Technical Specification

Transport and Main Roads Specification MRTS142 Thrust Boring and Auger Boring

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Queensland Government

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Contents

1 Introduction

This Technical Specification applies to the installation of pipelines, public utilities and plant underground structures using thrust boring or auger boring. Thrust or auger boring is typically performed by placing an auger equipped with a cutting head, with a steel pipe as a casing to facilitate trenchless excavation. The auger is then attached to the rotation shaft of a thrust boring machine to advance excavation and the steel pipe is jacked progressively.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements*, TN163 *Third Party Utility Infrastructure Installation in State Controlled Roads Technical Guidelines*, and other Technical Specifications and standards as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specification Manual.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*. Additional terms used in this Technical Specification shall be as defined in Table 2.

Table 2 – Definition of terms

Term	Definition
acid sulfate soils	Materials which contain iron sulfides in concentrations which have the potential to produce acidic conditions in the earthworks if left untreated. Acid sulfate soils shall include all materials which are actual acid sulfate soils or potential acid sulfate soils.
annular space	The outer annular space between the thrust bore hole and the casing pipe installed. The inner annular space is the space between the casing pipe and the carrier pipe.
backfill	Material placed in confined excavations for culverts, structures, conduits, pits, etc. or, in some instances, to fill excavations of Unsuitable Material.
carrier Pipe	The inner pipe forming part of the permanent pipeline, installed within the casing pipe.
Casing / sleeve Pipe	Pipe installed by jacking behind the auger boring machine.
confined excavation	An excavation for a culvert, pipe or conduit trench or for a structure, which requires the use of an excavator or similar machine fitted with a bucket. If the excavation is of sufficient size that would allow the operation of a crawler tractor of Class 150C or larger, as determined in accordance with the provisions of Table 10.1 of AS 2868 is not classed as a confined excavation.
contingency plan	A plan to mitigate the risk of an activity. The plan usually allows for backup procedures, emergency response, and post-disaster recovery.
entry & exit seal	Seals which are formed around the boring entry and exit pits / shafts to prevent pressurised ground and water rushing into the pits / shafts.
launch pit or shaft	An excavation at the commencement point of a thrust section of pipeline, in which the thrusting structure and other equipment is installed and from which the thrusting operations are carried out.
lift (shaft / pit)	The incremental construction height completed as the shaft / pit progresses downward.

Term	Definition
reception / retrieval pit / shaft	An excavation that is located at the end of a thrust boring section of pipeline
sand	Natural or manufactured material with 100% passing 6.7 mm AS sieve and a low plasticity index.
select backfill material	Backfill comprising gravel and/or loam materials with specified properties used for backfilling to trenches and structures.
spoil	Material removed in the course of an excavation or drilling process. Material surplus to the Contract requirements which shall be disposed of on or off the Site.
thrust boring	Thrust boring is a jack and bore drilling method
thrust wall	A wall constructed normal to the proposed line of thrust designed to dissipate the reaction to the thrust into the surrounding ground.
top soil	The top layer of existing soil on the Site which supports vegetation
unsuitable material	All materials identified as unsuitable for use as foundation for earthworks or structures and / or for use as fill or backfill materials

3 Reference documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1554	Structural Steel Welding
AS 1726	Geotechnical Investigations
AS 2868	Confined Spaces
AS 4100	Steel Structures
AS 4058	Precast Concrete Pipes
MRTS01	*Introduction to Technical Specifications*
MRTS03	*Drainage, Retaining Structures and Protective Treatments*
MRTS04	*General Earthworks*
MRTS16	*General Requirements Landscape and Revegetation Works*
MRTS25	*Steel Reinforced Precast Concrete Pipes*
MRTS50	*Specific Quality System Requirements*
MRTS63	*Cast-In-Place Piles*
MRTS70	*Concrete*
MRTS78	*Fabrication of Structural Steelwork*
MRTS91	*Conduits and Pits*
MUTCD	Queensland *Manual of Uniform Traffic Control Devices*
Standard Drawing 1178	Diversion of Water – Diversion of Water from Roadway and Table Drains
TN163	*Third Party Infrastructure Installation in State Controlled Roads Technical Guidelines*

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are detailed in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 4.1.

Table 4.1 – Hold Points, Witness Point and Milestones

Clause	Hold Point	Witness Point	Milestone
4.2	1. Acceptance of construction procedures by the Administrator		
5	2. Acceptance of traffic control by the Administrator 3. Acceptance of offset distance from road edge / footpath by the Administrator		
6.1	4. Acceptance of Approvals to undertake proposed work by the Administrator		
6.2	5. Acceptance of design requirements by the Administrator		
6.2.7	6. Acceptance of ground monitoring procedures by the Administrator		
6.3			Submission of construction procedures
6.4	7. Acceptance of construction risk and mitigation plan by the Administrator		
8.2	8. Acceptance of existing utilities location by the Administrator		
8.6	9. Acceptance of annulus grouting procedure by the Administrator 10. Acceptance of carrier pipe grouting procedure by the Administrator		
8.8	11. Acceptance of monitoring results by the Administrator		
9	12. Acceptance of alignment tolerances by the Administrator	1. Daily as built record	
10.1			Submission of as construction records

4.2 Construction procedures

The Contractor shall prepare documented procedures for all construction processes in accordance with construction procedures of MRTS50 *Specific Quality System Requirements*.

Those construction procedures which are required to be prepared by the Contractor in accordance with the quality system requirements and construction procedures of MRTS50 are listed in Table 4.2. **Hold Point 1**

Table 4.2 – Construction Procedure

Clause	Procedure
6.3, 8.9	Acid Sulfate Soil Management Plan
5	Spoil Disposal Plan
5, 6.3	Survey set out and alignment control procedure
5, 6.2.4, 8.5, 8.8	Surveying
5	Dewatering
5, 6.2.1, 6.2.5	Pit depth and off-set distance
6.2	Auger Boring and Thrust Boring Machine Selection and Operation
6.2.1	Shoring
6.3	Welding Procedure
6.4	Risk Assessment
8.6	Grouting procedures
8.8	Monitoring of ground movement
8.10	Restoration of site

5 Thrust boring and auger boring – Method statement

When carrying out trenchless excavation using thrust / auger boring method the contractor should undertake all preparatory measures including:

- Setting out thrust and receiving pits as per approved Standard Drawings ensuring that the location is free of obstruction and services. These pits are required on either side of the work area to accommodate the steel pipe and machinery used in the procedure.
- Appropriate barricades including warning signs and taps are established in place, to ensure the safety of the operating traffic, pedestrians and observers are taken in to consideration prior to commencement of excavation and approved by the Administrator. **Hold Point 2**
- Thrust and receiving pits shall be excavated as per relevant approved Standard Drawings. Measures shall be in place to ensure that trench is free of water all times during the operations. Further to prevent potential flooding of the trench following cloudburst suitable dewatering pump shall be ready and on standby at all times, during the operations, if found necessary.
- Thrust and receiving pit excavations are generally 3 m away from the edge of the road asphalt or 2 m from the edge of the footpath. Based on the subsoil condition and prevailing surface loading, the setback distance of the pits shall be established to ensure adequate short-term factor of safety and submitted to the Administrator's approval. **Hold Point 3**

- Thrust pit shall be levelled and compacted to provide a suitable working platform for the guiding tracks for proper alignment and level fixing at the required depth. A suitable concrete thrust blocks shall be firmly fixed in the excavated trench.
- Thrust boring machine shall be installed in driving (Thrust) pit. A suitable cradle guide system shall be installed to ensure correct line and level. The Guidance System shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system, if using a magnetic system.
- Prior to work commencement, level control points shall be established to keep level monitoring during Thrust bore operation.
- During and at end of excavation (auger retracted from the driving pit side) all spoil shall be removed from pit by suitable means without compromising the pit stability.
- The excavated spoils shall be disposed at the Administrator's approved dumpsites. If they are environmentally unfriendly such as acid sulphate soils etc., it is the Contractor's responsibility to treat them appropriately in consultation with the Administrator and disposed safely.
- The carrier pipe or conduits shall be installed through the casing by suitable means. Where the carrier pipe has to be installed to a certain grade suitable strapping to the pipe to help maintain grade shall be considered.
- To backfill, any remaining annular space suitable and approved grout shall be used.
- Once the installed pipe work is connected to existing or new infrastructure, both the entry and exit can be backfilled with approved fill materials, compacted and reinstated as per the Administrator's requirements.

The method statement prepared by the Contractor shall also address the details mentioned above for the Administrator's review and approval.

6 Project preliminaries

6.1 Approvals

No work is to begin on site preparation or related to thrust / auger boring until all relevant permits and approvals have been gained and signed off by the relevant authority. **Hold Point 4**

6.2 Design requirements

Prior to any approval being granted or any work commences, the following aspects (as a minimum) of the design shall be submitted to the Administrator. **Hold Point 5**

- All temporary works associated with the construction, including but not limited to the pit / shaft support (including access ladders and pipe fixings), crane pads and access roads or laydown areas.
- Thrust / auger boring alignment.
- Thrust / auger boring pits to accommodate all temporary and permanent works such as:
  a) support systems to withstand lateral earth pressures, ground loads, equipment loads, applicable traffic and construction loads, and other surcharge loads, and
  b) unrelieved hydrostatic pressures, bottom heave.

- Thrust support frame and shaft must be designed to withstand the maximum forces expected for the thrust system while ensuring that these forces are within the manufacturer's allowable jacking forces and deflection tolerances for the jacking pipe.
- Execution of the thrust / auger boring machine and processes.
- Cutter head to be used and the associated cutter tools.
- Planning and use of any slurry fluids, jacking lubrication fluids, polymer drilling fluids and other tunnel grout and tunnelling consumables to facilitate easy advance of auger head and sleeve pipe.
- Use of the guidance and steering system to achieve the design alignment both horizontally and vertically.
- Theoretical settlement calculations and the development of an acceptable ground loss percentage need to be produced. The operation of the thrust boring needs to conform to the established ground loss percentage.
- Any design amendments necessary to ensure that the construction techniques proposed comply with the permanent design.
- Ensure the safe operation and use of plant, equipment and materials handling under all expected loadings such as ground pressure, superimposed loads and thrust forces.
- Standard Drawings clearly identifying the impacts on natural watercourses, table drains, drainage structures and overland flow paths.
- Instrumentation and monitoring plans.
- Details of any geotechnical data relied upon in the design. As a minimum, a geotechnical investigation must be undertaken in accordance with AS 1726. Bore holes or test pits must be to at least 1 m below the proposed invert level, and located at the entry and exit pits. The investigation location shall be at 30 m intervals (max).
- Take account of all potential impacts on all existing infrastructure, utilities, trees and underground features, including but not limited to: impacts from ground movement, clearance to features, settlement / heave and any changes in the groundwater table resulting from the works, either temporarily during construction or permanently as a result of the construction.

No standard design details or historic as built information provided by the department shall be relied up on in the design unless otherwise approved.

Table 6.2 below outlines the required minimum design drawings for the works. It also details the RPEQ sign off requirement.

Table 6.2 – Design drawing requirements

Drawing Details	Drawing Detail	Comments
Site Layout(s)	Plan	Include all existing structures, roads, footpath and trees / vegetation. Identify any trees / vegetation and existing structures to be removed / re-located.
Pit Construction	Plan + Elevation + Section	Include all structural details and staging plans. These drawings should be signed off by RPEQ
Pit Layout	Plan + Elevation	Include details of access / egress, groundwater control and rainfall / rain off management.
Finished General arrangement	Plan + Section	Clearly identify dimensions including size of pit excavation, outer / inner diameter of the enveloper pipe / carrier pipe. These drawings should be signed off by RPEQ
Finished Alignment	Plan + Elevation	Clearly identify dimensions including length of thrust / auger boring and depth below the existing surface. These drawings should be signed off by RPEQ

6.2.1 Thrust and receiving pit

The sizes of all excavations shall conform to the following requirements:

- all pits shall be of the minimum possible size commensurate with safe working practices
- every face of any excavation that exceeds a depth of 1.0 m shall be supported or contained by appropriately designed shoring
- the shoring of the excavation shall be braced in accordance with the appropriate safety standards as the excavation progresses, and
- all necessary measures must be taken to ensure that excavations are left after each operating hours in a safe condition at the end of each workday. This should include the erection of suitable hard barricades, warning signs and hazard lights.

6.2.2 Casing / sleeve Pipe

The design calculations showing the anticipated installation forces to be imposed on the pipe during thrust / auger boring should be provided. These calculations are required to take into account the following but not limited to:

- jacking loads
- frictional forces
- ground conditions
- groundwater
- angular deflection, and
- any fluids used in the installation process.

The Contractor shall take all precautionary measures to avoid potential damage to the sleeve pipe during the installation process. In particular, the Contractor shall ensure that the magnitude of loadings

imparted onto the sleeve pipe does not result in buckling, spalling or cracking of the jacking pipe and excessive deflection or improper functioning of the pipe joints.

6.2.3 Carrier pipe

The details, including but not limited to, should be provided regarding the transportation, handling, storage, installation and testing of the carrier pipe.

6.2.4 Thrust / auger boring alignment

The boring shall pass under roads in a straight line and with a minimum skew of 5° to the road centreline, unless otherwise approved.

6.2.5 Minimum depth below road surface

The minimum depth of cover required for a thrust / auger bore within a state road corridor shall be in accordance with TN163 *Third Party Utility Infrastructure Installation in State Controlled Roads Technical Guidelines*. Refer to Figure 1 and Figure 2 below for an indication of cover requirements.

Figure 1 - Minimum depth below single carriageway

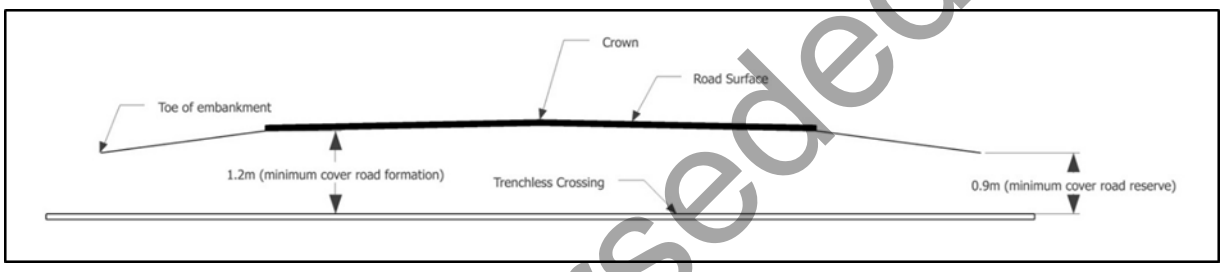
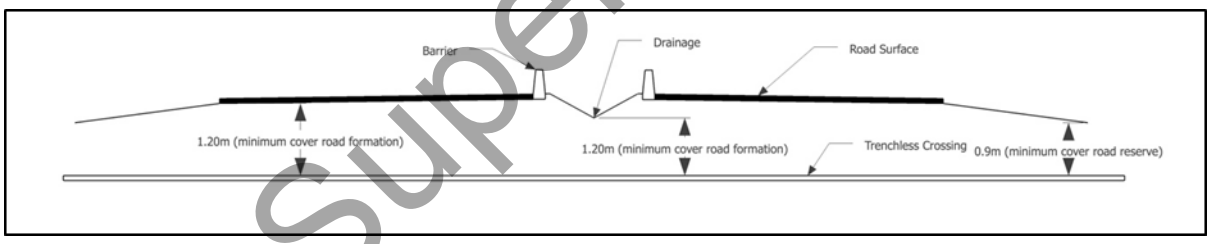


Figure 2 - Minimum depth below dual carriageway



6.2.6 Minimum distance from other infrastructure

The thrust / auger bore shall be located according to the requirements of TN163 *Third Party Utility Infrastructure Installation in State Controlled Roads Technical Guidelines*.

Thrust / auger boring shall not be passed directly under or within the zone of influence of any foundation without the approval.

There must be at least a 2 m clearance horizontally from a line extending at 45° from the horizontal from any point of the excavation to adjacent structures.

The distance between the thrust / auger boring and any existing utility service shall be as approved by the relevant utility owner.

6.2.7 Deformation

Permissible deformations depend on the sensitivity of the existing infrastructure and subjected to approval by the relevant authority. For preliminary design purpose, surface movement (either up or

down) shall be limited to 5 mm beneath existing services including roads and 10 mm beneath undeveloped land. The differential settlement must not be exceeded by 5 mm over any 2 m in length. Theoretical settlement calculations and predicted settlement contour plots are required before the thrust / auger boring works commence. The contractor shall submit to the Administrator a ground monitoring procedure prior to commencing any works. **Hold Point 6**

6.3 Construction procedures

The construction procedure shall be submitted to the Administrator for approval at least four weeks prior to any planned works. **Milestone** The construction procedures must document at least the following critical aspects of the works:

a) site establishment

b) construction of access road and working platform if required

c) pit construction and confined space entry

d) selection of thrust / auger boring equipment – plant suitability and maintenance plan

e) jacking wall / jacking support

f) operation of thrust / auger boring and removal of spoil from pit

g) welding / joining of pipes (enveloper and / or carrier pipe)

h) monitoring of ground deformation and ground loss – settlement monitoring plan

i) monitoring of as built alignment (survey) and thrust pipe deflection

j) monitoring of thrust load

k) survey methodology and surveying audit

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

m) acid sulfate management plan

n) risk and contingency management plan

o) lifting plan

p) annulus grouting procedures

q) the demobilisation of the equipment, and

r) landscaping, revegetation and making good of the work area following completion of the works.

6.4 Risk assessment and contingency plans

A comprehensive risk assessment addressing the entire scope of the proposed work and contingency plan to deal with identified risks shall be provided to the Administrator for Approval. **Hold Point 7** As a minimum, the Contractor is to have defined plans complete with equipment and materials on standby to mitigate against the following risks:

- Pit collapse
- Sleeve pipe collapse

- Pit flooding
- Major thrust / auger boring mechanical failure
- Settlement or heave scenarios
- Serious safety or environment incidents
- High water inflows at the face of thrust boring,and
- Higher jacking forces than expected.

The contingency plan should address, but not be limited to, the following:

- General procedures and labour issues for the duration of the project
- Equipment requirements and the basis of duty and standby
- Boring fluid fracture (borehole) and general spillage
- Time considerations
- Clean up, environmental and surface monitoring methods
- Contract details for the Administrator and any local regulatory bodies that may be affected by the project
- Waste disposal plans, and
- General Public Relations requirements.

7 Materials

7.1 Sleeve pipe

The sleeve / casing pipe used shall comply with the requirement of the standard list given in Table 7.1. Other pipe types (carrier pipe) may be subsequently pulled or pushed into the sleeve pipe.

Table 7.1 – Sleeve pipe material standards

Pipe material type	Standard
Glass Reinforced Plastic (GRP)	DIN 16869 & DIN 19565
Steel	AS 4100
Concrete	AS/NZS 4058
Polymer Concrete	DIN 54815-1/2 & DIN EN14636-1/2
HDPE Lined Concrete	AS/NZS 4058
Vitrified Clay	EN 295

8 Project execution / construction

8.1 General

A site supervisor who has extensive knowledge with the use of thrust / auger boring equipment and procedures must be present at the work site at all times while boring and installation is underway.

Protection of the public and work site shall be established with temporary fencing and traffic control devices in accordance with the MRTS02 *Provision for Traffic*.

All earthworks including site preparation and backfill of excavations shall comply with the requirements of MRTS04 *General Earthworks*. Topsoil shall be stockpiled at approved location onsite for reuse.

All excavated material is to be disposed in accordance with the environmental plan. Boring spoil shall be deemed unsuitable material unless approved for reuse by qualified experienced geotechnical engineer.

All temporary works are to be demolished and removed from the site following completion of the works, unless otherwise approved.

All concrete shall be placed in accordance with MRTS70 *Concrete* unless otherwise approved.

8.2 Utility location

Prior to commencing any excavation or thrust / auger, dial-before-you-dig (DBYD) searches shall be carried out to locate any underground utilities (i.e. gas, sewer, water, fuel, electrical, etc.,) in the work area. Once the utilities have been located the Contractor shall physically identify the exact location of the utilities by vacuum or hand excavation, when possible, in order to determine the actual location and path of any underground utilities which might be within thrust / auger boring path. Contractor shall not commence excavation or boring operations until the location of all underground utilities within the work area have been verified and the verification details to be submitted to the Administrator.
Hold Point 8

8.3 Dilapidation reports

The Contractor is responsible for all pre-construction and post-construction property assessments. These assessments shall be a means of determining whether, and to what extent, damage has resulted from the Contractor's operations during the Works. Moreover, damaged identified shall be made good at the Contractor's expense.

As a minimum, the dilapidation reports shall capture:

a) all work sites and any surrounding area likely to be impacted by the construction activities

b) a minimum distance of three times the depth of any shaft measured radially form its perimeter

c) a minimum distance of two times the depth to invert level each side of the centreline of any thrust / auger boring alignment

d) any area within the settlement trough or zone of influence as defined by the Contractors prediction of ground settlement, and

e) the report must capture the condition of all aspects of the natural and built environment within the nominated areas, including but not limited to inside buildings, public utilities and plant, roadways and landscaping.

8.4 Overcut allowance

The external diameter of the thrust / auger bore shall be designed to produce minimum overcut and the necessary clearance between the outside of the casing pipe and excavated ground. The overcut shall not exceed 30 mm or more than 2% of the pipe OD (whichever is smaller). The Contractor shall ensure the leading edge of the casing pipe is protected when connected to the thrust / auger boring machine.

8.5 Thrust / auger boring operation and bore path survey

All aspects of thrust / auger boring operations shall be documented in a selection and operation procedure. This procedure shall address at least the selection of equipment operating parameters (i.e., thrust, rotation speed, etc.,) control of face pressure, ground loss monitoring, spoil removal and alignment.

Entire thrust / auger boring path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on Standard Drawings. If the Contractor is using a magnetic guidance system, the thrust boring path shall be surveyed for any surface geo-magnetic variations or anomalies.

For any thrust / auger boring in excess of 100 m in length a survey audit shall be undertaken. This should address accuracy of the control points used for boring guidance, and where possible the excavated alignment as built to confirm the specified tolerances is being achieved.

8.6 Grouting

Outer annulus grouting is undertaken to ensure a uniform contact between the casing pipe and the excavated ground, to prevent the surrounding ground settling over time to fill the void. Outer annulus grouting shall be undertaken unless otherwise approved. The Contractor shall provide the annulus grouting procedure to the Administrator for approval prior to commencing any boring works. **Hold Point 9**

If outer annulus grouting is deemed necessary then grout used shall obtain a minimum strength of 1MPa at 48 hrs. Previous performance of the grout mix design shall be demonstrated before use. The outer annulus grouting is to be pumped until one of the following conditions is met:

- the installed grout volume has equalled the theoretical annulus volume between grout ports.
- the installed grout pressure exceeds the theoretical hydrostatic ground pressure plus 0.5 bar.

The space between the casing pipe and carrier pipe shall be completely filled with a cementitious grout unless otherwise approved by the Administrator. **Hold Point 10** Approval to not grout this space will only be approved if all of the following conditions are met:

a) the casing pipe is designed to provide permanent ground support for entire design life

b) the casing pipe has a grade of at least 1:200 to facilitate natural draining of any water

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 fill with sand, and

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

8.7 Environmental Protection / Environmental Management Plan

The Contractor shall undertake all Works in accordance with MRTS51 *Environment Management requirements*.

8.8 Instrumentation and monitoring

The Contractor shall monitor the effects of construction at the surface, including all ground movements and the effects on all structures influenced by the proposed works. The survey shall be carried out by a surveyor in accordance with the proposed monitoring regime as defined in the design

documentation. Generally, survey monitoring of the ground deformation is considered acceptable, and this shall be carried out in daily basis. The daily movement monitoring shall include as a minimum the following components:

a) survey markers at the edges of the shoulder points, edges of the pavements, each line marking

b) monitoring points along and perpendicular to the thrust boring alignment. Each set of surveying points shall have one point located on the centre line and two either side at an offset distance of 5 m and 10 m from the centre line. The survey points shall be at intervals along the centreline of a maximum of 30 m to monitor and interpret expected movements.

c) movement monitoring shall be undertaken daily within a plan distance of 30 m (each way) of the thrust/auger boring face whilst the boring is advancing

d) in the event that instability of the surface is observed (a breach of the 5 / 10 mm thresholds), advancement of the thrust / auger boring operation shall be suspended and the Administrator's representative shall be immediately informed. **Hold Point 11**

e) monitoring shall be referenced to stable survey stations located outside the zone of influence of the works and not subject to ground movement.

When passing under rail or other infrastructures, the Contractor will need to conform to the relevant authority's settlement requirements. Reporting of ground deformations shall be in accordance with the agreed instrumentation and monitoring plan. A notification trigger criteria shall be defined, typically being as follows:

a) alert – if deformations are between 80% to 100% of the predicted value. The frequency of monitoring shall be increased, and

b) alarm – if deformations are in excess of predicted value, all construction activities should be ceased immediately and a mitigation strategy shall be implemented and agreed upon with the Administrator.

8.9 Acid sulfate soils

Prior to undertaking any works onsite an initial assessment of acid sulfate soils shall be undertaken as per the procedure given in MRTS04 *General Earthworks*. Where acid sulfate soils are identified, the procedure given in MRTS04 *General Earthworks* shall be followed.

8.10 Remediation / reinstalment of disturbed areas

Following the thrust / auger boring operations, the Contractor shall demobilise equipment and restore the worksite to its original condition. This includes reinstating any disturbed ground surface to its original standard. Any area disturbed by the works shall be made in good in accordance with the relevant departmental Technical Specifications. These included MRTS03 *Drainage, Retaining Structures and Protective Treatments*, MRTS04 *General Earthworks*, MRTS16 *General Requirements Landscape and Revegetation Works*.

All disturbed area's must be backfilled or excavated to return the area to the level of the natural ground surface prior to the works being undertaken, unless approved otherwise and shown on the Standard Drawings.

9 Alignment Tolerances

The location of the thrust / auger boring machine shall be checked and recorded at least twice per installed pipe and the position recorded against the design grade in the thrust boring field report. This information shall be provided to the Administrator's representative on a daily basis unless agreed otherwise. **Witness Point 1**

Where the auger is out of alignment based upon the tolerances tabulated in Table 9, auger boring shall stop immediately. The boring shall not recommence until directed by the Administrator's representative. **Hold Point 12** The Contractor is responsible for all corrective works and associated costs needed to correct the alignment of the proposed tunnel.

Under no circumstances shall the Contractor take corrective action without the approval of the Administrator's representative.

The jacked pipe shall be installed in conformance with the horizontal and vertical alignment as shown on the Standard Drawings subject to the allowable construction tolerances as listed in Table 9 below.

Table 9 – Allowable construction tolerances

Activity	Limits / Tolerances	Comments
Horizontal	± 50 mm	N/A
Vertical	± 30 mm	N/A
Grade	± 0.25%	No back fall and no ponding

10 Construction Records

The Contractor must keep and submit the construction records to as depicted in Table 10.

Table 10 – Construction record / report

Construction Record / report	Handover Frequency / Details
Thrusting data – jacking pressures, rotation pressure, slurry flow rates, rotation velocity, line, level, advance rates, shove pressures and earth pressures.	Daily
Geological records	Daily
Ground support records (if applicable)	Daily
Quantities of consumables used	Weekly
Plant used	Weekly
Labour used	Weekly
Materials used	Weekly
Environmental details (water treatment, noise, dust and sediment controls)	Weekly and immediately if there is a problem
The diameter and type of pipe and pipe joints used	Weekly
Individual pipe identification by location	Weekly
Delivered jacking pipe dimension and damage checks	Weekly

10.1 As constructed records

The Contractor shall provide the following as built / constructed records within two weeks of completion of the works to the Administrator. **Milestone**

a) as built survey record of the completed thrust / auger boring, including thrust / auger boring machine operation records

b) grouting records

c) ground deformation monitoring records, including final measurements taken once no further movement is recorded, and

d) final dilapidation report capturing all area's affected / disturbed by the works, including photographic evidence that all required remediation had been completed.