SA Water

Engineering

Technical Standard

TS 0603 – Geotechnical Investigations

Version: 1.0.
Date: 27-03-2026.
Status: Final.
Document ID: SAWS-ENG-0603
Confidentiality: OFFICIAL

Government of South Australia

Issue and version number

Only the current version of the Technical Guideline should be used. Earlier versions of this Technical Guideline are superseded and must not be used. This Technical Guideline document is not controlled when printed or downloaded. Only online versions from the SA Water website may be used.

Copyright and intellectual property

This Technical Guideline is produced by the South Australian Water Corporation (SA Water). SA Water owns the copyright and all other intellectual property rights in its content, including text, graphics, designs, data or other information, unless otherwise stated. No part of this Technical Guideline may be reproduced, copied or transmitted without SA Water's prior written consent via legal@sawater.com.au. Any clarifications or explanations provided by SA Water regarding the document, do not constitute consent to reproduce, copy or transmit the information contained in the Technical Guideline.

Authorised extracts must be attributed to SA Water as: © SA Water. Use of this Technical Guideline for any purposes other than to progress SA Water's statutory functions, may infringe SA Water's copyright or other intellectual property rights, and may result in penalties under the Copyright Act 1968 (Cth), or other applicable laws.

SA Water are committed to upholding the rights of owners of copyright and intellectual property, and SA Water will make every effort to contact copyright owners and request permission to reproduce and make available copyright material. If you believe that any content in this Technical Guideline may infringe your copyright or other intellectual property rights, please contact us at legal@sawater.com.au and we will investigate the position, and if appropriate, endeavour to correct the situation.

Technical Guidelines are only applicable for intended use

This Technical Guideline is intended to be used only for application to progress activities associated with SA Water's statutory functions described particularly within the Water Industry Act 2012 (SA), the Water Industry Regulations 2012 (SA), and the South Australian Water Corporation Act 1994 (SA) (this includes use by SA Water employees and include but are not limited to its suppliers, developers, consultants and contractors delivering works and assets that will be taken over by SA Water), and otherwise as directed by SA Water in writing.

Any user intending to rely on this Technical Guideline must ensure, by independent verification, that the application of the Technical Guideline is suitable to any design for any particular project.

All users of this Technical Guideline are liable for ensuring that Australian standards, legislation, regulations, and codes which apply, are complied with.

Liability disclaimer

By using this Technical Guideline, you acknowledge and agree that, except for any non-excludable obligations, SA Water makes no warranty or guarantee (express or implied) that the information, services or materials it contains are accurate, complete, current, or fit for any purpose. You should not rely on this information without confirming suitability for your circumstances. SA Water shall not be liable for any loss, damage, cost or expense arising out of or in connection with, the use of or reliance on the information contained herein.

This disclaimer does not limit any rights you have under the Australian Consumer Law.

Documents superseded by this standard

The following documents are superseded by TS 0603:

a. TS 0632: Minimum Requirements of Geotechnical Investigations and Reports, V1.0

Document controls

Version history

Version	Date	Author	Comments
1.0	27-03-2026	M. Pham	Issued for use

Template: Technical Standard Version 8.5, 18 March 2026

Author

Author Name	Author Role	Signature
Neil Smith *Signed for and on behalf of Maria Pham*	Principal Engineer Geotechnical *(Acting)*	13/04/2026 X Neil Smith Senior Standards Engineer Signed by: Neil Smith

Approvers

Approver Name	Approver Role	Signature
Matthew Davis	Manager Engineering Quality and Innovation	13/04/2026 X Matthew Davis Manager Engineering Quality and Innovation Signed by: DA003681
Sofia Chouli	Senior Manager Engineering	27/04/2026 X Sofia Chouli Senior Manager Engineering Signed by: CH005288

Contents

List of tables

1 Introduction

SA Water is responsible for the construction and commissioning of an extensive amount of engineering infrastructure such that it is safe and functional.

This standard has been developed to assist in the design, maintenance, construction, and management of this infrastructure.

1.1 Purpose

The purpose of this standard is to detail minimum requirements to ensure that assets covered by the scope of this standard are constructed and maintained to consistent standards and attain the required asset life.

1.2 Glossary

Terms and Abbreviations utilised in this Standard are included in the following sections. The definitions presented below are to be used when interpreting this Standard and actions undertaken in relation to this Standard. Where a conflict exists, clarification is to be sought from SA Water.

1.2.1 Terms and Definitions

The following is a list of Terms applicable to this document:

Term	Description
Accepted	Determined to be satisfactory by SA Water's Representative.
Allow	Means that the cost of the item referred to is the responsibility of the Constructor
Constructor	The organisation responsible for constructing and installing infrastructure for SA Water whether it be a third party under contract to SA Water or an in-house entity.
Contract	A set of documents supplied to Constructor as the basis for construction; these documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes.
Designer	The organisation responsible for designing infrastructure for SA Water whether it be a third party under contract to SA Water or a Constructor, or an in-house entity. A Designer is a person who effects design, produces designs or undertakes design activities as defined in the *Work Health and Safety Act 2012 (SA)*.
Manufacturer	A person, group, or company that owns and operates a manufacturing facility that provides materials for use in SA Water infrastructure.
Must	Indicates a requirement that is to be adopted in order to comply with the Standard.
Person/s	Each word implying a person, or persons shall, where appropriate, also be construed as including corporations.
Provide	Means "supply and install".
Responsible Discipline Lead	The engineering discipline expert identified in the 'Approvers' table (via SA Water's Representative).
SA Water Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): Superintendent's Representative (for example AS 4300 and AS 2124 etc.) SA Water Project Manager SA Water nominated contact person

Term	Description
Service Provider	The Service Provider may include providers of services externally of SA Water. For external Service Provider, the provider is an entity that is engaged for the geotechnical investigation work to be carried out under the terms and conditions of the Contract Documents and in accordance with the requirements given in this Technical Standard.
Should	Indicates practices which are advised or recommended, but is not required
Site	The area of land/water within the project's boundary nominated in the Contract Documents, where geotechnical investigation works shall be undertaken.
Site Representative	The representative from the Service Provider who is on site acting on behalf of the Principal Engineer. The representative shall provide fulltime professional attendance to manage subcontractors and supervise the investigation works and is responsible for the technical direction and output of all field geotechnical investigation work.
State Authority	Relevant State government authority body in South Australia.
Subcontractor	A contractor engaged by the Service Provider for the work to be carried out under the Contract Documents.
Supplier	A person, group or company that provides goods for use in SA Water infrastructure.
Technical Dispensation Request Form	This form is part of SA Water's Technical Dispensation Request Procedure which details the process by which those required to comply, or ensure compliance, with SA Water's technical requirements may seek dispensation from those requirements.
WaterConnect	South Australian government web portal www.waterconnect.sa.gov.au, providing public access to state-wide water data, including groundwater and surface water information, reports on water quality, and interactive maps.
Work	Elements of a project which require design and/or construction.

1.2.2 Abbreviations

The following is a list of Abbreviations, Acronyms and Initialisms used in this document:

Abbreviation	Description
ANSIS	Australian National Soil Information System
AS	Australian Standard
ASS	Acid Sulphate Soil
BYDA	Before You Dig Australia
c_h	Coefficient of Consolidation
CoC	Chain of Custody
CPT	Cone Penetration Test
CPTu	Cone Penetration Test with dissipation
c_u	Undrained Cohesion
DCP	Dynamic Cone Penetrometer
G_{max}	Elastic Shear Modulus
GPS	Global Positioning System
JSA	Job Safety Analysis
K_0	At Rest Earth Pressure Coefficient

Abbreviation	Description
k_h	Modulus of Subgrade Reaction
NATA	National Association of Testing Authorities, Australia
NDD	Non-Destructive Digging
NMLC	51.9mm diameter drill core (triple tube wireline)
NQ3/HQ3/PQ3/SQ3	45.1mm / 61.1mm / 83.1mm / 102mm diameter drill core (triple tube wireline)
OCR	Over Consolidation Ratio
PASS	Potential Acid Sulphate Soil
QA/QC	Quality Assurance / Quality Control
RQD	Rock Quality Designation
SA Water	South Australian Water Corporation
SPT	Standard Penetration Test
SWMS	Safe Work Method Statement
TCP	Traffic Control Plan
TDRF	Technical Dispensation Request Form
TP	Test Pit
TS	SA Water Technical Standard
u_0	Initial Excess Pore Pressure
WH&S	Work Health and Safety
ϕ	Internal Friction Angle
γ	Bulk Unit Weight

1.2.3 Terminology

The following is a list of specific interpretations for Terminology used in this standard.

- Where an obligation is given and it is not stated who is to undertake these obligations, they are to be undertaken by the Constructor.
- Directions, instructions and the like, whether or not they include the expression "the Constructor shall" or equivalent, shall be directions to the Constructor, unless otherwise specifically stated.
- Where a submission, request, proposal is required and it is not stated who the recipient should be, it is to be provided to SA Water's Representative for review.
- Each word imparting the plural shall be construed as if the said word were preceded by the word "all".
- "Authorised", "approval", "approved", "selected", "directed" and similar words shall be construed as referring to the authorisation, approval, selection or direction of SA Water's Representative in writing.
- "Submit" mean "submit to the SA Water Representative or their nominated delegate".
- Unless noted otherwise, submissions, requests, proposals are to be provided at least 10 business days prior to work commencing or material ordering (unless noted otherwise).

1.3 References

1.3.1 Australian and international

The following table identifies Australian and International standards and other similar

documents referenced in this document:

Reference	Title
AS 1289 (series)	Methods of testing soils for engineering purposes
AS 1726	Geotechnical Site Investigations
AS 4133	Methods for testing rocks for engineering purposes
ISBN 978-0-6485439-1-6	Guidelines for Geotechnical Investigations of Dams, Their Foundations, and Appurtenant Structures

1.3.2 SA Water documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Reference	Title
TS 0136	Pipework Access and Protection
TS 0101	Safety in Design
TS 0104	Design quality management
TS 0105	Quality requirements
TS 0107	Sustainability by Design
TS 0630	Coarse Aggregates for Civil Works
TS 0631	Fine Materials for Pipe Embedment

2 Scope

2.1 Scope and application of this Technical Standard

The following core objectives are considered critical to the success of the geotechnical investigations and the project as a whole:

1. Planning and procurement of resources to carry out the scope of work.
2. Quality of the investigation, including drilling, logging, testing, data entry, data interpretation and reporting.

To achieve these objectives, this Technical Standard contains requirements for conducting geotechnical investigations in different types of terrains and ground conditions. These requirements are:

a. Site investigation planning

b. Access and utilities

c. Existing infrastructure, establishment, equipment and personnel

d. Site set-up and survey

e. Investigation methods and reinstatements

f. Logging, sampling and testing

g. Reporting as per AS1726.

Any clauses of this Standard relating to work or materials not required in the Contract Documents should be deemed not applicable.

The geotechnical investigation shall be planned and executed in conjunction with project environmental/contamination, hydrogeological studies and requirements from other disciplines to provide the best possible technical and commercial outcomes for the project.

Geotechnical investigation including reporting shall be carried out in accordance with the current revision of AS 1726 'Geotechnical Site Investigations' together with other relevant Australian Standards or as directed in this Technical Standard.

If an equivalent standard is to be used, full details of the request shall be provided to SA Water through the Technical Dispensation process described below.

2.2 Works not in scope

Contamination and environmental investigation.

Hydrogeological investigation.

2.3 Technical dispensation

Departure from any requirement of this Technical Standard shall require the submission of Technical Dispensation Request Form (TDRF) for the review and approval (or otherwise) of SA Water Principal Engineer listed in Page 4, on a case-by-case basis.

The Designer shall not proceed to document/incorporate the non-conforming work before the Principal Engineer has approved of the proposed action in writing via the Technical Dispensation Request Form (TDRF).

SA Water requires sufficient information to assess dispensation requests and their potential impact. The onus is therefore on the proponent to justify dispensation request submissions and provide suitable evidence to support them.

Design works that are carried out without being appropriately sanctioned by SA Water shall be liable to rejection by SA Water and retrospective rectification by the Designer/Constructor.

2.4 Hazards

A site-specific risk assessment for health, safety and environmental impacts is to be developed for the project, including the geotechnical investigations aspects, to ensure adequate controls are in place to minimise the risks.

Hazards shall be identified and addressed in accordance with TS 0101.

3 Quality Assurance

3.1 Hold points

Hold points applicable to this Technical Standard can be found in Appendix A. Please refer to TS 0105 for further detail on hold points.

3.2 Witness points

Witness Points applicable to this Technical Standard can be found in Appendix A. Please refer to TS 0105 for further detail on witness points.

3.3 Non-conformance

Please refer to TS 0105 for the requirements relating to non-conformance.

3.4 Workplace Health & Safety

It shall be the Service Provider's responsibility to work in accordance with the SA Water approved Safe Work Method Statement (SWMS) that relates directly to the scope of works. The Service Provider shall comply with all federal, state and local laws and regulations and any other WH&S requirements from the stakeholders governing the investigation methods and the furnishing and use of all safeguards, safety devices, protective equipment and environmental and hazardous material controls.

Submission of an approved SWMS provided under this Clause constitutes a **WITNESS POINT**.

4 Geotechnical Investigation Plan

4.1 Preliminaries

The Site Investigation Plan may be developed by SA Water or by the Service Provider.

A review of any existing relevant site information, available in-house and/or made available by SA Water, shall be carried out as part of the development of the Geotechnical Investigation Plan.

The Geotechnical Investigation Plan, together with any associated environmental, hydrogeological, and pavement investigations, shall be developed in accordance with the requirements of this Technical Standard.

The Geotechnical Investigation Plan aims to achieve the project outcomes with respect to site investigations and is to address, at a minimum, the following:

1. A summary of any relevant background data held/provided by the Service Provider, Designer, Constructor, SA Water and other stakeholders.
2. A program for the preparation, conducting and reporting of the site investigation works.
3. Extent of site investigations including a plan of the proposed investigation sites and access arrangements, refer to Section 5 for details of access requirements.
4. Evidence that all necessary permits have been obtained before proceeding with the works including underground and overhead utilities checks, licenses/paperwork for road occupancy, traffic control and other appropriate permits.
5. The proposed methodology for conducting the site investigation, including, but not limited to:
    a. Select the investigation locations to suit the project's requirements, upon consultation with the SA Water Representative and geotechnical designer.
    b. Carry out and review service search at nominate investigation locations, including consultation with all service authorities and engagement of a suitably qualified service locator to clear the investigation locations.
    c. Review geological data at the investigation site to assess the localised character, distribution and structure of the soil and rocks.
    d. Select investigating apparatus such as excavator, excavation type, drill rig type and drilling/sampling/testing methodology for the nominated investigation locations, with evidence of having engaged a suitably experienced Subcontractor to perform the works.
    e. Allow for combined multi-disciplined investigation (for example combined geotechnical and contamination investigation at a borehole location).
    f. For any required specialist equipment such as CPT, geophysical surveys and other investigative tools, provide QA/QC regime for field and analytical work in accordance with the relevant standards and guidelines.
    g. Sampling protocols, arrangement for sample containers and required preservation, CoC procedures and documentation.
    h. In-situ testing, including type and frequency.
    i. Installation of groundwater and gas monitoring equipment.
    j. Laboratory testing methods, including timeline and transportation of samples to laboratories, extraction and analysis.
    k. Reinstatement of investigation locations.
    l. Survey of investigation locations.

m. Other requirements as specified in the relevant codes and guidelines.

6. Manage WH&S aspects of the Work, via tools such as SWMS/JSA, including daily toolbox.
7. An Environmental Management Plan identifying environmental impacts of the investigation and covering aspects such as potential for encountering contaminated soil and groundwater, protection of aquifers in potentially contaminated areas, disposal of solid and fluid wastes.
8. Liaison with the project's environmental and groundwater specialists for coordinated and concurrent investigations.
9. Methodology for assessing the impact of the proposed investigation on any existing infrastructure.
10. Presentation of collected data. Details on the required format are given in respective sections.
11. Transfer of data.
12. Provision for internal review and verification of the site investigation and report as per TS0104.

Submission of a Geotechnical Investigation Plan to the SA Water Representative constitutes a **HOLD POINT**.

4.2 Clearances

4.2.1 Utilities

The Service Provider must ensure that all work on site is conducted without interference to services or utilities in the area. At a minimum, it is expected that the following will be conducted:

1. Before You Dig Australia (BYDA) search.
2. Obtaining and reviewing service records from SA Water and relevant authorities/stakeholders.
3. Use of an accredited service locator and an appropriate methodology to check and clear each investigation location. Note that additional requirements may be required for different utilities and stakeholders, and these must be accounted for.
4. Checking requirements from different utilities and engage accredited overhead service spotter where required.
5. Unless otherwise instructed, the Service Provider shall set out investigation locations at a sufficient distance from the indicated position of utilities, as appropriate to the regulatory requirements. For SA Water's requirements on clearance, refer to TS 0136.
6. Service clearance shall also extend to the access routes. Careful access planning should be carried out to avoid damage to utilities when driving heavy equipment over them.
7. If a location cannot be positively cleared for utilities by the service locator and there is a suspicion that the investigation location may be in the vicinity of a service, the Service Provider and their Subcontractor shall examine an alternative location and/or carry out additional precautions by starting the intrusive works with a hand-excavated inspection pit/hole from the surface, or Non-Destructive Digging (NDD) / potholing using an appropriated method to a suitable depth, or another appropriate method as deemed necessary. The associated risks shall be assessed, and precautions taken must be documented in writing as an update of the site Geotechnical Investigation Plan, an Excavation Permit or a Service Locating Report, which shall be submitted to SA Water for approval.

The Service Provider shall allow for all costs associated with service locating, spotting and the required supervision by service authorities.

4.2.2 Acid Sulphate Soils

Acid Sulphate Soil (ASS) risk maps by ANSIS should be reviewed by the Service Provider with respect to the proposed investigation locations as part of the preparation for the Geotechnical Investigation Plan. If ASS is likely to be present at the location of the proposed site investigation, specialist contamination scientists should be engaged by the Service Provider to conduct a geomorphic assessment and sampling, where appropriate.

If ASS is likely to be present at the investigation location, then the site investigation plan should, at a minimum, address the following:

1. A geomorphic assessment of each ASS site to aid the estimation of lateral distribution of ASS.
2. The importance of groundwater conditions for ASS behaviour and management (groundwater conditions must be assessed during investigations).
3. Ensuring minimal disturbance to the ground during investigation and testing where ASS is suspected. For backhoe test pits, the excavated material must be backfilled with the strata in approximately the same order as excavated.

5 Access

The Service Provider shall arrange all necessary permits and approvals with the relevant State Authority, stakeholder and asset owner, and provide a copy of these approved permits to SA Water fifteen working days prior to the anticipated start of the investigation.

Provision of all necessary permits and approvals shall constitute a **HOLD POINT**.

5.1 Investigation on Road Reserve

During the proposal/tender phase of the project, the Service Provider must assess and nominate investigation locations that are likely to require traffic control.

Where the work will, or is likely to, obstruct or have the effect of restricting, closing, interfering with or obstructing the free flow of all traffic on any lane or shoulder of an existing road or intersection, the Service Provider must:

1. Apply and obtain permission to carry out works on roads including all relevant details of the proposed work. The application for permission must be prepared in accordance with the requirements of the relevant State Authority, stakeholder and asset owner.
2. Lodge the approved Traffic Control Plan (TCP) with the relevant State Authority a minimum of ten days prior to the anticipated start of investigation at the affected location(s).

5.2 Land Access

Careful planning and consideration should be given to the type of vehicle required to access the site, such as tracked or non-tracked, depending on the proposed investigation location, anticipated terrain, surface ground condition, site drainage, land use and seasonal effect.

If land access includes access tracks, ground clearing or ground improvement treatments necessary to reach the site and set up on investigation locations is required, this shall be either provided or instructed by SA Water, on a case-by-case basis.

Where required, the Service Provider will issue relevant documents (such as a Notice of Entry) under the guidance of SA Water and/or relevant Authority. The Service Provider shall perform a site inspection to assess for themselves the degree of difficulty associated with access.

Where investigations are located along public access routes, the Service Provider shall be responsible for providing or arranging traffic control measures to the approval of the stakeholders and landowners.

In the event of access to a location being significantly more difficult than expected the location may only be changed with the agreement of the SA Water Geotechnical Owner Engineer and/or Principal Engineer.

All works should be confined to the minimum area of ground required for the works.

5.3 Over Water Access

Where over water work is specified, the provision, operation and maintenance of access, working and floating platforms on or over water, including access for the SA Water Representative, shall be the responsibility of the Service Provider.

This responsibility shall also extend to include all land access to boat ramps, wharfs and jetties necessary to obtain overwater access.

The Service Provider shall be responsible for liaison with all relevant maritime authorities, obtain permission and for compliance with the maritime authority's requirements and regulations.

Issue of relevant documents, if required, shall be the responsibility of the Service Provider.

5.4 Access Routes

Access to all investigation locations must be agreed in writing with SA Water and all other relevant stakeholders and landowners prior to site work commencing.

Development of access tracks, where required shall ensure protection against erosion and subsequent siltation of waterways and that the tracks be restored to as close to the original conditions or natural conditions (including revegetation, where required) when no longer required. Some tracks may be nominated by SA Water, stakeholders and landowner to be kept for other purposes (such as construction access).

5.5 Protection of Property

The Service Provider shall take due care in their operations to avoid damage to all site property, including associated utilities.

The Service Provider shall contact SA Water and the relevant authority, asset owner and landowner and take the necessary remedial actions should damage to property and associated utilities occur. All damages shall be remediated in accordance with the requirements of SA Water, relevant authority, asset owner and landowner as agreed with the Service Provider prior to works.

Any claims for damages associated with the work will be the responsibility of the Service Provider. A record of any damage caused, and compensation made should be prepared and signed off by the asset owner and landowner prior to being forwarded to SA Water in a property damages/compensation report.

5.6 Security of Site

Site security may be required in some instances during the field investigations and shall be arranged by the Service Provider with approval from SA Water.

5.7 Hours of Work

Working hours shall be agreed prior to commencement of any site works but will generally fall within ordinary hours. The working hours shall align with WH&S guideline developed specifically for the project.

5.8 Clean-up, Restoration and Maintenance

During work, whole of the site shall be kept in a clean and tidy condition.

On completion of each investigation location, all equipment, surplus material and rubbish shall be cleared away and removed from the site by the Service Provider.

More detailed information regarding reinstatement and maintenance is included in Section 8.7 “Reinstatement” of this Technical Standard.

6 Establishment, Equipment & Personnel

6.1 Establishment

The Service Provider shall be responsible for the establishment of all resources including labour, material, plant and equipment required to complete the works and for the demobilisation at the completion of the works.

6.2 Plant & Equipment

The Service Provider shall supply all plant, equipment, material and supply necessary to complete the works to fulfil the project requirement and this Technical Standard. The Service Provider shall maintain a list of plant and equipment that will be used for the project and provide the list to SA Water, if requested. The plant and equipment shall be well maintained with records of servicing/calibration certificates certified by relevant authority and comply with all relevant standards and WH&S requirements for the project.

The plant and equipment used by the Service Provider and/or by their sub-contractor, must be suitable to conduct all the necessary technical requirements discussed in this Technical Standard, including but not limited to, excavations, drilling methods, specialised in-situ testing, sampling requirements, testing requirements and groundwater monitoring installations.

6.3 Personnel

The Service Provider shall provide appropriately skilled, qualified and experienced personnel to complete the work to the satisfaction of the project's requirement and this Technical Standard. The Service Provider must ensure that the personnel are aware and conversant with the project requirements, statutory requirements for WH&S at the site and that their responsibilities are understood.

The Service Provider shall provide professional attendance, referred to herein as the Site Representative, full time on site during the investigation. As a minimum The Site Representative should be a geotechnical engineer or an engineering geologist with three years relevant experience, unless otherwise approved via the technical dispensation request process (TDRF). The personnel nominated as the Site Representative shall be approved in writing by the Principal Engineer and shall be responsible for the site supervision, technical direction and output of geotechnical site investigation work.

The contact details of all key personnel including Site Representatives and their emergency contact details shall be provide to the SA Water Representative prior to commencing the field program.

A submission of nominated personnel qualification and their contact details constitutes a **HOLD POINT**.

All field personnel shall be inducted in the required SA Water's induction program and site-specific procedures (where applicable).

For remote sites, all field program personnel shall be first aid trained and familiar with the appropriate procedures for working in remote areas.

All Subcontractors engaged by the Service Provider shall hold the appropriate licences and qualifications for their roles, including the engagement of appropriate licenced drillers and other personnel. This constitutes a **WITNESS POINT**.

7 Setting Up & Survey

Setting up of the investigation work shall be the responsibility of the Service Provider, including all necessary items required to commence work at the investigation locations.

Should standing time due to reasons beyond the control of the Service Provider and their Subcontractor, the Principal Engineer shall be notified immediately. The duration and rate of standing time shall be as agreed in the Contract Documents.

The SA Water Geotechnical Owner Engineer and/or Principal Engineer will provide broad guidance on the number and location of investigation locations. The Service Provider shall locate the exact investigation locations with reference to the guidance, including any updates to the scope of work, site terrains, ground conditions, access and utilities.

If an investigation location is abandoned for reasons which, in the opinion of the SA Water Representative, could have been reasonably foreseen by the Service Provider, a replacement investigation location (include revising investigation method) shall be carried out within five metres (5m) of the abandoned location at no additional cost to SA Water.

All investigation locations shall be pegged or marked appropriately for future reference and survey. This is particularly important where excavations are near existing site infrastructure/feature, as this shall provide a visual cue for future monitoring for change/settlement.

Unless otherwise specified, the horizontal position of the investigation location shall be defined to within an accuracy of ±0.5m and the vertical position to ± 0.1m accuracy.

7.1 Borehole Downhole Survey

A downhole survey to obtain the 3D 'locational' path of the boreholes may need to be carried out at nominated boreholes, depending on the project requirement. The Service Provider shall nominate the appropriate methodology to undertake the downhole survey, taking in consideration the likely presence of magnetic fields within the rock (if applicable), and submit to the Principal Engineer for approval. Downhole survey may be carried out at the end of drilling or as directed by the SA Water Representative.

7.1.1 Deviation Tolerances

The boreholes and specialist tests shall be conducted in the nominated direction and angle.

The tolerance for vertical boreholes and specialised test is plus or minus three degrees (±3°) in any direction.

Where inclined boreholes are specified, these boreholes shall be checked for inclination and bearing by the Service Provider. A tolerance of plus or minus five degrees (±5°) in any direction is permitted unless otherwise specified.

Should these tolerances be exceeded, the Service Provider may be directed to compensate for the out-of-tolerance by additional investigation alongside the first at no additional cost to SA Water.

8 Geotechnical Investigation Methodology

The investigation methodology shall be established based on:

1. Consultation with the project manager, design manager and the project's geotechnical designer to form an understanding of the project's scope of work.
2. Consultation with other related disciplines within the project team such as hydrogeological, environmental/contamination, and material, so that the proposed geotechnical investigation method is fitted for purpose, and opportunities for a multi-disciplined investigation are recognised.

Checking of the proposed geotechnical investigation methodology will constitute a **HOLD POINT** as per the requirement of the Geotechnical Investigation Plan given in Section 4.

Inspection by the SA Water Representative or by the Principal Engineer will constitute a **WITNESS POINT**.

8.1 Desktop Study

A desktop study shall be conducted to collect site information as part of the site investigation planning, enabling selection of suitable investigation method that will produce the required information to fulfil the project's scope of work.

The desktop study should include a review of available information, including but not limited to:

1. Geology maps and any published geotechnical/environmental/hydrogeological documents/data.
2. ANSIS maps/published ASS reports.
3. Topography maps.
4. Aerial and historical photographs of the site terrains, soil, ground conditions, assets/infrastructure.
5. Previous investigation (geotechnical/environmental/hydrogeological) data/reports, if available.
6. Records of past construction works including drawings, reports, pile testing records, monitoring data, dilapidation survey and inspection.

The desktop study may also involve a site reconnaissance visit in which visual examination of the site is performed to confirm and supplement desktop findings for the preparation of the subsequent site investigation works. The desktop study shall link with other proposed engineering disciplines' services and investigations to collectively inform the program of the intrusive geotechnical investigation.

8.2 Geological Mapping

The geotechnical designer shall determine whether geological mapping is required and document this in the geotechnical investigation plan submitted to SA Water for approval.

The objective of geological mapping is to assess the character, distribution and structure of the soils and rocks in the project area and their potential impact on the design and/or construction of the earthworks or infrastructure.

Interpretation of the geological conditions at the site shall be performed:

1. By mapping a larger area with the aid of photographic and/or drone imagery.
2. By a review of available geotechnical data and identify geological features.
3. Geological mapping is to be conducted by a suitably qualified engineering geologist and should include the following features:

a. Physical extent of natural and man-made exposures of soil and rock units, such as cut slopes and benches.

b. Lithology and mass characteristics of soil and rocks, such as soil/rock type, composition, orientation, frequency and extent of bedding and joint discontinuities, in accordance with AS 1726.

c. Topsoil, fill, natural soil and unsuitable materials.

d. Weathering, tension cracks, erosion and dispersion profiles.

e. Topographic and geomorphological features.

f. Landslide, slope instability and erosional features (upslope and downslope).

g. Stratigraphical sequences.

h. Structural mapping and transects including recording of dip/dip direction reading of bedding planes and defects.

i. Water courses, drainage lines, seepages and wells.

j. Any geological hazard, such as but not limited to landslides, sinkholes, cracking soils, collapsible soils.

k. Vegetation types and extent.

l. Cultural and heritage features.

m. Infrastructure features, such as roads and utilities, including SA Water assets.

Photographs must be taken and geotagged. Photographic evidence from the site reconnaissance and geological mapping is very important to support findings of these studies and to provide visual references of features and issues. Panoramic photographs of the site are required for recording site activities over a period of time and to provide a visual reference to the general site conditions.

The geological mapping shall be conducted on a scale suitable for the site and the information collected in a manner that can be easily transferred to drawings, maps or sketches as part of deliverables for the project, including annotations with geological features clearly identified. Impact/risks relating to each of the identified features shall be checked against the proposed scope of work of the project. The locations of the features may be surveyed or recorded using a hand-held GPS or drone imagery. The assessment shall include recommendations for any additional investigations (geotechnical, hydrogeological or environmental) to further define or mitigate the impact/risks and to determine design parameters used for design and construction works.

8.3 Investigation Locations and Depths

Where provisional investigations depths have been provided in the Contract Document or by the Principal Engineer, they may be subject to change based on the ground conditions encountered. The criteria below shall be used to determine the appropriate required investigation locations and depths based on the types of proposed infrastructure. For any proposed infrastructure not detailed below, and where no alternative criteria have been provided by SA Water, approval should be sought in the planning phase of the investigation.

Notes:

1. Ensure that the investigation extends below the base of any encountered fill layer at the site.

2. Ensure boulders or layers of cemented soils are not mistaken for bedrock by penetrating approximately 3m into bedrock.

3. The investigation is to comply to all State Authority and environmental requirements. Special care shall be taken when drilling cross aquifers and aquitards and water bearing sand strata. There is a need to seal exploratory boreholes especially in dams,

earth bank storage (for water and wastewater), tunnels and environmental studies to avoid cross contamination.

4. The investigation locations shall be arranged by the Designer so that the investigations cover all geological units and their interfaces (as identified from the desktop study) within the project's footprint. The investigations shall be sufficient to inform the ground conditions so that geotechnical risks and opportunities at the project site are allowed for in the design and construction of the proposed work.

5. Where not stated in Table 1, if soft/compressible natural soils and fills are encountered, the site investigation may need to extend to the full depth of that layer. This is depending on the scope of the Project (including constructability) and ground conditions and will be reviewed by the Principal Engineer on a case-by-case basis.

Table 1: Criteria for selection of investigation depth

Proposed Infrastructure	Minimum Number of Investigation Locations	Minimum Depth of Investigation
Building (with or without basement)	• 4 boreholes for each building with footprint of 1200m^2 or less. • 5 boreholes for each building with footprint greater than 1200m^2 but not more than 2000m^2. • For footprint greater than 2000m^2, 5 boreholes + 1 borehole for every 1000m^2 or part thereof.	• Shallow footing: 4B [1] or 4.5m depth, whichever is greater from nominated formation level. If the deepest SPT 'N' result is less than 10, continue drilling until SPT 'N' value of 30 or greater is encountered (3 consecutive SPTs). • Piled footing: 5m or 4 diameters below the nominated founding level, whichever is greater, with either SPT results 'N'>30 in soils (3 consecutive SPTs) or RQD>25% in rock.
Tank	As above for 'Building'	As above for 'Building'
Culvert	• Less than 3m long culvert, 1 borehole. • Greater than 3m but less than 20m long culvert: 1 borehole at each end. • Greater than 20m but less than 40m long culvert: 1 borehole at each end and 1 borehole in the middle. • Greater than 40m long culvert: 1 borehole at each end and 1 borehole for every 20m length interval or part thereof.	4B [1] from nominated invert level. If the deepest SPT 'N' result is less than 10, continue drilling until SPT 'N' value of 30 or greater is encountered (3 consecutive SPTs).
Pipeline (above ground)	• 1 borehole/test pit at each end and 1 for every 250m length interval. • If the local geology is complex, reduce the spacing to allow for at least 1 borehole/test pit per change in geological unit.	4B [1] from nominated formation level of pipe chair or foundation but below the base of compressible layer, whichever is greater.
Pipeline (in-ground)	As above for Pipeline '(above ground)'	• 1m below the nominated pipe invert level. • If pipe is greater than 0.5m diameter, increase investigation depth to 2 diameters below the nominated pipe invert but below the base of compressible layer, whichever is greater.

[1] B = width of loaded area for nominated footing.

Proposed Infrastructure	Minimum Number of Investigation Locations	Minimum Depth of Investigation
Pipeline HDD	• If HDD is less than 40m long: 1 borehole at each end and 1 borehole in the middle. • If HDD is greater than 40m: 1 borehole at each end and 1 borehole for every 20m length interval or part thereof.	3m below the nominated pipe invert.
Thrust block	• 1 borehole/test pit at each nominated location. • The investigation for thrust block can be incorporated/combined with the investigation for pipeline.	1m below the nominated thrust block's base.
Embankment	• 1 borehole/test pit at each end and every 25m length interval. • For access road and less significant bund, 1 borehole/test pit at each end and every 50m length interval.	At least 1 nominated height of the embankment below the nominated formation level but below the base of compressible layer, whichever is greater.
Cut slope	• For cut depth greater than 5m: 1 borehole/test pit at each end and every 25m length interval. • For cut depth less than 5m: 1 borehole/test pit at each end and every 50m length interval.	5m below the toe of the proposed cut or 3m into bedrock below the toe of the proposed cut, whichever is shallower.
Retaining structure	1 borehole/test pit at each end and every 25m length interval.	2 times nominated retaining height of the retaining structure from the nominated toe level.
Landslip	3 boreholes/test pits along critical section.	2 times height of slope or width of zone of movement, or 5m below toe of slope or 3m into bedrock below toe, whichever is shallower.
Swales/Drainage channel/ Detention basin	• Swale/Drainage channel: 1 borehole/test pit at each end and every 100m length interval. • Detention basin: borehole/test pit for every 10m grid.	3m minimum below nominated invert level or to a zone of low permeability.
Tunnel and tunnel cavern	• Tunnel: 1 borehole/test pit at each end and every 50m length interval. • Tunnel cavern: 1 borehole for every 5m grid.	• 3m below nominated invert level or 3 tunnel diameters, whichever is greater. • If piled retention system is proposed, refer to 'Retaining structure'.
Pit/ sump	1 borehole/test pit at each nominated location.	• 1m minimum or 4B [1] below nominated invert level, whichever is greater. • For deep pit/sump that requires piled retention system, refer to 'Retaining structure'.
Pavement (for carpark and access road)	1 borehole/test pit at each end and every 250m length interval.	2m below nominated formation level

Proposed Infrastructure	Minimum Number of Investigation Locations	Minimum Depth of Investigation
Dam and associated aperture[2]	1 borehole/test pit at each end and every 25m spacing.	2 times nominated height of dam, or 5m below toe or slope, or 3m into bedrock below toe, or extend to below zone of low permeability, whichever is greater.
Crane pad or hardstand	1 borehole/test pit for every 100m^2 area.	2B below nominated formation level, or 15m and below the base of compressible layer, whichever is greater.

8.4 Test Pits

A test pit defines in this Technical Standard is a temporary excavation used for subsurface investigations, including visual tactile inspections and bulk sampling.

The excavation pits shall be conducted in accordance with the current revision of the *Excavation Work Code of Practice* by SafeWork SA.

Test pits shall be excavated by a machine that is suitable to excavate to the required depth at the nominated investigation location to enable visual examination, logging, in-situ testing and sampling from outside the test pit as required.

The following controls must be implemented to reduce WH&S risk:

1. Communication protocols shall be agreed between all site personnel prior to commencing the excavating work.
2. Test pits must not be entered into. All sampling, logging, photography and measurements are to be conducted without entering a test pit.
3. All personnel shall locate on the short side (width) of the excavation, directly at the opposite end to the backhoe / excavator, so that all personnel are always within the view of the excavator operator. Depending on the ground condition and the width of the excavation, all personnel shall remain at a suitable offset away from the test pit at all times to avoid ground collapsing and personnel falling into the excavation. The offset shall be determined by the Site Representative and an exclusion zone must be established prior to work commencement.
4. All personnel shall obtain eye contact and acknowledgement from the operator of the excavator and the excavating bucket should be placed on the ground before personnel approaching the excavation.
5. Spoil should be placed on one side of the excavation and samples retrieved and reserved for logging and sampling from the other side of the excavation. Logging and sampling can only be done when the excavator is not in operation (turned off).

Pocket penetrometer testing shall be carried out on any retrieved intact samples of cohesive strata. The preferred testing frequency is every 200mm depth interval of the cohesive strata.

Where required, a Dynamic Cone Penetration (DCP) test shall be conducted adjacent to and/or at the nominated investigation location, prior to the test pit excavation.

At each test pit, photographs should be taken:

a. Prior to the excavation, at the nominated investigation location including the surrounding and any nearby site features

b. At completion of the excavation showing all excavated side wall profiles

[2] Refer to "Guidelines for Geotechnical Investigations of Dams, Their Foundations, and Appurtenant Structures" for detailed guidance.

c. The spoil pile and the retrieved samples for logging

d. The completion of backfilling.

Correct labelling shall be included in each photograph. Test pit photography shall be in accordance with the requirements outlined in Section 9.4 of this Technical Standard.

Where test pits are required to be left open for a period, the Service Provider shall provide fencing together with all necessary lighting and signage as determined by a specific risk assessment for the site. Precautions shall be taken to protect the test pits from the adverse effects of weather and man-made activities during this period. Temporary cover and temporary drainage measures to direct all runoff away from the excavation shall be required. If the excavation work is carried out within an operating/occupied site, at completion of each day's field work, a schedule is to be provided to the relevant SA Water site manager/project manager and/or site owner detailing:

i. The locations of all test pits and their progress, including the details of any abovementioned measures

ii. The conditions of the existing ground at each of the test pit sites

iii. The maximum depths of excavations

iv. Whether or not tamping was conducted.

Program for monitoring of the conditions of investigation locations during routine inspections shall be implemented (by SA Water personnel and/or delegates) to ensure that the abovementioned measures are in place.

8.5 Boreholes & Drillholes

All drilling investigations are to comply with the relevant State Authority and environmental requirements for groundwater and contaminated soils, including but not limited to:

1. Licensing requirements

2. Requirements for sealing/grouting of boreholes

3. Aquifer Interference and other related policies and their relevant permits.

Boreholes/drillholes and associated testing are aimed to define geological strata and their engineering properties of the ground at the project site. Emphasis is to be placed on the recovery of soil and rock core as a permanent record of the geological strata encountered. Therefore, the objective of drilling is to recover the maximum amount of sample possible until termination at the specified depth. For this reason, the accepted drilling method is core drilling. Non-core methods are insufficient in determining geological strata and their engineering properties. Depending on the objectives of the investigation, non-core method shall only be accepted in the conditions given in dot points 8 and 9 in Section 8.5.1 below. For any other conditions, application for non-core method shall be lodged via the TDRF.

Boreholes/drillholes can be drilled vertical or at an angle, depending on the project requirements and site access.

Soil and rock core may be contaminated and this needs to be managed by the Service Provider accordingly.

8.5.1 Borehole Drilling in Soils

Drilling must be carried out using the following drilling methodology, depending on the project requirements:

1. In minor investigation where the proposed borehole drilling is 5m deep or less in mostly cohesive soils above the water table: use push tube or geo-probe drilling method between in-situ testing and undisturbed sampling. The drilling run shall not exceed 1m in length.

2. In investigation where the proposed borehole drilling is 20m deep or less in mostly cohesive soils above and below the water table: use geo-probe method and/or hollow auger and split spoon between in-situ testing and undisturbed sampling. The geo-probe run shall not exceed 1m in length.
3. In all soils above and below the water table: use continuous hollow flight augers (hollow) with inner split barrel sampling between in-situ testing and undisturbed sampling.
4. Standard Penetration Testing (SPT) is to be carried out at nominal 1.5m vertical intervals, with intervals adjusted based on the stratigraphy and investigation requirements following agreement with the Principal Engineer or the geotechnical designer. The SPTs are to be carried out in accordance with AS 1289.
5. Target on obtaining undisturbed samples in clays and carrying out SPT tests in granular materials.
6. When drilling under the groundwater table, the drilling barrel shall be always kept full of water and/or drilling fluid to minimise the risk of blowing sand.
7. Pocket penetrometer readings are to be taken in the centre of the intact core samples in cohesive strata, at 200mm intervals, including the exposed ends of undisturbed tube samples.
8. On reaching drilling and SPT refusal when encountering obstructive or high resistant soils other than rock, the drilling can commence using solid auger method prior to start coring using diamond coring method. The Service Provider should note the possibility of encountering gravels and/or cobbles when considering drilling methods.
9. If rock head is expected in the bottom 0.5m of the specified borehole depth, solid auger method may be used to provide an estimated substance strength of the rock materials and/or confirm refusal on rock head, instead of diamond coring method.
10. Upon completion of the borehole drilling, the borehole may be converted to piezometer with instrumentation and monitoring equipment installed, depending on the project requirements.

8.5.2 Rock Drilling

For rock core drilling, unless otherwise specified, the drilling must comprise techniques which obtain continuous samples of the rock and any interbedded soils, such as triple barrel (conventional or wireline) diamond coring method. While triple barrels are the preferred method, double barrels may be allowed in specific circumstances with prior agreement from the Principal Engineer (application using the TDRF).

Core barrel size shall be a minimum NMLC, with larger diameter core preferred in difficult ground conditions or where large samples are required. Each core barrel shall have a core lifter suitable for catching and retaining cores in soft formations. While triple barrel conventional diamond coring will be the primary method, wireline (NQ3/HQ3/PQ3/SQ3) diamond coring methods are also accepted, noting that the procedure may need to be adjusted to reflect the wireline coring system.

The main core drilling requirements include:

1. Use diamond coring methods from the encountered rock head.
2. If coring is not possible due to encountered soils, obtain samples of all soils by continuous SPT testing (if necessary, SPT testing can be conducted through larger diameter wireline core barrels). SPT shall be carried out in accordance with AS 1289.
3. Field Point Load Tests (PLT) must be performed on representative rock core, at nominal 1m to 2m interval (axial and diametral), depending on the anticipated stratigraphy and project requirements.
4. Collection of rock core samples for laboratory Uniaxial Compressive Strength (UCS) testing shall be conducted at nominal 3m interval, depending on the anticipated stratigraphy and project requirements.
5. Installation of standpipe piezometers where required to determine hydrogeology of the site.

Core barrels shall be no longer than 3m, unless otherwise approved by the Principal Engineer. Special care shall be taken to ensure that maximum recovery is obtained on each drill run, as core recovery is of prime importance.

The Site Representative shall, in consultation with the Subcontractor, ensure that the drilling procedure and the length of each core run are tested and adjusted during the drilling program to obtain maximum possible core recovery.

Drill runs shall not exceed 3m in length and depending on the method the core barrel or core barrel inner tube shall be removed from the drill hole as often as is required to obtain the best possible core recovery. 100% core recovery in any single run should normally be obtained. If the measured core recovery is less than 90% the subsequent core run shall be halved or less, until improvement on the core recovery is achieved.

The Site Representative shall use their judgement to specify in-situ testing between drill runs, in accordance with the objectives of the investigation.

The core shall be pulled whenever necessary to prevent loss or damage of the core and a blocked core barrel shall be pulled. Grinding of the core after the core barrel has been blocked is not acceptable and the Site Representative should manage this accordingly. Reaming and casing, the use of drilling mud or grouting of the hole to control caving or high-water loss and blowing sand shall be managed on site by the Site Representative and should not be performed in any section of any hole without the prior consultation between the Site Representative and the Subcontractor.

Percussion (air hammer) drilling is a non-core drilling method. Logging of this method is limited to measurements of rate of penetration resistance and estimation of the substance strength of the rock materials based on assessment of the strength of the drill chips. This method provides very limited to no data on rock mass structures or interfaces between different stratigraphical units. This method can on be adopted for project where core drilling is not required, and where this method of drilling is specified in the drilling work schedule or in the

Contract Documents. If this method is proposed by the Service Provider, a consultation with the geotechnical designer and a submission of a TDRF will be required.

8.5.3 Other Drilling Supervision Requirements

The core should be logged as soon as possible after it is removed from the core barrel and placed in the core box. No core is to be removed from the investigation site until it is completely logged and photographed. This will ensure a record of the core in case it is damaged or lost during transport.

Upon retrieval of the soil/rock core from each drill run, the Site Representative will:

1. Confirm the drilled depth with the driller.
2. Measure the length of the core recovered.
3. Check if the length of the obtained core matches the depth of the section drilled and check for the presence of a flange on the bottom of a core string (which indicates that the core was retrieved from the bottom of the drilled hole). The depth check will also help to detect any occurrence of blowing sand.
4. Reconcile any differences with the driller, include confirming if cleaning out of the hole is required prior to proceeding with the next core run.

8.5.4 Core Packing and Labelling Requirements

Requirements for removal of soil/rock cores, core boxes, packing and labelling are as follows:

1. All handling entailed in recovering the cores from the ground shall be carried out in a manner such as to minimise disturbance to the cores.
2. Core barrels shall be held horizontally while the inner most liner containing the core is removed without breakage.
3. The core should always be rigidly supported while it is being extruded and during subsequent handling and the liner containing the core must not be allowed to flex to minimise risk of cracking/breaking it.
4. Immediately after removing the liner, the core shall be cleaned of any residual drilling mud, the top and bottom of the core shall be marked/tagged using a permanent marker.
5. Where the length of the rock core recovered from any single core run is such that it cannot be accommodated in one channel of the core box, the core shall be cut to coincide, if possible, with existing fractures. This man-made cut must be marked on the core. The marking shall be done in a manner that the cut sections can be matched.
6. Mark all drill breaks in rock core using a permanent marker while the core is still on the split. The drill break mark shall be distinguished from handling breaks or drill breaks.
7. Separate core boxes shall be used to store the core from each individual borehole. The core from different boreholes shall not be placed in one core box.
8. Cores shall be placed in core boxes in such a way that the core depth increases from left to right and from the top of the box to the bottom of the box. The Site Representative shall check that the core for each core run is placed correctly into core boxes.
9. “No Core” is to be used for any section where no core was recovered, including cases where the hole intercept voids or liquid filled cavities (such as underground abandoned structures with enclosed cavity, sinkholes in limestones and erosion caves in steep gorge) or where materials simply do not exist. “No Core” spacers are to be placed in the core box at the most likely depth of occurrence, based on the drilling action and communication with the driller.
10. “Core Loss” includes cases where less than 100% core recovery was achieved yet soil/rock materials were intercepted. “Core Loss” blocks or spacers are to be placed in

the core box at the most likely depth of occurrence based upon the drilling action and close examination of the core. If the core loss location cannot be determined, then the blocks/ spacers shall be placed at the bottom of the core run.

11. For samples, spacers with labels of the same samples using permanent marker, shall be placed in the core box where samples are removed from the core box.
12. All spacers for no core, core loss and samples shall be placed and orientated correctly such that they can be read in the photograph.
13. The outside ends of each core box shall be clearly labelled using a permanent marker, stating:
    a. The SA Water project name and number.
    b. The investigation location/name of the borehole.
    c. The depth "From x.xx m - To x.xx m".
    d. The box number of the total sample number for the hole (for example Box 1 of 4).
14. Rock cores need to be sealed using plastic sleeves to minimise core disturbance and loss of moisture.
15. The core boxes with cores shall be covered with the lid and sealed with wide adhesive tape to protect from loss of moisture when not in use, stored under shelter and secured during transport. All core boxes shall be transported with the boxes lying flat/horizontal, corrected side up on the floor of the transporting vehicle.

All measured depths in the hole shall be referenced from the ground surface at the investigation location from the commencement of drilling, whether the hole is vertical or at an angle. All measurements shall be to the nearest 0.01m.

The use of PVC splits for containment of core is recommended to provide extra support for fractured or low strength rocks as this will reduce damage to the core during removal from the core barrel and during subsequent transport and storage.

At the conclusion of the work at the investigation site, the Service Provider shall ensure the hole is backfilled correctly as given in Section 8.7 of this Technical Standard. All equipment, tools, materials and supplies shall be removed, and the site left clean and clear of all debris generated by this work, unless otherwise directed. The backfill shall be complied with State Authority, environmental and asset/site owners' requirements.

8.6 Cone Penetration Tests

Cone Penetration Tests (CPT) may be conducted by a specialist sub-contractor who shall provide the appropriate equipment that is calibrated and fit for purpose and perform all testing in accordance with AS 1289.

The aim of CPT is to provide assessments of soil strength, stiffness and compressibility characteristics of the natural soil profile for geotechnical design. The results of the test shall be made available to the Principal Engineer the following day after completion. All data shall be presented both in electronic raw data format, and hard copy format at the end of the testing program.

CPT probing may include dissipation tests (CPTu) and Dilatometer Marchetti Test (DMT) using a flat plate dilatometer. Seismic DMT and/or Medusa DMT may be adopted, depending on the application and project requirements. Unless otherwise specified, the parameters K_0, OCR, c_u, ϕ, c_h, k_h, γ, u_0, and G_{max}, small and working strain moduli shall be interpreted from the DMT results by the specialist sub-contractor. The Service Provider shall provide the interpretative report of CPT and DMT results by the specialist Subcontractor with the Geotechnical Interpretive Report.

Other technical aspects of the testing may be required depending on the project requirements, which will be decided on a case-by-case basis, in consultation with the

Principal Engineer, the Service Provider and the Subcontractor. In addition to the above-mentioned requirement, the interpretative report shall include the followings:

1. Frequency of measurement.
2. Acceptable pressure and inclination before terminating test.
3. For dissipation testing: depth/ interval, recording frequency and termination point.
4. For DMT: depths of targeted stratigraphical units and vertical interval.

8.7 Reinstatement

8.7.1 Test Pits

Upon completion, test pits shall be backfilled as soon as possible, and the excavation shall be reinstated to match the existing surrounding surface as far as practicable.

For unsealed areas, test pits shall be backfilled with excavated spoil, in the general order the material was excavated, and be compacted in loose layers of 300mm to 400mm (maximum) thick using the backhoe/excavator bucket. The excavation should be left with a slightly raised or mounded surface as a precaution against potential subsidence.

For road pavements, road shoulders, and other sealed areas, test pits shall be backfilled in accordance with the requirements for reinstating these areas as dictated by the State Authority and/or the asset/property owners.

8.7.2 Boreholes, Drillholes and CPTs

A borehole remaining open overnight shall be covered where the rig is not set up over it.

Upon final completion of the drilling work, the Service Provider, in consultation with the Subcontractors, shall determine the appropriate form of backfill and shall ensure that the chosen method complies with the relevant legislation, codes and practices including but not limited to measures to prevent contamination of the ground and groundwater as required by the State Authority, asset/property owners and stakeholders.

Generally, non-core typed tests such as CPT and DMT cannot be backfilled due to their sizes, the test hole shall be drilled then backfilled as required for reinstating borehole.

Boreholes and tests investigations must be adequately grouted to prevent movement of water or air which could have an adverse effect on any proposed excavation and/or the construction of substructures. Prior to commencement of the works, the Service Provider shall submit a written grouting methodology for the Principal Engineer's approval. Grouting of the boreholes shall not commence until written approval is granted from the Principal Engineer.

For paved areas, proposed reinstatement methodology shall be as agreed with the Principal, State Authority, asset/property owners.

If casing or drilling rods are broken off while drilling, it shall be the Service Provider's responsibility to remove any casing or drilling rods. If the broken off casing or drilling rods are approved (by SA Water/State Authority/property owner) to be left in the place, the Service Provider shall remove any casing or drilling rods protruding above the ground surface.

If casing or drilling rods are broken off while drilling boreholes, it shall be the Service Provider's responsibility to remove any casing or drilling rods that may impact any sub-ground works, to the satisfaction of the requirements by the Principal, State Authority and property owner.

The Service Provider shall ensure that all reinstated locations are left in a safe condition. Post investigation inspection shall be carried out to ensure that the reinstated holes are flushed with the surrounding ground surface. If subsidence is observed, top up of backfill shall be carried out by the Service Provider.

9 Geotechnical Logging and Sampling

9.1 Geotechnical Logging

9.1.1 Geotechnical Details

All geotechnical investigation boreholes test pits shall be logged and checked in detail in accordance with AS 1726 by suitably qualified and experienced engineering geologists or geotechnical engineers.

General information required for all logs includes:

1. Names of Site Representative logger and checker.
2. Soil classification symbol and graphic, including interpreted stratigraphical units.
3. Soil and rock descriptions.
4. Moisture condition.
5. Relative density / consistency corelated results of in-situ and laboratory tests.
6. Groundwater observations (if encountered) including struck and standing water levels during the investigation (measurements are to be done each day at the beginning of the work shift, at the mid shift break and at the end of each shift, each record shall include depth, date and time).
7. Rock weathering, strength and natural defect spacing.
8. Visual of the logged defects.
9. Details of each rock defect.
10. Record of where soil or rock samples have been taken, “No Core” and “Core Loss”. For “Core Loss”, provide estimate of drilling resistance and strata.
11. Results of in-situ testing, including pocket penetrometer, vane shear test, SPT, field PLT and laboratory tests.
12. Observations of environmental aspects such as discolouring, odour, foreign matter and fill.
13. If the investigation is a joint geotechnical/hydrogeological/environmental investigation, the produced logs shall comprise combined descriptions, classifications and data collected in all investigations.

9.1.2 Drilling Details

In addition to the geotechnical items outlined above, specific requirements for borehole logs include:

1. Date of commencement and completion.
2. Rig type and details.
3. Name of driller and company.
4. Drilling method and depth of any change in method.
5. Casing type, size and depth.
6. Size and type of drill bit and any bit changes.
7. Size and type of drilling barrel.
8. Borehole coordinate, orientation and alignment.
9. Drilling penetration rate including the depth at which any variation in drilling rate occurs (such as sudden drops).
10. Drilling fluid type, additives, return and loss, and depths of added drilling fluid.
11. Piezometer installation details and graphic.
12. Details of any other instrumentation installed, including gas monitoring and inclinometers.
13. DCP testing presented on the log, including annotation on approximate location and results.
14. When the rock is such that it's properties could change significantly in the core boxes, the logs are to be checked against the core as soon as practical after borehole completion but no more than ten business days.

9.1.3 Test Pit Details

In addition to the geotechnical items outlined above, the following are required for test pit logs:

1. Machinery type and identification number.
2. Excavation dimensions (length, width and depth).
3. Buckets and breaking tools used at different depths.
4. Estimate on excavatability / excavation resistance.
5. Other observations including stability and side wall collapse.
6. 2D sketch logs showing the arrangement of the stratigraphical layers versus depths relative to ground surface.
7. Digital photography of the location with reference to directions (for example: photo looking northeast) and from the side (up and down). The photographs are to identify the condition of the ground and assessment of any nearby assets and evidence of perched water.

9.1.4 Log Format

All field logs shall be typed using electronic software and presented as a part of reporting requirements in *.pdf format and in native file format. The native file format required by the Principal Engineer is AGS 4.0 but may be subject to change.

9.2 Geotechnical Sub-Sampling

Sampling must be conducted in accordance with this Technical Standard for obtaining, preserving, and labelling any soil, rock, water or other material intersected during the investigation work.

General notes for geotechnical soil and rock sampling include:

1. Samples are to be representative of each of the stratigraphical units, cross unit sampling in a sample is not acceptable. Sample collection and quantity requirements shall be in accordance with AS 1289.
2. Samples are to be preserved in accordance with AS 1289 and laboratory's requirements.
3. Samples for testing are to be delivered to the laboratory within the required timeframe with an associated Chain of Custody (CoC).
4. Rock core samples should be preserved in rock sleeve or wrapped in cling-film or similar to preserve condition where appropriate following core photography.
5. All samples must be labelled using a waterproof marker with sample details such as:
    a. The SA Water project name and number.
    b. The investigation location.
    c. The depth of sample "From x.xx m - To x.xx m".
    d. Sampler' initial and Service Provider's name.
    e. The date and time of sampling.
6. Sample bags and boxes of the core shall be stored only in a secure area and in conditions where the bags, core, boxes and labelling are safe from damage or deterioration.
7. Unless stated, all soil cores and untested samples collected are to be maintained by the Service Provider until the completion of the Design Phase, as a minimum, at which time they should seek permission to dispose of all remaining and untested soil and rock samples. The SA Water Representative will define storage retention and disposal requirements of samples. Disposal shall only be carried out with permission from SA Water.
8. SA Water may request core samples to be transported by the Service Provider to a location nominated by SA Water. The Service Provider shall catalogue each bulk sample and core box and provide a detailed inventory to the Principal Engineer outlining the number and location of each core box for each borehole and each sample from each test pit.

9.2.1 Undisturbed Soil Sampling

Undisturbed soil sampling shall be conducted in cohesive soils using the following methodology:

1. Carry out thin-walled tube sampling in cohesive soils at 1.5m intervals or at observed change in soil type.
2. At 0.5m below ground level thin-walled tube samples shall be taken in accordance with AS 1289.
3. 75mm diameter tubes (U75) are to be used to take an undisturbed sample where possible.
4. 50mm diameter tubes (U50) or 63mm diameter tubes (U63) may be used if recovery is not possible with a U75 tube (for example where soil consistency is stiff or greater).
5. Where thin-walled tube samples are taken, the recovery in the tube should be measured and recorded on the log.
6. Consistency tests using a pocket penetrometer are to be performed in the base of the tube before sealing.
7. Tubes are to be sealed at both ends using low shrinkage wax and a plastic cap (or a suitable alternative) to prevent moisture loss.
8. Carry out fixed piston sampling where thin-walled tube samples cannot be obtained because of very soft and soft ground (recommended for soils with undrained shear strength less than 25kPa). Samples shall be clearly labelled as described above.
9. The following precautions shall be taken to ensure samples are not compressed:
    a. Care must be taken by the driller not to overdrive and overfill the sampling tube.
    b. Measure the distance between the cutting head of the tube and the bottom of the adaptor and push the tube in approximately 5cm less than this distance to ensure there is no compression of the sample.
    c. After taking a sample, inspect the top of the tube for signs of compressed material, a small lump indicates that material has been forced up into the ball bearing valve in the adaptor.
    d. If the soil sample has been compressed, another sample shall be taken.
    e. Storage and transport of thin-walled tube samples shall be carefully managed to ensure samples are well protected and maintain original verticality as extracted from the ground.

9.2.2 Disturbed Soil Sampling

The disturbed samples most commonly taken from boreholes are those obtained from SPT. These samples are to be logged, placed in a Ziplock bag in the core tray, effectively sealed and clearly labelled with the SA Water project number, investigation location and depth interval details.

Disturbed samples may be taken from the flights of the augers or bulk sampling barrel and spoil piles of excavated material, when the material being penetrated is of a uniform nature. It should be noted that samples taken from the auger bit on removal are more accurate with respect to depth. Samples shall be representative of the zone from which they have been taken.

Samples to be submitted to laboratory shall be placed immediately into the correct container required by AS 1289 and laboratory's requirements, be clearly labelled with the SA Water project number, investigation location, depth interval details, sampler' initial and Service Provider's name, date and any other relevant information.

9.2.3 Geotechnical Rock Sampling

Rock core sampling involves the followings as a minimum:

1. Recovering continuous rock core, with the correct length required for testing.
2. The rock core shall be sleeved with both ends of the sleeve sealed to prevent moisture loss.
3. Point Load Testing of the core at regular intervals, as nominated in Section 8.5 of this Technical Standard.
4. UCS samples must be taken from representative rock cores of all strengths at the vertical interval nominated in Section 8.5 of this Technical Standard.
5. Samples may be tested using specialised suite for aggregate material characteristic or tunnel design parameters. Requirements for sampling will be specified in the Contract Documents, or as directed by the Principal Engineer.

9.3 Continuous Sampling of Soft Soil

Continuous sampling may be conducted at selected locations in soft alluvial/estuarine material. The purpose of obtaining the continuous soil profile is to:

1. Confirm the soft clayey soil beds and interbedded sand lenses.
2. Confirm and correlate material type interpretations for nearby CPTs, if relevant.
3. Provide sampling source for Potential Acid Sulphate Soil (PASS) testing and durability testing.

Where the soil material is not encased in plastic during the sampling process, the sampled soil should be encased in plastic wrapping immediately upon extrusion to preserve the natural moisture content. Where soil samples are to be used for PASS and/or durability tests the relevant preserving procedures must be applied.

The Service Provider shall store the samples in a manner that permits later inspection. This may require cutting of the sample into 1m sections and storing in a core box of appropriate dimensions.

9.4 Site and Core Photography

Colour photographs of the site and core shall be taken and supplied by the Service Provider in *jpg format as part of the delivery requirements.

Photographs of the site may present the surrounding terrain, vegetation and nearby existing site features at the location of the investigation.

For bulk sampling using the non-cored drilling method, photographs of the recovered cuttings are required to be taken in the field with the label board (as described above) after completion of the borehole.

9.4.1 Photographs of Test Pits

Photographs of test pits may present spoil piles, samples and excavated side-wall profiles. All photographs of excavations, samples and spoil shall present:

1. With a label board outlining the SA Water project number, date and test location information and a correct scale ruler. A standard colour chart must accompany the label-board during photography with red, blue, yellow, white and black included as a minimum.
2. A survey staff or depth indicator in the excavation that is legible in the photos.

9.4.2 Photographs of Core Boxes

Good quality photographs of boxed cores are required to be taken in the field after completion of each box. Such photographs are a record of the core in its least disturbed state after being taken out of the core barrel sampler and are an important record, particularly in fractured rock.

The following procedures are recommended for soil and rock core box photography:

1. Cores are required to be wetted, using a fine sprayer, prior to taking photograph.
2. A high-definition digital camera with a zoom lens and good flash should be used.
3. A label board is required in the photo to present the investigation information in a clear and concise manner, with the SA Water project description, date, test location and drill run depths clearly stated. The label board should also contain a scaled ruler. A standard colour chart must accompany the label board during photography with red, blue, yellow, white and black included as a minimum.
4. All core boxes shall be photographed under uniform good even lighting conditions to minimise shadowing, shading, reflection and distortion.
5. Core box photographs shall be in a line perpendicular to the centre of the core box to minimise distortion due to parallax. A zoom lens may be used to minimise distortion.
6. Photographs shall have a uniform background behind and surrounding the core boxes to avoid different colour reflections on core sample.
7. Photographs of boxed cores should be taken without Ziplock bag, cling-wrap or core sleeve (these preserving measures shall be reapplied after photographs are taken).
8. All samples, spacers, labels should be placed right side up and legible in core photographs.
9. Photograph alteration by photoshop or similar tools is not acceptable.

Any alterations to the above requirements shall be submitted in a TDRF prior to administering any alterations.

9.5 Specialised Requirements

If specialised geotechnical investigation requirements are required for a project, these will be given in the Contract Documents or specified by the Principal Engineer.

9.5.1 Core Orientation

At locations selected by the Principal Engineer, the Service Provider shall carry out coring orientation using a core orientation tool. Unless otherwise arranged, the Service Provider shall supply an appropriate tool suitable for use in NMLC or other approved core barrels.

The Service Provider may propose an alternative methodology to undertake the core orientation, such as downhole televiewer (acoustic and/or optical), or other. Details of alternatives shall be submitted to the Principal Engineer for approval.

9.5.2 Downhole Geophysics

Specialist downhole geophysics may be conducted in the borehole. Downhole geophysics may include but not limited to optical and acoustic televiewer, full wave sonic logging, Gamma ray, etc, depending on the project requirements.

The proposed methodology and interpretation of results should be conducted by a suitably qualified professional to ensure that the work satisfies the project requirements.

9.5.3 Seismic Survey

Seismic survey techniques, including, but not limited to reflection, refraction, cross-hole tomography, surface to borehole seismic, multi-channel analysis of surface waves, resistivity, electro-magnetic or ground probing radar may be used between proposed cored boreholes, especially in significant cuttings to enhance the understanding of the expected ground conditions.

The planning of adopted seismic survey methodology and interpretation of results to suit specific project requirements shall be conducted by a suitably qualified professional.

9.5.4 Investigations for Tunnels and Large Cuttings

The following requirements apply to tunnel specific investigations:

1. Boreholes should be positioned adjacent to the nominated alignment, close enough to inform the ground conditions at the nominated tunnel location but not too close to affect or penetrate the planned cross section of the tunnel as this could lead to undesired effect on the excavation and construction of the tunnel.
2. Information should be obtained from the various strata overlying, underlying and will be encountered within the tunnel, this shall involve sampling in the boreholes from above and below tunnel horizon depending on the characteristics of the strata.
3. Boreholes shall be adequately grouted and sealed to prevent movement of air, water, soils and potential associated contaminations, especially at tunnel horizon which could have an undesired effect during construction.

Additional specialised testing may be required for tunnels and large cuttings, these will be specified depending on the project requirements:

a. In-situ stress testing by either over-coring or hydro-fracturing. The Service Provided will be requested to provide a work method statement for in-situ stress testing to the Principal Engineer for agreement prior to investigation mobilisation.
b. Additional hydrogeological testing and monitoring.
c. Petrography and X-Ray diffraction testing of the rock.
d. Other laboratory testing of the rock.
e. Tunnel specific laboratory testing to assess cutability, drillability and abrasivity of the rock.

10 Field, In-situ & Laboratory Testing

All geotechnical field, in-situ, and laboratory testing shall be in accordance with AS 1289 unless specified. Where alternative methodologies are proposed, this will require a submission of TDRF and can only be adopted if an approval from the Principal Engineer is granted.

All laboratory testing shall be conducted and reported by a NATA accredited laboratory. The proposed tests shall be submitted to the Principal Engineer for approval. Any changes to the approved test request require further approval from the Principal Engineer.

The results of the testing shall be presented on the logs and be correlated with the lithology descriptions, classifications and interpretations of each of the stratigraphical units presented on the logs.

Required range of laboratory tests is provided in Table 2 for the various nominated proposed works. The number of tests will be depending on the project requirement, the ground conditions and the quality of the investigation. It is recommended to collect more samples than required, to allow for any replacement or additional tests. It shall be noted that for tunnel works, specialised rock tests may also be required. These will be specified in the Contract Documents, rather than stating in Table 2. Other test methods, which are not given in Table 2 , may be nominated by the Designers and Investigators if these are deemed appropriate to inform the design and construction of the project.

Testing for construction materials such as aggregates and fine materials is specified in TS 0630 and TS 0631, respectively.

Nominated geotechnical testing and request will constitute a **HOLD POINT**.

Table 2: Required Geotechnical Testing (Minimum)

Proposed Infrastructure	Laboratory Test															
	Particle Size Distribution[1]	Atterberg Limits & Linear Shrinkage[2]	Emerson Class & Pinhole Dispersion[3]	Standard & Modified Compaction[4]	Dry Density Ratio[5]	Field Moisture Content[6]	California Bearing Ratio[7]	Direct Shear[8]	Triaxial Consolidated Undrained[9]	One-Dimensional Consolidation[10]	Soil Permeability[11]	Soil Shrink-Swell[12]	Soil Suction[13]	Soil/Water Aggressivity[14]	Uniaxial Compressive Strength[15]	Point Load Strength Index[16]
Building (with or without basement)	Y	Y	Y			Y			Y	Y	Y	Y	Y	Y	Y	Y
Tank	Y	Y	Y			Y			Y	Y	Y	Y	Y	Y	Y	Y
Culvert	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y
Pipeline (elevated)	Y	Y	Y			Y			Y	Y	Y	Y	Y	Y		
Pipeline (in-ground)	Y	Y	Y	Y	Y	Y					Y	Y	Y	Y	Y	Y
Pipeline HDD	Y	Y	Y			Y					Y			Y	Y	Y
Thrust block	Y	Y	Y			Y					Y			Y		
Embankment	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				
Cut slope	Y	Y	Y			Y					Y	Y				
Retaining structure	Y	Y	Y	Y	Y	Y		Y			Y			Y	Y	Y
Landslip	Y	Y	Y			Y					Y					
Swales/Drainage channel/ Detention basin	Y	Y	Y	Y	Y	Y					Y					
Tunnel	Y	Y	Y			Y			Y	Y	Y			Y	Y	Y
Pit/ sump	Y	Y				Y			Y	Y	Y	Y		Y	Y	Y
Pavement subgrade (for carpark and access road)	Y	Y	Y	Y	Y	Y	Y				Y	Y	Y			
Dam and associated aperture	Y	Y	Y	Y		Y			Y	Y	Y	Y		Y	Y	Y
Crane pad or hardstand	Y	Y	Y	Y	Y	Y					Y					

The test methods shall conform to the following Australian Standards:

1. Particle Size Distribution: AS 1289.3.6.1
2. Atterberg Limits and Linear Shrinkage: AS 1289.3.1.2, AS 1289.3.2.1, AS 1289.3.3.1, AS 1289.3.4.1
3. Emerson Class and Pinhole Dispersion: AS 1289.3.8.1 and AS 1289.3.8.3
4. Standard and Modified Compaction: AS 1289.5.1.1 and AS 1289.5.2.1
5. Dry Density Ratio: AS 1289.5.4.1
6. Field Moisture Content: AS 1289.5.8.1
7. California Bearing Ratio: AS 1289.6.1.1
8. Direct Shear: AS 1289.6.2.2
9. Triaxial Consolidated Undrained AS 1289.6.4.2
10. One-Dimensional Consolidation Oedometer: AS 1289.6.6.1
11. Soil Permeability: AS 1289.6.7.1, 6.7.2 and 6.7.3 as appropriate depending on site conditions
12. Soil Shrink-Swell: AS 1289.7.1.1
13. Soil Suction: AS 1289.2.2.1
14. Soil/Water Aggressivity: pH, Chloride, Sulphates and Electrical Resistivity: AS 1289.4.3.1, AS 1289.4.2.1, AS 1289 4.4.1
15. Uniaxial Compressive Strength: AS 4133.4.2
16. Point Load Strength Index: AS 4133.4.1

11 Geotechnical Report

All data collected during the geotechnical site investigation shall be compiled into a comprehensive Geotechnical Factual and Interpretive Report, issued at the conclusion of the investigation in accordance with the agreed program. The report shall comply with all requirements of AS 1726 – Geotechnical Site Investigations. As a minimum, the report shall include:

1. Statement of Scope and Purpose: A clear description of the Service Provider's understanding of the investigation scope and the purpose of the investigation.
2. Confirmation of Project Intent: A statement confirming that the investigation meets the project's intention, including an explanation of how the investigation satisfies that intention.
3. Description of Site Conditions: A summary of the site conditions at the time of investigation, including site locations, dimensions, topography, gradients, site features and relevant observations from the surrounding area.
4. Review of Regional Geology and Hydrogeology: An overview of the anticipated geological and hydrogeological conditions, including relevant historical information and the Service Provider's previous experience at or near the site.
5. Investigation Methodology: A detailed description of the investigation methodology, including evidence demonstrating that the investigation was carried out in accordance with the approved Geotechnical Investigation Plan.
6. Surveyed Coordinates: Tabulated surveyed coordinates for all test locations
7. Test Location Plan: A plan showing the site boundary, investigation locations and site features, presented to scale with clear labels, keys and notes.
8. Engineering Logs: Engineering borehole/test pit logs and explanatory notes.
9. Photographic Records: Site photographs taken during the investigation and photographs of core boxes and other samples.
10. Summary of Test Results: Tabulated and graphical presentations of in-situ and laboratory test results, including explanatory notes and justification for any disqualified results.
11. Test Certificates: Certified laboratory, CPT, seismic and other relevant test reports.
12. Interpretation of Ground Conditions: A discussion of encountered ground conditions including soils, rocks and groundwater supported by test pit logs, borehole logs, laboratory results, geological/hydrogeological review and relevant historical data.
13. Geological and Geotechnical Cross Sections: Longitudinal and cross sections interpreting ground conditions across the project footprint, showing site features, boundaries, borehole and test pit locations, offsets, lithology, test results and interpreted geological and hydrogeological features.
14. Interpretation and Design Parameters: Tabulated and graphical interpretation of test data, including calculations used to derive geotechnical design parameters. All methods adopted shall reflect accepted industry practice and be fully stated in the report.
15. Impact Assessment: A discussion of how the interpreted geotechnical model influences the project, including both risks and opportunities.
16. Assessment of Risks and Gaps: Identification of any geotechnical risks, opportunities, and any gaps in the investigation, with justifications.
17. Recommendations: Recommendations to sufficiently inform the design and construction of the project.
18. Limitations: A statement of limitations applicable to the interpretation. These limitations must not contradict the investigation scope or purpose.

A Schedules of hold points, witness points and identified records

A1 Schedule of hold points and witness points

Section	Type	Description
3	Hold	Audit report and audit schedule.
3	Witness	Safe Work Method Statement (SWMS)
4	Hold	Approval of Geotechnical Investigation Plan, including all WH&S documentations
5	Hold	Documentations and approval required for access.
6	Hold	Nominated establishment equipment and their maintenance record showing that these are up-to-date and are calibrated. Personnel's qualification and experience to carry out the work.
6	Witness	Subcontractor's licenses.
8	Hold	Nominated geotechnical investigation methodology suitable for delivering the project.
8	Witness	Site inspection during site investigation.
10	Hold	Sampling and testing request.
11	Hold	Approval of the Draft Geotechnical Report and closure of any non-conformance and Technical Dispensation prior to re-issuing as a Final Geotechnical Report, marking completion of the geotechnical investigation service.

A2 Schedule of identified records

Section	Description of Identified Record
3	Audit report and audit schedule
4	Geotechnical Investigation Plan
2	Technical Departure Request Form
4	WH&S documentations
5	Site access permits and other permits required by State Authority
6	Equipment maintenance record
6 and 8	Site inspection records
9	Sampling request forms
11	Draft and Final Geotechnical Reports