extensive recharge zone in an area with no competing existing groundwater users; and
- The drillers airlift reports the bore has a capable yield in excess of the project requirements and a suitable WAL has been secured for 20ML to support the site proposal.

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1.0 INTRODUCTION

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1.1 OBJECTIVES

The project objectives were to prepare a site specific hydrogeological assessment to document the hydrogeological setting and aquifer properties, and provide an assessment if the test bore is capable of meeting the project water supply requirements

water Provide recommendations on potential yields, sustainable pumping regimes and assess potential impacts in support the proposed development.

1.2 SCOPE OF WORK

A hydrogeological assessment was conducted for the site by undertaking the following scope of work:

- Pre-commencement groundwater target study - desktop review of available site data including; previous reports (if any); aerial photographs; geological and topographic maps; registered bore records;
- Review of the site proposal, water demand and operational requirements;
- Site inspection, check licensing requirements for distance setbacks and peg drilling targets;
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- Compile the investigation results, prepare a hydrogeological report including recommendations for bore licensing, groundwater management, and pumping regimes.

2.0 SITE DESCRIPTION

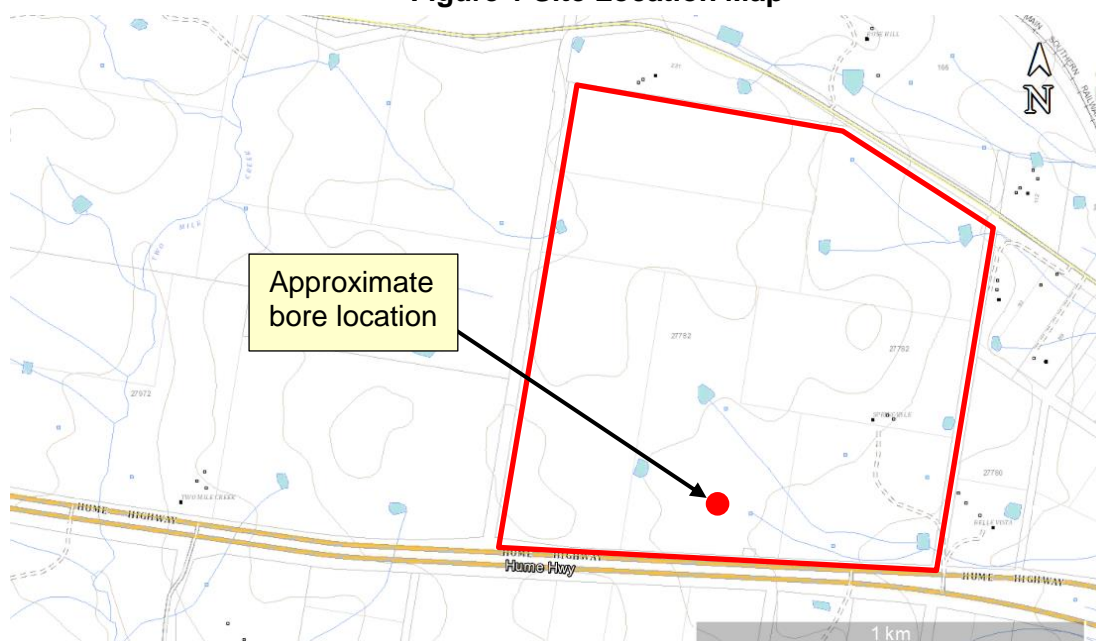
2.1 LOCATION

The Site is located approximately two (2) kilometres west of the Township in Bowning in the Southern Tablelands of NSW. The site location is shown in Error! Reference source not found.. The key features required to identify the Site are summarised in **Table 1**.

Table 1: Site Identification

SITE	DESCRIPTION
Street Address	27782 Hume Highway, Bowning, NSW, 2582
Lot / Deposited Plan	172 / 649063
Local Government Area	Yass Valley
Water Sharing Plan	NSW Murray Darling Basin Fractured Rock

Figure 1 Site Location Map



2.2 TOPOGRAPHY

A review of the Yass (8628-2N) 1:25,000 topographic map sheet was conducted to assess the regional topography and identify potential groundwater controls including the location of structural lineaments, paleo-channels, recharge and discharge zones, and groundwater flow gradients. The Site is situated in a relatively flat and undulating area with a subtle regional gradient to the east as illustrated by drainage features mapped as blue lines on the topography sheet in **Figure 1**. The drainage features mapped within the Site are expected to be ephemeral.

2.3 GEOLOGY

Review of the geological setting was conducted with reference to the Yass 1:100,000 geological series sheets. The site geology is provided in **Figure 2**. The assessment area is mapped as underlain by Laidlaw Volcanic (Sdl) with residual Quaternary deposits in lower lying areas through the central north and to the east. The mapped geology indicates there is a structural boundary in the far east of the site where the volcanics meet sedimentary deposits (Sdws-Mudstone). The stratigraphy is summarised in Table 2 below:

Table 2: Stratigraphic Formations

Period	Stratigraphy / Formation	Symbol	Lithology
Quaternary	Quaternary	Qa	Alluvial gravel, sand silt and clay.
Siluro-Devon	Laidlaw Volcanics	Sdl	Porphyritic rhyodacitic ignimbrite (extrusive volcanic)
Siluro-Devon	Brickies Creek Mudstone	Sdws	Light grey to beige aphanitic vitric tuff, light to grey siliceous mudstone

Figure 2 Geological Setting



Source: NSW Government. Yass 1:100,000 Geological Series Sheet 8628.

2.4 HYDROGEOLOGY

The Site is located within the Murray-Darling basin fractured groundwater system. Based on the site geology, groundwater resources in the area are expected to be associated with two (2) primary forms of aquifer systems:

- *Shallow unconfined* systems hosted in unconsolidated alluvium and colluvium deposits, generally less than 10 m in depth with low to moderate yields, and variably salinity. These shallow systems are strongly controlled by rainfall recharge and are not considered a reliable source of long-term water supply. Flow regimes are expected to mimic the topographic gradient pending any structural or geological barriers; and
- *Deep fractured rock* and dual porosity aquifers hosted by the underlying rock sequences. Typically deeper than 40 m with variable yields and water quality controlled by geological faults, fractures, and joints from local and district faulting. Enhanced hydraulic conductivity is largely dependent on the scale and density of primary (void space between sediments grains) and secondary (fractures) porosity.

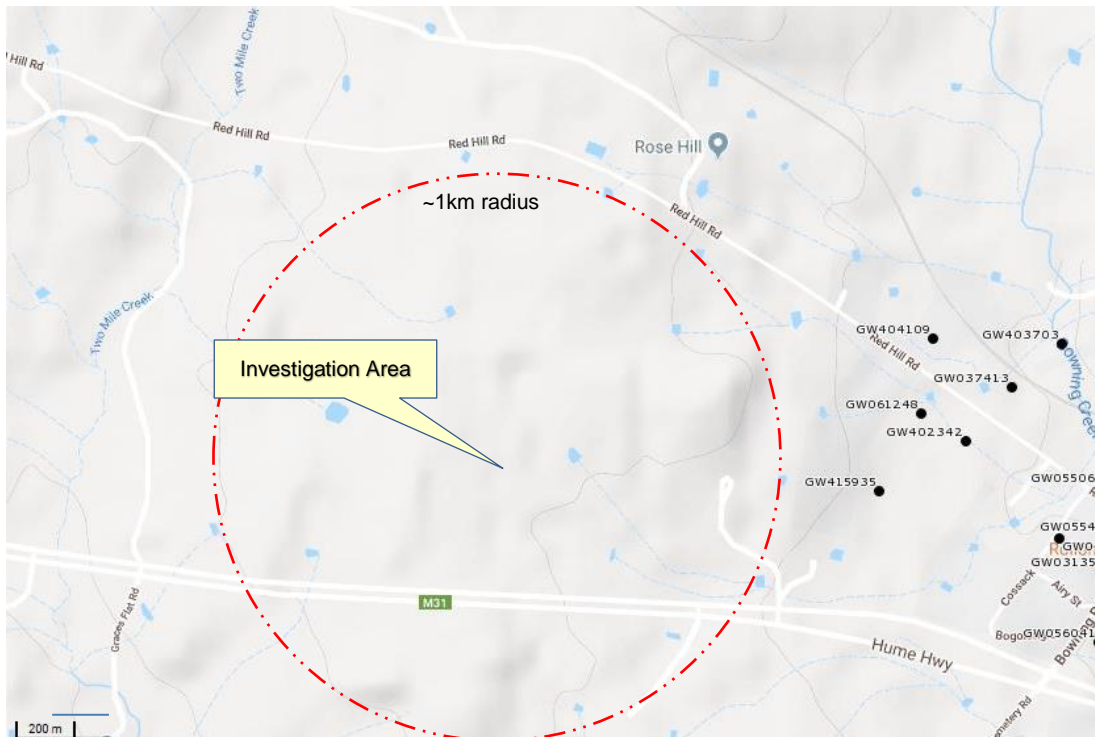
A review of *NOW* registered bore records was conducted prior to drilling to develop a conceptual model of regional groundwater conditions, including aquifer depths, yields, and water quality. The search did not identify any registered bores within a one (1) kilometre radius of the site (**Figure 3**) which is expected to be well beyond the maximum radius of any potential drawdown due to the low proposed pumping rate at the Site. The bore search area was expanded to include bores within a 5 km radius of the Site to assess groundwater conditions in other bores within the area. A summary of the available hydrogeological records is summarised below in Table 3.

- Bore depths in the area ranged between 19.5 to 90 metres,;
- Yields ranged from 0.18-0.95 L/s;
- Standing Water Levels ranged from 3-14m below ground level (mbgl) and
- Host units are listed as both volcanic and igneous rocks.

Table 3: Registered Bores within 5 km of the Site

Bore ID	Lat.	Long.	Bore Depth (m)	Yield L/s	SWL (mbgl)	Aquifer	Geology	Drilled Date	Use
GW416182	-	-	54	0.18	11	18-20, 46-48	0-36 shale, 36-54 volcanics	18/03/2013	Stock & Domestic
GW061248	-34.7652	148.8065	41.1	0.2	3	16.7-18.2	Shale	1/05/1985	N/A
GW014383	-34.7557	148.7695	25	0.51	13.4	15-25	Granite	1/01/1958	Stock & Domestic
GW020967	-34.7334	148.8087	37.3	0.59	-	26-37	Porphyry	1/08/1953	N/A
GW016395	-34.7093	148.8093	19.5	0.63	4	14.6-19.5	Porphyry	1/07/1957	Stock & Domestic
GW031388	-34.7512	148.7606	27.4	0.95	-	18-18.3	Shale	1/01/1967	Unknown
GW409412	-34.7505	148.7663	250	2.13	20	22-39, 96-99	0-60 shale 60-250 granite	15/01/2010	N/A
GW045239	-34.7546	148.7737	34.1	-	14	29-34	Shale	1/04/1976	Monitoring
GW415395	-	-	90	-	-	-	-	4/07/1905	Domestic

Figure 3 Registered bore locations (NOW online database)



3.0 TEST DRILLING

3.1 TEST BORE LICENCE

Prior to commencement ENRS submitted applications for test drilling and borehole construction with NOW. A Test Bore Licence was issued by NOW under Section 115 of the Water Act 1912. A summary of the test bore license is provided in **Table 4** below:

Table 4: Test Bore Licence Summary

Licence	Purpose	Lot/DP	Issued	Valid	Number of Bores
40BL192710	Test Bore	263//753596 128//753596 18//246891 172//649063 107//753596 16//246891 262//753596	20/3/2018	Perpetuity	8x Test Bores

3.2 DRILLING TARGETS

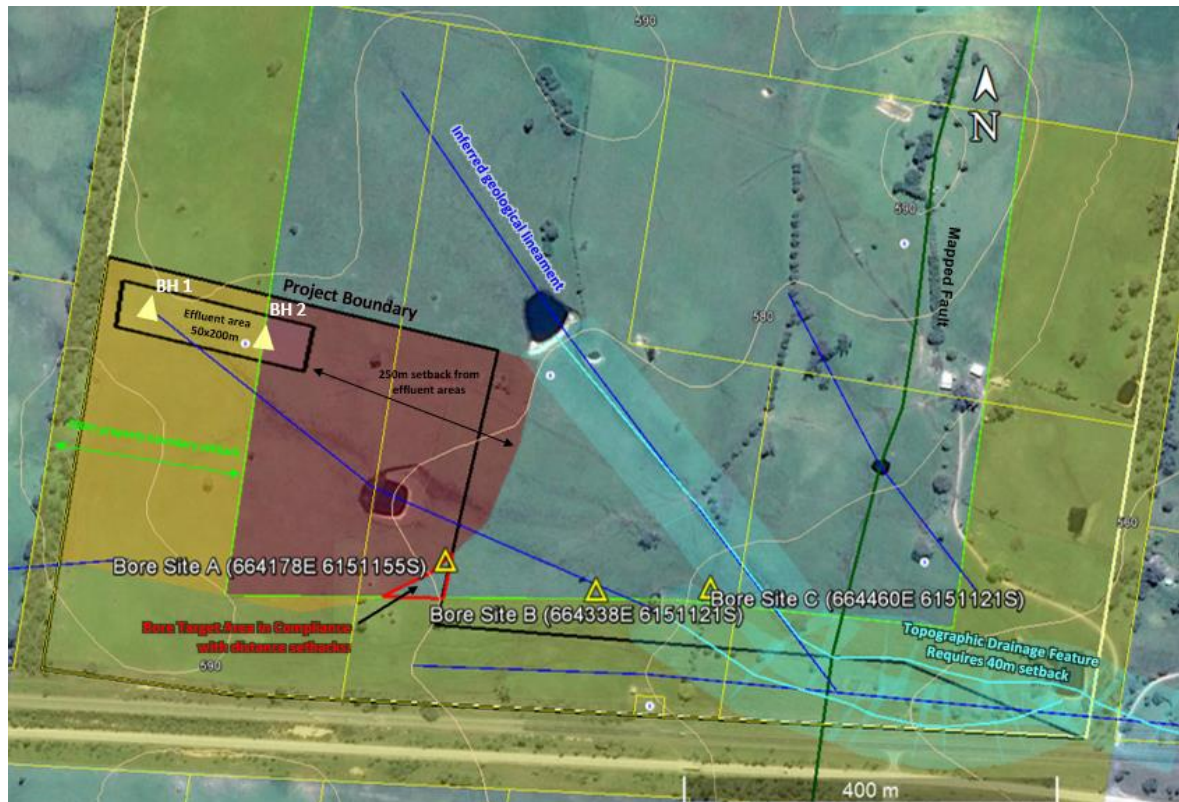
Drilling targets were selected following a desktop review of the hydrogeological setting with consideration of the following:

- Test bore licence terms and conditions;
- Land tenure and property boundary;

- Proximity to geological lineaments and potential groundwater controls;
 - 40 m from high bank (blue line on topographic maps);
 - 400 m from another WAL bore (irrigation/commercial pumping bore);
 - 200 m from a Basic Landholder Right (BLR/stock & domestic) bore;
 - 200 m from property boundary (or letter of non-objection from neighbouring landowners);
 - 500 m from Town Water Supply (TWS) Bores;
 - 400 m from NOW government monitoring bores; and
 - 250 m from effluent disposal area (or up/across gradient supported by Hydro Assessment).
- The distribution of alluvial deposits where additional surface casing is required to stabilise the borehole during drilling;
- Suitable distances between boreholes to minimise potential pumping interference;
- Suitable distance setback from potential sources of contamination including any dangerous goods storage and effluent disposal areas; and
- Drilling rig access, and proximity to services, namely power and existing reticulation pipelines;

Three (3) test bore targets were identified. The primary area of interest was positioned adjacent potential geological lineaments inferred from site topography. The location of test bore targets is shown in **Figure 4**.

Figure 4 Test Bore Targets



3.3 DRILLING RESULTS

Test drilling encountered two (2) metres of shallow soil and clay overlying volcanics. As sufficient flow was intercepted during the first test bore to warrant construction no further bores were drilled. A summary of the drilling results is provided below in **Table 5**:

Table 5: Test Bore Drilling Results

Site	E (MGA)	N (MGA)	Depth	Result	Status
TB1	664195	6151138	120m	50-52m 0.21 L/s 112-115m 1.47 L/s	Constructed as PB1

4.0 BORE CONSTRUCTION

Drilling and borehole construction was conducted by *Bungendore Water Bores* during April 2018 in accordance with the minimum construction requirements for water bores in Australia (3rd ed. 2012). Details of the bore construction are documented in the 'Form A' reports contained in **Appendix A** with a summary provided in **Table 6** below.

Table 6: Test Bore Construction Summary

Bore ID	Production Bore 1 (TB1)
Easting (MGA 56)	664195
Northing (MGA)	6151138
Drilled Depth (m)	120
Final Depth (m)	120
SWL (metres below ground level - mbgl)	0.5 mbgl (10/4/2018)
Casing (150mm CI 9)	0-120m
Slots (150mm CI 9)	48-54m 108-120m
Clay Seal	0-5.0m
Gravel pack (4-6mm)	5.0-120m
TDS Lab	392 mg/L
EC Lab	602 μ S/cm
pH Lab	8.17 pH

5.0 AQUIFER TESTING

5.1 AIRLIFT TEST METHODOLOGY

The bore was subject to minimum three (3) hour airlift test at completion of drilling in general accordance with the *Minimum Construction Requirements for Water Bores in Australia – 3rd Edition* (2012) and the Australian Standard for Test Pumping of Water Wells (AS 2368-1990). The flow rate during air lifting was recorded by the driller and documented on the Form A construction log.

5.2 AIRLIFT RESULTS

Bore 1 was airlift tested for three (3) hours at an average rate of 1.7 L/s. The bore sustained a constant flow throughout the duration of the airlift and no significant variation in water quality (pH and EC) was observed. The bore construction comprises 48 metres of PVC surface casing sealed with clay to prevent contamination from shallow water infiltration.

The driller's aquifer intercepts and airlift test results identify the available drawdown in Bore 1 is approximately 48mbgl to the top of the secondary aquifer zone. In general the drawdown level is set at the top of primary aquifer or highest yielding aquifer. The aim for sustainable pumping is not to lower the water level below viable aquifers as this may depressurise the aquifer and cause irreversible impacts on aquifer structure through dewatering. Hence, we recommend the maximum drawdown be set at the top of the shallowest aquifer.

The drilling and aquifer test results indicate the subject bore is capable of sustaining discharge rates of 1.5 L/s from the primary aquifer supported by monitoring and equipping the bore with cut out transducers to prevent drawdown below the available limit (48m). Based on the test results it is recommended to operate the bore under the following pumping regime:

- **Bore 1** - up to 1.5 L/s; 10hrs Pumping; 14hrs Recovery; 20 ML per year at 40% duty. A higher pump duty may be realised supported by monitoring of pumping performance and recovery rates.

5.3 CAPABLE YIELD

Groundwater investigations comprised drilling of one (1) test bores culminating in the construction of one (1) production bore. The bore has intersected deep fractured rock aquifers supported by an extensive recharge area and no competing registered groundwater users. Based on the drillers airlift results the bore has a **capable yield of 20 ML** per annum at 40 per cent duty. The pumping yield of 1.5 L/s exceeds the estimated peak daily demand for the Site of approximately 20,000 Litres per day (or up to 7.3 ML year).

It should be noted that the indicated groundwater extraction regimes are based on the aquifer response during a 3 hour period of testing and simulation stress. Groundwater extraction should be supported by appropriate groundwater management practices including regular water level monitoring. Bore performance may alter as a result of structural and chemical changes within the bore or due to variations in aquifer recharge, namely extended droughts or reductions in recharge from rainfall. ENRS recommend the bore be pumped on a maximum cyclic pump duty of 50 per cent (12 hours on and 12 hours off) to provide for sufficient water level recovery between pumping cycles and ensure the long-term sustainability of the bore structure and groundwater resources. The Bore should also be equipped with cut-out probes to prevent dewatering the primary aquifer.

6.0 WATER QUALITY

Water samples were collected during air lifting and submitted to a NATA accredited laboratory for analysis. The reader is referred to **Appendix B** for laboratory Certificates of Analysis (CoA).

6.1 PH

pH is a measure of hydrogen activity. pH determines the balance between positive hydrogen ions (H⁺) and negative hydroxyl ions (OH⁻) and provides a test of water acidity (low pH) or alkalinity (high pH). Most natural freshwaters have a pH in the range 6.5 to 8.0. pH in the bore was reported at 8.17 (B1) which is within the Australian Drinking Water (ADWG;2011) guideline of 6.5-8.5 pH.

6.2 SALINITY

Salinity reported as TDS is within the ADWG aesthetic criteria which is suitable for the proposed use (industrial, commercial and domestic). The ADWG note that typical values for TDS in regional water supplies can be up to 1,000 mg/L or higher due to groundwater characteristics. A summary of the salinity guidelines for palatability is provided in Table 8.

Table 7: Identified potential GDEs

Bore ID	TDS Criteria (ADWG;2016)	Palatability
	0 – 600 600 – 900 900 – 1200 >1200	Good Fair Poor Unacceptable
Bore 1	392 mg/L (602 uS/cm)	Good

6.3 METALS AND METALLOIDS

Water samples are analysed for a suite of sixteen (16) selected heavy metals and metalloids including:

- Aluminium (Al);
- Arsenic (As);
- Boron (B);
- Barium (Ba);
- Cadmium (Cd);
- Calcium (Ca);
- Total Chromium (T.Cr.);
- Copper (Cu);
- Iron (Fe);
- Lead (Pb);
- Magnesium (Mg);
- Manganese (Mn);
- Mercury (Hg);
- Nickel (Ni);
- Silver (Ag); and
- Zinc (Zn).

Analysis for Heavy Metals and Metalloids reported concentrations below the limits stipulated in the Australian Drinking Water Guidelines (ADWG 2016). These results are considered satisfactory.

7.0 IMPACT ASSESSMENT

7.1 DISTANCE DRAWDOWN

A search of the *NOW* groundwater database did not identify any licensed water bores within one (1) kilometre of the assessment site which indicates there is no existing users in proximity to the site. Given the significant distance from registered bores and recommended 50 per cent maximum pumping duty it is assessed that there is a low risk for distance drawdown impacts on existing groundwater users in the area.

7.2 GROUNDWATER DEPENDENT ECOSYSTEMS (GDE)

Review of the property and surrounding landuse indicates that the site is located within the Bowning Creek sub catchment area. It was identified that there is potential for shallow colluvium aquifers to interact with intermittent streams recorded on the topographic map sheet. An online search of the Bureau of Meteorology (BOM) GDE atlas was conducted to identify any potential sensitive ecosystems within 5 km of the Bore. Information held in the GDE atlas includes:

- The supplied ecosystem type;
- The GDE potential, which is a measure of the assessed dependence potential of the ecosystem on groundwater resources; and
- The Inflow Dependent Ecosystem (IDE) likelihood, which is a measure of the likelihood of the landscape accessing water in addition to rainfall.

A summary of identified potential ecosystems within 5km of the bore is presented below in **Table 8**.

Table 8: Identified potential GDEs

Distance from Bore Site	Supplied Ecosystem Type	GDE Potential
600m	Northern slopes dry grass woodland	Low potential
3km	Western slopes herb/grass woodland	Moderate potential
4km to Bowning Creek riparian area	Western slopes herb/grass woodland	Moderate potential

Further review of the Site's hydrogeological setting including walkover and aerial imagery did not identify any GDE's at the Site. Furthermore, given the borehole has been constructed with a five (5) metre clay sanitary seal to prevent inflow of shallow soil water, this assessment considers the bore to be adequately constructed so as not to be in direct hydraulic connection with any overlying shallow aquifer. Hence, the proposed pumping from the deep fractured rock aquifers is not assessed to present any measurable impact on Groundwater Dependent Ecosystems (GDE's) in connection with the colluvial systems.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings obtained during the scope of work the following conclusions and recommendations may be made:

- The subject bore was drilled and constructed by *Bungendore Water Bores* in April 2018. The bore was drilled to a depth of 120 m with a 5 metres clay sanitary seal at the surfaces to prevent ingress of any shallow soil water. The bore was completed with slotted PVC casing and gravel packed in general accordance with the *Minimum Construction Requirements for Water Bores in Australia – 3rd Edition* (2012). A summary of the bore construction, aquifer intercepts and drillers airlift is provided in **Table 6**;
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- The NATA accredited laboratory CoA provided in Appendix B documents the groundwater bore quality is suitable for the proposed use with salinity measured as TDS 392 mg/L which is low and within the drinking water guidelines;
- This hydrogeological assessment concludes the bore has a capable yield of 20 ML operating at 40% pump duty, supported by significant fractured rock and regional scale aquifers with an extensive recharge zone in an area with no competing existing groundwater users; and
- The drillers airlift reports the bore has a capable yield in excess of the project requirements and a suitable WAL has been secured for 20ML to support the site proposal.

9.0 REFERENCES

- Cooper H.H. and Jacob C.E. 1946. A Generalised Graphical Method for Evaluating Constants and Summarising Field History. Trans. Amer. Geophys. Union. Vol. 27, pp.526
- Australian Government National Water Commission (2012). Minimum Construction Requirements for Water Bores in Australia (third Edition).
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- Standards Australia, New South Wales. 1998b, AS/NZS 5667.11:1998 Water Quality Sampling Guidance on Sampling of Groundwaters, Standards Australia, New South Wales.

LIMITATIONS

This report and the associated services performed by ENRS are in accordance with the scope of services set out in the contract between ENRS and the Client. The scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to Site.

ENRS derived the data in this report primarily from visual inspections, and, limited sample collection and analysis made on the dates indicated. In preparing this report, ENRS has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while ENRS believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

Limitations also apply to analytical methods used in the identification of substances (or parameters). These limitations may be due to non-homogenous material being sampled (i.e. the sample to be analysed may not be representative), low concentrations, the presence of 'masking' agents and the restrictions of the approved analytical technique. As such, non-statistically significant sampling results can only be interpreted as 'indicative' and not used for quantitative assessments.

The data, findings, observations, conclusions and recommendations in the report are based solely upon the state of Site at the time of the investigation. The passage of time, manifestation of latent conditions or impacts of future events (e.g. changes in legislation, scientific knowledge, land uses, etc) may render the report inaccurate. In those circumstances, ENRS shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of the report.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between ENRS and the Client. ENRS accepts no liability or responsibility whatsoever and expressly disclaims any responsibility for or in respect of any use of or reliance upon this report by any third party or parties.

It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

Appendix A

Form A Drillers Logs

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Driller's Licence No: **1623** **1**

Class of Licence: **4**

Driller's Name: **Danny Hill**

Assistant Driller: **Gerry Hill**

Contractor: **Bungendore Water Bores**

New bore ☒ Replacement bore ☐

Deepened ☐ Enlarged ☐

Reconditioned ☐ Other (specify)

Final Depth **120.0 m**

Work Licence No: **40 B L 40BL192710** **2**

Name of Licensee: **Wayne Lawrence**

Intended Use: **Domestic Supply**

Completion Date: **Apr-18**

DRILLING DETAILS **3**

From	To	Hole Diameter	Drilling Method
(m)	(m)	(mm)	Code
0	120	200	5

WATER BEARING ZONES **4**

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s)		Test method	D D L at end of test (m)	Duration		Salinity (Conductivity or TDS)	
				Individual Aquifer	Cumulative			Hrs	min	Cond. (µS/cm)	TDS (mg/L)
50	52	2	0.5	0.21	0.21	1					
112	115	3		1.26	1.47	1				602	

CASING / LINER DETAILS **5**

Material	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing	Casing support method	Code
Code					Code	Type of casing bottom	Code
5	150		0	120	1	Centralisers installed No <input type="checkbox"/> Yes <input type="checkbox"/>	2
						Sump installed No <input checked="" type="checkbox"/> Yes <input type="checkbox"/>	2
						Pressure cemented No <input checked="" type="checkbox"/> Yes <input type="checkbox"/>	
						Casing Protector cemented in place No <input type="checkbox"/> Yes <input type="checkbox"/>	

WATER ENTRY DESIGN **6**

General							Screen	Slot Details		
Material	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type	Fixing	Aperture (mm)	Length (mm)	Width (mm)	Alignment
Code					Code	Code				Code
5	150		48	54	5	1				V
5	150		108	120	5	1				V

GRAVEL PACK **7**

Type	Grade	Grain size (mm)	Depth (m)	Quantity
		From To	From To	Litres or m ³
Rounded <input checked="" type="checkbox"/>	Graded <input checked="" type="checkbox"/>	4 6	5 120	
Crushed <input type="checkbox"/>	Ungraded <input type="checkbox"/>			
Bentonite/Grout seal No <input type="checkbox"/> Yes <input checked="" type="checkbox"/>		0 5		
Method of placement of Gravel Pack	Code	1		

For D W E use only:

G W

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK
Work Licence No: **4 0 B L 40BL192710****BORE DEVELOPMENT****8**

Chemical used for breaking down drilling mud No ☒ Yes ☐ Name: _____

Method	Bailing/Surging <input type="checkbox"/>	Jetting	Airlifting <input checked="" type="checkbox"/>	Backwashing <input type="checkbox"/>	Pumping <input type="checkbox"/>	Other:
Duration	hrs	hrs	3 hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION**9**

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION**10**

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

Height of measuring point above ground level _____ Test Method **Code** See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED**11**

Original depth of work: _____ metres Is work partly backfilled: No ☒ Yes ☐

Is work abandoned: No ☒ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From _____ m To _____ m

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

Site chosen by: Hydrogeologist ☒ Geologist ☐ Driller ☐ Diviner ☐ Client ☐ Other _____

12

Lot No **16** DP No **246891**

13

Work Location Co ordinates Easting **664195** Northing **6151138** Zone **55H**

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

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

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

Signatures:**Driller:** Danny Hill (on behalf of applican**Licensee:** W E Larene**Date:** 9/05/2018**Date:** 9/05/2018

FORM A
PARTICULARS OF COMPLETED WORK

Natural Resource Products

Work Licence No: 4 0 B L 40BL192710

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)			15	
Depth		Description	WORK CONSTRUCTION	
From (m)	To (m)		SKETCH	
0	2	Soil, brow clay		
2	33	Light brown volcanics		
33	56	Grey brown volcanics		
56	120	Black fractured volcanics		
30				
35				
40				
45				
50				
55				
60				
65				
70				
75				
80				
85				
90				
95				
100				
105				
110				
115				
120				

WORK NOT CONSTRUCTED BY DRILLING RIG

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

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

Please attach copies of the following if available

Geologist log No ☒ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☒ Pumping test(s) No ☒ Yes ☐

Geophysical log No ☒ Yes ☐ Sieve analysis of aquifer material No ☒ Yes ☐ Installed Pump details No ☒ Yes ☐

Bore Location

Work Licence No: 40
BL: 40BL192710

Lot 172
DP 649063



Google Earth

700 m



Appendix B

NATA Laboratory Certificates of Analysis (CoA)



Chain of Custody



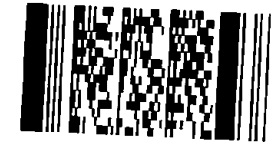
☐ SYC
Ph 02

☐ NO
Ph 0

☐ W:
Ph 1

ALS Water Resources Group
Canberra
Work Order Reference
CA1802496

CLIENT:	ENRS Pty Ltd	TURNAROUND REQUIREMENTS :		Standard TAT (List due date):		FOR LABOUR
OFFICE:	25 River Rd Shoalhaven Heads	(Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	X	Non Standard or urgent TAT (List due date):	23/4/2018	Custody Seal
PROJECT NO./PO:	ENRS0978	ALS QUOTE NO.:	EN/222/17		COC SEQUENCE NUMBER (Circle)	Free Ice / frozen receipt?
SITE/DESCRIPTION:	Bowling Test Bore 1	COUNTRY OF ORIGIN:			COC: 1 2 3 4 5 6 7	Random Sam
PROJECT MANAGER:	Rohan Last	CONTACT PH:	02 9037 4708		OF: 1 2 3 4 5 6 7	Other comme
SAMPLER:	DH	SAMPLER MOBILE:	0401 518 443		RELINQUISHED BY:	RELINQUISHED
COC Emailed to ALS? (YES / NO)		EDD FORMAT (or default):			RECEIVED BY:	
Email Reports to (will default to PM if no other addresses are listed):	lab@enrs.com.au				DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):	accounts@enrs.com.au					



Telephone : + 61 2 6202 5404

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE <i>(refer to codes below)</i>		DW-3								Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	Bowring Test Bore 1	10/04/2018	water	2x unpreserved bottle		1								Groundwater bore after 2 hours development

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Solids; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CERTIFICATE OF ANALYSIS

Work Order	: CA1802496	Page	: 1 of 4
Client	: Environmental & Natural Resources Solutions	Laboratory	: ALS Water Resources Group
Contact	: Mr Rohan Last	Contact	: Client Services
Address	: 25 River Road	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
	Shoalhaven Heads NSW 2535		
Telephone	: 02 9037 4708	Telephone	: +61 2 6202 5404
Project	: ----	Date Samples Received	: 17-Apr-2018 15:37
Order number	: ----	Date Analysis Commenced	: 18-Apr-2018
C-O-C number	: ----	Issue Date	: 24-Apr-2018 16:42
Sampler	: ----		
Site	: ----		
Quote number	: ----		
No. of samples received	: 1		
No. of samples analysed	: 1		



Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Clare Kennedy	Analyst	Inorganics, Fyshwick, ACT
Geetha Ramasundara	Chemistry Teamleader	Inorganics, Fyshwick, ACT
Kai Squires	Laboratory Manager	ALS Environmental, Fyshwick, ACT
Kathika Atapattu	QC Technician	Inorganics, Fyshwick, ACT
Titus Vimalasiri	Metals Teamleader	Inorganics, Fyshwick, ACT



General Comments

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

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67
- EK026SF Performed at ALS Sydney
- Result for pH in water tested in the laboratory may be indicative only as holding time is generally not achievable.



Analytical Results

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

Client sample ID

				----	----	----	----	----
				Bowning Test Bore 1				
Client sampling date / time				10-Apr-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	CA1802496-001	-----	-----	-----	-----
				Result	----	----	----	----
EA005: pH								
pH	----	0.01	pH Unit	8.17	----	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	2	µS/cm	602	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	2	mg/L	392	----	----	----	----
EA041: Colour (True)								
Colour (True)	----	1	PCU	1	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	139	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	285	----	----	----	----
ED009: Anions								
Chloride	16887-00-6	0.1	mg/L	17.1	----	----	----	----
Sulfate	14808-79-8	0.4	mg/L	42.5	----	----	----	----
ED037: Alkalinity								
Hydroxide Alkalinity as CaCO3	DMO-210-001	0.1	mg/L	<0.1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	0.1	mg/L	<0.1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	0.1	mg/L	271	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	271	----	----	----	----
EG005F: Dissolved Metals by ICP-OES								
Calcium	7440-70-2	0.05	mg/L	94.3	----	----	----	----
Magnesium	7439-95-4	0.05	mg/L	12.0	----	----	----	----
Potassium	7440-09-7	0.1	mg/L	3.5	----	----	----	----
Sodium	7440-23-5	0.1	mg/L	24.7	----	----	----	----
EG005T: Total Metals by ICP-OES								
Boron	7440-42-8	0.01	mg/L	<0.01	----	----	----	----
Iron	7439-89-6	0.01	mg/L	1.18	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	0.742	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	0.058	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	9	µg/L	705	----	----	----	----
Antimony	7440-36-0	3	µg/L	<3	----	----	----	----
Arsenic	7440-38-2	1	µg/L	9	----	----	----	----



Analytical Results

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

Client sample ID

				----	----	----	----	----
				Bowning Test Bore 1				
Client sampling date / time				10-Apr-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	CA1802496-001	-----	-----	-----	-----
				Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued								
Barium	7440-39-3	0.5	µg/L	25.9	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	----	----	----	----
Chromium	7440-47-3	2	µg/L	<2	----	----	----	----
Copper	7440-50-8	1	µg/L	6	----	----	----	----
Lead	7439-92-1	0.2	µg/L	6.3	----	----	----	----
Molybdenum	7439-98-7	1	µg/L	<1	----	----	----	----
Nickel	7440-02-0	1	µg/L	11	----	----	----	----
Selenium	7782-49-2	1	µg/L	2	----	----	----	----
Silver	7440-22-4	1	µg/L	<1	----	----	----	----
Mercury	7439-97-6	0.1	µg/L	<0.1	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	----	----	----	----
EK040: Fluoride								
Fluoride	16984-48-8	0.05	mg/L	0.44	----	----	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	0.1	mg/L N	<0.1	----	----	----	----
EK057: Nitrite as N								
Nitrite as N	14797-65-0	0.01	mg/L N	<0.01	----	----	----	----
EK058: Nitrate as N								
Nitrate as N	14797-55-8	0.01	mg/L N	0.51	----	----	----	----
EK059: Nitrite plus Nitrate as N (NOx)								
Nitrite + Nitrate as N	----	0.05	mg/L N	0.51	----	----	----	----
EK085M: Sulfide as S2-								
Sulfide as S2-	18496-25-8	0.02	mg/L	0.05	----	----	----	----