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AUSTROADS TECHNICAL SPECIFICATION ATS 4541

Microtunnelling and Auger Boring

Austroads

Contents

1. Scope

1.1 Austroads Technical Specification ATS 4541 sets out the requirements for the installation of pipes by Microtunnelling or Auger Boring, which are types of trenchless technology that are launched from an excavated pit. The pipes may be for the purpose of moving fluids or gases or for the protection of telecommunications/electrical cables.

1.2 The pipes are typically installed using the following process:

a) excavating a launching pit and receiving pit to enable the placement of the installation equipment at the appropriate level;

b) forming the bore using techniques such as Microtunnelling or Auger Boring;

c) jacking pipe segments (the Casing Pipe) into position behind the boring machine or auger;

d) progressively removing excavated material by a suitable method, such as auger, slurry with pressure, vacuum extraction or conveyors; and

e) where required, inserting a Carrier Pipe inside the Casing Pipe.

1.3 This Specification does not apply to:

a) installation of pipes using horizontal directional drilling (HDD) with drilling fluids (refer to ATS 4540); and

b) construction of large diameter tunnels using a segmental type lining.

2. Referenced Documents

2.1 The following documents are referenced in this Specification:

Australian/New Zealand Standards	
AS 1579	Arc-welded steel pipes and fittings for water and wastewater
AS 1726	Geotechnical site investigations
AS 1741	Vitrified clay pipes and fittings with flexible joints – Sewer quality
AS 3571.1	Plastics piping systems – Glass reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin, Part 1: Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)
AS 4100	Steel structures
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)
AS/NZS 5131	Structural steelwork – Fabrication and erection
Austroads	
AP-C87	Austroads Glossary of Terms
ATS-1140	Environmental Management Systems
ATS-1330	Management of Utilities on Site
ATS-2135	Management of Acid Sulfate Soils
ATS-4540	Horizontal Directional Drilling
ATS-5316	Cementitious Mortar and Grout
American Society of Civil Engineers	
ASCE/CI 36	Standard design and construction guidelines for microtunneling

International Standards	
ISO 25780	Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage – Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin – Pipes with flexible joints intended to be installed using jacking techniques
EN14636-1	Plastics piping systems for non-pressure drainage and sewerage –Polyester resin concrete (PRC), Part 1: Pipes and fittings with flexible joints

3. Definitions

3.1 In addition to the definitions in Austroads Glossary of Terms (AP-C87), the following definitions apply to this Specification.

Auger Boring (or 'Thrust Boring'): A trenchless construction methodology that involves the use of rotating augers to bore into the ground and remove the excavated spoil while simultaneously jacking a Casing Pipe into position behind the auger.

Carrier Pipe (or 'Product Pipe'): A permanent pipe or conduit carrying fluids, gases or telecommunications/electrical cables. A Carrier Pipe may be installed inside a Casing Pipe or directly into the borehole.

Casing Pipe (or 'Enveloper Pipe'): A temporary or permanent pipe that provides support to the excavated bore. It protects a Carrier Pipe from external loads or installation damage and may also provide a larger bore for future upgrades. In some circumstances, a Casing Pipe may also function as a Carrier Pipe.

Design Documentation: The drawings, schedules, calculations and any other documentation, designated as such, required for the construction of the Microtunnelling or Auger Boring.

Existing Infrastructure: Includes existing buildings, utilities and other structures, whether owned by the Principal or by others.

Inner Annular Space: The space between the Casing Pipe and the Carrier Pipe.

Microtunnelling: A trenchless construction methodology with 4 key attributes[1]:

a) remote control is used in operating the Microtunnelling boring machine;

b) a guidance system is used;

c) pipe jacking is used to install pipelines; and

d) continuous pressure is exerted at the excavation face to balance groundwater and earth pressures.

Outer Annulus Space: The space between the bore hole and the installed Casing Pipe.

[1] From ASCE/CI 36.

Professional Engineer:

A person who:

a) is registered on any scheme of registration of engineers prescribed by legislation in the applicable jurisdiction;

b) is appropriately registered or prequalified if the Principal has implemented an applicable registration or prequalification scheme; and

c) satisfies at least one of the following requirements:

i) is a Chartered Professional Engineer; or

ii) holds a 4-year civil engineering degree from a university that is accredited under the Washington Accord and is registered in a relevant area of practice on the National Engineering Register (in Australia) or the Register of Chartered Professional Engineers (in New Zealand)

4. Quality System Requirements

4.1 The Contractor must prepare and implement a Quality Plan that includes the documentation in Table 4.1.

Table 4.1: Quality Plan

Clause	Description of document
5.1	Qualifications and experience of key personnel
6.1	Risk Management Plan and Emergency Response Management Plan
9.6	Construction details, procedures and Inspection and Test Plans
11.2	Monitoring Plan

HOLD POINT 1	
Process Held	Commencement of excavation, Microtunnelling or Auger Boring operations
Submission Details	The Quality Plan must be provided to the Principal at least 10 working days prior to the commencement of work on site.

5. Personnel

5.1 The Quality Plan must include details of the qualifications and experience of the Supervisor and all other key personnel, including all welders.

5.2 The Supervisor must:

a) have at least 5 years of experience in the relevant trenchless technology;

b) be on site at all times when boring operations are in progress; and

c) have the authority to ensure that boring operations are undertaken safely and in accordance with this Specification.

5.3 The Contractor must ensure that all personnel engaged for the delivery of the works are suitably trained and experienced with current licences and qualifications where required.

6. Project Preliminaries

Construction Risk Management

6.1 The Contractor must prepare a Risk Management Plan for the management of the key construction risks. The Risk Management Plan must address risk assessment (identification, analysis, and evaluation) and risk treatment (such as equipment and materials on standby). The Risk Management Plan must be submitted to the Principal with the Quality Plan and as a minimum, must address the following risks:

a) site establishment, access, and traffic control;

b) flooding of the work site or high water inflows during boring;

c) major mechanical failure, including temporary site closure with partial excavations/partial boring;

d) encountering unforeseen obstructions (including live underground services) or geotechnical conditions;

e) higher jacking forces than expected;

f) damage to Existing Infrastructure;

g) excessive immediate and/or long-term settlement or heave at the ground surface;

h) excessive ground loss during boring;

i) rapid slurry pressure rises, potentially causing upheave, localised fissures and slurry leakages;

j) stability of entry and exit pits, particularly if situated closer to road infrastructure or embankments;

k) site contamination by drilling fluid; and

l) differential settlements arising from skewed micro tunnel.

6.2 The Risk Management Plan must cross reference the Work Health and Safety Management Plan to address safety matters such as working at heights, working in confined spaces and management of safety incidents.

6.3 An Emergency Response Management Plan must be attached to, or cross referenced by, the Risk Management Plan. The Emergency Response Management Plan must address a major failure of the Microtunnelling or Auger Boring that may adversely affecting the safety of traffic and/or pedestrians or may damage property, including:

a) names and contact details of the Contractor’s responsible personnel; and

b) measures to comply with the Principal’s requirements and procedures for reporting incidents affecting live traffic to the appropriate traffic/transport management centre.

Environmental Management

6.4 The Contractor must ensure that all environmental aspects of the work are managed in accordance with the Environmental Management Plan (refer to ATS 1140). This includes management of environmental aspects (such as impacts on water courses/flow paths, vegetation, contaminated land, pest species and groundwater) and the management of environmental incidents (such as a hydrocarbon spill).

6.5 The Environmental Management Plan must include a comprehensive response plan to address a spill of drilling fluid. This may include temporary berms or trenches, coupled synthetic hydraulic barriers or additional fluid tanks.

6.6 If specified in the Contract documents, prior to undertaking any works onsite, the Contractor must undertake an investigation to identify the possible presence of acid sulfate soils (refer to ATS 2135). If acid sulfate soils are identified, the requirements specified in ATS 2135 must be implemented.

7. Design

General

7.1 The Contractor must ensure that the pipe is designed to achieve the structural and serviceability requirements of this Specification and the Contract documents. Temporary loading and permanent loading must be considered in the design process.

7.2 The person(s) undertaking the design must be a Professional Engineer with suitable experience that is relevant to the design of Microtunnelling and/or Auger Boring systems.

7.3 The design process must verify that the pipe is suitable for installation by jacking without being damaged and that the jacking forces do not exceed the structural capacity of the pipe. If precast concrete pipes are used, the pipes must be Load Class 4 to AS/NZS 4058 or higher.

7.4 The design must take account of all potential impacts on all Existing Infrastructure and vegetation and mitigate those impacts to the extent practicable. This includes impacts from ground movement, clearance to Existing Infrastructure, settlement/heave and any changes in the groundwater table resulting from the works, either temporarily during construction or permanent.

7.5 The Design Documentation must include a through settlement analysis that demonstrates that the predicted deformations comply with the requirements of Clause 10.4, along the bore alignment and transverse direction. The Microtunnelling technique, equipment adopted and their performance in the anticipated ground conditions must be considered in the settlement analysis.

7.6 Any standard design details or historic ‘as-constructed’ information provided by the Principal cannot be relied upon in the design of the Works, unless specified otherwise in the Contract documents.

7.7 All excavations must be of the minimum possible size commensurate with operating the equipment and safe working practices. The design of temporary work must include shoring or bracing of excavations in accordance with the applicable Work Health and Safety regulations. Where shoring is used, the Contractor must submit a certificate from a Professional Engineer to the Principal verifying that the design complies with the applicable Work Health and Safety regulations.

Utility Location

7.8 Unless specified otherwise in the Contract documents, prior to commencing Microtunnelling or Auger Boring operations, the Contractor must undertake an investigation to locate existing utilities on the Site in accordance with ATS 1330.

7.9 The Contractor must ensure that the position of all utilities in the proximity of the Works has been verified in accordance with ATS 1330 and any necessary protective measures have been implemented.

7.10 If an unknown utility is encountered during the installation process, the requirements of ATS 1330 will apply.

7.11 The distance between the bore and any existing utility must comply with the requirements of the owner of the utility.

7.12 The Design Documentation (refer to Clause 7.25) must include:

a) evidence that the location of all underground utilities within the work area have been verified;

b) any relevant permits and approvals required by utility owners; and

c) any other permit or approval specified in the Contract documents, such as approval to enter private property.

Geotechnical Investigation

7.13 If the Principal has provided a geotechnical investigation, the Contractor:

a) must review that investigation and verify that the scope of the investigation is suitable for the Microtunnelling or Auger Boring operations; and

b) unless specified otherwise in the Contract documents, undertake any additional investigation that it considers necessary in accordance with Clause 7.16.

7.14 If the Principal has not provided a geotechnical investigation, the Contractor is responsible for undertaking a suitable geotechnical investigation in accordance with Clause 7.16.

7.15 Where the Contractor proposes to carry out a geotechnical investigation, the Contractor must submit details of the proposed investigation to the Principal, including number, location and other details of the boreholes and details of the proposed field and laboratory testing. This does not apply to any investigation and testing carried on private land or outside of the road corridor.

HOLD POINT 2 (WHERE APPLICABLE)	
Process Held	Geotechnical investigation
Submission Details	Details of the proposed geotechnical investigation must be submitted to the Principal at least 5 working days prior to the commencement of the investigation.

7.16 A geotechnical investigation must comply with the following:

a) The investigation must be undertaken in accordance with AS 1726, including field and laboratory tests.

b) As a minimum, boreholes must be drilled at the entry and exit locations and at intervals not exceeding 30 m.

c) Boreholes or test pits must be at least 2 m below the proposed invert level of the lowest point of the crossing. Where crossing a dual carriageway, a borehole must be drilled at approximately the mid-point of the crossing.

Existing Infrastructure and Dilapidation Reports

7.17 Where a bore or an associated excavation will be constructed in the immediate vicinity of Existing Infrastructure, the design process must determine the minimum permissible distance from the Existing Infrastructure, taking into account any requirement specified by the owner of the Existing Infrastructure. This applies to infrastructure owned by the Principal and to infrastructure owned by others.

7.18 Unless approved otherwise by the Principal, the bore must not pass directly under a foundation or within the zone of influence of a foundation.

7.19 Where Existing Infrastructure may be adversely affected by the work, the Contractor must ensure that a dilapidation assessment of that infrastructure is undertaken and a Dilapidation Report is prepared. This applies to any Existing Infrastructure within the settlement trough or zone of influence as defined by the prediction of ground settlement. The Principal must be given the opportunity to be present during all inspections for dilapidation assessment.

WITNESS POINT 1	
Process	Inspection for dilapidation assessment
Notification Period	At least 2 working days before the inspection.

7.20 Each Dilapidation Report must photographically record the condition of all aspects of the natural and built environment associated with the Existing Infrastructure, including the building interior and exterior, utilities, roadways and landscaping. The dilapidation report must include the following, as a minimum:

a) details of each defect;

b) dimensions of cracks (width, length, depth);

c) photos of each defect with labels showing locations; and

d) signs of depressions, humps, seepage or slippage.

7.21 Dilapidation assessments must be undertaken at the pre-construction and post-construction stages and certified by a suitably experienced Professional Engineer. While the work is in progress, additional inspections may be required to determine whether the construction work is causing damage to the Existing Infrastructure. The pre-construction Dilapidation Report must be submitted to the Principal with the Design Documentation (refer to Clause 7.25). The post-construction Dilapidation Report must be completed within 20 working days of the completion of boring, or earlier if directed by the Principal).

Grouting of the Inner Annulus Space

7.22 Where a Carrier Pipe is to be installed inside a Casing Pipe, the Inner Annulus Space must be grouted unless all of the following conditions are met and the Principal has approved the omission of the grout:

a) the Casing Pipe is designed to provide permanent ground support for entire design life, but not less than 100 years;

b) the Casing Pipe is free draining and will have a minimum grade exceeding 1:200 at all locations for the entire design life;

c) the Casing Pipe does not alter the existing flow path of ground water;

d) the Casing Pipe is either suitably sealed at each end to prevent unauthorised access or is filled with sand; and

e) failure of the Carrier Pipe will not cause any damage to the roadway or adjacent embankment.

Alignment

7.23 Unless specified otherwise in the Contract documents, the bore must pass under roads (including shoulders) in a straight line and within 5° of perpendicular to the road centreline.

Minimum Depth Below Roads

7.24 The required cover for a bore within a road corridor must be determined during the design process. The minimum cover, measured from the top of the formation, must be greater than:

a) any requirements specified by the relevant utility owner (where applicable); and

b) the minimum cover specified in the Contract documents or, if nothing is specified, 4 times the outer diameter of the pipe and 1.2 m, whichever is greater.

Design Documentation

7.25 As a minimum, the Contractor must prepare the following Design Documentation.

a) Calculations and/or details for:

i) temporary works, including the pit excavation support, crane pads and access roads or laydown areas;

ii) thrust force reaction structures, jacking pipe thrust capacity and anticipated thrust loads;

iii) unrelieved hydrostatic pressures, bottom heave;

iv) deflection of the jacking pipe;

v) predicted ground deformation (settlement and heave); and

vi) determination of maximum permissible surface deformation (if not specified in the Contract documents).

b) Drawings meeting the requirements of Table 7.26.

c) Geotechnical investigation, including all site investigation results with field/laboratory test results, deformation analysis results and recommendation (refer to Clause 7.15).

d) Where appropriate:

i) an impact assessment discussing the effects on existing utilities (including the details listed in Clause 7.12) and any other Existing Infrastructure that may be affected by the work;

ii) any other approvals required for performing the work (such as an approval to enter private property);

iii) Dilapidation Reports (refer to Clause 7.19); and

iv) Monitoring Plan (refer to Clause 11.2).

7.26 Drawings prepared by the Contractor must comply with the requirements in Table 7.26 and must be certified by a Professional Engineer with at least 3 years of experience which is relevant to the design of Microtunnelling or Auger Boring.

Table 7.26: Design drawing requirements

Drawing description	Drawing detail	Information to be shown
Alignment and profile	Plan and longitudinal section	• Planned alignment and key dimensions of the bore, including length, depth below the existing surface and proximity to any Existing Infrastructure. • Minimum permissible depth below the existing surface and clearance to any Existing Infrastructure. • Position of geotechnical investigation boreholes and geological strata determined from the investigation. • Ground water table.
General arrangement	Cross sections	• Dimensions including excavation diameter, outer / inner diameter of the Casing Pipe and outer / inner diameter of the Carrier Pipe. • Where applicable, geological strata determined from the investigation. • predicted surface deformation contour plots (where appropriate). • Details of boring and jacking pipe, including joints.
Site layout	Plan	• All Existing Infrastructure, roads, paths and vegetation. • Details of any impacts on natural watercourses, table drains, drainage structures and overland flow paths. • Any vegetation or Existing Infrastructure to be protected, removed and/or relocated. • Where applicable, location of any Existing Infrastructure to be monitored.
Pit construction and layout	Plan and longitudinal section (cross sections if appropriate)	• All structural details, including thrust blocks and construction staging plans. • Details of access/egress, groundwater control, rainfall/runoff management and any impact on Existing Infrastructure. • Entry/exit pit shoring details, if applicable. • Pit backfilling details, including material, compaction and testing.

Submission of Design Documentation to the Principal

7.27 All Design Documentation must be submitted to the Principal prior to the commencement of pit excavation and boring operations. The Design Documentation must be accompanied by a statement from a Professional Engineer certifying that the design complies with this Specification. The Professional Engineer must have at least 3 years of experience relevant to the design of Microtunnelling or Auger Boring.

HOLD POINT 3	
Process Held	Commencement of excavation, Microtunnelling or Auger Boring operations
Submission Details	All design documentation and the certification of compliance must be submitted to the Principal at least 10 working days prior to the commencement of pit excavation and boring operations.

8. Materials

Pipes

8.1 Unless the pipe material is specified in the Contract documents, the Contractor must determine the appropriate pipe material that will fulfil the engineering functionality of the bore. The pipe materials must comply with the respective standards/specifications listed in Table 8.1.

Table 8.1: Pipe materials

Material	Standard/Specification
Concrete	AS/NZS 4058
Glass reinforced polymer (GRP)	AS 3571.1 or ISO 25780
Polyester resin concrete (PRC)	EN14636-1
Steel	The standards listed in Clause 2.2 of AS 4100 or AS 1579 (for arc-welded pipes)
Vitrified Clay	AS 357.1

Certification of Material Conformance

8.2 At least 5 working days prior to the commencement of the Microtunnelling or Auger Boring, the Contractor must submit a signed statement certifying that the materials used for permanent work comply with the requirements of this Specification. The certificate must be accompanied by certificates of conformance from each supplier of materials.

HOLD POINT 4	
Process Held	Commencement of Microtunnelling or Auger Boring
Submission Details	The compliance certificates for the materials must be provided to the Principal at least 5 working days prior to the commencement of installation.

9. Construction

General

9.1 The Contractor must construct the Microtunnelling and Auger Boring in accordance with the approved Design Documentation and approved Quality Plan. If the Contractor proposes to construct the Microtunnelling and Auger Boring at variance to the approved Design Documentation, amended Design Documentation must be submitted to the Principal and Hold Point 2 Clause 7.27) will reapply.

9.2 Materials used in the permanent installation must not be damaged at any stage during transportation, handling, fabrication or installation.

9.3 Pedestrians and vehicles must be protected from the Site in accordance with the Traffic Management Plan and Work Health and Safety Plan and the worksite must be protected from entry by unauthorised personnel. This includes the provision of temporary fencing, barricades, warning signs and hazard lights were appropriate.

9.4 All equipment must be suitable for carrying out the Microtunnelling and Auger Boring in accordance with this Specification and it must be maintained in accordance with the manufacturer's instructions.

9.5 Any welding or fabrication of a steel pipe must be carried out in accordance with AS/NZS 5131.

Quality Plan

9.6 The Quality Plan must include details, procedures and Inspection and Test Plans which address the following, at a minimum:

a) site establishment;

b) construction of access road and working platforms, where permitted in the Contract documents;

c) equipment and tooling selection, equipment details, size, capacity and if requested, maintenance records;

d) methodology for pit construction and confined space entry;

e) methodology for lifting of equipment and pipes;

f) the proposed drilling methods, including the method of monitoring and controlling the position of the bore;

g) methodology for the selection of equipment operating parameters (including thrust and rotation speed), control of face pressure, ground loss monitoring, spoil removal and steering;

h) welding/jointing of pipes, including the manufacturer's instruction for welding/jointing;

i) removal of spoil;

j) monitoring of the bore alignment and remedial measures in the event that the bore is outside the specified tolerances;

k) management of the interception of contaminated materials;

l) methodology for predicting and monitoring unexpected latent geotechnical conditions and mitigation measures;

m) for Microtunnelling, methodology for the operation of a steering system alignment;

n) use of drilling fluids, lubricants, cementitious grouts or other consumables, including relevant environmental and disposal information;

o) annulus grouting, including re-grouting in the event of incomplete penetration of the grout;

p) demobilisation of the equipment;

q) reinstatement of the site following completion of the work (where applicable); and

r) reporting and auditing schedule.

Overcut Allowance

9.7 Overcut (the distance between the outside of the jacking pipe and excavated ground) must be minimised. The overcut must not exceed 30 mm, or more than 2% of the pipes outside diameter, whichever is the smaller.

Monitoring of the Position of the Bore

9.8 Where Microtunnelling is used to construct the bore, the tunnelling machine must be constantly monitored during operations to ensure the design alignment is achieved.

9.9 The Contractor must ensure a suitable guidance system is used, which may include one or more of the following systems: laser target, GPS, theodolite and/or gyroscope.

9.10 For any Microtunnel bore greater than 100 m in length, a survey must be undertaken at the midpoint of the bore. The survey must address accuracy of the control points used for guidance of the equipment and verify that the bore has been constructed within the specified tolerances.

Grouting of the Outer Annulus Space

9.11 If grouting of the Outer Annulus Space is specified in the Design Documentation, the Outer Annulus Space must be fully grouted to ensure that there is uniform contact between the Casing Pipe and the excavated ground and to prevent the surrounding ground settling over time to fill the void. If nothing is specified in the Design Documentation, the Outer Annulus Space must not be filled with grout.

9.12 Grout must comply with ATS 5316 and obtain a minimum strength of 1MPa at 48 hrs.

9.13 The grout must be pumped into the Outer Annulus Space until all of the following conditions are met:

a) the pumped grout volume equals the theoretical annulus volume between grout ports, allowing for any over excavation identified during boring;

b) the pumped grout pressure exceeds the theoretical hydrostatic ground pressure plus 25 kPa; and

c) the pumped grout is visible at the next inbye open crown (or upper) grout port, or for short tunnels grouted from one end only, at the opposite end of the bore.

9.14 If it is feasible for a person to safely access the inside of a Microtunnel, a secondary inspection process must be undertaken to verify that grout surrounds the pipe. To carry out the inspection, selected crown (or upper) grout ports are to be opened and inspected for grout with a screwdriver. If requested, the inspection must be undertaken in the presence of the Principal. If the annulus is not fully grouted, the Contractor must re-grout the annulus. All inspection holds must be fill with cementitious mortar complying with ATS 5316.

WITNESS POINT 2	
Process	Checking of grout ports to verify that the grout surrounds the pipe
Notification Period	At least 2 working days before the inspection.

Grouting of the Inner Annulus Space

9.15 If grouting of the Inner Annulus Space is specified in the Design Documentation, the Inner Annulus Space between the Casing Pipe and Carrier Pipe must be completely filled with a cementitious grout complying with ATS 5316. If nothing is specified in the Design Documentation, the Inner Annulus Space must not be filled with grout.

9.16 Unless approved otherwise, before commencing grouting, one end of the pipe must be blocked temporarily to prevent leaking out of grout. The grouting tube must be inserted into the annulus so that its outlet is at the blocked end of the pipe. The tube must then be gradually withdrawn while grouting is underway to ensure complete and uniform grouting of the drilling annulus.

10. Conformity

Construction Tolerances

10.1 The location of the bore must be checked and recorded daily at least 2 locations per installed pipe and the position recorded against the design position in a field report. This information must be submitted to the Principal on a daily basis unless directed otherwise by the Principal.

10.2 Unless specified otherwise, the deviation between the actual position of the bore and the approved design alignment must not exceed the tolerances specified in Table 10.2.

Table 10.2: Construction tolerances

Attribute	Tolerance
Horizontal position	± 50 mm
Microtunnel grade	± 0.25%
Vertical position	± 30 mm

10.3 If 2 or more consecutive readings show that the alignment of the bore is outside of the tolerances specified in Table 10.2, the Microtunnelling or Auger Boring must stop immediately and remedial action taken in accordance with the Quality Plan.

HOLD POINT 5	
Process Held	Remedial action if the bore is outside of the permissible tolerances
Submission Details	Details of the proposed remedial action must be submitted to the Principal prior to the implementation of the remedial action.

Settlement and Heave

10.4 Unless specified otherwise in the Contract documents, the deformation at the ground surface in the vicinity of the work must not exceed the maximum permissible deformation specified in Table 10.4.

Table 10.4: Permissible deformation

Attribute	Permissible deformations
Surface movement (either up or down)	• 5 mm over any 2 m in length along the longitudinal and transverse directions beneath existing services and roads. • 10 mm beneath undeveloped land.
Differential settlement	• 5 mm over any 2 m in length.

11. Instrumentation and Monitoring of Ground Deformation

11.1 The Contractor must ensure that geotechnical instrumentation and monitoring of the work is undertaken in accordance with this Clause 11, if:

a) the potential exists for Existing Infrastructure to be adversely affected by the work; or

b) monitoring is specified in the Contract documents.

11.2 Where geotechnical instrumentation and monitoring is required, the Contractor must prepare and implement a Monitoring Plan and submit it to the Principal at Hold Point 2 (Clause 7.27) with the Design Documentation. The Monitoring Plan must include:

a) the proposed monitoring methodology;

b) details of the instrumentation;

c) the frequency of monitoring;

d) details of post construction monitoring (where applicable) and decommissioning;

e) details of the reporting to the Principal;

f) intervention levels (warning and alarm); and

g) nomination of responsible personnel to supervise any intervention necessary.

11.3 A baseline survey must be performed prior to commencement of the boring operations and submitted to the Principal with the Monitoring Plan. Any Existing Infrastructures within 20 m on either side of the alignment must be monitored.

11.4 Ground deformation must be monitored by survey or other techniques approved by the Principal. Sufficient monitoring points must be provided to produce deformation contours along the alignment of the bore for a minimum distance of 10 m on either side of the alignment. Monitoring over carriageways must consider survey markers at the edges of the shoulder points, edges of the pavements, each line marking, and otherwise at 3 m intervals along the bore centreline.

11.5 During drilling activities, survey must be performed daily, until the zone of active excavation has passed and no further movement is detected. If necessary, action in accordance with Table 11.5 must be implemented.

Table 11.5: Notification and intervention levels

Description	Definition	Action
No action	Actual deformation < 80% of the maximum permissible surface deformation.	No action required.
Notification	Actual deformation ≥ 80% but < 100%, of the maximum permissible surface deformation.	• The Principal must be notified within 24 hours. • The responsible personnel nominated in the Monitoring Plan must be notified within 24 hours and placed on standby. • The frequency of monitoring must be increased.
Intervention	Actual deformation ≥ the maximum permissible surface deformation.	• The Principal and responsible person(s) must be notified immediately. • Work must stop until corrective/preventative action is implemented. • The Emergency Response Plan must be implemented if appropriate.

11.6 Monitoring must continue for the longer of the following periods:

a) any period specified in the Contract documents; and

b) the monitoring shows that the deformation has stabilised and is not continuing.

11.7 If the deformation has not stabilised and is continuing, the Contractor must investigate the cause of the deformation, calculate the projected future deformation and implement mitigation measures, subject to the prior approval of the Principal.

11.8 The Contractor bears all costs incurred as a consequence of the deformation caused by the boring exceeding the maximum permissible surface deformation, including the repair of pavement and any other Existing Infrastructure.

12. Completion of the Work

General

12.1 Unless specified otherwise in the Contract documents:

a) where the ground surface level has been changed as a result of undertaking the boring work, the area must be returned to the ground surface level that existed prior to the work commencing;

b) all areas disturbed by the work must be reinstated to a condition which is comparable to the condition immediately prior to the commencement of boring operations;

c) backfilling, where required, must comply with all requirements specified in the Design Documentation; and

d) all waste and excess spoil must be removed from site upon completion of the works and disposed of in accordance with the relevant regulations and the Environmental Management Plan.

12.2 If the post-construction dilapidation report identifies that the work has caused damage to Existing Infrastructure, the Contractor must rectify that damage and the Existing Infrastructure must be restored to the condition existing prior to the commencement of the work. At the completion of the rectification work, a further dilapidation report must be prepared and submitted to the Principal.

Records

12.3 No later than 10 working days after of the completion of the boring work, the Contractor must submit a Completion Report to the Principal in relation to each bore. The Completion Report must include:

a) all construction records, including steering records where Microtunnelling is used;

b) ‘as constructed’ survey record of the completed bore,

c) grouting records (where carried out);

d) ground deformation monitoring records; and

e) records, including compaction test results, of the backfilling of entry/exit pits.

12.4 Where ground deformation monitoring continues after the completion of boring (refer to Clause 11.6) the readings must be submitted to the Principal every 28 days (or such other period directed by the Principal) until no further movement is recorded.

12.5 Within 20 working days of the completion of boring, the post-construction dilapidation report (where applicable) must be submitted to the Principal.

12.6 If the post-construction dilapidation report identifies that the work has caused damage to Existing Infrastructure, a follow-up Dilapidation Report must be submitted to the Principal demonstrating that the Existing Infrastructure has been restored in accordance with Clause 12.2.

Annexure A Summary of Hold Points, Witness Points and Records

The following is a summary of the Witness Points/Hold Points that apply to this Specification and the Records that the Contractor must submit to the Principal to demonstrate compliance with this Specification.

CLAUSE	HOLD POINT	WITNESS POINT	RECORD
4.1	1. Commencement of excavation, Microtunnelling or Auger Boring operations		Quality Plan
7.15	2. Geotechnical investigation		Details of proposed investigation
7.19		1. Inspection for dilapidation assessment	
7.27	3. Commencement of excavation, Microtunnelling or Auger Boring operations		Design documentation
8.2	4. Commencement of Microtunnelling or Auger Boring		Compliance certificates for the materials
9.14		2. Checking of grout ports to verify that the grout surrounds the pipe	
10.1			Field report of construction tolerances
10.3	5. Remedial action if the bore is outside of the permissible tolerances		Details of the proposed remedial action
12.3			As constructed records

Amendment Record

Edition no.	Clauses amended	Action	Date
1.0	New specification	New	August 2025
1.1	11.5 – Removal of word ‘critical’ from drilling activities. Change in table number to 11.5.	Substitution	November 2025
1.2	Minor amendments to Table 10.2 units of vertical position and cross-referenced ATS numbering.	Substitution	February 2026

Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed