

Guideline

Geotechnical Investigations

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1 Introduction

The purpose of this guideline is to outline the basic requirements for the planning and execution of geotechnical investigations for Transport and Main Roads infrastructure projects.

In this guideline, the term 'geotechnical investigation' (or site investigation or site characterisation) is used in the context of subsurface (or below ground) investigation. Other aspects of site investigation, which may be relevant in a broader context, are not necessarily detailed here.

The minimum requirements for undertaking site investigations for pavement design and rehabilitation, as well as for environmental purposes (for example, contaminated land and acid sulfate soils), are outside the scope of this guideline. In addition, inspection pitting or pot holing for utility detection or assessments are not covered by this document.

Due to the broad range of requirements for various elements of infrastructure design, the minimum frequencies for sampling and testing of soil, rock and groundwater for geotechnical investigations are not provided in this guideline. It is intended that these details should be specified by the Designer or determined from other relevant technical manuals.

2 Definition of terms

Additional terms used in this guideline should be as defined in Table 2.

Table 2.1 – Definition of terms

Term	Definition
ASS	Acid Sulfate Soil
CH	Cultural Heritage
CPT	Cone Penetrometer Test
Geological model	A model of the existing ground conditions of a site, developed from the available data. The geological model generally includes details of existing soil types and rock lithologies and the boundaries between them, the degree of alteration and weathering experienced, any mineralised zones for each geological unit.
Geotechnical model	A geotechnical model can be defined as the delineation of the subsurface (rock or soil mass) where geotechnical conditions are anticipated to be largely similar from a performance standpoint. This involves identifying parameters that suitably describe the conditions within each delineated area.
May	A permissive condition that indicates that usage of the device is conditional, or optional.
NATA	National Association of Testing Authorities
PASS	Potential Acid Sulfate Soil
PUP	Public Utility Plant
RPEQ	Registered Professional Engineer of Queensland
Shall	A mandatory condition. Where certain requirements in the document are described with the 'shall' stipulation, it is mandatory that these requirements be met.
Should	Indicates a recommendation. Where the word 'should' is used, it is considered to be recommended use, but not mandatory.

Term	Definition
Suitably Qualified Person (SQP) - Environment	A person that has the necessary qualifications and experience to perform regulatory functions to ensure human health and environmental risks are managed appropriately, with regard to land that is contaminated.
WHS	Work Health and Safety

3 Referenced documents

Table 3 lists the documents referenced in this guideline.

Table 3 – Referenced documents

Reference	Title
Acid Sulfate Soils	<i>National Acid Sulfate Soils Sampling and Identification Methods Manual</i> , Water Quality Australia
AS 1726	<i>Geotechnical site investigations</i> , Standards Australia
AS 5488.1	<i>Classification of subsurface utility information, Part 1: Subsurface utility information</i> , Standards Australia
ASTM D5092-04	<i>Standard Practice for Design and Installation of Groundwater Monitoring Wells</i>
Austroroads	<i>Guide to Road Design Part 1: Objectives of Road Design</i>
Biosecurity Regulation 2016	Subordinate Legislation 2016 No. 75, Queensland Government
DAF 2018	<i>Accepted development requirements for operational work that is constructing or raising waterway barrier works</i> , Department of Agriculture and Fisheries
Geotechnical Design Standard	<i>Geotechnical Design Standard – Minimum Requirements</i>
Geotechnical Logging	<i>Geotechnical Logging Guideline</i>
Minimum Construction Requirements for Water Bores in Australia 2020	<i>Minimum Construction Requirements for Water Bores in Australia 2020</i>
MTM	<i>Materials Testing Manual</i>
MRTS02	<i>Provision for Traffic</i>
MRTS04	<i>General Earthworks</i>
MRTS10	<i>Plant-Mixed Lightly Bound Pavements</i>
MRTS12	<i>Sprayed Bituminous Emulsion Surfacing</i>
MRTS30	<i>Asphalt Pavements</i>
MRTS39	<i>Lean Mix Concrete Sub-base for Pavements</i>
MRTS51	<i>Environmental Management</i>
MRTS96	<i>Management and Removal of Asbestos</i>
QGD	<i>Queensland Geotechnical Database</i>
TMR Surveying Standards	<i>TMR Surveying Standards</i> Part 1 – General Information TMR Surveying Standards Part 2 – Geomatic Survey Types Schedule 1 – Codes, Linestyles and Examples

Reference	Title
Water Regulation 2016	Subordinate Legislation 2016 No. 216, Queensland Government

4 Planning for geotechnical investigations

4.1 General

The scope of any proposed geotechnical investigation to be undertaken on behalf of the department shall be prepared to adequately inform the intended stage of study / design for the project. The scope shall also ensure that geological and geotechnical models for the site can reasonably be established.

The requirements for the *Geotechnical Design Standard*, and other applicable design standards, shall be considered in the planning and development of any geotechnical investigation scope.

Geotechnical investigations should be undertaken in a systematic manner to reduce the likelihood of contract variations arising from unexpected geological (latent) conditions. The detail of the geotechnical investigation shall be appropriate for the apparent and potential risks and hazards, and the complexity of the project.

In planning and preparing for a geotechnical investigation, the following items shall be considered:

- Purpose of the geotechnical investigation (that is, whether the proposed investigation is for a feasibility study, option analyses, business case, concept design, preliminary design, detailed design, or construction).
- Availability of existing geotechnical information. To confirm this, a desktop study (including a gap analysis) should be carried out prior to the development of the geotechnical investigation scope.
- Availability of any existing environmental / cultural heritage assessments (for example, contaminated land assessments).
- Environmental and cultural heritage risks or constraints.
- Site access, including permits and approvals.
- Health and safety risks / hazards, and
- Time constraints.

4.2 Desktop study

The purpose of the desktop study is to identify potential geotechnical risks that may impact on specific infrastructure development. It also allows for the design of an appropriate and targeted site investigation where there is insufficient information available to adequately assess the geotechnical risks to the project.

A desktop study shall be carried out for any proposed infrastructure development and prior to any site investigation work.

The desktop study may include (but not be necessarily limited to) the following sources of information for the development of a desktop study report. Note that other sources of information may also be considered (for example, AS 1726):

- published geological and soil maps
- published geotechnical investigation reports

- published environmental assessments
- Queensland Geotechnical Database (ggd.org.au)
- current and historical aerial and ground photographic images
- hydrological data from local water authorities or instrumentation data from adjacent projects
- registers of contaminated land
- local knowledge of residents and past owners / occupiers / asset managers
- historical societies and libraries
- available public utility plant plans
- past and future development activities
- other investigation data reports that may be applicable (for example, published subgrade assessment reports for pavements and so on)
- existing asset data such as 'As Constructed' drawings or other published construction records, and
- information on the design, construction, maintenance and condition of existing infrastructure.

The report from the desktop study should identify any areas of the site where there is insufficient information to characterise the ground conditions, and acceptable levels of geotechnical risk for construction and in-service performance associated with the site. Other risks that may impact on the site (for example, the presence of dispersive soils, potential contamination or acid sulfate soils, environmental and heritage risks, site access issues), may also be a consideration in the production of the report.

The report may include recommendations on any geotechnical investigations and assessments required to improve the understanding of the geological conditions and risks to construction, and in-service performance associated with the site.

4.3 Preparation of investigation scope brief

Typically, the department's infrastructure projects develop in stages, such as feasibility studies, options analysis, business cases, preliminary and detailed designs. The geotechnical investigation requirements differ for each of these project development stages, which should be recognised in the development of scope briefings and the planning of geotechnical investigations. The findings of the desktop study should be used as the basis for the development of the scope of any geotechnical investigation required.

Geotechnical investigation techniques should be proposed for the assessment of subsurface conditions along the footprint of the project and/or at foundation locations. A preliminary site visit to understand any site access constraints, confirm suitability of proposed methodologies, and to document existing features relevant to the proposed investigation should be initially undertaken prior to developing the scope brief. Typically, the level of understanding of geotechnical risks associated with a site relies on the amount of gathered information about ground conditions.

4.4 Geotechnical site investigation techniques

The geotechnical site investigation techniques nominated in the scope brief shall be relevant to the expected ground conditions (geological model) identified in the desktop study, the proposed

infrastructure design and the phase of the project. Selected geotechnical investigation techniques must also consider site access, permits, approvals, environmental / cultural heritage, and so on.

The geotechnical investigation methodologies selected will depend on (but not be necessarily limited to):

- investigation objectives
- considerations of proposed design elements
- information obtained from the desktop study
- site conditions and access requirements
- availability of any specialised plant and equipment
- cost and time constraints
- health, safety, and environmental considerations, and
- regulatory requirements.

An example template for the development of a scope brief for departmental geotechnical investigations is provided in Appendix A of this guideline.

An experienced geotechnical professional with extensive experience in a similar scope of work shall describe the site investigation techniques necessary for the study. This includes specifying the type, quantity, and frequency of sampling and testing in the scope brief.

All scope briefings for geotechnical investigations shall be accepted by the department's Geotechnical section (by the Director Geotechnical or his/her nominee) prior to the initiation of any onsite activities.

5 Undertaking site activities

5.1 General

Geotechnical site investigations shall be carried out in accordance with:

- Australian Standard AS 1726 *Geotechnical site investigations*
- the requirements of the scope brief
- all safety and environmental requirements (as documented in the site specific Safety Management Plan and Environmental Management Plan), and
- all statutory requirements from regulatory authorities.

Geotechnical drilling shall be carried out by a suitably qualified, and licensed drilling contractor in accordance with the Queensland Water Regulation, 2016, and the *Minimum Construction Requirements for Water Bores in Australia, 2020*.

An assessment shall be made to determine if the work is to occur within the fire ant biosecurity zones. Fire ant-safe practices must be undertaken when working within a fire ant biosecurity zone.

Sampling and testing for purposes other than geotechnical requirements are outside the scope of this guideline.

5.2 Access to site

5.2.1 General

The occupation of a site for intended geotechnical investigation works should be confined to the minimum area of ground required for safe operation.

Where the site location is on private property or land controlled by other regulatory authorities, authorisation to enter upon the land shall be obtained from the appropriate departmental delegate. Consent from the landowner or lessee shall also be obtained prior to entering a property.

It is recommended that at each investigation location and the access to these sites, that pre and post investigation photographs be taken as evidence of compliance with the requirements of the investigation.

At all times, access to the site shall be controlled, ensuring that only authorised personnel are allowed into the work areas.

5.2.2 Clearing of vegetation

Where clearing of vegetation or preparation of temporary working platforms for plant and equipment is required, approval for such activities from the department and other relevant regulatory bodies shall be obtained, prior to any site access preparation work commencing. All works carried out shall comply with the departmentally approved, site specific Environmental Management Plan.

5.2.3 Traffic management

Where traffic management is required to carry out investigation activities on a site, works shall be undertaken in accordance with MRTS02 *Provision for Traffic*, or the relevant road authority requirements, and all permits to work obtained prior to the commencement of works.

5.2.4 Over water works

All operational barge works shall be carried out in accordance with relevant federal, state and local legislative requirements, and be compliant with the relevant waterway authority procedures, environmental permits, and the site-specific Environmental Management Plan for the duration of works.

5.2.5 Temporary access to waterways

Where investigation sites are located within a dry watercourse or a shallow waterway (i.e. not deep enough for a barge), a temporary track may be constructed to enable access to borehole locations by associated plant and equipment. The construction, operation and removal of the temporary track shall be in accordance with Section 7 of the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF, 2018).

5.3 Location of Public Utility Plant (PUP)

All necessary measures shall be undertaken to identify and locate utilities (below and above ground) that may be impacted by geotechnical investigation works, prior to works commencing, and works shall be carried out in accordance with asset owner requirements. It is the Contractor's responsibility to ensure public utility plant assets are protected and not damaged during geotechnical site investigation works.

5.4 Set out and survey of investigation locations

It is recommended that the test locations for any proposed structures (for example, bridge abutments and piers) should be initially located and marked by a surveyor who meets the competency requirements as specified in the relevant categories of Section 2.4.3 of the *TMR Surveying Standards*, Part 1.

Where an investigation point must be re-located, the reason for the shift in location shall be documented.

At the completion of the site work, the surveyor shall survey all completed investigation points in accordance with the project requirements.

Each investigation point shall be the horizontal coordinate datum of Geocentric Datum of Australia 2020 (GDA2020) and implemented in the relevant zone of Map Grid of Australia (GDA2020 / MGA Zone5*). The surface level for all investigation points shall be reported to Australian Height Datum 1971 (AHD71).

5.5 Contaminated sites

When dealing with known or suspected contaminated land, all works shall conform to the relevant regulations / Acts applicable.

An assessment shall be made by a Suitably Qualified Person to advise of the appropriate health and safety measures to be taken prior to and during the geotechnical investigation, at sites which have been identified as contaminated (for example, as per the contaminated land register), or are suspected of being contaminated.

The planning and execution of contaminated land investigations is outside the scope of this manual.

5.6 On-site sampling and testing

For each investigation point, a photographic record of the location before and after the work should be undertaken.

Sampling and testing of soil, groundwater and rock shall be carried out in accordance with the relevant Australian Standard where applicable.

AS 1726, as well as Appendix B, should also be used as a reference for the types of on-site sampling and testing methods commonly used for geotechnical investigations.

Undisturbed sampling of soils should be undertaken using thin-walled tubes or a fixed piston sampler or equivalent. The minimum size of sampling tube should generally be 75 mm diameter.

Other published methods and codes of practice may also be considered, subject to approval from the department's Geotechnical Section.

Where investigation points are required on an existing roadway, all test pit and boreholes should be located outside existing wheel paths, where possible.

5.7 Groundwater observations and monitoring

Observations and measurements of existing groundwater should be undertaken in accordance with AS 1726. An installation record for standpipes / piezometers must be provided for each unit. This record should encompass, at a minimum, the following details: characterization of subsurface soil and rock materials, standpipe depth, response zone, particulars concerning backfill and sealing,

groundwater level, actual construction location, and monument type. Reference material such as (but not necessarily limited to) Appendix B, AS 1726, and the *Minimum Requirements for Water Bores*, 2020, should also be used as a guide to the use and application of standpipe piezometers.

5.8 Sample handling and storage

Care should be taken whilst onsite to ensure that all soil and rock samples are not exposed to extremes of temperature or humidity.

All soil and rock samples obtained during the investigation should be protected to ensure that their insitu properties are preserved for further analysis.

Disturbed samples should be placed in sealable containers and/or airtight plastic bags to prevent loss of moisture.

Undisturbed tube samples should be appropriately sealed to maintain the insitu moisture conditions of the soil, in accordance with AS 1726, Clause 5.5.4.1.

All samples should be handled, stored, and transported with care to avoid sample disturbance from excessive vibration prior to laboratory testing.

Rock core samples should be carefully placed in purpose made core trays with core tray lids for storage and transportation.

The type of core tray used for the storage of rock samples should be suitable for minimising any potential sample disturbance during handling and transportation.

Safe manual handling techniques should also be considered in the selection of the core tray size. For NMLC sized core, it is recommended that no more than three linear metres be placed in any one core tray.

Storage of samples obtained for the purpose of environmental testing (for example Acid Sulfate Soil or contamination testing) is outside the scope of this document.

Soil samples taken from within a known fire ant biosecurity zone shall be managed in accordance with the Queensland Biosecurity Regulation 2016 and the *Soil Movement Guidelines*.

5.9 Reinstatement of boreholes and test pits

At the completion of each borehole or test pit, the ground shall be reinstated to prevent any future ingress of water or hazard to personnel, livestock or vehicles.

All boreholes and test pits shall be reinstated in accordance with the requirements detailed in Appendix B of this guideline, unless otherwise approved by the department.

5.10 Disestablishment from site

At completion of the investigation, each site shall be left in a condition equal to the site conditions prior to the commencement of the investigation, or as otherwise directed by the departmental delegate. All waste shall be removed from site and disposed of in accordance with the regulatory requirements for each waste type. Surplus material, such as cuttings from drilling, should be managed in accordance with the site Environmental Management Plan.

Any changes to the environmental conditions to the site as a result of the investigation activities shall be reported in accordance with the requirements of the Environmental Management Plan.

6 Geotechnical logging

Geotechnical logging of all soil and rock during the investigation should be carried out in accordance with the department's *Geotechnical Logging* guideline and AS 1726.

Where there is a conflict between the *Geotechnical Logging* guideline and AS 1726, the content of the guideline should take precedence.

Geotechnical logging of all soil and rock materials should be carried out by a suitably trained and qualified person under the supervision of a Geotechnical Professional. The Geotechnical Professional should be either an Engineering Geologist or a Geotechnical Engineer who is also a Registered Professional Engineer Queensland (RPEQ). The Geotechnical Professional shall have at least five years' experience in the logging and assessment of soil and rock materials for road transport infrastructure projects.

In addition, all geotechnical borehole and test pit logs shall be reviewed by the Geotechnical Professional.

6.1 Rock core photography

As a general approach, all images should be of a sufficient quality and resolution to enable the clear identification of the features and properties of the rock core sample.

All photographic images of rock core samples should comply with the following requirements:

- photography of core shall be undertaken at high resolution, and in natural light, or standard artificial light of equivalent quality
- rock core samples to be photographed in wet condition
- include start and finish measurement labels for each core run
- include depth marker labels every metre, and
- include a measurement scale bar.

7 Laboratory testing

The testing of all geotechnical samples shall be carried out by National Association of Testing Authorities (NATA) accredited laboratories that are registered with the department's [Construction Materials Testing Supplier Registration System](#).

Samples submitted to a laboratory for testing shall be accompanied by all relevant information to enable testing and reporting of results. As necessary, the potential of any hazardous substances within samples shall be nominated.

Australian Standards (AS) test methods or methods from the department's *Materials Testing Manual* (MTM) shall be used for all soil and rock testing, as nominated within the investigation brief. Other equivalent published test methods may be used as alternatives to AS and MTM methods, subject to the approval of the department's Geotechnical Section.

Testing for environmental purposes (for example Acid Sulfate Soils and Contaminated land) is outside the scope of this document.

8 Storage and retention of soil, groundwater and rock samples

All samples taken during a departmental geotechnical investigation remain the property of the Department of Transport and Main Roads.

At the completion of site work, all soil, groundwater and rock samples should be stored at a location that is weatherproof and provides protection from damage and deterioration, such as from excessive heat, direct sunlight or change in humidity.

All untested soil and water samples should be stored for six months after the completion of the site work, unless otherwise agreed upon with the department's Geotechnical Section.

Soil samples taken for the purposes of environmental testing (for example Acid Sulfate Soils or Contaminated Land), is outside the scope of this document.

Rock core is generally retained until after construction of the project is complete, and it is clear that claims related to the rock are not forthcoming. It is noted that the retention requirements of rock core samples may differ depending on the design elements (for example for foundation locations). Post construction, the core may be disposed of unless it is repossessed by the relevant project authority.

Subject to prior approval of the relevant project authority, as well as the department's Director, Geotechnical Section, rock core may be disposed of prior to project construction if it is determined that the risk of claims related to rock quality issues is sufficiently low, and/or the rock core is degraded and therefore not useful for visual inspection or testing, or possibly other reasons that cause the risk of early core disposal to be low.

In all cases, whether or not early disposal of the core is conducted, all rock core shall be photographed at high resolution and in colour correct light, to provide a permanent record of the core.

9 Geotechnical investigation reporting

All information obtained from the geotechnical investigation should be reported in accordance with AS 1726 and Appendix C (as appropriate) of this guideline.

All Geotechnical Investigation Reports prepared for the department shall be the intellectual property of Transport and Main Roads.

The borehole logs submitted as part of reports may be published outside of the department, such as in Queensland Geotechnical Database (ggd.org.au/), subject to getting approval from the department's Geotechnical Section.

Electronic data files used for the creation of engineering borehole logs and test pit logs shall be submitted to the department's Geotechnical Section at the completion of the investigation. The data files shall be in AGS4 ANZ format or later versions, and as plain text files in CSV format.

All other electronic data files generated from site investigation techniques (such as cone penetrometer tests, other insitu tests, or geophysical surveys) should be submitted to the department's Geotechnical Section at the completion of the investigation.

Appendix A: Scope briefing for geotechnical investigations (template)

This template provides a framework for creating scope briefing documents for geotechnical investigations. It is intended for use by both internal (departmental) personnel and external consultants.

The required elements of a geotechnical investigation scope briefing are outlined herein, including the minimum scope of works, definition of roles and responsibilities and the expected format of deliverables upon completion of the investigation works.

Before commencing the geotechnical investigation, scope briefing document shall be accepted by the department's Geotechnical Section.

A.1 Introduction

The introduction should include, but not necessarily be limited to, a concise description of the project, the parties involved, the purpose of geotechnical investigation work and any background or previous history relevant to the current scope of work.

A.2 Investigation objectives

The scope of the geotechnical investigation to be undertaken should be adequate to meet the following objectives:

- provide sufficient geotechnical information at an appropriate level of detail for the particular stage of the project being undertaken
- describe the geological and engineering characteristics of the identified underlying geology
- define an appropriate and representative geological model for the project
- assess and define geotechnical parameters for the subsurface materials and/or layers identified onsite
- identify known geotechnical risks for which the investigation is targeted, and
- identify and assess other geotechnical constraints and risks to design.

A.3 Roles and responsibilities

The scope brief should include clear definition of the roles, responsibilities, and accountabilities of stakeholders / personnel to be involved in the geotechnical investigation.

A.4 Workflow and processes

A.4.1 Approvals and licencing

A concise overview of required permits, approvals and licences should be provided. This overview should include items relating to land and over water access, utilities, Cultural Heritage and environmental management, Work Health and Safety (WHS), traffic management, navigational permits, and technical instruction, as required.

A.4.2 Site inductions and technical instructions

Procedures for formal site induction, WHS and Environmental Management Plan document sign off, technical instruction and general field briefing should be outlined.

A.5 Scope of geotechnical investigation works

The following items should be included as is appropriate in the minimum scope of works for the geotechnical investigation.

A.5.1 Preliminary site visit

Following the establishment of appropriate entry arrangements and prior to the commencement of any site works, a site walkover should be carried out in consultation with relevant stakeholders. The site walkover should include observations for the following:

- delineation of the site into geomorphological units based on field observations as well as the presence and description of any rock outcrops, boggy ground and so on, and
- identification of new or confirmation of initially identified geotechnical risks for the proposed project such as access, vegetation, overhead power line, other underground utilities.

A.5.2 Preparation of site access for plant and equipment

The requirements and options for the safe preparation of site access for plant and equipment should be clearly documented.

Where clearing of vegetation or preparation of temporary working platforms for plant and equipment is required, the proposed access preparation activities and associated Cultural Heritage, safety, and environmental protection measures should be documented in the Site Safety Management Plan and Environmental Management Plan documents.

For access to waterways, consideration should be given to vessel access by existing boat ramps jetties and ports. Where heavy lifting equipment is required to place vessels onto waterways, provisions for temporary crane platforms and their assessment should be included.

A.5.3 Traffic management

The provision of any Traffic Management Plans and controls required for carrying out investigation activities on site should be in accordance with Technical Specification MRTS02 *Provision for Traffic*.

A risk assessment should be undertaken during the preliminary site visit to identify and address any potential issues or hazards in undertaking site activities working in or adjacent to live traffic.

Where traffic management is required to address on-site risks, the consultant should engage a Transport and Main Roads approved traffic management organisation to develop and implement a Traffic Management Plan.

A.5.4 Working over water

The requirements and options for the safe access and operation of plant and equipment to a marine site or water way should be clearly documented. A process for verification of compliance with the relevant waterway authority procedures and environmental permits should also be documented.

A.5.5 Underground and overhead services

An outline of procedures for the avoidance, detection, and/or reinstatement (if appropriate) of municipal services should be provided.

A.5.6 Proposed investigation techniques, locations, and objectives

The proposed investigation methods (direct and indirect) should be presented in a table with the purpose / design element, test location coordinates, the nominal depth of testing below the ground surface level, any required installations, and test location termination criteria.

A.5.7 Reinstatement and clean-up

Responsibilities and procedures for the following aspects of site reinstatement should be specified:

- offsite disposal of wastewater and drilling residues
- backfilling of excavations to original surface level and condition
- requirements for the removal of temporary works (for example drilling platforms, culverts), and
- assurance that the site is free of debris at completion of investigation.

A.5.8 Survey requirements

The process for locating all test locations and determining their surface levels should be documented. Set out and survey of investigation points should be in accordance with the minimum requirements of the *TMR Surveying Standards* (Parts 1 and 2 and Schedule 1).

A.5.9 Sample handling, storage and retention

All processes for the sample handling, storage and retention of soil, groundwater and rock samples should be documented in the scope brief.

A.5.10 Proposed laboratory testing

A separate tabulated list for proposed soil, groundwater and rock laboratory tests, including their purpose, should be provided to be deemed acceptable by the department.

A.6 Reporting

The requirements of reporting are detailed in Appendix C in this guideline.

A.7 Cost estimate

A schedule of rates and cost estimate for the proposed geotechnical investigative works should be included. For design and construct contracts, the consultant should allocate a lump sum for adequate additional geotechnical investigation in their offer.

A.8 Indicative timeline

An indicative timeline should be provided, showing all investigation related activities and reporting deadlines (not required for design and construct contracts).

Appendix B: Typical departmental requirements for reinstatement of boreholes and test pits

B.1 Boreholes on greenfield sites

At the completion of drilling and any borehole installations that are required, the hole should be grouted, using a slurry of cement and bentonite (generally at a ratio of 4:1). The grout should be placed commencing at the bottom of the hole and continued to the top of the natural ground surface.

Where there is no requirement for the installation of instrumentation in the borehole, the top of the hole shall be capped and sealed to prevent any ingress of water and any future hazard to personnel, fauna, livestock or vehicles. The capping should be constructed flush with the existing ground surface and shall be resistant to settlement over time.

A record of reinstatement (including details of grouting undertaken) should be completed for each borehole location.

B.2 Boreholes on existing roadways

Completed boreholes should be grouted as per requirements detailed for boreholes on greenfield sites. Backfilling and sealing the top section of the borehole within the existing pavement should be undertaken in accordance with the requirements of the asset owner or relevant road authority.

B.3 Boreholes for tunnel investigations

Special care should be taken in the reinstatement of the borehole so that potential water / air movement is prevented at the borehole location during future tunnel excavation works. All specific reinstatement requirements for these boreholes should be explicitly presented in the scope brief and verified by the designer.

As a minimum, all boreholes drilled for investigations for tunnel design and construction should be fully grouted immediately upon their completion. The grout should comprise a slurry of bentonite and cement and should be placed commencing at the bottom of the hole and continued to the top of the natural ground surface.

The top of the hole should then be capped and sealed to prevent any ingress of water and any future hazard to personnel, fauna / livestock or vehicles.

The capping should be constructed flush with the existing ground surface and shall be resistant to settlement over time.

A record of reinstatement should be completed for each borehole location.

B.4 Test pits on greenfield sites

At the completion of a test pit, the spoil removed by excavation should be replaced into the trench in the order of excavation, where possible, in layers no more than 250 mm in thickness. Mechanical compaction should be used for each layer until no observable deformation or deflection occurs in the placed material. In general, tamping of materials with an excavator bucket should be satisfactory to achieve compaction. Test pits should be reinstated to match the natural surface contour. However, for some sites, the use of purpose-built compaction equipment may be required for compaction of layers, depending on the requirements of the land-owner.

Topsoil, where it has been removed, should be reinstated on top of the backfilled trench.

Where the spoil from the test pit is deemed unsuitable for re-use, it should be replaced with clean earth fill materials in accordance with Technical Specification MRTS04 *General Earthworks*.

B.5 Test pits or shallow boring on existing roadways

The reinstatement of test pits on existing roadways should be undertaken in accordance with the requirements of the asset owner or relevant road authority. Table B.5 below provides some guidance on typical reinstatement details that may be used, subject to approval from the asset owner or relevant road authority.

Table B.5 – Typical reinstatement details: trenching or shallow boring on existing pavements

Site condition	Reinstatement requirements
<p>Existing pavement is asphalt on cement treated base or the pavement is on a highway or major arterial road</p>	<ul style="list-style-type: none"> • The excavated pit may be backfilled up to 1 m below existing surface level using only good quality excavated base, sub base and imported granular material. The reinstatement should be machine compacted in 150 mm layers (refer to Technical Specification MRTS04 <i>General Earthworks</i>). <p>Note: Asphalt profiling and any unsuitable excavated material is not to be used and should be removed from site and disposed.</p> <ul style="list-style-type: none"> • Reinstatement from 1 m below existing surface level to 0.2 m below existing level should be backfilled with lean mix concrete (no slump, target 5 MPa), placed and compacted in layers of maximum thickness of 150 mm (refer to Technical Specification MRTS39 <i>Lean Mix Concrete Sub-base for Pavements</i>). • Reinstatement of surfacing from 0.2 m to finished wearing surface level should be hot mix asphalt conforming to AC14 (A15E) asphalt (or similar that is available within proximity). • Prior to placement of asphalt, the surface should be brushed clean of any loose material and finished in a manner which should promote adhesion of the bituminous emulsion to the surface. • Bitumen emulsion tack coat should be applied to the bottom and sides of the trench / auger (refer to Technical Specification MRTS12 <i>Sprayed Bituminous Emulsion Surfacing</i>). • Asphalt should be placed in accordance with Technical Specification MRTS30 <i>Asphalt Pavements</i> and mechanically compacted in 50 mm finished layer thickness. • Joints between the finished reinstated surface and existing road surface should be appropriately sealed.
<p>Existing pavement is asphalt / seal on granular base</p>	<ul style="list-style-type: none"> • The subgrade should be backfilled using only good quality excavated base, sub base and imported granular material. The reinstatement should be machine compacted in 150 mm layers (refer to MRTS04 <i>General Earthworks</i>). <p>Note: If any of the excavated material is not suitable to be compacted, it should be removed from site.</p>

Site condition	Reinstatement requirements
	<ul style="list-style-type: none"> • Reinstatement of the granular base (to 100 mm below existing surface level) should be backfilled with plant mixed type 2.1 cement modified / treated road base (unconfined compressive strength 1.5 MPa in 28 days) and placed in accordance with Technical Specification MRTS10 <i>Plant-Mixed Lightly Bound Pavements</i>. • Reinstatement of surfacing should be a minimum of 100 mm of hot mix asphalt conforming to AC14 (A15E) asphalt (or similar, that is available within proximity) and placed in accordance with MRTS30 <i>Asphalt Pavements</i>. • Prior to placement of asphalt, the surface should be brushed clean of any loose material and finished in a manner which should promote adhesion of the bituminous emulsion to the surface. • Bitumen emulsion tack coat should be applied to the bottom and sides of the trench / auger (refer to MRTS12 <i>Sprayed Bituminous Emulsion Surfacing</i>, Clause 10). • Hot mix asphalt should be placed in accordance with MRTS30 <i>Asphalt Pavements</i> and mechanically compacted in 50 mm finished layer thickness. • Joints between the finished reinstated surface and existing road surface should be appropriately sealed.
150 mm cores in asphalt pavements	<ul style="list-style-type: none"> • Hot mix asphalt should be placed in accordance with Technical Specification MRTS30 <i>Asphalt Pavements</i> and mechanically compacted in 50 mm finished layer thickness. • If CTB is cored, the full depth of cemented tailings backfill should be reinstated with rapid set concrete or similar product before placing the asphalt. • In terms of geotechnical boring, the lower layers below the road pavement should be reinstated following appropriate geotechnical bore reinstatement procedures so that the reinstatement does not settle over time.

Appendix C: Reporting requirements for geotechnical investigations

A Geotechnical Investigation Report (factual and interpretive, where available) should be submitted initially to Transport and Main Roads' Geotechnical Section as a draft for review and comment.

All comments received should be addressed and the report should be resubmitted as final with any agreed modifications.

The final report should be verified by an experienced engineering geologist or geotechnical engineer and then certified by an RPEQ accredited geotechnical engineer.

It is acknowledged that the delivery of the geotechnical investigation may occur through a number of different contractual arrangements. As such, due to various contractual requirements, it may not be possible to submit the interpretative report inclusive with the factual report for some projects. If required, the report may be prepared and submitted separately in two parts:

- Part 1 – Factual Report, and
- Part 2 – Interpretive Report.

The Geotechnical Investigation Report should include the sections and items listed in Table C.1.

Table C.1 – Proposed structure of Geotechnical Investigation Report

Report section	Item
Introduction and background	<ul style="list-style-type: none"> • Investigation scope and objectives. • Existing geotechnical reports. • Proposed development details. • Proposed design elements. • Relevant Desktop Study data / results.
Site description	<ul style="list-style-type: none"> • Topography, vegetation, water courses and so on. • Existing structures / infrastructure and their condition. • References to attached site plan.
Site investigation	<ul style="list-style-type: none"> • Details of all direct and indirect techniques used, including the provider. • Insitu testing performed. • Tabulated test locations. • Reference to test location plans, logs and results. • General arrangement / site plan showing locations of investigation points.
Laboratory testing	<ul style="list-style-type: none"> • Separate sub sections for laboratory testing carried out on soil, rock and groundwater samples. Include all test result certificates for material classification, engineering and chemical analysis.
Geology	<ul style="list-style-type: none"> • Regional geology (published). • Subsurface geology and geological model of the site. • Drawings relevant to the factual subsurface geology (for example, long sections and cross sections along investigated area).

Report section	Item
Surface water and groundwater	<ul style="list-style-type: none"> • General description of any encountered surface water and groundwater, including any measured phreatic surface levels at the time of investigation. • Any sampling and testing undertaken for analysis (for example, aggressivity to steel and concrete).
Geotechnical engineering considerations ¹	<ul style="list-style-type: none"> • General. • Geotechnical model. • Cuttings, (stability and material re-use). • At grade sections. • Embankments. • Suitable foundations for bridges, retaining walls and culverts. • Subgrade evaluations and potential issues. • High risk soil issues (for example, ASS, expansive soil, dispersive soil). • Groundwater issues. • Contaminated land. • Any other element that may pose geotechnical risk to the project.
Construction considerations ¹	<ul style="list-style-type: none"> • Variable geology and unsuitable materials. • Groundwater ingress to open excavations. • Requirements for excavations; IE open excavations; excavation of piled shafts. • Requirements for piling i.e. stability of unsupported cast in place pile excavations, issues for driven piles and pile liners. • Concrete and steel aggressiveness and durability. • Subgrade suitability and treatment options. • Re-use of materials options. • Rippability of materials in cuttings. • PASS/ASS treatment and management options (plan to be developed as a separate document). • Management and treatment options for Expansive or dispersive soils. • Contaminated land management options.
Summary	<ul style="list-style-type: none"> • Provide a concise summary of the investigation findings and recommendations.
Limitations	<ul style="list-style-type: none"> • Statement of intent and limits of use of the provided information.

Note

¹ The items in this section are generally to be considered for interpretive geotechnical reports; however, the items addressed for this section will be dependent on the purpose and scope of the investigation.

