ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC
QLD 4207

Dispersive Soil Assessment & Management Plan

Proposed Development:

Lot 30 on SP309195, 176-228 Mountain Ridge Road, South Maclean, Queensland

October 2019

Prepared for:
Peak Urban

Report details

Project ref:	ADG1059.19
Project Manager:	Dr Samuel Gregory
Report title:	Dispersive Soil Assessment & Management Plan Proposed Development: Lot 30 on SP309195, 176-228 Mountain Ridge Road, South Maclean, Queensland
Version:	Rev0
Author:	Dr Samuel Gregory
Reviewer:	Michael Campbell
Client:	Peak Urban
Client contact:	Troy Schultz
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ADG Consulting

Dr Samuel Gregory
PhD(Soil & EnvSc), MSc(Genetics), BSc(Plant Biology)
MEIANZ, MALGA
Senior Environmental Scientist

Michael Campbell BEnvSc, BSc[Hons],
DipProjMgt, DipOHS, DipBusMgt, DipBus(Quality Auditing)
MEIANZ, MALGA, MASSI
Director & Principal Environmental Scientist

Date: 11 October 2019

Table of Contents

1 Introduction

ADG Consulting Pty Ltd (ADG) was engaged by Peak Urban to undertake a Dispersive Soil Assessment and Dispersive Soil Management Plan (DSMP) for the proposed development within Lot 30 on SP309195, situated at 176-228 Mountain Ridge Road, South Maclean, Queensland. The proposed scope of work was detailed in ADG's fee proposal dated 13 September 2019, and Peak Urbans' acceptance of the engagement was confirmed 16 September 2019.

1.1 Background

It is understood that the evaluation and reports are required to support a development application (DEV2019/1013) that has been submitted to the Minister for Economic Development Queensland (MEDQ) due to the site's location within the Greater Flagstone Priority Development Area. It is proposed to reconfigure the approximately 40.7 ha site to create 527 individual lots for a mix of residential development and associated uses.

MEDQ has issued a Further Issues Letter dated 16 August 2019 requesting further information, which makes reference to the following:

> *"5h. Provide confirmation on whether dispersive soils are in the area, and include information on how construction practices and stormwater outlets constructed within the Flagstone Creek riparian corridor is to be managed to prevent ongoing scour and erosion given the likelihood of dispersive soils in the area".*

Dispersive soils have the potential to be exposed and/or disturbed to varying degrees throughout the entire development footprint during the bulk earthworks phase of construction. Poorly managed dispersive soils can result in significant impacts upon downstream environments, and compromise assets due to erosion and tunneling.

A site and soil assessment was undertaken on 20 September 2019 by ADG. Samples were collected and analysed by ADG for Emerson Aggregate Testing with further analysis (described within) carried out by ALS Laboratories (Brisbane).

1.2 Relevant guidelines

The investigation was conducted with reference to the following documents:

- *Best Practice Erosion & Sediment Control (*International Erosion Control Association (IECA), Australasia Chapter, 2008
- *Implementation Guideline No. 28, Dispersive Soil Management* (ICC 2016).
- *Salinity Management Handbook*, Queensland Department of Natural Resources DNRQ97019, 1997.
- *Dispersive Soils and their Management - Technical Reference Manual*. Department of Primary Industries and Water, Tasmania, 2009.
- *Understanding and managing soils in the Moreton Region.* Department of Primary industries, Training Series QE96003, Brisbane. *Noble, K. E. (ed.) (1996).*

1.3 DSMP objectives

The objectives of the DSMP were to:

- Characterise the site and soil conditions with respect to sodic and dispersive soils.
- Prepare a Dispersive Soil Management Plan for submission to MEDQ care of Peak Urban.

1.4 Scope of work

To achieve the DSMP objectives, the following scope of work was undertaken:

- Conduct a desktop study including:

    1. Review of the development proposal including any proposed cut/fill plans and existing erosion and sediment control plan (ESCP), if available.

2. Review of geology and soil maps for the area.
3. Review of current aerial photographs of the site and surrounds.
4. Review of relevant information provided by the client.

- An inspection of the site and surrounding environment to identify dispersive soils and areas susceptible to erosion.

- Construction of approximately 17 boreholes of varying depth to a maximum depth of 3 m (using a drill rig and hand auger at inaccessible locations) to characterise surface soils and subsoils across the site, with a focus on areas and proposed depths of planned 'cut' earthworks. It is noted that the site was heavily vegetated during the assessment with limited access for the drill rig. The use of the drill rig to obtain soil samples to a maximum depth of 3 m was restricted to the western boundaries of the site. Hand augering to a maximum depth of 1 m was employed in other areas.

- Recovery of representative soil samples for dispersion analysis via the Emerson Aggregate Test for 33 samples.

- Laboratory analysis of ten (10) selected samples for pH, electrical conductivity (EC), exchangeable sodium percentage (ESP), exchangeable cations (calcium, magnesium, sodium, potassium & aluminium), calcium/magnesium ratio and effective cation exchange capacity (ECEC).

- Preparation of a Dispersive Soil Management Plan (this report) for submission to MEDQ care of Peak Urban.

2 Site characteristics

2.1 Site description

The subject site is described as Lot 30 on SP309195, situated at 176-228 Mountain Ridge Road, South Maclean, Queensland. The site was generally only accessible during the site inspection (20 September 2019) along the western border with the majority of the rest of the site limited for access due to site fencing and dense vegetation.

A series of photos were taken during the site inspection which show the terrain and general features of the area. The images are displayed below. The site and soil sampling locations are shown in Figure 1, Appendix A.

Image 1. View south along Mountain Ridge Road towards the site.

Image 2. View east towards the site from the neighbouring lot.

Image 3. Pale brown soils within BH1

Image 4. General vegetation within the site

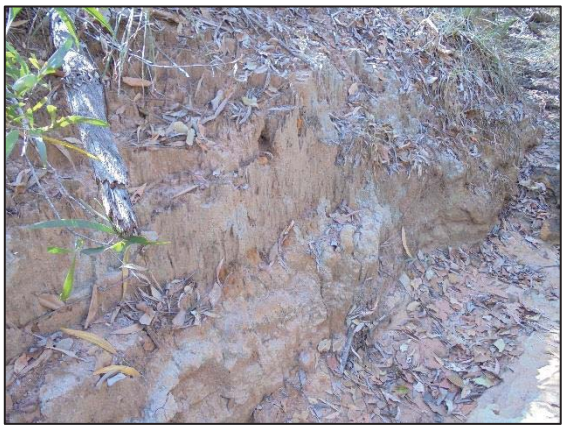


Image 5. Minor tunnel erosion to bank edge

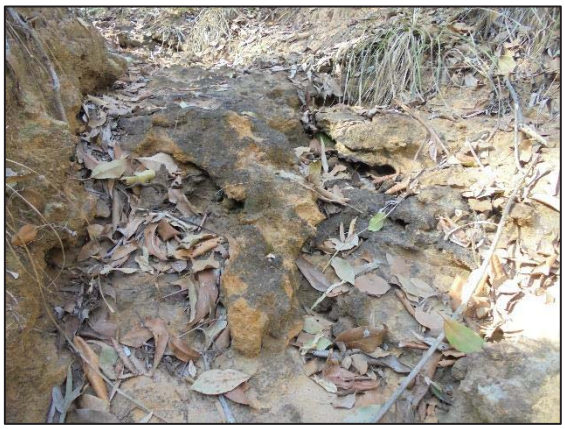


Image 6. Tunnel erosion within drain bed

2.2 Surrounding land use and environment

A brief description of the surrounding environment is described in Table 1 below.

Table 1. Surrounding land use and environment

Direction	Environment
North	Mountain Ridge Road, then rural residential development.
East	Rural residential development and Tralee Court.
South	Residential development, then Silver Wattle Drive
West	Residential and recreational development (new development), then rural residential and Paula Road

2.3 Topography

The site is considered to be generally level to the south of Flagstone Creek with a gentle decline towards Flagstone Creek to the north.

2.4 Hydrology

It is assumed that the northern section of the site drains towards Flagstone Creek through natural drainage pathways. It is further assumed that drainage within southern sections of the site (south of Flagstone Creek) is locally controlled by engineered drainage towards the borders of the site with general drainage towards Flagstone Creek.

2.5 Geology

The geology at the site (north and south of Flagstone Creek) is mapped as early Jurassic aged arenite consisting of lithic labile and feldspathic labile sandstone (Gatton Sandstone) and Quaternary aged alluvium consisting of clay, silt and gravel in proximity to Flagstone Creek (Queensland Globe, accessed online 10 October 2019).

2.6 Soils

Soils are described as hard pedal mottled-yellow duplex soils, with a hard setting A horizon and conspicuous bleached A2 horizon and acid pedal mottled B horizon (Queensland Globe, accessed online 10 October 2019). On review of further mapping (Queensland Globe, accessed online 10 October 2019) soils in proximity to the site are described as grey sodosols and chromosols.

3 Site investigation

3.1 Site observations and constraints

A comprehensive site inspection was conducted by Dr Samuel Gregory and David Knight of ADG on 20 September 2019. The assessment focused on areas that were able to be accessed and to a lesser extent, areas affected by planned cut and fill events (on review of earthworks plans provided).

3.2 Methodology

A total of 17 boreholes were advanced to a maximum depth of three metres below ground level (mbgl) to characterise and confirm the presence of dispersive soils. Discrete soil samples were based on visual description of the soil profile and collected directly into supplied sample containers using nitrile examination gloves which were replaced between samples. The borehole locations are provided in Figure 1, Appendix A. Each borehole was advanced using a ute mounted drill rig with 100mm auger or a hand auger which was considered appropriate given the conditions encountered.

A total of 33 samples were subjected to dispersivity analysis via the Emerson Aggregate Test (EAT) with a further 10 samples analysed for pH, electrical conductivity (EC), exchangeable sodium percentage (ESP), exchangeable cations (calcium, magnesium, sodium, potassium & aluminium), calcium/magnesium ratio and effective cation exchange capacity (ECEC).

3.3 Soil characteristics and results

The soil characteristics identified during the site evaluation are provided in Table 2 below and select images of various EAT provided below. Soil borelogs are provided in Appendix B with analytical results provided in Appendix C.

The majority of the soils encountered can be characterised as containing a silty sandy upper profile, with an abrupt change to a dispersive clay subsoil. Based upon the field assessment and supporting laboratory analysis, the soils associated with the site are dominated by Sodosols. These soils generally have a weak structure in the surface with a firm to hardsetting surface condition (ICC, 2016).

Table 2. Soil characteristics

BH	Depth (m)	ESP (%)	Dispersive	EAT Class	pH	Ca : Mg
1	0.0 - 0.5	-	Yes	2	-	-
2	0.5 - 1.0	32.6	Yes	2	5.3	<0.1
3	1.0 - 1.5	-	No	7	-	-
	1.5 - 2.0	-	Yes	2	-	-
	2.0 - 2.5	-	Yes	2	-	-
	2.5 - 3.0	45.0	Yes	2	5.3	<0.1
4	0.0 - 0.5	-	No	7	-	-
	0.5 - 1.0	-	Yes	2	-	-
5	0.5 - 1.0	-	Yes	2	-	-
6	0.0 - 0.5	-	Yes	2	-	-
	0.5 - 1.0	18.6	Yes	2	7.4	0.3
	1.0 - 1.5	-	Yes	2	-	-

BH	Depth (m)	ESP (%)	Dispersive	EAT Class	pH	Ca : Mg
	1.5 - 2.0	-	Yes	2	-	-
	2.0 - 2.5	20.0	Yes	2	8.3	0.4
7	0.0 - 0.5	25.2	Yes	2	5.5	<0.1
	0.5 - 1.0	-	Yes	2	-	-
	1.0 - 1.5	30.9	Yes	2	5.1	<0.1
	1.5 - 2.0	-	Yes	2	-	-
8	0.5 - 1.0	-	No	7	-	-
	1.0 - 1.5	33.8	Yes	2	5.2	<0.1
	1.5 - 2.0	-	No	7	-	-
	2.0 - 2.5	-	No	7	-	-
	2.5 - 2.7	-	No	7	-	-
9	0.0 - 0.5	-	No	7	-	-
	0.5 - 1.0	-	No	7	-	-
	1.0 - 1.5	-	No	7	-	-
10	0.5 - 1.0	-	No	7	-	-
12	0.0 - 0.5	-	Yes	2	-	-
13	0.5 - 0.8	-	No	7	-	-
14	0.0 - 0.5	22.0	Yes	2	5.7	0.2
15	0.0 - 0.5	6.6	Yes	2	5.6	0.5
17	0.0 - 0.5	-	No	8	-	-
	0.5 - 1.0	5.5	No	8	5.8	0.3

Image 7. EAT in BH17 0.5-1.0m

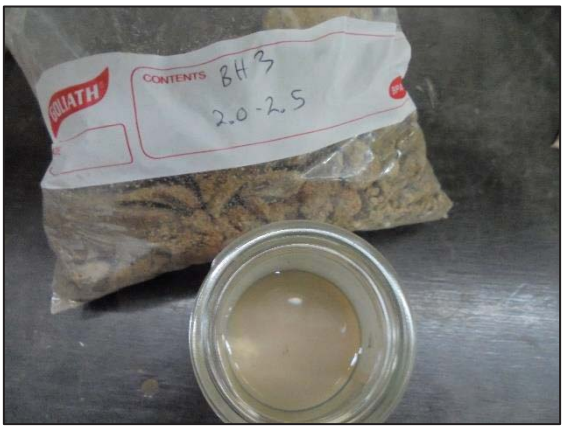


Image 8. EAT in BH3 2.0-2.5m

Image 9. EAT in BH5 0.5-1.0m

Image 10. EAT in BH5 0.5-1.0m

Soils from the following locations can be classified as dispersive based on EAT observations:

- BH1 to BH7
- BH8 subsoils at a depth of 1.0-1.5mbgl
- BH12, 14 and BH15

Borehole locations BH9, 10, 13 and 17 are not classified as dispersive based on EAT observations.

Exchangeable sodium percentage (ESP%) was reported to range from 5.5 – 45.0%, soil pH from 5.1 – 8.3 and calcium : magnesium ratio from <0.1 – 0.5.

4 Discussion

Untreated, or poorly managed dispersive soils can result in significant impacts upon onsite and downstream environments. The assessment undertaken has shown that the site is dominated by sandy silt and silty clay solodics. The texture-contrast solodic soils are characterised by a sandy surface horizon with an abrupt change to a dispersive clay subsoil. When undisturbed (vegetation remaining intact) only minor erosion is observed. However, once these surface soils and subsoil layers are exposed to water and mechanical disturbance, erosion is likely to become a significant issue, especially around Flagstone Creek, where tunnel erosion may develop.

Soils can disperse because of high concentrations of exchangeable sodium (ESP >6% indicates a sodic soil) and low ratios of calcium relative to magnesium (Ca:Mg of <0.1 is often associated with highly dispersive soils). Also, the Emerson Aggregate Test classifies the behaviour of soil aggregates when immersed, on their coherence in water, and is the primary method of identifying dispersive soils. An Emerson Class Number of 1 and 2 denotes dispersive soils. Emerson Class Numbers of 5 and above are rated non-dispersive.

Samples obtained from BH9, BH10, BH13 and BH17 reported Emerson Class 7 and higher and based on this test alone the soils in these areas of the site are considered as non-dispersive. Soil samples collected from BH1-BH7, BH8, BH12, BH14 and BH15 reported an Emerson Class 2, indicating the soils are dispersive. Topsoil in the affected dispersive soil area should be kept intact for as long as possible during the development of the site to prevent erosion/dispersivity of underlying subsoils.

Select soil samples from BH1 – BH14 analysed for ESP% reported concentrations ranging from 18.6 – 45.0 % and consequently rated as strongly sodic. These samples also reported calcium : magnesium ratios of <0.1 - 0.4 which supports the assessment that highly dispersive soils are present in the area.

4.1 Erosion risk mapping

It appears that majority of the site is affected by dispersive soils, to the extent of the assessment undertaken. Where minor cuts are required treatment and/or improvements should be undertaken during the earthworks stage to eliminate the risk of dispersive soil loss from the dispersive soils currently present or alternatively remove the dispersive soil and ensure that all imported fill material is non-dispersive and/or appropriately treated and managed during the earthworks stage of development. Proposed treatment/improvement measures are included at Section 5.

5 Recommendations

Based on site observations, review of the earthworks plan, classification and EAT/analytical results, the site is considered suitable for residential/recreational development, with the implementation of the following management provisions. Dispersive soils were identified over the majority of the site and would not be suitable for development use without treatment.

Any potential and unforeseen risks can be managed with the implementation of a standard Erosion and Sediment Control Plan prepared by a Certified Practitioner in Erosion and Sediment Control (CPESC) with reference to Best Practice Erosion & Sediment Control (IECA 2008) and these control measures should be in place prior to and during the commencement of earthworks. Specific control and construction measures within the Flagstone Creek riparian corridor to prevent scour and erosion could include:

- Effective drainage control such as diversion of up-slope stormwater and installation of scour protection mechanisms
- Minimise surface water flow velocities
- Provision of soil binders or stabilisers.

Progressive clearing of the site is also recommended (and generally cost effective compared to full scale clearing as ESC controls will not be required for areas that haven't been disturbed). Stabilisation of soils through amelioration should also be progressively carried out. Soil structure and moisture holding capacity can be improved through the incorporation of composted organic matter leading to better seedling establishment during landscaping. Consideration of polymer sprays is also recommended in areas that have been cleared.

5.1 Amelioration rates required

Chemical amelioration via application of gypsum will need to be applied (at a minimum rate of 5t/ha) and mixed well into the top 300 mm, followed by testing to confirm that these soils have been adequately treated. Final capping should include 150 mm of suitable non-dispersive imported material. Alternatively, this material should be removed off site and suitable material (non-dispersive) soils should be brought in and placed to final surface levels for a depth not less than 300 mm.

5.2 Construction specifications

It is recommended that this DSMP is provided to the earthworks Contractor so as to ensure the necessary soil information is provided during construction to manage dispersive soils on the site. This DSMP should also be incorporated into any landscape plans and Erosion and Sediment Control Plan developed by a CPESC.

It is recommended that supervision and auditing be undertaken on ameliorated topsoil / subsoils by a suitably qualified person.

Testing shall include the following:

- soil pH
- salt content (EC)
- ESP %
- Exchangeable Cations Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K) and Aluminium
- (Al)
- Effective Cation Exchange Capacity (ECEC)
- Calcium to Magnesium ratio
- Texture
- Phosphorus
- Trace Elements Copper (Cu), Zinc (Zn), Manganese (Mn) & Iron (Fe)
- Sulfate and boron

6 Limitations

ADG Consulting Pty Ltd (ADG) has prepared this report for Peak Urban in accordance with the agreed scope of work. The services performed by ADG have been conducted in a manner consistent with the normal level of care and expertise exercised by members of the environmental consulting profession. No other warranty or guarantee, expressed or implied, is made as to the professional advice included in this report.

This report is solely for the use of Peak Urban & MEDQ and ADG accepts no responsibility for the use of any part of this report for any other purpose or by third parties, as it may not contain sufficient information for the purposes of other parties or users. This report must only be presented in full, and may not be used for any other objective, except where prior written approval is obtained from ADG. This report does not comment on legal obligations, as legal advice can only be given by qualified legal practitioners.

The information contained in this report is provided to minimise potential impacts on the receiving environment, however implementation of the described management procedures does not guarantee that the objectives will be achieved.

The information contained in this report is considered to be accurate at the date of issue. Subsurface conditions, including contaminant concentrations can change in space and time, either through natural processes or by the accidental or intentional addition of contaminants to a site. Where conditions encountered subsequently at the site are significantly different from those reported herein, ADG must be notified and be provided the opportunity to review the conclusions and recommendations of this report.

7 References

Department of Primary Industries and Water Tasmania. 2009. *Dispersive Soils and their Management - Technical Reference Manual*

Department of Sustainable Natural Resources. *Soil Survey Standard Test Method – Emerson Aggregate Test*

International Erosion Control Association (IECA). 2008. *Best Practice Erosion & Sediment Control.* Australasia Chapter.

Ipswich City Council (ICC). 2016. *Implementation Guideline No. 28, Dispersive Soil Management*.

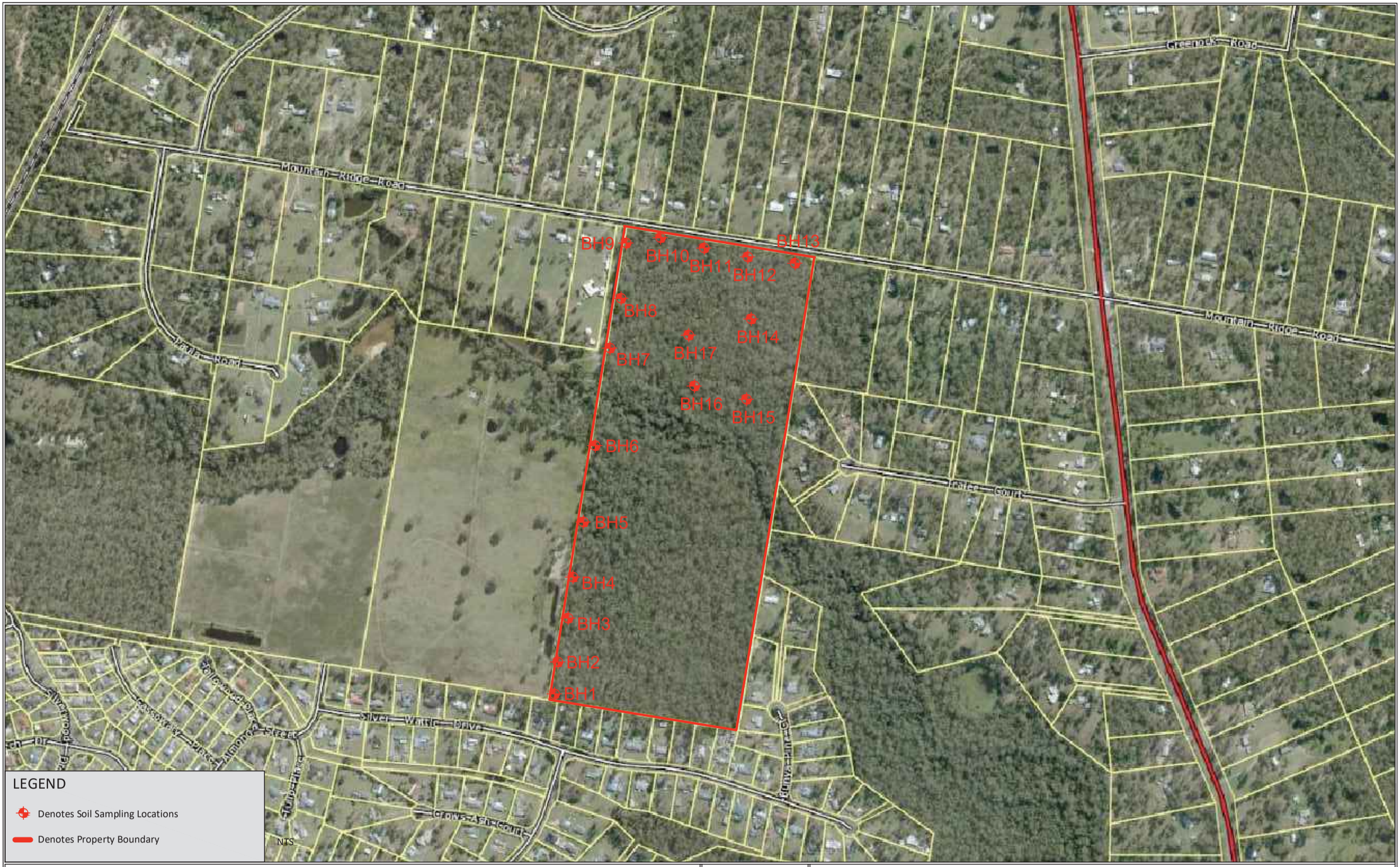
Queensland Department of Natural Resources. 1997. *Salinity Management Handbook.* DNRQ97019

Queensland Globe. 2019. Accessed online 20 October 2019 : https://qldglobe.information.qld.gov.au/

Department of Primary industries. 1996. *Understanding and managing soils in the Moreton Region - Training Series QE96003*

Appendix A: Figures

Figure 1. Site and borehole locations



Client: Peak Urban

Project: Lot 30 SP309195, Mountain Ridge Road, South Maclean, QLD

Project ref: ADG1059.19

Drawn by: Samuel Gregory Date: 10.10.19 Base plan source: Queenland Globe

Figure 1 - Site and Borehole Locality

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ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC
QLD 4207

ADG CONSULTING
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Appendix B: Soil borelogs

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH1
Project: DSMP			Location: 257
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					silty SAND light brown dry fine grained
			0.6		silty SAND yellow dry fine grained
			1.5		Termination @ 1.5m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH2
Project: DSMP			Location: 258
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					silty SAND light brown dry fine grained
			0.6		silty SAND yellow dry fine grained
			1.0		Termination @ 1m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH3
Project: DSMP			Location: 259
Project ref: 1059.19	Logged by: SC	Date: 20/4/19	Surface level:
Equipment type: 4x4 Drill Rig.		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Silty SAND light brown dry fine grained
			1.2		SILTY clay light brown dry low plasticity. Firm trace of orange mottling
			1.5		change to D-M
			3.0		Termination @ 3m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			**Borehole:** BH4
Project: DSMP			**Location:** 260
Project ref: 1059.19	**Logged by:** SG	**Date:** 20/9/19	**Surface level:**
Equipment type: 4x4 Drill Rig		**Hole diameter:** 100mm	**Notes:**

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					silty CLAY brown dry low plasticity firm
			0.5		silty SAND light brown dry fine grained
			1.0		Termination @ 1m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH5
Project: DSMP			Location: 261
Project ref: 1059.19	Logged by: SG	Date: 20/9/17	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes: *

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					silty SAND light brown dry fine grained.
			0.6		Silty CLAY light brown dry low plasticity firm
			1.2		sandy SILT grey-yellow dry. v. soft
			2.0		Termination @ 2m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: DH6
Project: DSMP			Location: 262
Project ref: 1059 19	Logged by: SC	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Silty CLAY light brown dry low plasticity Firm
			1.2		Silty CLAY yellow-grey dry low plasticity firm
			1.5		change to brown-grey M-D
			2.6		sandy SILT yellow M-D v. soft
			3.0		Termination @ 3m

ADG CONSULTING
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ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban.			Borehole: BH7
Project: DSMP			Location: 263
Project ref: 1059.	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: Auger Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					silty CLAY yellow-brown dry low plasticity firm
			0.4		silty CLAY grey-brown dry med plasticity stiff with some red mottling.
			1.1		change to grey v. stiff with red mottling.
			1.7		change to firm
			2.3		change in colour grey-red
			2.5		Sandy SILT yellow-brown dry. VL
			2.7		Termination @ 2.7m @ refusal

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH8
Project: DSMP			Location: 264
Project ref: 1059.17	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					sandy SILT grey-brown dry v. soft
			0.5		silty CLAY grey dry low plasticity firm with some red mottling
			1.1		sandy SILT yellow-grey dry v soft
			1.8		sandy SILT red-brown dry v soft
			2.1		sandy SILT grey dry v soft with a trace of red fines.
			3.0		Termination @ 3m

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ABN: 98 630 555 225

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W adgconsulting.com.au

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PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH9
Project: DSMP			Location: 265
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig	Hole diameter: 100mm		Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Sandy SILT grey dry v soft
			0.2		Sandy SILT brown ~~orange~~ grey dry v. soft
			1.3		silty CLAY grey dry firm
			1.6		Sandy SILT yellow brown dry v. soft
			2.3		Termination & refusal at 2.3m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: DH10
Project: DSMP			Location: 266
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4×4 Drill Rig	Hole diameter: 100mm		Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					sandy SILT brown dry v soft
			0.2		sandy SILT grey-brown dry v soft
			1.0		Termination @ 1m.

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ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH 11
Project: DSMD			Location: 267
Project ref: 1059 19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4 x 4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Sandy SILT light brown dry v soft
			0.3		Sandy SILT grey-brown dry v soft
			1.0		Termination @ refusal @ 1m

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ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH12
Project: QSMP			Location: 268
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Sandy SILT grey-brown dry v soft
			0.5		Refusal @ 0.5m

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SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

All Correspondence
PO Box 6405
Yatala DC QLD 4207

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH13
Project: DSMP			Location: 269
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 100mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					sandy SILT grey-brown dry v. soft
			0.8		Refusal & termination @ 0.8m.

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

All Correspondence
PO Box 6405
Yatala DC QLD 4207

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

BOREHOLE DESCRIPTION

Client: Peak Urban			**Borehole:** BH1
Project: DSMP			**Location:** 270
Project ref: 1059.1A	**Logged by:** SC	**Date:** 26/9/19	**Surface level:**
Equipment type: Hand Drill Rig		**Hole diameter:** 100mm	**Notes:**

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					sandy SILT grey-brown dry soft
			0.5		Refusal @ 0.5m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

All Correspondence
PO Box 6405
Yatala DC QLD 4207

P 07 3801 1564
E mail@adgconsulting.com.au
W adgconsulting.com.au

BOREHOLE DESCRIPTION

Client: Peak Urban			**Borehole:** BH15
Project: DSMP			**Location:** 271
Project ref: 1059.19	**Logged by:** SC	**Date:** 20/9/19	**Surface level:**
Equipment type: 4x4 Drill Rig		**Hole diameter:** 100mm	**Notes:**

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					sandy SILT grey-brown dry soft
			0.5		Refusal @ 0.5m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
F 07 3801 1563
E mail@adgconsulting.com.au
W adgconsulting.com.au

Head Office
29/8 Riverland Drive
Loganholme
QLD 4129

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH16
Project: OSMP			Location: 272
Project ref: 1059.19	Logged by: SC	Date: 20/9/19.	Surface level:
Equipment type: 4x4 Drill Rig	Hole diameter: 100mm		Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Sandy silt grey-brown dry soft
			0.5		Refusal @ 0.5m

ADG CONSULTING
SOIL AIR WATER ENVIRONMENT

ADG Consulting Pty Ltd
ACN: 630 555 225
ABN: 98 630 555 225

P 07 3801 1564
F 07 3801 1563
E mail@adgconsulting.com.au
W adgconsulting.com.au

Head Office
29/8 Riverland Drive
Loganholme
QLD 4129

BOREHOLE DESCRIPTION

Client: Peak Urban			Borehole: BH17
Project: OSMP			Location: 273
Project ref: 1059.19	Logged by: SG	Date: 20/9/19	Surface level:
Equipment type: 4x4 Drill Rig		Hole diameter: 60mm	Notes:

Geological profile	Water	Well detail	Depth (m)	Graphic log	Soil or rock type
					Sandy silt grey-brown dry v. soft
			0.6		Silty CLAY grey dry low plasticity firm
			1.0		Termination @ 1m

Appendix C: Laboratory certificates

ALSCompass
SAMPLING *Intelligence*

ALS

Environmental Division
Brisbane
Work Order Reference
EB1925050

Telephone : +61-7-3243 7222

Custody Document for Submissions via ALS Compass App

Project: ADG 1059.19 **Client:** ADG Consulting Pty Ltd **Project Manager:** Michael Campbell
Phone: (0415 960 372

ALS Compass COC Reference: 4307 **# Samples:** 10 **Sampler:** Sam Gregory
Phone: 0418795859

Turnaround Requirements: Standard 1/10/19 Urgent

Special Instructions:

Custody:

Relinquished by:	**Received by:**	**Relinquished by:**	**Received by:**
Sam	J Butler		
Date / Time:	**Date / Time:**	**Date / Time:**	**Date / Time:**
24/9/19 0900	24/9 11:30		

CHAIN OF CUSTODY

(ALS) *COC#:* **4307** *ALS Laboratory:* EB Brisbane

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE TIME:	DATE TIME:	DATE TIME:	DATE TIME:

CLIENT: ADGCON - ADG CONSULTING P/L

PROJECT: DSMP

SITE: ADG1059.19

ORDER NO:

PROJECT MANAGER: Samuel Samuel
PRIMARY SAMPLER: Samuel Samuel

CONTACT PH:
QUOTE NO: BN/269/19

SAMPLER MOBILE:
/ EB2019ADGCON0003

EMAIL REPORTS TO: mail@adgconsulting.com.au

EMAIL INVOICES TO: mail@adgconsulting.com.au

TURNAROUND REQUIREMENTS : 5 Days

Biohazard info:

LABORATORY USE ONLY (Circle)

Custody Seal intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

Other comments:

SAMPLE DETAILS							ANALYSIS REQUIRED		
SAMPLE	NAME	DESCRIPTION	DATE / TIME	MATRIX	TOTAL BOTTLES	ON HOLD	Table 1: Soil Analysis SOIL	ALTERNATIVE ANALYSIS	ADDITIONAL INFORMATION
001	BH2 0.5-1.0		20/09/2019 03:09 PM	Soil	ALS: 1 Non ALS: 0	No	X		
002	BH3 2.5-3.0		20/09/2019 03:11 PM	Soil	ALS: 1 Non ALS: 0	No	X		
003	BH6 0.5-1.0		20/09/2019 03:14 PM	Soil	ALS: 1 Non ALS: 0	No	X		
004	BH6 2.0-2.5		20/09/2019 03:15 PM	Soil	ALS: 1 Non ALS: 0	No	X		
005	BH7 0.0-0.5		20/09/2019 03:16 PM	Soil	ALS: 1 Non ALS: 0	No	X		
006	BH7 1.0-1.5		20/09/2019 03:17 PM	Soil	ALS: 1 Non ALS: 0	No	X		
007	BH8 1.0-1.5		20/09/2019 03:18 PM	Soil	ALS: 1 Non ALS: 0	No	X		
008	BH14 0.0-0.5		20/09/2019 03:18 PM	Soil	ALS: 1 Non ALS: 0	No	X		
009	BH15 0.0-0.5		20/09/2019 03:19 PM	Soil	ALS: 1 Non ALS: 0	No	X		

CHAIN OF CUSTODY

ALS COC#: 4307 *ALS Laboratory:* EB Brisbane

CLIENT: ADGCON - ADG CONSULTING P/L

PROJECT: DSMP

SITE: ADG1059.19

ORDER NO:

PROJECT MANAGER: Samuel Samuel
PRIMARY SAMPLER: Samuel Samuel

CONTACT PH:
QUOTE NO: BN/269/19

SAMPLER MOBILE:
/ EB2019ADGCON0003

EMAIL REPORTS TO: mail@adgconsulting.com.au

EMAIL INVOICES TO: mail@adgconsulting.com.au

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE TIME:	DATE TIME:	DATE TIME:	DATE TIME:

TURNAROUND REQUIREMENTS : 5 Days

Biohazard info:

LABORATORY USE ONLY (Circle)

Custody Seal intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:		°C	
Other comments:			

SAMPLE DETAILS							ANALYSIS REQUIRED		
SAMPLE	NAME	DESCRIPTION	DATE / TIME	MATRIX	TOTAL BOTTLES	ON HOLD	Table 1: Soil Analysis SOIL	ALTERNATIVE ANALYSIS	ADDITIONAL INFORMATION
010	BH17 0.5-1.0		20/09/2019 03:20 PM	Soil	ALS: 1 Non ALS: 0	No	X		

CHAIN OF CUSTODY

(ALS) COC#: 4307 *ALS Laboratory:* EB Brisbane

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE TIME:	DATE TIME:	DATE TIME:	DATE TIME:

CLIENT: ADGCON - ADG CONSULTING P/L

PROJECT: DSMP

SITE: ADG1059.19

ORDER NO:

PROJECT MANAGER: Samuel Samuel
PRIMARY SAMPLER: Samuel Samuel

CONTACT PH:
QUOTE NO: BN/269/19

SAMPLER MOBILE:
/ EB2019ADGCON0003

EMAIL REPORTS TO: mail@adgconsulting.com.au

EMAIL INVOICES TO: mail@adgconsulting.com.au

TURNAROUND REQUIREMENTS : 5 Days

Biohazard info:

LABORATORY USE ONLY (Circle)

Custody Seal intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

Other comments:

SAMPLE	SAMPLE NAME	BOTTLE NAME	VOLUME	BARCODE	TYPE	FILTERED	REASON
001	BH2 0.5-1.0	Soil Glass Jar - Unpreserved	250 mL	00260519025162	Orange	No	
002	BH3 2.5-3.0	Soil Glass Jar - Unpreserved	250 mL	00260519044850	Orange	No	
003	BH6 0.5-1.0	Soil Glass Jar - Unpreserved	250 mL	00260519037468	Orange	No	
004	BH6 2.0-2.5	Soil Glass Jar - Unpreserved	250 mL	00260519037447	Orange	No	
005	BH7 0.0-0.5	Soil Glass Jar - Unpreserved	250 mL	00260519044788	Orange	No	
006	BH7 1.0-1.5	Soil Glass Jar - Unpreserved	250 mL	00260519044713	Orange	No	
007	BH8 1.0-1.5	Soil Glass Jar - Unpreserved	250 mL	00260519044519	Orange	No	
008	BH14 0.0-0.5	Soil Glass Jar - Unpreserved	250 mL	00260519044775	Orange	No	
009	BH15 0.0-0.5	Soil Glass Jar - Unpreserved	250 mL	00260519044904	Orange	No	
010	BH17 0.5-1.0	Soil Glass Jar - Unpreserved	250 mL	00260519044900	Orange	No	

Total Bottle Count: ALS: 10, Non ALS: 0

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1925050**

Client	: **ADG CONSULTING P/L**	Laboratory	: Environmental Division Brisbane
Contact	: SAMUEL GREGORY	Contact	: Customer Services EB
Address	: PO Box 6405 Yatala DC 4207	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: ----	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: ----	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: DSMP	Page	: 1 of 2
Order number	: -	Quote number	: EB2019ADGCON0003 (BN/269/19)
C-O-C number	: 4307	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ADG1059.19		
Sampler	: SAMUEL GREGORY		

Dates

Date Samples Received	: 24-Sep-2019 11:30	Issue Date	: 24-Sep-2019
Client Requested Due Date	: 28-Sep-2019	Scheduled Reporting Date	: **01-Oct-2019**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 15.3°C - Ice Bricks present
Receipt Detail	: HARD SMALL ESKY	No. of samples received / analysed	: 10 / 10

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - AG-1 EB Only Agricultural Soil Suite 1 EB Only
EB1925050-001	20-Sep-2019 15:09	BH2 0.5-1.0	✓
EB1925050-002	20-Sep-2019 15:11	BH3 2.5-3.0	✓
EB1925050-003	20-Sep-2019 15:14	BH6 0.5-1.0	✓
EB1925050-004	20-Sep-2019 15:15	BH6 2.0-2.5	✓
EB1925050-005	20-Sep-2019 15:16	BH7 0.0-0.5	✓
EB1925050-006	20-Sep-2019 15:17	BH7 1.0-1.5	✓
EB1925050-007	20-Sep-2019 15:18	BH8 1.0-1.5	✓
EB1925050-008	20-Sep-2019 15:18	BH14 0.0-0.5	✓
EB1925050-009	20-Sep-2019 15:19	BH15 0.0-0.5	✓
EB1925050-010	20-Sep-2019 15:20	BH17 0.5-1.0	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- *AU Certificate of Analysis - NATA (COA)	Email	mail@adgconsulting.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	mail@adgconsulting.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	mail@adgconsulting.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	mail@adgconsulting.com.au
- A4 - AU Tax Invoice (INV)	Email	mail@adgconsulting.com.au
- Chain of Custody (CoC) (COC)	Email	mail@adgconsulting.com.au
- EDI Format - XTab (XTAB)	Email	mail@adgconsulting.com.au

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1925050**	Page	: 1 of 4
Client	: **ADG CONSULTING P/L**	Laboratory	: Environmental Division Brisbane
Contact	: SAMUEL GREGORY	Contact	: Customer Services EB
Address	: PO Box 6405 Yatala DC 4207	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: DSMP	Date Samples Received	: 24-Sep-2019 11:30
Order number	: -	Date Analysis Commenced	: 25-Sep-2019
C-O-C number	: 4307	Issue Date	: 30-Sep-2019 16:12
Sampler	: SAMUEL GREGORY		
Site	: ADG1059.19		
Quote number	: BN/269/19		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
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.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

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.

- ED007 (Exchangeable Cations): Unable to calculate Magnesium/Potassium Ratio for some samples as the required results for Magnesium/Potassium are below LOR.
- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result as required Potassium and/or Magnesium results are less than the limit of reporting.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH2 0.5-1.0	BH3 2.5-3.0	BH6 0.5-1.0	BH6 2.0-2.5	BH7 0.0-0.5
			Client sampling date / time	20-Sep-2019 15:09	20-Sep-2019 15:11	20-Sep-2019 15:14	20-Sep-2019 15:15	20-Sep-2019 15:16
Compound	CAS Number	LOR	Unit	EB1925050-001	EB1925050-002	EB1925050-003	EB1925050-004	EB1925050-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.3	5.3	7.4	8.3	5.5
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	272	295	179	236	224
ED005: Exchange Acidity								
ø Exchange Acidity	----	0.1	meq/100g	5.2	2.6	----	----	4.7
ø Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	----	----	<0.1
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	----	----	3.0	2.9	----
ø Exchangeable Magnesium	----	0.2	meq/100g	----	----	8.7	7.9	----
ø Exchangeable Potassium	----	0.2	meq/100g	----	----	<0.2	0.2	----
ø Exchangeable Sodium	----	0.2	meq/100g	----	----	2.7	2.8	----
ø Cation Exchange Capacity	----	0.2	meq/100g	----	----	14.6	13.8	----
ø Exchangeable Sodium Percent	----	0.2	%	----	----	18.6	20.0	----
ø Calcium/Magnesium Ratio	----	0.2	-	----	----	0.3	0.4	----
ø Magnesium/Potassium Ratio	----	0.2	-	----	----	----	33.4	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	0.2	----	----	0.7
Exchangeable Magnesium	----	0.1	meq/100g	7.3	7.3	----	----	9.6
Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	----	----	0.6
Exchangeable Sodium	----	0.1	meq/100g	3.7	6.3	----	----	3.7
Cation Exchange Capacity	----	0.1	meq/100g	16.4	16.6	----	----	19.3
Exchangeable Sodium Percent	----	0.1	%	32.6	45.0	----	----	25.2
Calcium/Magnesium Ratio	----	0.1	-	<0.1	<0.1	----	----	<0.1
Magnesium/Potassium Ratio	----	0.1	-	48.6	35.7	----	----	14.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH7 1.0-1.5	BH8 1.0-1.5	BH14 0.0-0.5	BH15 0.0-0.5	BH17 0.5-1.0
			Client sampling date / time	20-Sep-2019 15:17	20-Sep-2019 15:18	20-Sep-2019 15:18	20-Sep-2019 15:19	20-Sep-2019 15:20
Compound	CAS Number	LOR	Unit	EB1925050-006	EB1925050-007	EB1925050-008	EB1925050-009	EB1925050-010
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	5.1	5.2	5.7	5.6	5.8
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	473	205	22	7	10
ED005: Exchange Acidity								
ø Exchange Acidity	----	0.1	meq/100g	3.0	6.8	0.5	0.8	1.1
ø Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	<0.1	<0.1	<0.1
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	----	<0.1	0.1	0.2	0.3
Exchangeable Magnesium	----	0.1	meq/100g	----	6.6	0.5	0.4	1.0
Exchangeable Potassium	----	0.1	meq/100g	----	0.3	<0.1	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	----	3.5	0.2	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	----	17.2	1.3	1.4	2.4
Exchangeable Sodium Percent	----	0.1	%	----	33.8	22.0	6.6	5.5
Calcium/Magnesium Ratio	----	0.1	-	----	<0.1	0.2	0.5	0.3
Magnesium/Potassium Ratio	----	0.1	-	----	24.8	----	----	----
ED008: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	<0.1	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	4.2	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.2	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	2.0	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	9.4	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	30.9	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	<0.1	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	21.3	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1925050**	Page	: 1 of 4
Client	: **ADG CONSULTING P/L**	Laboratory	: Environmental Division Brisbane
Contact	: SAMUEL GREGORY	Contact	: Customer Services EB
Address	: PO Box 6405 Yatala DC 4207	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: DSMP	Date Samples Received	: 24-Sep-2019
Order number	: -	Date Analysis Commenced	: 25-Sep-2019
C-O-C number	: 4307	Issue Date	: 30-Sep-2019
Sampler	: SAMUEL GREGORY		
Site	: ADG1059.19		
Quote number	: BN/269/19		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
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 Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA002: pH 1:5 (Soils) (QC Lot: 2603375)									
EB1925050-001	BH2 0.5-1.0	EA002: pH Value	----	0.1	pH Unit	5.3	5.4	0.00	0% - 20%
EB1925145-001	Anonymous	EA002: pH Value	----	0.1	pH Unit	3.5	3.5	0.00	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 2603374)									
EB1925050-001	BH2 0.5-1.0	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	272	255	6.52	0% - 20%
EB1925145-001	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	7510	6400	16.0	0% - 20%
ED005: Exchange Acidity (QC Lot: 2607693)									
EB1925050-006	BH7 1.0-1.5	ED005: Exchange Acidity	----	0.1	meq/100g	3.0	3.0	0.00	0% - 20%
		ED005: Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
ED005: Exchange Acidity (QC Lot: 2607700)									
EB1925050-001	BH2 0.5-1.0	ED005: Exchange Acidity	----	0.1	meq/100g	5.2	5.2	0.00	0% - 20%
		ED005: Exchangeable Aluminium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
ED006: Exchangeable Cations on Alkaline Soils (QC Lot: 2607681)									
EB1925013-001	Anonymous	ED006: Exchangeable Calcium	----	0.2	meq/100g	0.6	0.6	0.00	No Limit
		ED006: Exchangeable Magnesium	----	0.2	meq/100g	3.0	3.0	0.00	0% - 50%
		ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Sodium	----	0.2	meq/100g	0.9	0.9	0.00	No Limit
		ED006: Cation Exchange Capacity	----	0.2	meq/100g	4.5	4.5	0.00	0% - 20%
ED007: Exchangeable Cations (QC Lot: 2607699)									
EB1925050-001	BH2 0.5-1.0	ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	7.3	7.3	0.00	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	0.00	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	3.7	3.6	0.00	0% - 20%
ED008: Exchangeable Cations (QC Lot: 2607694)									
EB1925050-006	BH7 1.0-1.5	ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	0.00	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED008: Exchangeable Cations (QC Lot: 2607694) - continued									
EB1925050-006	BH7 1.0-1.5	ED008: Exchangeable Magnesium	----	0.1	meq/100g	4.2	4.2	0.00	0% - 20%
		ED008: Exchangeable Potassium	----	0.1	meq/100g	0.2	0.2	0.00	No Limit
		ED008: Exchangeable Sodium	----	0.1	meq/100g	2.0	2.0	0.00	0% - 20%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA002: pH 1:5 (Soils) (QCLot: 2603375)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	100	98.0	102
EA010: Conductivity (1:5) (QCLot: 2603374)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	101	97.0	103
ED005: Exchange Acidity (QCLot: 2607693)								
ED005: Exchange Acidity	----	0.1	meq/100g	<0.1	----	----	----	----
ED005: Exchangeable Aluminium	----	0.1	meq/100g	<0.1	----	----	----	----
ED005: Exchange Acidity (QCLot: 2607700)								
ED005: Exchange Acidity	----	0.1	meq/100g	<0.1	----	----	----	----
ED005: Exchangeable Aluminium	----	0.1	meq/100g	<0.1	----	----	----	----
ED006: Exchangeable Cations on Alkaline Soils (QCLot: 2607681)								
ED006: Exchangeable Calcium	----	0.2	meq/100g	<0.2	11.3 meq/100g	79.5	70.0	130
ED006: Exchangeable Magnesium	----	0.2	meq/100g	<0.2	5.61 meq/100g	108	70.0	130
ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	1.15 meq/100g	121	70.0	130
ED006: Exchangeable Sodium	----	0.2	meq/100g	<0.2	3.54 meq/100g	70.1	70.0	130
ED006: Cation Exchange Capacity	----	0.2	meq/100g	<0.2	21.6 meq/100g	87.7	70.0	130
ED007: Exchangeable Cations (QCLot: 2607699)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	18.1 meq/100g	92.0	79.0	113
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	9.08 meq/100g	90.0	85.0	115
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.918 meq/100g	89.9	70.0	122
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	3.15 meq/100g	101	76.0	112
ED007: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	31.3 meq/100g	92.1	82.0	112
ED008: Exchangeable Cations (QCLot: 2607694)								
ED008: Exchangeable Calcium	----	0.1	meq/100g	<0.1	16.7 meq/100g	94.2	91.0	109
ED008: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	7.74 meq/100g	93.3	89.0	111
ED008: Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.711 meq/100g	90.4	79.0	116
ED008: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.91 meq/100g	101	75.0	118
ED008: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1925050**	Page	: 1 of 5
Client	: **ADG CONSULTING P/L**	Laboratory	: Environmental Division Brisbane
Contact	: SAMUEL GREGORY	Telephone	: +61-7-3243 7222
Project	: DSMP	Date Samples Received	: 24-Sep-2019
Site	: ADG1059.19	Issue Date	: 30-Sep-2019
Sampler	: SAMUEL GREGORY	No. of samples received	: 10
Order number	: -	No. of samples analysed	: 10

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA002: pH 1:5 (Soils)							
Soil Glass Jar - Unpreserved							
BH2 0.5-1.0,	BH3 2.5-3.0,	----	----	----	26-Sep-2019	25-Sep-2019	**1**
BH6 0.5-1.0,	BH6 2.0-2.5,						
BH7 0.0-0.5,	BH7 1.0-1.5,						
BH8 1.0-1.5,	BH14 0.0-0.5,						
BH15 0.0-0.5,	BH17 0.5-1.0						

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002: pH 1:5 (Soils)								
Soil Glass Jar - Unpreserved (EA002)								
BH2 0.5-1.0,	BH3 2.5-3.0,	**20-Sep-2019**	**25-Sep-2019**	27-Sep-2019	✓	**26-Sep-2019**	25-Sep-2019	×
BH6 0.5-1.0,	BH6 2.0-2.5,							
BH7 0.0-0.5,	BH7 1.0-1.5,							
BH8 1.0-1.5,	BH14 0.0-0.5,							
BH15 0.0-0.5,	BH17 0.5-1.0							
EA010: Conductivity (1:5)								
Soil Glass Jar - Unpreserved (EA010)								
BH2 0.5-1.0,	BH3 2.5-3.0,	**20-Sep-2019**	**25-Sep-2019**	27-Sep-2019	✓	**26-Sep-2019**	23-Oct-2019	✓
BH6 0.5-1.0,	BH6 2.0-2.5,							
BH7 0.0-0.5,	BH7 1.0-1.5,							
BH8 1.0-1.5,	BH14 0.0-0.5,							
BH15 0.0-0.5,	BH17 0.5-1.0							

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED005: Exchange Acidity								
Soil Glass Jar - Unpreserved (ED005)								
BH2 0.5-1.0,	BH3 2.5-3.0,	**20-Sep-2019**	**27-Sep-2019**	18-Oct-2019	✓	**27-Sep-2019**	18-Oct-2019	✓
BH6 0.5-1.0,	BH6 2.0-2.5,							
BH7 0.0-0.5,	BH7 1.0-1.5,							
BH8 1.0-1.5,	BH14 0.0-0.5,							
BH15 0.0-0.5,	BH17 0.5-1.0							
ED006: Exchangeable Cations on Alkaline Soils								
Soil Glass Jar - Unpreserved (ED006)								
BH2 0.5-1.0,	BH3 2.5-3.0,	**20-Sep-2019**	**27-Sep-2019**	18-Oct-2019	✓	**27-Sep-2019**	18-Oct-2019	✓
BH6 0.5-1.0,	BH6 2.0-2.5,							
BH7 0.0-0.5,	BH7 1.0-1.5,							
BH8 1.0-1.5,	BH14 0.0-0.5,							
BH15 0.0-0.5,	BH17 0.5-1.0							
ED007: Exchangeable Cations								
Soil Glass Jar - Unpreserved (ED007)								
BH2 0.5-1.0,	BH3 2.5-3.0,	**20-Sep-2019**	**27-Sep-2019**	18-Oct-2019	✓	**27-Sep-2019**	18-Oct-2019	✓
BH6 0.5-1.0,	BH6 2.0-2.5,							
BH7 0.0-0.5,	BH7 1.0-1.5,							
BH8 1.0-1.5,	BH14 0.0-0.5,							
BH15 0.0-0.5,	BH17 0.5-1.0							
ED008: Exchangeable Cations								
Soil Glass Jar - Unpreserved (ED008)								
BH2 0.5-1.0,	BH3 2.5-3.0,	**20-Sep-2019**	**27-Sep-2019**	18-Oct-2019	✓	**27-Sep-2019**	18-Oct-2019	✓
BH6 0.5-1.0,	BH6 2.0-2.5,							
BH7 0.0-0.5,	BH7 1.0-1.5,							
BH8 1.0-1.5,	BH14 0.0-0.5,							
BH15 0.0-0.5,	BH17 0.5-1.0							

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Electrical Conductivity (1:5)	EA010	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchange Acidity by 1M Potassium Chloride	ED005	2	8	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations	ED007	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations on Alkaline Soils	ED006	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations with pre-treatment	ED008	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Electrical Conductivity (1:5)	EA010	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations	ED007	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations on Alkaline Soils	ED006	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations with pre-treatment	ED008	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Electrical Conductivity (1:5)	EA010	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchange Acidity by 1M Potassium Chloride	ED005	2	8	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations	ED007	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations on Alkaline Soils	ED006	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Exchangeable Cations with pre-treatment	ED008	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH (1:5)	EA002	SOIL	In house: Referenced to Rayment and Lyons 4A1 and APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to Rayment and Lyons 3A1 and APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3)
Exchange Acidity by 1M Potassium Chloride	* ED005	SOIL	In house: referenced to Rayment and Lyons, (2011), method 15G1. This method is unsuitable for near neutral and alkaline soils. NATA accreditation does not cover performance of this service.
Exchangeable Cations on Alkaline Soils	* ED006	SOIL	In house: Referenced to Soil Survey Test Method C5. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with alcoholic ammonium chloride at pH 8.5. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil.
Exchangeable Cations	ED007	SOIL	In house: Referenced to Rayment & Lyons (2011) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)
Exchangeable Cations with pre-treatment	ED008	SOIL	In house: Referenced to Rayment & Higginson (2011) Method 15A2. Soluble salts are removed from the sample prior to analysis. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (2013) Schedule B(3) (Method 301)

Preparation Methods	Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method (Alkaline Soils)	ED006PR	SOIL	In house: Referenced to Rayment and Lyons 2011 method 15C1.
Exchangeable Cations Preparation Method	ED007PR	SOIL	In house: Referenced to Rayment & Higginson (1992) method 15A1. A 1M NH4Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.