G3 56 Delhi Road
North Ryde NSW 2113
P +61-2 9812 5000
E mailbox@psm.com.au
www.psm.com.au

Our Ref: PSM4951-005L REV1

6 October 2023

Project Manager
JBS&G
Level 1
50 Margaret Street
Sydney, NSW
gpinget@jbsg.com.au

Attention: Gina Pinget

Dear Gina

RE: BROKEN HILL HOSPITAL REDEVELOPMENT
SALINITY MANAGEMENT PLAN

1. Introduction

This letter presents a Salinity Management Plan (SMP) for the proposed development at Broken Hill Hospital, NSW (the Site). The aim of the SMP is to effectively manage site salinity, minimise the effect of the proposed development on salinity processes and to protect the proposed development from salinity damage.

The work was undertaken in accordance with our email proposal, dated 20 April 2023.

To assist with the preparation of the SMP, we have been provided with the following documents:

- Architectural Drawings - Broken Hill Acute Adult Mental Health Unit and Emergency Department by STH (dated 17 April 2023)
- Broken Hill Acute Adult Mental Health Unit and Emergency Department - Concept Design Options by STH (dated 12 December 2022)
- Broken Hill Acute Adult Mental Health Unit and Emergency Department – Road Relocation Option by STH (dated 25 January 2023)
- Broken Hill Acute Adult Mental Health Unit and Emergency Department – 'Stage 1' and 'Stage 2' REF Submission by STH (dated 18 August 2023)
- Detail Survey by Monteath & Powys (ref. 22/0418 REV3, dated 9 December 2022)

Based on the documents above, PSM understands the following regarding the Site and proposed development:

- A new mental health unit (MHU), with an area of approximately 1000 m^2, will be developed across the existing hospital carpark.
- A new emergency department (ED), with an area of approximately 700 m^2, will be developed across the existing ambulance bay. The building will be connected to the existing imaging department.
- The MHU and ED will be single storey buildings, constructed at grade.
- New pavement areas will be developed to provide vehicle access and parking near the new MHU

- Existing services on site include underground drainage lines, gas, water, and sewer mains, and electric and telecommunications cables.

Figure 1 presents a locality plan of the site and the approximate extent of the proposed areas for development.

2. Salinity Assessment

PSM conducted a round of site investigations during February of 2023 (reported in PSM4951-004R REV1, dated 6 October 2023).

During in the investigation, three (3) soil samples were recovered and sent to a NATA accredited analytical laboratory for the following testing:

- Cation Exchange Capacity (CEC) of calcium, magnesium, potassium and sodium
- Exchange sodium percentage
- Salinity ($EC_{1:5}$, one part soil to five parts water)
- Soil PH
- Chlorides
- Sulphates
- Resistivity.

Table 1 represents a summary of the results of the analytical soil testing undertaken. Laboratory test reports are included in Appendix A.

Table 1 – Summary of Salinity and Aggressivity Test results

Sample ID (Depth)	Exchangeable Cations [meq/100g]					Exchange Sodium [%]	pH	Electrical Conductivity [µS/cm]	Sulfate [mg/kg]	Chloride [mg/kg]	Resistivity [ohm cm]	Moisture Content [%]
	Ca	Mg	K	Na	CEC							
BH01 (0.3 – 0.5 m)	5.1	4.0	1.0	5.2	15.2	34.3	8.9	1190	1080	1240	840	11.9
BH03 (0.3 – 0.6 m)	2.1	0.9	0.2	0.7	4.0	17.6	9.1	434	330	260	2300	8.8
ED-B4[1] (0.3 – 0.5 m)	3.9	0.9	0.2	<0.2	5.0	<0.2	9.1	137	60	50	7300	7.5

(1) ED-B4 is a JBS&G hand augered hole in the ED area

2.1 Salinity

Site Investigations for Urban Salinity (DLWC 2002)[1] classify soil salinity based on electrical conductivity (EC_e) as per Richards (1954)[2]. The method of conversion from $EC_{1:5}$ to EC_e (electrical conductivity of saturated extract) is based on DLWC (2002) and given by $EC_e = EC_{1:5} \times M$, where M is the multiplication factor based on "Soil Texture Group".

The "Soil Texture Group" of the samples tested has been assessed during our investigation. The salinity classification for the soil samples that were tested are presented in Table 2.

Table 2 – Salinity Classification

Sample ID (Depth)	$EC_{1:5}$ [dS/m]	Soil Texture Group	M	EC_e [dS/m]	Salinity Class
BH01 (0.3 – 0.5 m)	1.19	Medium clays[2]	7	8.3	Very saline
BH03 (0.3 – 0.6 m)	0.43	Sands[3]	17	7.3	Moderately saline
ED-B4[1] (0.3 – 0.5 m)	0.14	Sands[3]	17	2.4	Slightly saline

(1) ED-B4 is a JBS&G hand augered hole in the ED area
(2) Natural soil
(3) Fill

Based on the classifications provided, it is assessed that the soils on site are classified as "slightly-saline to very saline" as per "site Investigations for Urban Salinity", DLWC (2002).

In addition to the salinity classification, we have referred to Clause 4.8.2 of Australian Standard AS3600-2018 "Concrete Structures" and note that the assessed soil electrical conductivity (EC_e) is within the "A2" to "B1" exposure classification.

2.2 Corrosivity / Aggressivity

Table 4.8.1 of AS3600:2018 "Concrete Structures" provides a criteria for exposure classification for concrete in sulphate soils based on sulphates in soil and groundwater and pH of soil. On the basis of the sulphate and pH testing completed we assess the exposure classification for concrete in sulphate soils to be "A1" for the natural soils (i.e., the sample recovered from BH01) and "A2" for the fill (i.e., the samples recovered from BH03 and ED-B4).

Similarly, Table 6.4.2(C) of Australian Standard AS2159-2009[3] provides a criteria for exposure classification for concrete piles in soil, and here the exposure classification for concrete piles in soils is "Non-aggressive" for the natural soils and "Mild" for the fill.

2.3 Sodicity

Sodicity provides a measure of the likely dispersion on wetting and to shrink/swell properties of a soil. Soil sodicity is classified based on the Exchangeable Sodium Percentage (ESP) which is the amount of exchangeable sodium as a percentage of the Cation Exchange Capacity (DLWC, 2002).

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[1] DLWC (2002) Site Investigations for Urban Salinity. Department of Land and Water Conservation, Sydney.

[2] Richards, L.A. (1954) Diagnosis and improvement of saline and alkali soils. Agricultural handbook 60. U.S. Dept. of Agriculture, Washington DC., 160 p.

[3] Standards Australia (2009) Piling – Design and Installation, AS2159:2009, Standards Australia, NSW.

The ESP provided in Table 1, ranging from <0.2% to 34.3%, indicate that the soils on site are sodic to highly sodic when compared to criteria listed in “Site Investigations for Urban Salinity”, DLWC (2002).

3. Salinity Management Plan

3.1 Development Components

This SMP addresses the components of the proposed development at Broken Hill Hospital at the construction stage. Recommendations regarding the following development components are provided in the following sections:

- Earthworks
- Imported soils
- Gardens and landscaped areas
- Roads, footpaths, and hardstand areas
- Surface water, stormwater, and drainage
- Durability of concrete structures in contact with the ground.

3.2 Earthworks

Based on the provide documents, we understand earthworks will occur, with fill/cuts depths up to 2.0 m. The design and construction of the earthworks should consider the following recommendations:

- Importation of soil as per Section 3.3 of this letter
- Vegetation cover should be established and maintained on permanent batters upon completion to control erosion
- The final surface of all areas of the development should be graded to prevent the ponding of surface water
- Erosion control of temporary batters, stockpiles and disturbed areas should be planned prior to undertaking the earthworks and implemented during the earthworks. Consideration should be given to:
  - Grading and partially sealing completed surfaces
  - Installation of clearly visible fencing and traffic control measures to prevent unnecessary trafficking of areas and preventing site disturbance
  - Establishing set vehicular access points and roads
  - Protecting stockpiles (temporary vegetation or mulching) where these are to be left in place for long durations.
- Sediment control shall be implemented by means of sediment traps and silt fencing where considered necessary.

3.3 Importation of Soil

It may be required to import topsoil or other soil onto site. Materials to be imported to site should be addressed for suitability for the intended use. Highly saline or contaminated soils should not be imported to site.

3.4 Gardens and Landscaped Areas

Based on the provided drawings, we understand the proposed development will include new garden and landscaped areas. The design and construction of the gardens and landscaped areas should consider the following recommendations:

- Selection of plant species should consider the soil conditions, including moderately to highly saline soils with relatively poor fertility and clayey low permeability soil profiles. The promotion of successful revegetation is likely to require the use of nutrient-rich topsoil. Saline topsoils should not be imported to site.

- Potential for waterlogging should be minimised by:
  - Adopting plant species with minimal watering requirements
  - Adopting ‘waterwise’ gardening principles
  - Minimising the use of potable water in landscaped areas
  - Properly designed and implemented irrigation systems
  - Establishment of perennial species and deep-rooted trees.

3.5 Roads, Footpaths, and Hardstand Areas

As stated, PSM understands the proposed development will include new roads, footpaths, and hardstand areas. The design and construction of roads, footpaths and hardstand areas should consider the following recommendations:

- Roads, footpaths and hardstand surfaces should be graded, and the grades maintained at all times to prevent ponding of surface water at locations where this can result in infiltration into the underlying soils (e.g pavement joints)
- Connections between the roads, footpath and hardstand surfaces and the surface water and stormwater drainage infrastructure should be designed, constructed and maintained to restrict infiltration into underlying soils
- Services that are to be located below the roads, footpath and hardstand surfaces should be installed, where practical, at the time of construction
- Provision for a damp-proof course or membrane beneath slabs should be considered by the slab designer.

3.6 Surface Water, Stormwater and Drainage.

Surface water, stormwater and drainage design should aim at restricting infiltration into the ground resulting in groundwater recharge. The design and construction of surface water, stormwater and drainage measures should thus consider the following recommendations.

- Disturbance of natural drainage patterns should be reduced. Where these are disturbed or altered appropriate artificial drainage should be installed
- Stormwater and surface water should be managed to restrict infiltration
- Temporary water retaining structures used during construction should be managed to restrict infiltration
- Stormwater and surface water infrastructure should be redesigned and constructed to minimise the likelihood of leakage
- Guttering and down pipes should be connected and maintained
- Surface water runoff should be directed around all exposed surfaces, temporary stockpiles and landscaped areas.

3.7 Durability of Concrete Structures in Contact with the Ground

In designing structural concrete elements in contact with the ground the design should consider the results of the salinity assessment and the durability requirements in AS2159:2009 “Piling Design and Installation” and AS3600:2018 “Concrete Structures”.

Both these standards provide guidance on minimum concrete grade/strength and minimum cover requirements.

Based on the salinity and resistivity test results from the conducted testing, it is recommended that

1. The design of structural concrete members (excluding piles) in contact with natural soils adopt a “A1” exposure classification, as defined in AS3600:2018
2. The design of structural concrete members (excluding piles) in contact with fill adopt a “A2” exposure classification, as defined in AS3600:2018

3. The design of concrete case in situ piles adopt a “mild” classification as defined in AS2159:2009.

4. Conclusion

We recommend the designer(s) and contractor(s) responsible for the various development components give appropriate consideration to the recommendations in this SMP.

The designer and contractors should contact PSM during the works if they have any queries with regards to the requirements in the SMP or if conditions significantly differ from those described.

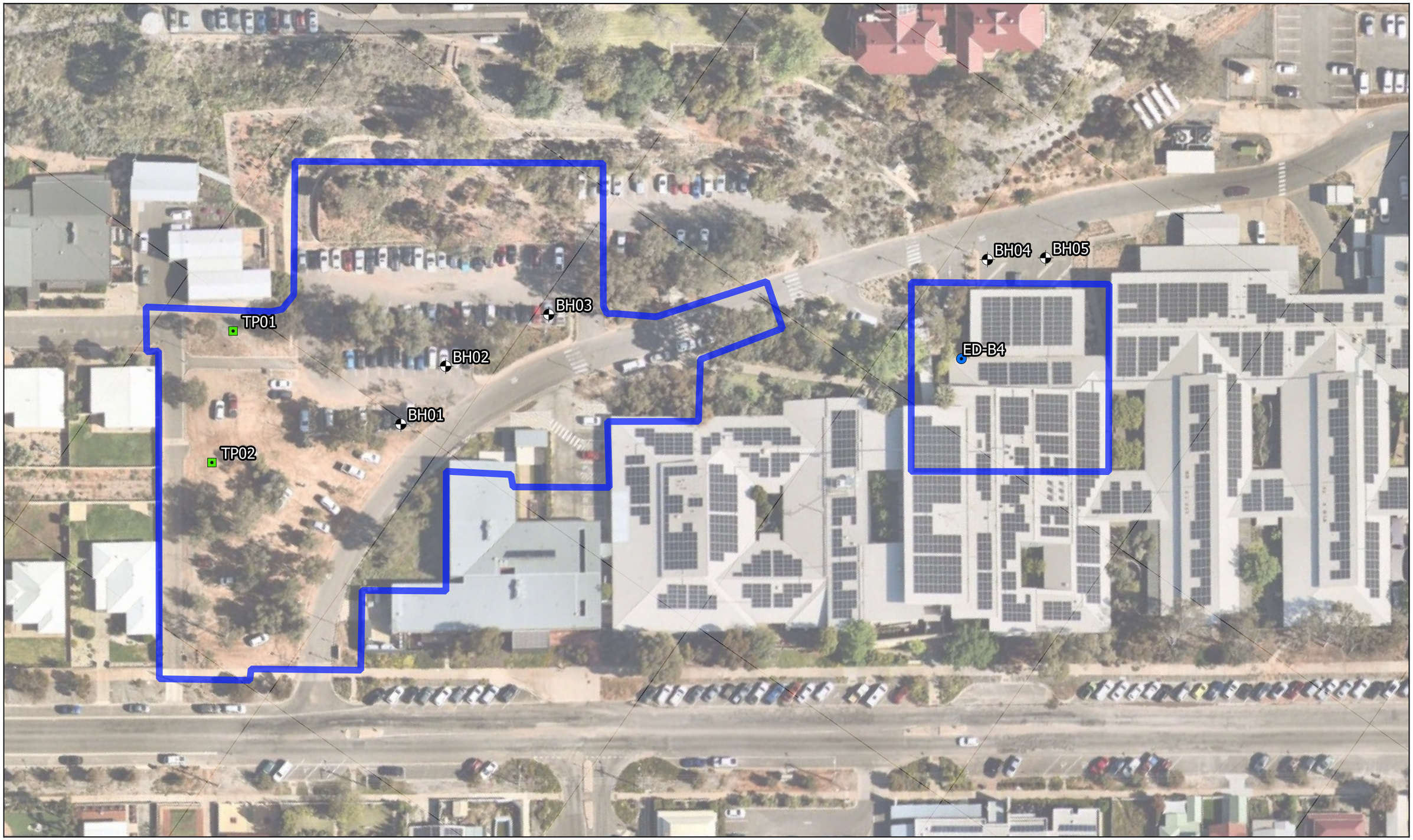
Yours Sincerely

HARLEY ZHENG
GEOTECHNICAL ENGINEER

DAVID PICCOLO
PRINCIPAL

Enc.

Figure 1	Locality Plan
Appendix A	Salinity and Aggressivity Test Results



Legend

- Approximate extent of hospital Lot
- Approximate extent of proposed development area
- Boreholes
- Test Pits
- Hand augered hole (JBS&G)

Scale 1:800

0 15 30 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7854

P S M

Created By:	Revision:
PSM	A
Date: 05 Oct 2023	Paper Size: A3

JBS&G
Broken Hill Hospital Redevelopment
176 Thomas St, Broken Hill

Locality Plan

PSM4951-005L | Figure 1

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Appendix A
Salinity and Aggressivity Test Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2303962**	Page	: 1 of 3
Client	: **PELLS SULLIVAN MEYNINK T/A PSM Admin PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HARLEY ZHENG	Contact	: Customer Services ES
Address	: G3, 56 DELHI ROAD NORTH RYDE NSW, AUSTRALIA 2113	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: PSM4951	Date Samples Received	: 08-Feb-2023 11:20
Order number	: ----	Date Analysis Commenced	: 08-Feb-2023
C-O-C number	: ----	Issue Date	: 13-Feb-2023 15:45
Sampler	: ----		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
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, unless the sampling was conducted by ALS. 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*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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 Contract 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.

- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- 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 ($H^+ + Al^{3+}$).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	BH01	BH03	ED-B4	----	----
			Sampling date / time	02-Feb-2023 00:00	01-Feb-2023 00:00	04-Feb-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2303962-001	ES2303962-002	ES2303962-003	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.9	9.1	9.1	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1190	434	137	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	11.9	8.8	7.5	----	----
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	840	2300	7300	----	----
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	5.1	2.1	3.9	----	----
Exchangeable Magnesium	----	0.2	meq/100g	4.0	0.9	0.9	----	----
Exchangeable Potassium	----	0.2	meq/100g	1.0	0.2	0.2	----	----
Exchangeable Sodium	----	0.2	meq/100g	5.2	0.7	<0.2	----	----
Cation Exchange Capacity	----	0.2	meq/100g	15.2	4.0	5.0	----	----
Exchangeable Sodium Percent	----	0.2	%	34.3	17.6	<0.2	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	1080	330	60	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	1240	260	50	----	----