

Specification
For
**Augerboring
Construction**

Pr9789



Unitywater

Pr9789 - Specification for Auger Boring

Documents Details

This document is only valid on the day it was printed.

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1 Purpose

- 1.0.0.1 The intent of this document is to outline the minimum deliverables and standards that the contractor needs to comply with when performing Augerboring works on Unitywater projects.
- 1.0.0.2 Its purpose is to ensure consistency across all projects delivered by Unitywater and that the safety, quality, environmental & design objectives required by Unitywater are achieved.

2 Scope

- 2.0.0.1 This Specification defines the minimum technical requirements for auger boring construction works undertaken on Unitywater projects.
- 2.0.0.2 The auger or thrust boring process employs an auger boring machine to rotate an auger chain or flight positioned within an enveloper pipe and fitted to a cutter head at the front of the enveloper.
- 2.0.0.3 The rotating cutter head, which is slightly larger in diameter than the enveloper pipe, excavates the soil in front of the enveloper.
- 2.0.0.4 The soil is transported back to the machine via the helical auger chain where the soil is removed by hand or machine. In some instances the works will then extend to install a carrier pipe within the enveloper for the permanent use of the planned infrastructure.

2.1 Order of Precedence

- 2.1.0.1 Where a discrepancy exists between the Drawings, this Specification and the other Unitywater specifications the Contractor shall seek clarification from the Superintendent's Representative.

3 Standards, Codes and Regulations

3.1 General

- 3.1.0.1 All work carried out under this Specification shall comply in all aspects (i.e. in design, construction, testing and performance) with the latest relevant Australian (AS), British (BS) and IEC Standards and standards in the following sections.
- 3.1.0.2 Reference to specific clauses of the various codes is intended to highlight those points and shall not be taken to imply a lesser importance for all other applicable clauses.
- 3.1.0.3 All the works shall conform to the Rules and Regulations of the Statutory Authorities having jurisdiction over the Site.
- 3.1.0.4 If the requirements of this Specification do not comply with the minimum requirements of the statutory regulations and standards, the latter shall apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.

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- 3.1.0.5 All Materials, fittings, accessories and equipment supplied by the Contractor shall be new and the best obtainable of their kind and shall comply in all respects with the requirements of the relevant Standards Australia specifications.
- 3.1.0.6 All works shall be completed in accordance with this Specification, the Job Specification and stated supplementary specifications.
- 3.1.0.7 The Contractor shall undertake his own assessment as to the type of material to be excavated and sub-surface conditions and shall allow for any dewatering, timber shuttering and shoring that may be required.
- 3.1.0.8 Unless otherwise specified, the equipment covered by this Specification shall be designed, manufactured, installed and tested in accordance with the following, listed in order of precedence:
- The Project Contract documents;
 - Requirements of the Statutory Authorities having jurisdiction over all or part of the manufacture, installation or operation of the plant;
 - The SEQ WS&S D&C Code;
 - All relevant Australian and governing Queensland standards where applicable;
 - Water Services Australia (WSAA) national codes.
- 3.1.0.9 In the absence of relevant SEQ WS&S D&C Code, WSAA or Australian codes or standards, relevant industry, international (ISO), European or British standards shall be followed. International standards shall take precedence over European or British standards.
- The Contractor shall obtain approval from the Superintendent prior to using any non-Australian standards not nominated in the equipment specifications, schedules, datasheets or associated drawings.
- 3.1.0.10 Where local or international standards do not exist, the manufacture and installation of equipment shall be in full compliance with the manufacturer's own recognised standards. Manufacturer's standards, where used, shall be submitted to the Superintendent by the Contractor for review and acceptance shall be obtained by the Contractor from the Superintendent prior to commencement of manufacture.
- 3.1.0.11 All equipment shall comply with relevant Federal and State Acts, Regulations and Codes including, but not necessarily limited to, the following:
- *Work Health and Safety Act 2011* (Qld);
 - *Work Health and Safety Regulation 2008* (Qld);
 - Work Health and Safety Queensland Codes of Practice.
- 3.1.0.12 The version of any applicable standard or regulation shall be the revision in place at the date of invitation of contract packages.
- 3.1.0.13 The Contractor shall have in place a dedicated quality system that conforms to ISO 9001.
- 3.1.0.14 Quality control procedures for management, inspection, review and evaluation of all materials, manufacture, workmanship and testing of all products shall be planned and implemented by appropriately skilled and qualified persons to ensure that requirements of the quality procedures are met and that high quality is maintained.

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- 3.1.0.15 The Contractor shall ensure that all equipment supplied/installed under this Specification is the product of a manufacturer who is fully experienced, reputable, qualified and regularly engaged for at least five years in the manufacture of the equipment to be supplied/installed.

3.2 Applicable Legislation and Regulation

- 3.2.0.1 At least the following legislation and related regulation shall apply:

- a. *Work Health and Safety Act 2011* (Qld);
- b. *Work Health and Safety Regulation 2011* (Qld);
- c. *Water Supply (Safety and Reliability) Act 2008* (Qld);
- d. *Environmental Protection Act 1994* (Qld);
- e. *Queensland Building Services Authority Act 1991*;
- f. *Professional Engineers Act 2002*.

3.3 Codes of Practice (ratified by Legislation)

SEQ Water Supply and Sewerage Design and Construction Code

- 3.3.0.1 The requirements of the South East Queensland Water Supply and Sewerage Design and Construction Code (SEQ WS & S D & C Code) shall supersede the requirements of this specification where advised in the Job Specification. In this case the requirements of this specification shall only apply where no requirement is provided in the SEQ WS & S D & C Code.
- 3.3.0.2 If the Job Specification does not reference SEQ WS & S D & C Code, the requirements of SEQ WS & S D & C Code shall apply where no requirements are stated in this specification.
- 3.3.0.3 Other Codes of Practice that apply to works carried out under this Specifications are:
- a. *Workplace Health and Safety Queensland Code of Practice, Managing noise and preventing hearing loss at work 2011*;
 - b. *Workplace Health and Safety Queensland, Confined Space Code of Practice 2011*
 - c. *Workplace Health and Safety Queensland, Scaffolding Code of Practice 2009*.

3.4 Codes of Practice (not ratified by Legislation)

- 3.4.0.1 The following Codes of Practice (not ratified by legislation) apply to works carried out under this Specification:
- a. *Pipe Jacking Association (UK), Guide to Best Practice for the Installation of Pipe jacks and Microtunnels* (1995).

3.5 Industry Guidelines

- 3.5.0.1 The following industry guidelines apply to works carried out under this Specification:
- a. *Australasian Society for Trenchless Technology, Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking* (Rev 1, February 2010);

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3.6 Unitywater Technical Specifications

3.6.0.1 This Specification makes reference to a number of Unitywater's technical specifications, including but not limited to the following:

Specification #	Title
Pr9902	Civil and Earth Works Specification
Pr9903	Building and Structural Works Specification
Pr9875	Non Pressure Pipe Construction
Pr9904	Pressure Pipe Construction
Pr9680	Electrical Installations at Unitywater Network Sites Specification
Pr9693	Mechanical Specification
Pr9080	CAD Drafting Standard
Pr9087	Pressure testing of Water Mains Work Instruction

3.7 Principal/Standard Drawings

3.7.0.1 Where the form of Contract is design and construct the Principal Drawings are a high level concept design of the Principal's project requirements. The Contractor is to use these drawings as a guide to base the preliminary and final design upon. The Principal Drawings will typically illustrate the following elements:

- Site constraints.
- An indicative trenchless alignment according to best practice.
- Pits, shaft or tie in locations.
- Approximate drive lengths.
- Jacking/Envelope/Casing pipe and carrier pipe details.

3.7.0.2 Alternatively, where the form of Contract is a construct only the Principal Drawings are a prescriptive representation of exactly what is to be constructed under the Contract. These drawings will include the minimum information that the Contractor will require to build the works. Any changes required or ambiguities found must be discussed with the Principal immediately.

4 Definitions, Abbreviations, Acronyms

4.1 Definitions

Term	Definition
Act	The Work Health and Safety Act 2011 (QLD)
Auger/Thrust Boring	A technique for forming a bore from a start or drive shaft to a reception shaft by means of a rotating cutterhead. Spoil is removed back to the drive shaft by helically wound auger flights rotating in a steel casing. This equipment may have limited steering capability.
Carrier Pipe	A pipe installed for the conveyance of water, gas, sewage and other products and services. In auger bored installations it is usually installed inside an envelope pipe.

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Term	Definition
Contract	The legally binding agreement between two or more parties for doing or not doing something specified.
Contractor	An organisation that is bound to carry out and complete the works under the Contract.
Contingency Plan	A plan to mitigate the risk of an activity. The plan usually allows for backup procedures, emergency response and post-disaster recovery.
Drawings	Drawings prepared by the Designer(s) for the purpose of illustrating the design requirements for the works under the Contract.
Designer	A professional engineer (RPEQ) who is appointed by the Contractor to carry out design and to issue instructions regarding standards, specifications and techniques to be observed in the construction of the project.
Design Documentation	Drawings, specifications and other design documentation (including design standards, design or durability reports and calculations) in computer readable and written forms prepared by the Designer for the purposes of the trenchless works under the Contract.
Enveloper Pipe	Pipe installed by auger boring to house the carrier pipe.
Geotechnical Baseline Report (GBR)	The GBR describes the 'Ground Reference Conditions' at the location (alignment as shown in the GBR) of the proposed alignment. The Baseline Conditions presented in GBR represent what is assumed to be encountered for the purpose of defining "indications of the Contract". The provision of a baseline in the Contract is not a warranty that the baseline conditions will, in fact, be encountered. It is therefore not appropriate for the Principal or Contractor to conclude that baseline statements are warranties.
Ground Loss	Ground loss is defined as the volume of material that has been excavated in excess of the theoretical design volume of excavation.
Launch pit or shaft	An excavation at the commencement point of an auger bore, in which the jacking structure and other equipment is installed and from which the auger boring operations are carried out.
Lift (shaft / pit)	The incremental construction height completed as the shaft/pit progresses downward.
Operator	Suitably trained or qualified person who operates machinery, an instrument, or other equipment.
Permit	A document that controls an activity that is considered high and not able to be commenced without completing important requirements.
Principal	Unitywater
Principal Drawings	Drawings issued to the Contractor forming part of the Contract. These drawings are owned by the Principal and are to be used to guide or govern the work under the contract.
Project Manager	A person nominated by the Contractor responsible for the construction of the contract.

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Term	Definition
Red Line Drawings	Original, as constructed drawings marked up in red detailing the as-built data.
Safe Work Method Statement	A document summarising the work required for an activity. This document summarises the hazards and the required measures to control and minimise safety risk.
Scope of Work	A document summarising the works to be completed under the Contract.
Specification	This document, that specifies, in a complete, verifiable manner, the requirements, design, behaviour, or other characteristics of a system, component, product, result or service and often, the procedures for determining whether these provisions have been satisfied.
Superintendent	An individual appointed by the Principal to perform two functions: Be the Principal's agent for the works under the Contract. Administer the Contract fairly and perform certain certifier requirements.
Superintendent's Representative	A person nominated by the Superintendent, to act on behalf of the Superintendent
Trenchless Construction	Installation of new or replacement of underground infrastructure with minimal disruption to surface environment, traffic, business, and other activities.

4.2 Abbreviations and Acronyms

Acronym	Description
ASTT	Australasian Society for Trenchless Technology
AS/NZS	Australian / New Zealand Standard
ASS	Acid Sulphate Soils
AS	Australian Standard
CAD	Computer Aided Design
CCTV	Closed Circuit Television
DBYD	Dial Before You Dig
GBR	Geotechnical Baseline Report
GRP	Glass Reinforced Plastic
HDPE	High Density Polyethylene Pipe
ID	Inside Diameter
IFC	Issued for Construction
ISO	International Standards Organisation
ITP	Inspection and Test Plan
NATA	National Association of Testing Authorities

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Acronym	Description
N/A	Not Applicable
OD	Outside Diameter
QA	Quality Assurance
RPEQ	Registered Professional Engineer Queensland

5 Project Preliminaries

5.1 Approvals

- 5.1.0.1 Project approvals are usually looked after by Unitywater, however, in some instances approvals may be the responsibility of the Contractor. The Contractor is to refer to the Project Specific Specification for required approvals.
- 5.1.0.2 No work is to begin on site preparation or auger boring activities until all relevant permits and approvals have been gained and signed off by the relevant authority. The following authorities may be required to authorise the works:
- Queensland Government Department of Transport and Main Roads;
 - Queensland Rail and/or other rail infrastructure owners;
 - Local Government;
 - Private land owners.
- 5.1.0.3 The Contractor shall be required to adhere to any approval conditions that the asset owner specifies.

5.2 Design

- 5.2.0.1 The Contractor shall be responsible for the design and construction of all works for the auger boring works including any temporary works and temporary pit/shaft supporting structures.
- 5.2.0.2 All design assumptions regarding subsurface conditions, equipment requirements, groundwater and other factors are the responsibility of the Contractor and shall be fully documented.
- 5.2.0.3 Based on the alignment shown in the Principal Drawings, the Contractor shall design and size the excavated profile to accommodate all temporary and permanent works.
- 5.2.0.4 The design is to be certified by a RPEQ engineer and shall be submitted to the Superintendent's Representative for review prior to commencement of work.
- The Contractor shall not proceed with any work until the Contractor's design has been accepted by the Superintendent's Representative.
- Acceptance of the Contractor's design by the Superintendent's Representative in no way diminishes the responsibility of the Contractor for the design.
- 5.2.0.5 The Contractor is responsible for submitting the following design elements for approval prior to commencing work:

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- The design of all temporary works associated with the trenchless construction, including but not limited to the pit/shaft support (including access ladders and pipe fixings), crane pads and access roads or laydown areas;
- Where the permanent works are to accommodate thrust arrangements, these shall be designed to ensure the permanent works are not damaged;
- The auger bore alignment;
- Collaboratively working with the Principal's permanent infrastructure functionality and permanent design team to ensure the overall project achieves the intent;
- The thrust support frame and shaft/pit must be designed to withstand the maximum forces expected for the boring system while ensuring that these forces are within the manufacturer's allowable jacking forces and deflection tolerances for the enveloper pipe;
- The design and execution of the auger boring equipment and processes;
- The design of the means of excavation to be used and the associated cutter tools;
- Verifying the suitability of the specified pipe for the methodology proposed with respect to pipe install;
- The planning and use of slurry fluids, jacking lubrication fluids, polymer drilling fluids, tunnel grout and tunnelling consumables (if required);
- The design and 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 to be produced;
 - The operation of the trenchless equipment needs to conform to the established ground loss percentage;
- Any design amendments necessary to ensure that the construction techniques proposed are in compliance with the permanent design.

5.2.0.6 The trenchless design shall take account of all potential impacts on all existing infrastructure and underground features, including but not limited to: impacts from ground movement, seismic activity, 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.

5.2.0.7 All designs shall 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.

5.2.0.8 Table 1 below outlines the required design drawings for the works under the contractor. It also details the RPEQ sign off.

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Table 1 – Design Drawing Requirement

Drawing Details	Plan / Elevation	RPEQ Sign Off
Site Layout	Plan	<input type="checkbox"/>
Shaft Construction	Plan + Elevation	<input checked="" type="checkbox"/>
Shaft Layout	Plan + Elevation	<input type="checkbox"/>
Finished Auger Bore General Arrangement	Plan	<input checked="" type="checkbox"/>
Finished Auger Bore Alignment	Plan + Elevation	<input checked="" type="checkbox"/>

5.2.1 Enveloper Pipe

- 5.2.1.1 The enveloper pipe provides support to the ground during excavation of the bore. A high pressure fluid pipeline is installed into the enveloper or it may act as the permanent carrier pipe in a low pressure or gravity fluid pipeline. Table 2 below describes the typical enveloper pipes used in auger boring within the water industry.

Table 2 – Enveloper/Carrier Pipe Type and Usage

Type	Enveloper / Carrier Pipe	Permanent Uses
Steel	Enveloper Pipe	N/A
Concrete	Carrier Pipe	Storm Water/Trunk Main
Polymer Concrete	Enveloper or Carrier Pipe	Storm Water/Trunk Main/Sewer
HDPE	Carrier Pipe	Pressure Main
GRP	Carrier Pipe	Storm Water/Trunk Main/Sewer

- 5.2.1.2 The Contractor is to source and use the enveloper pipe to the appropriate standard as outlined in Table 5 below.

Table 3 – Enveloper Pipe Standards

Type	Standard
Steel	To achieve temporary works loadings
Concrete	AS/NZS 4058
Polymer Concrete	DIN 54815-1/2 & EN14636-1/2

- 5.2.1.3 Prior to construction, the Contractor shall submit to the Superintendent's Representative for approval calculations showing the anticipated installation forces to be imposed on the enveloper pipe.

These calculations are required to take into account jacking loads, joint configuration, stress transfer, joint seal design, frictional forces, ground conditions, groundwater, angular deflection and any fluids used in the installation process.

- 5.2.1.4 The Contractor shall take all precautionary measures to avoid damaging the enveloper pipe during the installation process. In particular, the Contractor shall ensure that the magnitude of loadings imparted onto the enveloper pipe do not result in buckling or damage of the enveloper pipe.

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5.2.2 Carrier Pipe

- 5.2.2.1 The carrier pipe is the pipe employed to fulfil the permanent functionality of the infrastructure. This pipe is usually specified and supplied by the Principal.
- 5.2.2.2 The Contractor shall submit to the Superintendent's Representative for approval details showing the transportation, handling, storage, installation and testing of the carrier pipe.

All details must adhere to the manufacturer's guidelines and ensure that the carrier pipe is not overloaded during the auger boring process.

5.2.3 Design Collaboration

- 5.2.3.1 The Contractor and Principal shall collaboratively work to ensure that all pipeline design aspects have been adequately considered and analysed across the two key project phases: Auger Boring Installation and the Infrastructure's Permanent Operation.

5.3 Governing Documentation

- 5.3.1.1 As a minimum and in addition to those required by the general contract documentation the Contractor must submit for approval the following governing documentation as outlined in Table 4; Table 5 and Table 6 below.

Table 4 – Work Plans

Procedure	Submission
Settlement Monitoring Plan	4 weeks before work
Major Lift Plan(s)	4 weeks before work
Plant Suitability and Maintenance Plan	4 weeks before work
Risk and Contingency Management Plan	4 weeks before work

Table 5 – Work Procedures

Procedure	Submission
Site establishment	4 weeks before work
Construction of the crane/excavator support slab/pad (if required)	4 weeks before work
Pit/shaft construction (if applicable)	4 weeks before work
Auger boring	4 weeks before work
Enveloper/carrier pipe welding (or jointing)	4 weeks before work
Carrier pipe welding (or jointing) (if applicable)	4 weeks before work
Pipe installation	4 weeks before work
Man access (if applicable)	4 weeks before work
Carrier pipe installation procedure (if applicable)	4 weeks before work
Annulus grouting of the overcut (if applicable)	4 weeks before work
Annulus grouting between the enveloper and the carrier pipe	4 weeks before work
Hydrostatic, vacuum and chlorination commissioning (if required)	4 weeks before work
The demobilisation of the equipment and site	4 weeks before work

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Table 6 – Safe Work Method Statements

Safety Work Method Statements	Submission
Operation of a crane / excavator	4 weeks prior to works
Operation of the auger boring rig	4 weeks prior to works
Work at heights	4 weeks prior to works
Work in a confined space	4 weeks prior to works
Hot works	4 weeks prior to works
Work at night under artificial light	4 weeks prior to works
Lifting	4 weeks prior to works

5.4 Risk and Contingency Plans

5.4.0.1 The Contractor shall prepare and implement an approved contingency plan dealing with the key project or auger boring risks identified. As a minimum the Contractor shall have defined plans complete with equipment and materials on standby to mitigate against the following auger boring risks:

- Shaft/pit collapse;
- Face/bore collapse;
- Shaft/pit flooding;
- Auger bore flooding;
- Major equipment mechanical failure;
- Settlement or heave scenarios;
- Serious safety or environment incidents;
- Higher jacking (thrust) forces than expected.

5.5 Geotechnical Information and Risk

5.5.0.1 A Geotechnical Data Report (GDR) will be commissioned by/carried out for the Principal for the project and be provided to the Contractor. The level of geotechnical investigation shall be determined by, but not limited to the following inputs:

- Proposed methodology;
- Local site geology;
- Local site hydrogeology;
- Project capital value.

5.5.0.2 The Report will cover a minimum set of requirements/criteria to aid and guide the Contractor to assess the project and specifically make informed decisions with regards to at least the following aspects:

- Equipment Selection;
- Penetration Rates;
- Enveloper Pipe;

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- Carrier pipe selection;
- Time and Cost.

5.5.0.3 The Contractor shall inform itself thoroughly and make its own deductions and conclusions as to the difficulty of maintaining required excavations and of doing other work affected by the geology and hydrogeology of the Site.

5.5.0.4 Where the Contractor considers it necessary that additional site or subsurface investigations are required, the Contractor shall bring this to the attention of the Superintendent's representative in a timely manner.

6 Procurement

6.1 Approved Suppliers

6.1.0.1 The Contractor is to provide materials which have previously been approved for use as per the SEQ WS & S D & C Code Infrastructure Products and Materials (IPAM).

6.1.0.2 If the Contractor proposes to utilise non pre-approved products these are to be submitted to the Superintendent's Representative for consideration.

6.2 Principal Supplied Materials

6.2.0.1 The Contractor shall document the receipt of any Principal Supplied Materials formally with the Superintendent's Representative. The receipt of materials by the Contractor accepts the suitability of these products for inclusion in the Works.

6.2.0.2 All Principal Supplied materials shall be handled strictly in accordance with the manufacturer's written instructions at all times.

6.3 Storage and Security of Materials

6.3.0.1 The Contractor is to provide security for the Site and Works including the construction facilities, plant and equipment. Materials shall also be secured by the Contractor to prevent their removal by unauthorised personnel.

6.4 Personnel

6.4.0.1 Appropriately trained and experienced personnel are required for the delivery of the works. Details of key personnel experience shall be provided to the Superintendent's Representative for approval before the works commence.

6.4.0.2 A site supervisor who is thoroughly knowledgeable of the equipment and auger boring procedure is to be present at the job site at all times. The site supervisor is to be present to address immediate auger boring construction concerns, health and safety and environmental issues.

6.5 Plant

6.5.0.1 All trenchless construction operations shall be performed using specialist equipment.

6.5.0.2 All plant must be of a good standard and the Superintendent's Representative shall be permitted to inspect the proposed plant.

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- 6.5.0.3 All plant must pass the Principal's equipment assessment/inspection criteria prior to site mobilisation. The key Principal's equipment assessment/inspection criteria are listed below:
- Plant is required to be in good safe working order;
 - Plant is required to have a good service history;
 - Plant is required to be fit for purpose.
- 6.5.0.4 The auger boring equipment may consist of a steel jacking shield with hydraulic/threaded steerable front section, rotating head, augers, jacking frame and hydraulic power pack.
- 6.5.0.5 The auger boring machine shall be complete with calibrated hydraulic gauges to ensure the forces exerted on the pipes or augers are within the design limits.
- 6.5.0.6 Suitable load conversion charts are to be provided prior to commencing works.
- 6.5.0.7 When wet ground and/or ground loss is expected along the bore alignment the machine should be fitted with a suitable means of creating a pressurised bore to minimise ground loss and limit any ground settlement.
- 6.5.0.8 The Contractor's management plans must detail a system for daily checking and resolving of issues with the supplied plant and equipment. The Contractor must supply key critical spares to ensure that the all equipment achieves a 90% working availability target.

6.6 Materials

- 6.6.0.1 Permanent materials are to fully comply with this Specification and the documents referenced herein. Any deviation is to be approved in writing by the Superintendent's Representative.
- 6.6.0.2 The Contractor shall use materials in a safe and responsible manner.
- 6.6.0.3 All materials used in the auger boring operation are to be approved by the Superintendent's Representative.
- 6.6.0.4 The Contractor is to ensure that chemicals and hydrocarbons are used in accordance with accepted environmental practises complete with control measures to mitigate risk.
- 6.6.0.5 The Contractor is to ensure that the auger boring fluids and chemicals that have the potential to come into contact with the ground are biodegradable, safe to water bodies and fire resistant.

7 Project Execution

- 7.0.0.1 The Contractor shall maintain control of site operations at all times. The Contractor has ultimate responsibility for site safety, the environment, quality workmanship and the satisfactory completion of the work as authorised under the Contract.

7.1 Site Setup

- 7.1.0.1 The Contractor is to set the launch and reception sites up in accordance with the approved site layout drawing which as a minimum must cover the following key aspects:

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- Perimeter fencing in the allowed location;
- Site topsoil stockpile complete with erosion and sediment control;
- Entry and exit points;
- Pedestrian walkways and appropriate exclusion zones around cranes or moving plant;
- Any underground or overhead power lines and the appropriate exclusion zone;
- Shaft/pit locations (launch and reception);
- Traffic guidance systems.

7.2 Existing Services

- 7.2.0.1 The Contractor shall note the presence of overhead and underground services on the works site. Special care shall be taken in the vicinity of electricity services.
- 7.2.0.2 The locations of some underground services are indicated on the drawings and are based on information supplied by the respective Authorities where such information is available.
- 7.2.0.3 It is emphasised that information supplied regarding these services is tentative only with respect to both details of services shown and the existence of other services not shown.
- 7.2.0.4 Neither the Principal nor the Superintendent warrant the completeness or accuracy of the information given and the Contractor is required to make enquiries into the presence and location of underground services with the relevant Authorities.
- 7.2.0.5 The attention of the Contractor is drawn to the fact that private underground and overhead services and individual services to premises from public utility mains are not shown on the drawings.
- 7.2.0.6 The Contractor shall verify the position of each underground service before commencement of excavation. The Contractor shall pre-locate the services as to depth, alignment and extent or size, so as to ensure such services are not adversely affected. Hand excavation may be necessary to close proximity to services until the exact location is determined.
- 7.2.0.7 Trenches containing underground services shall be backfilled so that the subgrade is restored as nearly as possible to its original state of compaction.
- Where selected backfill has been placed by other utilities and has had to be removed, it shall be replaced by the same type of selected material.
- All backfill shall be carefully deposited in the trench and around the utility service in layers and adequately compacted by proper hand rammers and tampers or by use of effective mechanical equipment.
- 7.2.0.8 Extra care shall be taken by the Contractor to re-compact excavations near existing underground pipework, so that foundations of that pipework are restored and more especially when re-compacting in the vicinity of low flexibility pipework.
- 7.2.0.9 The Contractor shall be held responsible for any damage caused to existing overhead or underground services.

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In case of failure or damage, the Contractor shall immediately notify the relevant service provider and arrange for repairs to be undertaken.

If there is any delay, the Superintendent will arrange for repairs to be carried out by the Principal or others and the full cost of such repairs shall be borne by the Contractor.

If, in the opinion of the Superintendent, the failure or damage causes an emergency situation, then remedial action will be taken by the Principal and the full cost of such action shall be borne by the Contractor.

- 7.2.0.10 Only those persons qualified to undertake repairs on the relevant services shall be permitted to perform the work with the prior approval of the service authority.
- 7.2.0.11 Where it is necessary to carry out alterations to existing overhead or underground services, this work will be arranged by the Contractor unless otherwise specified.
- 7.2.0.12 The Contractor shall allow to co-ordinate and work around service authorities where relocations are necessary during the Contract.
- 7.2.0.13 The Contractor shall promptly advise the Superintendent of any services affecting the works which were not shown on drawings so that appropriate action can be taken.

7.3 Dilapidation Reports

- 7.3.0.1 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.

7.4 Monitoring and Reporting

7.4.1 Daily Site Record

- 7.4.1.1 Records shall be maintained describing the major works being carried out on Site for each day of the Works and be available for inspection by the Superintendent's Representative at any time.

7.4.2 Daily Auger Bore Report

- 7.4.2.1 Once the auger boring works commences a daily auger boring report must be produced and submitted daily to the Superintendent's Representative.

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Table 7 – Auger Boring Reporting

Auger Boring Record/Report	Details
Pit/shaft construction – verticality, support details, progress	Daily
Boring data – shove pressures, line, level, advance rates, over cut volume	Daily
Enveloper/carrier pipe data	Daily
Grouting annulus data (over cut and enveloper / carrier)	Daily
Quantities of consumables used	Daily
Gas monitoring data	Daily
The diameter and type of pipe and pipe joint used	Daily
Geological/hydrogeological data	Daily

7.4.3 Surface Settlement

- 7.4.3.1 Information on the permissible subsidence or heave at the ground surface shall be provided considering the use of the area, structures and systems in the sphere of influence of the auger boring project, taking into consideration the subsoil and groundwater conditions and the depth of cover.

7.5 General Earthworks

- 7.5.1.1 General earthworks requirements shall conform to the requirements of Unitywater's *Specification for Civil and Earth Works (Pr9902)*.

7.6 Auger Boring

- 7.6.0.1 Auger boring/thrust boring or boring and jacking shall be defined as a trenchless construction method for installing pipelines which incorporates the following features:

- A hole is bored by a rotary cutting head;
- Spoil is removed by a helical rotor flights rotating in the enveloper which is progressively jacked behind the cutting head;
- When the enveloper pipe is jacked into position a carrier pipe will be installed and grouted in place.

7.6.1 Excavation

- 7.6.1.1 During the boring operation, elevation and alignment of the pipe shall be regularly monitored to ensure the correct line and level is maintained.

This shall be carried out by a surveyor or engineer who shall plot (mathematically) the alignment of the bore to confirm the exit location. The elevation shall be checked at the front and rear end of the enveloper pipe as it is loaded in the boring machine.

- 7.6.1.2 If it is determined that the bore alignment is offline beyond the permissible tolerance, then boring activities shall cease and only recommence once rectification steps have taken place.

The following steps may be implemented as determined by the Superintendent's Representative.

- Adjust machine/auger alignment via machine/rail mount adjusters;

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- Pullback and realign auger;
- Pullback and realign boring machine and or railings;
- Abandon and start new bore.

7.6.1.3 To avoid ground loss during boring operations, the Contractor will implement the following:

- Boring machine operator will ensure that the rate of forward progress of the auger drill is comparable to the amount of spoil discharged by the auger;
- Boring machine mountings to be checked to ensure that vibration(s) are kept to a minimum during boring operations;
- Only suitably experienced personnel will be involved in boring activities;
- Employ a means of pressurising the bore on the machine (cuttings discharge door).

7.6.1.4 The bore will be continuously cleaned by rotating the auger and spoil removed from the pit/shaft by a suitable excavator during the installation of the enveloper pipe.

7.6.1.5 The enveloper pipe shall be installed as per the design drawings and shall conform to the construction tolerances as shown in Table 8 unless detailed in Project Job Specification. If the drive deviates from these tolerances the Contractor shall inform the Superintendent's Representative immediately.

Table 8 – Auger Boring Alignment Tolerances

Auger Boring Alignment Tolerance	Allowable Deviation
Horizontal Tolerance from Designed Alignment	± 500mm
Vertical Tolerance from Designed Alignment	± 100mm
Gradient (including entry angle and exit angle)	± 1%

7.6.2 Outer Annulus Grouting

7.6.2.1 Outer annulus grouting is undertaken to ensure a uniform contact between the enveloper pipe and the excavated ground and to prevent the surrounding ground settling over time by filling the void.

In conjunction with the Superintendent's Representative, the Contractor shall determine if annulus grouting is required. This operation usually requires personnel access and this is not always possible (especially in pipes less than 900 mm in diameter).

7.6.2.2 The outer annulus grouting shall be undertaken using an onsite grout mixer, pump and pressure gauge. The grouting will take place in a number of stages, determined by the length and grade of the pipe.

7.6.2.3 The grouting shall be undertaken generally following the sequence of:

- The tunnel openings (eye) will be adequately sealed to ensure a complete seal between the ground and enveloper pipe;
- A breather hole will be left in the crown at the uphill end to allow air to escape and to provide visual confirmation that the void is full;

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- Grouting will continue until the grouting operation achieves any of the following conditions:
 - Grout is visible from the breather hole;
 - The quantity of grout injected into the annulus equals the theoretical volume of the annulus;
 - The pressure that the grout is injected at is 0.25 bar greater than the theoretical hydrostatic ground pressure.

7.6.2.4 The grout shall be an approved minimum 1 MPa mix which has been submitted to the Superintendent's Representative for approval. The mix shall have historical and actual NATA laboratory testing to confirm its suitability. The grout mix design and pumping equipment shall be suitably matched to ensure complete filling of the annulus without issues onsite.

7.6.3 Carrier Pipe Installation

7.6.3.1 Carrier pipe installation will be undertaken as a separate operation upon completion of the auger boring/bored and jacked pipe crossing works.

7.6.3.2 Generally, the Contractor shall install the pipes in pretested lengths utilising an excavator, crane or other suitable lifting equipment. The carrier pipe shall be centralised in the bore using casing spacers at a minimum of 1.5 m intervals or as specified by the manufacturer to support the weight of the pipe.

7.6.3.3 Pipe installation shall be generally carried out using the following procedure:

- Pit made safe, either using a suitable shoring system or by benching and battering;
- Ensure suitable area is available for the pipe lengths or the pipe string;
- Suitable length trench to be excavated on line and level required for installation of pipe;
- Pipe launch cradle to be installed in the pit to assist in pipe alignment;
- Site specific lift plan to be developed prior to pipe installation commencing;
- Pipe to be lifted into trench using suitably sized equipment;
- spacers to be installed onto carrier pipe at manufacturer recommended spacing or at least every 1.5 m;
- Pipe to be loaded into the enveloper pipe using suitably sized equipment.

7.6.4 Grouting of Inner Annulus

7.6.4.1 Once the carrier pipe is installed, centred, continuity tested (if required) and hydrostatically tested (if required), the Contractor shall grout the inner annulus of the enveloper pipe.

7.6.4.2 The grout shall be an approved minimum 1 MPa mix which has been submitted to the Superintendent's Representative for approval.

The mix shall have historical and actual NATA laboratory testing to confirm its suitability.

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The grout mix design and pumping equipment shall be suitably matched to ensure complete filling of the annulus without issues onsite.

7.6.4.3 The gap between the enveloper pipe and the carrier shall be sealed at each end of the enveloper pipe. A breather pipe shall be installed at each end with the end of the pipe at least 1 m above the lowest obvert of the pipe.

7.6.4.4 Grouting shall commence from the downhill end of the pipe.

Grout shall be added into the void, under gravity pressure or by pump, through the pipe until grout is visible and bleed water is expelled from the breather pipe at the upper end.

The quantity of injected grout shall be recorded on a concrete pour card and that quantity shall be compared to the calculated theoretical volume.

8 Testing and Commissioning

8.1 Hydrostatic Testing

8.1.0.1 The Contractor is required to conduct the hydrostatic test of each carrier pipe within the works under the Contract **prior** to grouting operations taking place.

8.1.0.2 The Contractor shall engage a NATA accredited testing authority to conduct the hydrostatic testing.

8.1.0.3 The test must conform to the relevant Unitywater specification, either the *Specification for Pressure Pipe Construction (Pr9904)* or the *Specification for Non-Pressure Pipeline Construction (PR9875)*.

9 Project Completion and Handover

9.0.0.1 Throughout the construction of the project the Contractor shall complete and submit all records mentioned in the above sections of this document. In addition to these documents the Contractor shall submit the as-built package in hard copy and electronic format.

9.0.0.2 The Contractor shall keep records of all trenchless operations, and all such data as directed by the Superintendent. These records will form part of the As-Constructed data. As-Constructed information shall be prepared in accordance with the SEQ WS&S D&C Code – Asset Information Specification.

9.0.0.3 All records are to be approved by the Superintendent and submitted in accordance with Unitywater specifications listed within the contract documentation.

9.1 Documentation Submittals

9.1.0.1 The Contractor shall liaise closely with the Superintendent during the documentation of survey work and shall provide the Superintendent with adequate opportunity to verify any measurement or detail the Contractor considers necessary prior to the commencement of reinstatement operations.

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9.2 Post-Construction Dilapidation Report

- 9.2.0.1 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.

10 Typical Auger Boring Inspection and Test Plan (ITP)

- 10.0.0.1 The Contractor shall prepare and submit for approval by the Principal at least four (4) weeks prior to the commencement of auger boring works, an Inspection and Test Plan (ITP) for the works in accordance with the requirements of the relevant specifications.
- 10.0.0.2 Table 11 below details the typical activities that trigger a visual inspection, witness point verification or hold point release. This list is to be used as a minimum guide for the Contractor to develop their ITP.
- 10.0.0.3 The Contractor must provide the Principal at least 8 hrs notice of a required visual inspection, witness point verification or hold point release.

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Table 9 - Inspection and Test Plan

Project Elements	Activity	Contractor Responsibilities			Principal Responsibilities		
		Visual	Witness	Hold	Visual	Witness	Hold
Project Documentation	Company HSEQ System Project Safety Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Project Safety Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Project Environmental Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Project Quality Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Site Establishment Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Settlement Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Auger boring design – coordinated with permanent works design	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Auger Boring Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Pipe Installation Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Grouting Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Lift Plans (Auger boring machine, pipes)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Commissioning Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Design Documentation	Crane Pad	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Pit/Shaft	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Jacking Frame/Thrust Wall	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Auger Boring Machine (Thrust, torque, steerability)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Settlement Calculations	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Project Execution	Site Set Up To Plan	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Crane Pad Installation To Design	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Shaft Mark Out To Design	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Shaft Built To Design	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Envelope Pipe Built To Design	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

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Project Elements	Activity	Contractor Responsibilities			Principal Responsibilities		
		Visual	Witness	Hold	Visual	Witness	Hold
	Jacking Frame And Jacking Wall Block Set Out	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Settlement Monitoring And Review	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Auger Boring Machine Commissioning (Mechanical, electrical and hydraulics)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Auger Boring Machine and Enveloper Alignment Checks	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Auger Boring Machine Overcut Checks	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Ongoing Jacking (Thrust) Forces	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ongoing Face Loss Control	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ongoing Auger Bore Alignment Checks	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Annulus Grouting Checks (if required)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Enveloper Internal Clean	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Carrier Pipe Installation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Carrier Pipe Grouting Records	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Commissioning And Hand Over	Hydrostatic Testing (if required, NATA)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Leakage Testing (if required, NATA)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	CCTV Inspection (if required)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Red Line Drawing	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	As Built Survey	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Submission Of All Project Records	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>