Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
18 Waler Crescent
Smeaton Grange NSW 2567
Phone (02) 4647 0075

Boyuan Bringelly Pty Ltd
Level 6, 5 Martin Place
SYDNEY NSW 2000

Project 92225.04
7 December 2022
R.002.Rev3
LOC

Attention: Trent Argaet

Email: trent.argaet@bhlgroup.com.au

Preliminary Groundwater Investigation
Proposed Rezoning
621 - 705 The Northern Road, Cobbitty, NSW

1. Introduction

Douglas Partners Pty Ltd (DP) were commissioned by Boyuan Bringelly Pty Ltd to conduct a preliminary groundwater investigation at 621 – 705 The Northern Road, Cobbitty (the site). The site location is shown on Drawing 1, attached.

It is noted that the previous versions of this PSI were completed with reference to a previous Indicative Layout Plan (ILP) which considered the entirety of Sub Precinct 5. The current ILP incorporates only Lots 2 and 4 in DP1216380, Lots 1 and 4 in DP1273487, and Lot 500 in DP1231858, as depicted in Drawing 1. As such, this report has been revised to exclude part Lot 45 in DP1104369 which is no longer within the current ILP.

DP previously prepared a *Report on Preliminary Site Investigation (Contamination), Proposed Rezoning, 621 – 705 The Northern Road, Cobbitty, NSW, Project 92225.04.R.001.Rev0* dated August 2021 (the PSI) and *Report on Preliminary Geotechnical Investigation, Proposed Rezoning, 621 – 705 The Northern Road, Cobbitty, NSW, Project 92225.02.R.001.Rev0* dated August 2021.

The purpose of this investigation was to assess any impacts that the proposed development may have on groundwater.

2. Scope of Works

The scope of work undertaken was as follows:

- Desktop review of Groundwater Dependant Ecosystems;
- Drilling of five boreholes across the site where access was made available;
- Conversion of the five boreholes into groundwater wells;
- Laboratory analysis of four groundwater samples for chemicals of potential concern; and

- Provision of this report.

3. Groundwater Dependant Ecosystem Review

Review of the *Groundwater Dependant Ecosystem Atlas* (BOM, 2020) did identify a Groundwater Dependant Ecosystem (GDE) of Cumberland Shale Hills Woodland and Cumberland River Flat Forest marginally within the southern boundary and northern boundary of the site, respectively (as shown on Figure 1 below). Groundwater at the site is inferred to generally flow towards the north, and therefore is unlikely to impact on the GDE. To the north of the site, GDEs of Cumberland Shale Hills Woodland and Cumberland River Flat Forest were identified approximately between 400 m to 900 m from the site boundary and were associated with creeks and drainage lines. As stormwater will be directed toward these areas as part of development, it is not considered likely that there will be any impact from development with suitable controls.

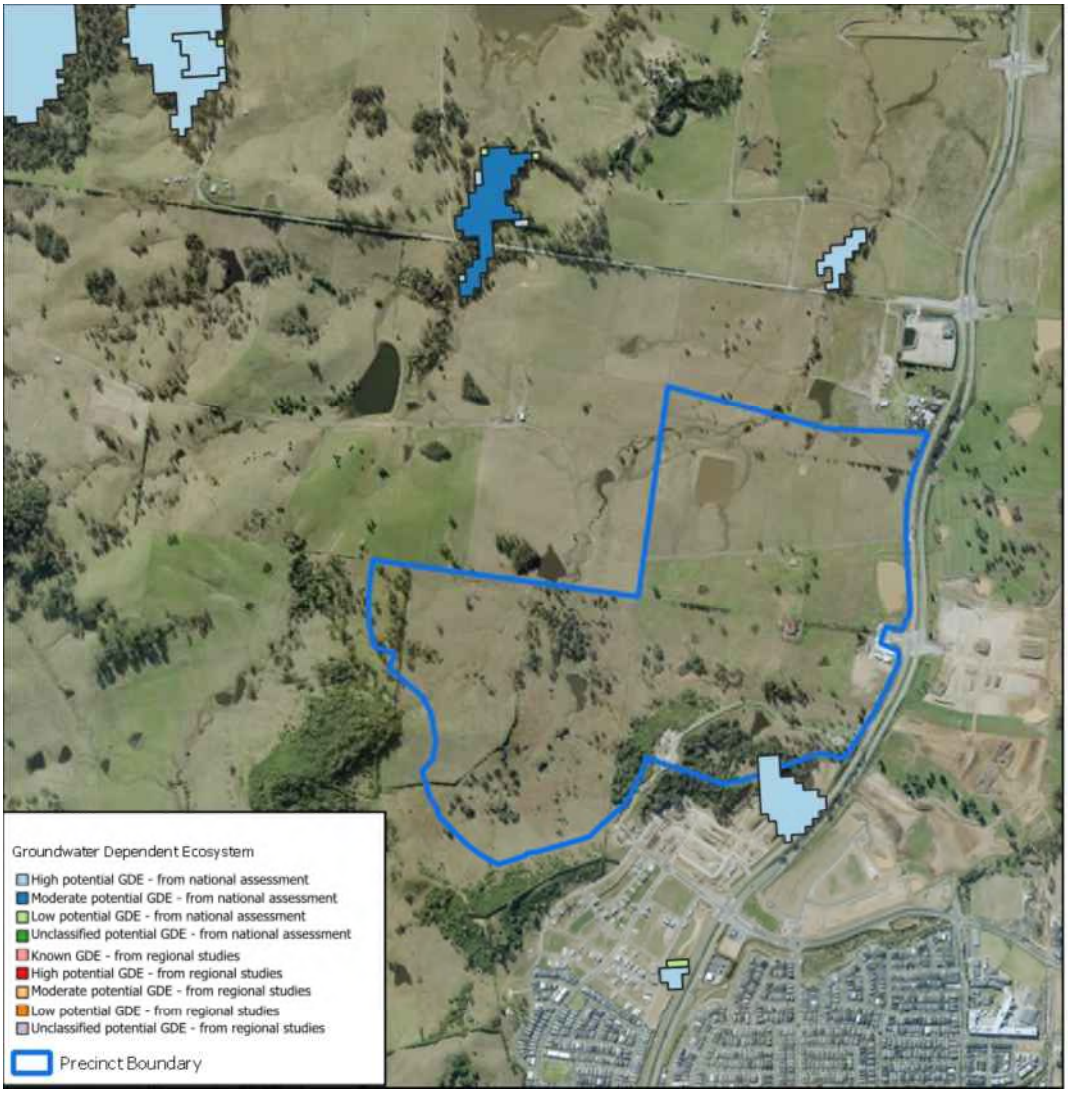


Figure 1 GDE in proximity to the site

4. Field Work Methodology and Observations

Field investigations were undertaken by a DP Environmental Engineer on 21 and 24 February 2020. The field work involved the following:

- Five boreholes were drilled using track mounted drill rigs (Comacchio GEO 405 and Geoprobe 6600) to a maximum depth of 7.9 m bgl using solid flight augers and rotary air blast; and
- All five boreholes were converted into groundwater monitoring wells in accordance with *Minimum Construction Requirements for Water Bores* in Australia (LWBC, 2003). Groundwater wells were constructed of Class 18 50 mm PVC pipe with slotted PVC casing 3 m in length installed at the following depths:
  - GW01 – between 4.0 m and 7.0 m bgl;
  - GW02 – between 3.9 m and 6.9 m bgl;
  - GW03 – between 4.6 m and 7.6 m bgl;
  - GW04 – between 4.9 m and 7.9 m bgl; and
  - GW05 – between 4.0 m and 7.0 m bgl.

The locations of the boreholes are shown on Drawing 1, attached. The borehole logs, including the construction details of the wells, are attached, together with notes defining classification methods and descriptive terms.

Sampling was conducted on 10 March 2020 using a disposable bailer. The groundwater samples were collected in HCL preserved 40 mL vials, 250 mL glass amber bottles and 200 mL nitric acid preserved plastic bottles. The groundwater samples were filtered in the field for dissolved metals analysis. The groundwater samples were sent to a National Association of Testing Authorities (NATA) accredited laboratory, Envirolab Services at Chatswood NSW for analysis including metals/metalloids, polycyclic aromatic hydrocarbons (PAH), total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylene (BTEX), pH, electrical conductivity and cation exchange capacity. GW5 was not sampled as only four samples were deemed necessary for the assessment.

5. Groundwater Assessment Criteria

The groundwater results were compared against Australian Drinking Water Guidelines (ADWG 2019), and the Australian and New Zealand Guidelines (ANZG 2018) default guideline values (DGV) for freshwater quality, 95% level of protection of species. Comparison against drinking water guidelines has been adopted as an initial conservative screen. The adopted criteria are provided in the attached Table 1.

6. Results

6.1 Gauging Results

Water was struck at approximately 7 m in BH4 during drilling. The other wells were dry during drilling but made water after installation. Groundwater levels are affected by factors such as soil permeability and weather conditions and will vary with time.

Table 1: Depth to Groundwater on 10 March 2020

Location	Depth to Groundwater (m bgl)
GW1	5.78
GW2	1.46
GW3	3.48
GW4	0.98
GW5	2.26

6.2 Analytical Results

The sample identification, analytical results and the adopted guideline values are summarised in Table 1, attached. The laboratory certificates and chain-of-custody documentation are also attached.

All samples returned results below the laboratory practical quantification limit (PQL) for PAH, TRH and BTEX. Slightly elevated concentrations of cadmium, copper, nickel and zinc were above the DGVs but were found to be within the drinking water guidelines. All remaining analytes were either below the PQL or within the adopted guidelines.

Electrical conductivity results show that the water was saline (as expected for groundwater from the Wianamatta Shales).

7. Conclusions

Groundwater wells were installed in drainage lines or near existing surface water bodies and as such are likely to be slightly higher than the levels at which groundwater at other locations at the site is expected. Based on the geology at the site, it is expected that the hydraulic conductivity of the surrounding soils and rock will be low and this was confirmed by the observation that the wells were all dry during construction (with the exception of BH4) though made water over time.

Laboratory results indicate that groundwater beneath the site contains elevated metals (cadmium, copper, nickel and zinc) concentrations above the DGVs (but were found to be within the drinking water guidelines). As the results were only marginally above the DGVs and relatively evenly distributed across the site, it is considered that these are indicative of natural background concentrations and are not considered to prevent any potential development proposed for the site.

The GDEs to the north of the site were associated with creeks and drainage lines. As stormwater will be directed toward these areas as part of development, it is not considered likely that there will be any impact from development. The GDE to the south is inferred to be in a separate groundwater catchment to the majority of the site and is unlikely to be impacted by the current development.

Based on the findings of the current investigation, further groundwater investigation at the site is not considered to be required at this time.

8. References

ANZG (2018), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.

BOM (2020), Groundwater Dependant Ecosystem Atlas. Australian Government Bureau of Meteorology (online site accessed in August 2020).

DP *Report on Preliminary Site Investigation for Contamination, Due Diligence, 1037 The Northern Road, Bringelly, NSW, Project 92336.03.R.001.Rev0* dated 6 October 2020.

NEPC. (2013). *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) [NEPM].* Australian Government Publishing Services Canberra: National Environment Protection Council.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 621 – 705 The Northern Road, Cobbitty in accordance with DP's proposal MAC180379.P.001.Rev1 dated 9 February 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Boyuan Bringelly Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the groundwater components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above), or to vegetation preventing visual inspection and reasonable access. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Lachlan Clement
Environmental Scientist

Christopher C Kline
Principal

Attachments: Drawing 1
Borehole Logs
Table 1: Groundwater Results Summary
Laboratory Certificates and Chain-of-Custody documentation


GW2
Lot 2 DP 1216380
Part Lot 45 DP 1104369
GW3
Lot 4 DP 1216380
GW4
Lot 500 DP 1231858
GW5
Lot 4 DP 1273487
Lot 1
DP 1273487
The Northern Road
Dick Johns
0
100

BOREHOLE LOG

CLIENT: Boyuan Bringelly Pty Ltd
PROJECT: Proposed Rezoning
LOCATION: 621 - 705 The Northern Road, Cobbitty, NSW

SURFACE LEVEL: –
EASTING: 290132
NORTHING: 6237715
DIP/AZIMUTH: 90°/–

BORE No: GW1
PROJECT No: 92225.02
DATE: 21/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	TOPSOIL/Silty CLAY: brown, with rootlets							
		Silty CLAY: pale grey and brown							grout
	3.0	SHALE: pale grey and brown							bentonite
									sand
								10-03-21	screen
	7.1	Bore discontinued at 7.1m - limit of investigation							

RIG: Comacchio GEO 405 **DRILLER:** Terratest **LOGGED:** ERL **CASING:**

TYPE OF BORING: SFA and rotary air blast

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Boyuan Bringelly Pty Ltd
PROJECT: Proposed Rezoning
LOCATION: 621 - 705 The Northern Road, Cobbitty, NSW

SURFACE LEVEL: –
EASTING: 290327
NORTHING: 6237683
DIP/AZIMUTH: 90°/–

BORE No: GW2
PROJECT No: 92225.02
DATE: 21/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	TOPSOIL/Silty CLAY: brown, with rootlets							
		Silty CLAY: orange brown and grey						10-03-21	grout
	2.5	SHALE: pale grey, possibly some sandstone							bentonite
									sand
									screen
	7.1	Bore discontinued at 7.1m - limit of investigation							

RIG: Comacchio GEO 405 **DRILLER:** Terratest **LOGGED:** ERL **CASING:**
TYPE OF BORING: SFA and rotary air blast
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Boyuan Bringelly Pty Ltd
PROJECT: Proposed Rezoning
LOCATION: 621 - 705 The Northern Road, Cobbitty, NSW

SURFACE LEVEL: –
EASTING: 289923
NORTHING: 6237057
DIP/AZIMUTH: 90°/–

BORE No: GW3
PROJECT No: 92225.02
DATE: 24/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	TOPSOIL/Silty CLAY: brown, with rootlets							
		Silty CLAY: red brown and grey mottled							
		- becoming grey and orange mottled below 0.5m							
	3.5	SHALE: pale brown						10-03-21	grout; bentonite; sand; screen
	7.7	Bore discontinued at 7.7m							
		- limit of investigation							

RIG: Comacchio GEO 405 **DRILLER:** Terratest **LOGGED:** ERL **CASING:**

TYPE OF BORING: SFA and rotary air blast

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Boyuan Bringelly Pty Ltd
PROJECT: Proposed Rezoning
LOCATION: 621 - 705 The Northern Road, Cobbitty, NSW

SURFACE LEVEL: –
EASTING: 289665
NORTHING: 6236789
DIP/AZIMUTH: 90°/–

BORE No: GW4
PROJECT No: 92225.02
DATE: 24/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	TOPSOIL/Silty CLAY: brown, with rootlets							
		Silty CLAY: brown and grey						10-03-21	grout
	3.5	SHALE: pale brown and grey							bentonite
		- becoming dark grey below 6.0m							sand
									screen
	8.0	Bore discontinued at 8.0m - limit of investigation							

RIG: Comacchio GEO 405 **DRILLER:** Terratest **LOGGED:** ERL **CASING:**
TYPE OF BORING: SFA and rotary air blast
WATER OBSERVATIONS: Groundwater observed whilst augering at 7.3m
REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Boyuan Bringelly Pty Ltd
PROJECT: Proposed Rezoning
LOCATION: 621 - 705 The Northern Road, Cobbitty, NSW

SURFACE LEVEL: –
EASTING: 289665
NORTHING: 6236789
DIP/AZIMUTH: 90°/–

BORE No: GW5
PROJECT No: 92225.02
DATE: 21/2/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	TOPSOIL/Silty CLAY: brown, with rootlets							
		Silty CLAY: red brown and orange brown							
		- becoming grey and red mottled below 3.0m						10-03-20	grout; bentonite
	4.5	SHALE: pale brown							sand; screen
	7.0	Bore discontinued at 7.0m - limit of investigation							

RIG: Comacchio GEO 405 **DRILLER:** Terratest **LOGGED:** ERL **CASING:**
TYPE OF BORING: SFA and rotary air blast
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Location coordinates are in MGA94 Zone 56. Not bailed

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

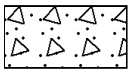
Symbols & Abbreviations

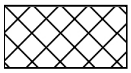
Graphic Symbols for Soil and Rock

General


Asphalt

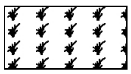

Road base

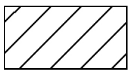

Concrete

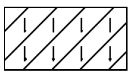

Filling

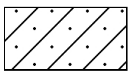
Soils


Topsoil

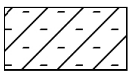

Peat

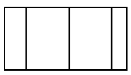

Clay

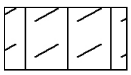

Silty clay

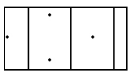

Sandy clay

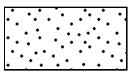

Gravelly clay

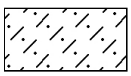

Shaly clay

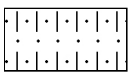

Silt


Clayey silt


Sandy silt

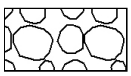

Sand

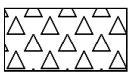

Clayey sand


Silty sand


Gravel

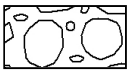

Sandy gravel


Cobbles, boulders

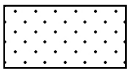

Talus

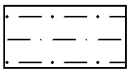
Sedimentary Rocks

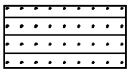

Boulder conglomerate

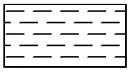

Conglomerate


Conglomeratic sandstone

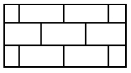

Sandstone


Siltstone

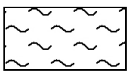

Laminite

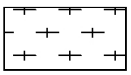

Mudstone, claystone, shale


Coal


Limestone

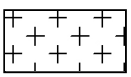
Metamorphic Rocks

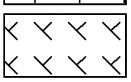

Slate, phyllite, schist

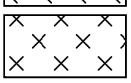

Gneiss

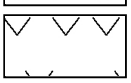

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

	Heavy Metals (µg/l)											PAH [2] (µg/l)					TRH (µg/l)		
	Arsenic	Bromine	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc	Napthalene	Anthracene	Phenanthrene	Fluoranthene	Benzo(a)pyrene	C6-C9	C10-C36	Benzene
Groundwater Investigation Levels (GIL)																			
Water	10	-	2	50 [a]	2000	-	10		1	20	3000	-	-	-	-	-	-	-	1
shwater	24 / 13 [c]	-	0.2	1	1.4	-	3.4	1,900	0.06*	11	8	16	0.4	0.6*	1.0*	0.1*	-	-	95
Results -September 2019																			
	3	**28,000**	**0.3**	<1	**4**	**100**	<1	**1,700**	<0.05	**12**	**24**	<1	<1	<1	<1	<1	<10	<100	<1
	2	**22,000**	<0.1	<1	<1	**45**	<1	**640**	<0.05	**5**	**12**	<1	<1	<1	<1	<1	<10	<100	<1
	<1	**14,000**	**0.1**	<1	**7**	<10	<1	**520**	<0.05	**2**	**26**	<1	<1	<1	<1	<1	<10	<100	<1
	<1	**23,000**	<0.1	<1	**3**	**350**	<1	**970**	<0.05	**3**	**17**	<1	<1	<1	<1	<1	<10	<100	<1

All Chromium are assumed to exist in the stable Cr(III) oxidation state, as Cr(VI) will be too reactive and unstable under the normal environment

Only those compounds for which GILs have been determined are included in the list

Given as Cr (VI)

Limit as below identification

As (III) and As (V) respectively

as m-Xylene

99% Level of protection adopted due to potential for bioaccumulation or to protect key species from chronic toxity

Corresponding to an unknown level of protection

not defined/ not analysed/ not applicable

3) ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, A

9) NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Minister Australia, Canberra.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 238591

Client Details

Client	Douglas Partners Pty Ltd Smeaton Grange
Attention	Erin Leslie
Address	18 Waler Crescent, Smeaton Grange, NSW, 2567

Sample Details

Your Reference	**92225.04, Cobbity SWP Prelim**
Number of Samples	8 water
Date samples received	10/03/2020
Date completed instructions received	10/03/2020

Analysis Details

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

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

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

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

Report Details

Date results requested by	17/03/2020
Date of Issue	17/03/2020

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Josh Williams, Senior Chemist
Loren Bardwell, Senior Chemist
Priya Samarawickrama, Senior Chemist

Authorised By
[redacted]
Nancy Zhang, Laboratory Manager

vTRH(C6-C10)/BTEXN in Water						
Our Reference		238591-1	238591-2	238591-3	238591-4	238591-5
Your Reference	UNITS	1	2	3	4	TB
Date Sampled		10/03/2020	10/03/2020	10/03/2020	10/03/2020	10/03/2020
Type of sample		water	water	water	water	water
Date extracted	-	12/03/2020	12/03/2020	12/03/2020	12/03/2020	12/03/2020
Date analysed	-	12/03/2020	12/03/2020	12/03/2020	12/03/2020	12/03/2020
TRH C_6 - C_9	µg/L	<10	<10	<10	<10	<10
TRH C_6 - C_{10}	µg/L	<10	<10	<10	<10	<10
TRH C_6 - C_{10} less BTEX (F1)	µg/L	<10	<10	<10	<10	<10
Benzene	µg/L	<1	<1	<1	<1	<1
Toluene	µg/L	<1	<1	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2	<2	<2
o-xylene	µg/L	<1	<1	<1	<1	<1
Naphthalene	µg/L	<1	<1	<1	<1	<1
Surrogate Dibromofluoromethane	%	107	108	108	110	98
Surrogate toluene-d8	%	99	98	100	100	98
Surrogate 4-BFB	%	103	104	106	105	101

vTRH(C6-C10)/BTEXN in Water		
Our Reference		238591-6
Your Reference	UNITS	TS
Date Sampled		10/03/2020
Type of sample		water
Date extracted	-	12/03/2020
Date analysed	-	12/03/2020
Benzene	µg/L	106%
Toluene	µg/L	103%
Ethylbenzene	µg/L	100%
m+p-xylene	µg/L	95%
o-xylene	µg/L	101%
Surrogate Dibromofluoromethane	%	104
Surrogate toluene-d8	%	101
Surrogate 4-BFB	%	102

svTRH (C10-C40) in Water					
Our Reference		238591-1	238591-2	238591-3	238591-4
Your Reference	UNITS	1	2	3	4
Date Sampled		10/03/2020	10/03/2020	10/03/2020	10/03/2020
Type of sample		water	water	water	water
Date extracted	-	12/03/2020	12/03/2020	12/03/2020	12/03/2020
Date analysed	-	13/03/2020	13/03/2020	13/03/2020	13/03/2020
TRH C_{10} - C_{14}	µg/L	<50	<50	<50	<50
TRH C_{15} - C_{28}	µg/L	<100	<100	<100	<100
TRH C_{29} - C_{36}	µg/L	<100	<100	<100	<100
TRH >C_{10} - C_{16}	µg/L	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	<50	<50	<50	<50
TRH >C_{16} - C_{34}	µg/L	<100	<100	<100	<100
TRH >C_{34} - C_{40}	µg/L	<100	<100	<100	<100
Surrogate o-Terphenyl	%	108	136	103	113

PAHs in Water						
Our Reference		238591-1	238591-2	238591-3	238591-4	238591-7
Your Reference	UNITS	1	2	3	4	D1
Date Sampled		10/03/2020	10/03/2020	10/03/2020	10/03/2020	10/03/2020
Type of sample		water	water	water	water	water
Date extracted	-	12/03/2020	12/03/2020	12/03/2020	12/03/2020	12/03/2020
Date analysed	-	13/03/2020	13/03/2020	13/03/2020	13/03/2020	13/03/2020
Naphthalene	µg/L	<1	<1	<1	<1	<1
Acenaphthylene	µg/L	<1	<1	<1	<1	<1
Acenaphthene	µg/L	<1	<1	<1	<1	<1
Fluorene	µg/L	<1	<1	<1	<1	<1
Phenanthrene	µg/L	<1	<1	<1	<1	<1
Anthracene	µg/L	<1	<1	<1	<1	<1
Fluoranthene	µg/L	<1	<1	<1	<1	<1
Pyrene	µg/L	<1	<1	<1	<1	<1
Benzo(a)anthracene	µg/L	<1	<1	<1	<1	<1
Chrysene	µg/L	<1	<1	<1	<1	<1
Benzo(b,j+k)fluoranthene	µg/L	<2	<2	<2	<2	<2
Benzo(a)pyrene	µg/L	<1	<1	<1	<1	<1
Indeno(1,2,3-c,d)pyrene	µg/L	<1	<1	<1	<1	<1
Dibenzo(a,h)anthracene	µg/L	<1	<1	<1	<1	<1
Benzo(g,h,i)perylene	µg/L	<1	<1	<1	<1	<1
Benzo(a)pyrene TEQ	µg/L	<5	<5	<5	<5	<5
Total +ve PAH's	µg/L	NIL (+)VE	NIL (+)VE	NIL (+)VE	NIL (+)VE	NIL (+)VE
Surrogate p-Terphenyl-d14	%	107	101	78	96	91

PAHs in Water		
Our Reference	UNITS	238591-8
Your Reference		D2
Date Sampled		10/03/2020
Type of sample		water
Date extracted	-	12/03/2020
Date analysed	-	13/03/2020
Naphthalene	µg/L	<1
Acenaphthylene	µg/L	<1
Acenaphthene	µg/L	<1
Fluorene	µg/L	<1
Phenanthrene	µg/L	<1
Anthracene	µg/L	<1
Fluoranthene	µg/L	<1
Pyrene	µg/L	<1
Benzo(a)anthracene	µg/L	<1
Chrysene	µg/L	<1
Benzo(b,j+k)fluoranthene	µg/L	<2
Benzo(a)pyrene	µg/L	<1
Indeno(1,2,3-c,d)pyrene	µg/L	<1
Dibenzo(a,h)anthracene	µg/L	<1
Benzo(g,h,i)perylene	µg/L	<1
Benzo(a)pyrene TEQ	µg/L	<5
Total +ve PAH's	µg/L	NIL (+)VE
Surrogate p-Terphenyl-d14	%	89

HM in water - dissolved						
Our Reference		238591-1	238591-2	238591-3	238591-4	238591-7
Your Reference	UNITS	1	2	3	4	D1
Date Sampled		10/03/2020	10/03/2020	10/03/2020	10/03/2020	10/03/2020
Type of sample		water	water	water	water	water
Date prepared	-	12/03/2020	12/03/2020	12/03/2020	12/03/2020	12/03/2020
Date analysed	-	12/03/2020	12/03/2020	12/03/2020	12/03/2020	12/03/2020
Aluminium-Dissolved	µg/L	370	30	10	10	10
Arsenic-Dissolved	µg/L	3	2	<1	<1	2
Bromine-Dissolved	µg/L	28,000	22,000	14,000	23,000	2,800
Cadmium-Dissolved	µg/L	0.3	<0.1	0.1	<0.1	0.4
Chromium-Dissolved	µg/L	<1	<1	<1	<1	<1
Copper-Dissolved	µg/L	4	<1	7	3	<1
Iron-Dissolved	µg/L	100	45	<10	350	<10
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Manganese-Dissolved	µg/L	1,700	640	520	970	500
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	12	5	2	3	4
Zinc-Dissolved	µg/L	24	12	26	17	24

HM in water - dissolved		
Our Reference		238591-8
Your Reference	UNITS	D2
Date Sampled		10/03/2020
Type of sample		water
Date prepared	-	12/03/2020
Date analysed	-	12/03/2020
Aluminium-Dissolved	µg/L	10
Arsenic-Dissolved	µg/L	2
Bromine-Dissolved	µg/L	2,300
Cadmium-Dissolved	µg/L	0.1
Chromium-Dissolved	µg/L	<1
Copper-Dissolved	µg/L	<1
Iron-Dissolved	µg/L	20
Lead-Dissolved	µg/L	<1
Manganese-Dissolved	µg/L	600
Mercury-Dissolved	µg/L	<0.05
Nickel-Dissolved	µg/L	5
Zinc-Dissolved	µg/L	18

Miscellaneous Inorganics					
Our Reference		238591-1	238591-2	238591-3	238591-4
Your Reference	UNITS	1	2	3	4
Date Sampled		10/03/2020	10/03/2020	10/03/2020	10/03/2020
Type of sample		water	water	water	water
Date prepared	-	10/03/2020	10/03/2020	10/03/2020	10/03/2020
Date analysed	-	10/03/2020	10/03/2020	10/03/2020	10/03/2020
pH	pH Units	7.0	7.1	7.2	6.9
Electrical Conductivity	µS/cm	29,000	24,000	20,000	25,000

Ion Balance					
Our Reference		238591-1	238591-2	238591-3	238591-4
Your Reference	UNITS	1	2	3	4
Date Sampled		10/03/2020	10/03/2020	10/03/2020	10/03/2020
Type of sample		water	water	water	water
Date prepared	-	11/03/2020	11/03/2020	11/03/2020	11/03/2020
Date analysed	-	11/03/2020	11/03/2020	11/03/2020	11/03/2020
Calcium - Dissolved	mg/L	210	230	130	160
Potassium - Dissolved	mg/L	31	30	33	23
Sodium - Dissolved	mg/L	5,400	4,900	4,200	5,200
Magnesium - Dissolved	mg/L	1,100	810	600	820
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	820	1,200	1,400	950
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	820	1,200	1,400	950
Sulphate, SO4	mg/L	1,100	860	940	1,100
Chloride, Cl	mg/L	11,000	9,000	7,100	9,300

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA latest edition, 2320-B.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012/017	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS and/or GC-MS/MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-013	Water samples are analysed directly by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			12/03/2020	[NT]	[NT]	[NT]	[NT]	12/03/2020	[NT]
Date analysed	-			12/03/2020	[NT]	[NT]	[NT]	[NT]	12/03/2020	[NT]
TRH C_6 - C_9	µg/L	10	Org-016	<10	[NT]	[NT]	[NT]	[NT]	98	[NT]
TRH C_6 - C_{10}	µg/L	10	Org-016	<10	[NT]	[NT]	[NT]	[NT]	98	[NT]
Benzene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Toluene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Ethylbenzene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
m+p-xylene	µg/L	2	Org-016	<2	[NT]	[NT]	[NT]	[NT]	97	[NT]
o-xylene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Naphthalene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-016	104	[NT]	[NT]	[NT]	[NT]	103	[NT]
Surrogate toluene-d8	%		Org-016	101	[NT]	[NT]	[NT]	[NT]	99	[NT]
Surrogate 4-BFB	%		Org-016	103	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			12/03/2020	3	12/03/2020	12/03/2020		12/03/2020	[NT]
Date analysed	-			13/03/2020	3	13/03/2020	13/03/2020		13/03/2020	[NT]
TRH C_{10} - C_{14}	µg/L	50	Org-003	<50	3	<50	<50	0	133	[NT]
TRH C_{15} - C_{28}	µg/L	100	Org-003	<100	3	<100	<100	0	113	[NT]
TRH C_{29} - C_{36}	µg/L	100	Org-003	<100	3	<100	<100	0	116	[NT]
TRH >C_{10} - C_{16}	µg/L	50	Org-003	<50	3	<50	<50	0	133	[NT]
TRH >C_{16} - C_{34}	µg/L	100	Org-003	<100	3	<100	<100	0	113	[NT]
TRH >C_{34} - C_{40}	µg/L	100	Org-003	<100	3	<100	<100	0	116	[NT]
Surrogate o-Terphenyl	%		Org-003	108	3	103	107	4	107	[NT]

QUALITY CONTROL: PAHs in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	238591-2
Date extracted	-			12/03/2020	1	12/03/2020	12/03/2020		12/03/2020	12/03/2020
Date analysed	-			13/03/2020	1	13/03/2020	13/03/2020		13/03/2020	13/03/2020
Naphthalene	µg/L	1	Org-012/017	<1	1	<1	<1	0	98	110
Acenaphthylene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Acenaphthene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Fluorene	µg/L	1	Org-012/017	<1	1	<1	<1	0	94	110
Phenanthrene	µg/L	1	Org-012/017	<1	1	<1	<1	0	96	80
Anthracene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Fluoranthene	µg/L	1	Org-012/017	<1	1	<1	<1	0	94	78
Pyrene	µg/L	1	Org-012/017	<1	1	<1	<1	0	88	82
Benzo(a)anthracene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Chrysene	µg/L	1	Org-012/017	<1	1	<1	<1	0	140	84
Benzo(b,j+k)fluoranthene	µg/L	2	Org-012/017	<2	1	<2	<2	0	[NT]	[NT]
Benzo(a)pyrene	µg/L	1	Org-012/017	<1	1	<1	<1	0	88	90
Indeno(1,2,3-c,d)pyrene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Benzo(g,h,i)perylene	µg/L	1	Org-012/017	<1	1	<1	<1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012/017	91	1	107	108	1	88	112

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	238591-2
Date prepared	-			12/03/2020	1	12/03/2020	12/03/2020		12/03/2020	12/03/2020
Date analysed	-			12/03/2020	1	12/03/2020	12/03/2020		12/03/2020	12/03/2020
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	370	390	5	97	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	3	3	0	96	[NT]
Bromine-Dissolved	µg/L	10	Metals-022	<10	1	28000	[NT]		96	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	0.3	0.1	100	95	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	99	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	4	4	0	104	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	1	100	110	10	98	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	103	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	1700	1700	0	94	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	95	91
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	12	12	0	99	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	24	23	4	97	[NT]

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	238591-4
Date prepared	-			[NT]	3	12/03/2020	12/03/2020		[NT]	12/03/2020
Date analysed	-			[NT]	3	12/03/2020	12/03/2020		[NT]	12/03/2020
Aluminium-Dissolved	µg/L	10	Metals-022	[NT]	3	10	[NT]		[NT]	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	[NT]	3	<1	[NT]		[NT]	[NT]
Bromine-Dissolved	µg/L	10	Metals-022	[NT]	3	14000	14000	0	[NT]	#
Cadmium-Dissolved	µg/L	0.1	Metals-022	[NT]	3	0.1	[NT]		[NT]	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	[NT]	3	<1	[NT]		[NT]	[NT]
Copper-Dissolved	µg/L	1	Metals-022	[NT]	3	7	[NT]		[NT]	[NT]
Iron-Dissolved	µg/L	10	Metals-022	[NT]	3	<10	[NT]		[NT]	[NT]
Lead-Dissolved	µg/L	1	Metals-022	[NT]	3	<1	[NT]		[NT]	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	[NT]	3	520	[NT]		[NT]	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	[NT]	3	<0.05	[NT]		[NT]	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	[NT]	3	2	[NT]		[NT]	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	[NT]	3	26	[NT]		[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			10/03/2020	[NT]	[NT]	[NT]	[NT]	10/03/2020	[NT]
Date analysed	-			10/03/2020	[NT]	[NT]	[NT]	[NT]	10/03/2020	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]

QUALITY CONTROL: Ion Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			11/03/2020	[NT]	[NT]	[NT]	[NT]	11/03/2020	[NT]
Date analysed	-			11/03/2020	[NT]	[NT]	[NT]	[NT]	11/03/2020	[NT]
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	94	[NT]
Potassium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	92	[NT]
Sodium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	91	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	96	[NT]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	[NT]	[NT]	[NT]	[NT]	104	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	108	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

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

Douglas Partners
Geotechnics | Environment | Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	92225.04	**Suburb:**	South Creek West, Cobbit	**To:**	Envirolab
Project Name:	COBBITTY, SWP, Prelim Contam Asse	**Order Number**			12 Ashley St, Chatswood NSW 2067
Project Manager:	Chris Kline	**Sampler:**	E Leslie	**Attn:**	Tania Notaras
Emails:	Erin.Leslie@douglaspartners.com.au			**Phone:**	(02) 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard [X]			**Email:**	tnotaras@envirolabservices.com.au
Prior Storage:	☐ Esky ☐ Fridge ☐ Shelved	Do samples contain 'potential' HBM?	Yes ☐ No ☐	(If YES, then handle, transport and store in accordance with FPM HAZID)	

Sample ID	Lab ID	Date Sampled	Sample Type (S - soil, W - water)	Container Type (G - glass, P - plastic)	Analytes: Metals	TRH	BTEX	PAH	Anions and Cations	pH	EC			Notes/preservation
1	1	03/10/20	W	G, P	X	X	X	X	X	X	X			Please test the following
2	2	03/10/20	W	G, P	X	X	X	X	X	X	X			metals:
3	3	03/10/20	W	G, P	X	X	X	X	X	X	X			Al, As, Br, Cd, Cr, Cu,
4	4	03/10/20	W	G, P	X	X	X	X	X	X	X			Fe, Pb, Mn, Hg, Ni, Zn
TB	5	03/10/20	W	G, P	X	X	X	X	X	X	X			
TS	6	03/10/20	W	G, P	X	X	X	X	X	X	X			Please apply suite
D1	7	11	11	11	X			X						pricing if applicable
D2	8	11	11	11	X			X						
														If possible, please report D1,
														TB and TS with
														92336.02
PQL (S) mg/kg													**ANZECC PQLs req'd for all water analytes** ☐	

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 238591
Date Received: 10.03.2020
Time Received: 17:20
Received By: TC
Temp: Cool/Ambient
Cooling: Icepack
Security: Intact/Broken/None

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here:

Lab Report/Reference No: 238591

Total number of samples in container: **Relinquished by:** **Transported to laboratory by:**

Send Results to: Douglas Partners Pty Ltd **Address** **Phone:** **Fax:**

Signed: **Received by:** ES Tmudiad courier **Date & Time:** 10.03.2020, 17:20

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Pty Ltd Smeaton Grange
Attention	Erin Leslie

Sample Login Details

Your reference	92225.04, Cobbity SWP Prelim
Envirolab Reference	238591
Date Sample Received	10/03/2020
Date Instructions Received	10/03/2020
Date Results Expected to be Reported	17/03/2020

Sample Condition

Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	8 water
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	15.7
Cooling Method	Ice
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	vTRH(C6-C10)/BTEXN in Water	svTRH (C10-C40) in Water	PAHsin Water	HM in water - dissolved	pH	Electrical Conductivity	Calcium - Dissolved	Potassium - Dissolved	Sodium - Dissolved	Magnesium - Dissolved	Hydroxide Alkalinity (OH-) as CaCO3	Bicarbonate Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulphate, SO4	Chloride, Cl
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TB	✓															
TS	✓															
D1			✓	✓												
D2			✓	✓												

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.

TAT for Micro is dependent on incubation. This varies from 3 to 6 days.