SAMOA WATER AUTHORITY

ENGINEERING STANDARDS (Water)

PART 4
CONSTRUCTION STANDARDS

June 2014

Engineering Standards (Water)
Part 4: Construction Standards Issue: June 2014

REV	AMENDMENT	DATE	APPROVED BY:	SIGNED
0	Final	23/06/13		

Table of Contents

1 GENERAL

1.1 SCOPE

Part 4, "Construction" details default requirements for the construction of water mains and associated components and structures.

This document should be read in conjunction with other relevant sections from SWAES (Water), development agreements, specific project contract documents, general conditions of contract and shall comply with the latest version of **NZS 3910 Conditions of Contract for Building and Civil Construction** and other documents nominated by the SWA.

Unless specifically stated otherwise, construction of the water mains includes all functions described in this Part and the provision of any minor materials and services, which are not described but are reasonable necessary to produce a fully functional water supply and reticulation system.

1.2 INTERPRETATION

For the purposes of this Part, except where otherwise shown:

"**Authorised**" means acceptable to, authorised by or approved by the SWA or Owner or Regulator.

"**Contractor**" means the individual, corporation or legal entity including any c ontractors and sub-contractors that is accountable at law for delivery of Works under a specific contract or development agreement.

"**Design Drawings**" means plans and drawings required for the construction of the water supply transfer, distribution or reticulation systems and showing the locality including roads and water main details, the site plan including lots, boundaries, roads, proposed and existing water mains, proposed property services, sewers, drains, watercourses, site contours, proposed aqueducts, proposed boreholes, a level schedule or longitudinal elevation if the water main is to be constructed prior to road or drainage construction and construction details. Supplementary information may include proposed buildings, existing services and groundwater and watercourse levels. The Designer may nominate Standard Drawings or parts thereof as Design Drawings for the purposes of the project.

"**Improvements**" are deemed to include but not be limited to pavements, shrubs, gardens, retaining walls, fences and all other structures.

"**Owner**" means the legal identity who is the owner of the asset and/or who has responsibility for the asset.

"**Part**" means the Samoa Water Authority Engineering Standards (SWAES) Part 4: Construction Standards.

"**Purchase Specification**" means the SWA Purchase Specification detailing the requirements for the supply of a project or material.

"**Regulator**" means a Regulator who has the power to enforce Regulations related to the activities and responsibilities of the Samoan government. It applies to environmental management and protection, occupational health and safety and the like.

"**Specification**" means the Specification detailing the work involved in the particular project in hand.

"**Specified**" means as specified in the Specification, Design Drawings, Purchase Specifications and/or by the Engineer.

"**Standard Drawings**" means the SWAES Part 5: Standard Drawings.

"**Engineer**" means the individual appointed by the Employer as an independent arbiter of contract directions, issues, claims and variations, as defined by NZS 3910 Conditions of Contract for Building and Civil Construction.

"**Tester**" means an individual, corporation or legal entity for the relevant classes of tests and that is accountable at law for delivery of testing services under a specific contract with the Contractor.

"**SWA**" means the Samoa Water Authority.

"**Works**" means all those Works being water mains, valves, hydrants and accessories and shall include valve chambers and storage facilities as shown on the Design Drawings an includes any part or parts of the Works.

Specific requirements, including those in the Specification and Design Drawings, shall take precedence over general requirements.

2 QUALITY

2.1 QUALITY ASSURANCE

The SWA is responsible for specifying quality assurance of construction activities and personnel qualifications. Unless otherwise specified, the requirements of this section apply.

2.1.1 Quality Management Plan

The Contractor shall plan, establish, document and maintain a quality system that conforms to the requirements of the contract and shall provide the Engineer with access to the Contractor's systems for monitoring and quality auditing. The Quality Management Plan proposed by the Contractor shall be used as an aid to achieve compliance with the requirements of the contract and to document such compliance.

If the Contractor discovers material or work that is not in accordance with the contract, the Contractor shall promptly notify the Engineer. If the Contractor proposes any non-conforming materials or work which is at variance with the requirements of the contract, the proposal shall be submitted in writing to the Engineer whose decision on the proposal shall be obtained in writing before the non-conforming material or work is covered up and/or incorporated into the Works, or is the subject of any other disposition.

2.1.2 Method Statement/Methodology

A project method statement/methodology details how the construction project will be managed. The requirements for a method statement/methodology vary between projects depending on the size of the project etc. Specific requirements for a method statement/methodology are usually defined in the tender documents however it may detail the following where relevant: project objective, management structure and personnel, the quality assurance system used, the traffic management system, the environmental management plan, the inspection and test plans, the project budget and construction schedule (including inspection and test plans).

The Contractor's Method Statement/Methodology shall conform to the Technical Specifications outlined in the Employer's Tender Document.

Should there be any discrepancies between the two, The Technical Specifications in the Employer's Tender Document shall take precedence.

2.1.3 Inspection and Test Plans

An inspection and test plan (ITP) i details the timing and responsibilities for carrying out compliance inspections and tests during construction. For example, the ITP might identify which concrete pours will be tested, at what stage in the construction program, and who will carry out the tests. It might also highlight which tests must be approved before construction can proceed. Specific requirements vary for each project and are usually defined in the tender documents.

The Contractor shall submit inspection and test plans (ITPs), on its own or as part of a Quality Management Plan as outlined in SSWS to the Engineer for verification before commencing work. The ITPs shall include where applicable, observations, measurements or tests at the Contractor's facilities.

2.1.4 Quality Tests

The Contractor shall be responsible for the quality of all products, processes and services under the contract, and unless otherwise specified, shall provide all tests required to demonstrate conformance of all products, processes and services to the technical requirements of the contract.

Unless otherwise agreed by the Engineer, all laboratory tests and field tests undertaken by the Contractor shall be performed by an approved and recognised authority for the class of tests being undertaken.

2.1.5 Quality Audits

The Engineer may nominate selected times and hold points at which quality compliance audits may be conducted within the contract period. The Engineer shall be entitled to carry out the second or third party audits of the Contractor's quality system by:

a) Reviewing Contractor's conformance to the project management plan; and

b) Reviewing and verifying of the Contractor's quality procedures and work instructions and documentary evidence of compliance with technical requirements of the contract.

2.1.6 Quality Records

The Contractor shall maintain records clearly identifying the source of materials and equipment, the supplier's declaration of conformity, the design drawings used for the construction of the works and all test results.

Quality records shall be stored and maintained such that they are readily retrievable in facilities that provide a suitable environment to minimise deterioration or damage, and to prevent loss. Quality records shall be available for evaluation by the Engineer during the period of the Contract and shall include all pertinent Contractor and third party records.

The Contractor shall retain quality records for two (2) years from the date of practical completion of the Works.

The Contractor shall maintain records in two categories:

a) Test records, which shall comprise all working sheets and summaries associated with testing in accordance with the Inspection and Test Plans.

b) Project quality records, which shall include, but not be limited to site meeting minutes, technical reviews, minutes of meetings between Engineer and Contractor and other relevant documentation.

The Contractor shall submit to the Engineer quality records as evidence that the work has complied with the specified quality requirements. If unsatisfactory, the records shall be submitted within twenty-four (24) hours of creation or receipt.

Within three (3) months of the date of practical completion the Contractor shall make available a register of all quality records required to be held under the contract. The Contractor shall supply copies of all quality records or parts thereof as required by the Engineer.

2.1.7 Inspection

The Engineer shall be given access in conjunction with or through the Contractor to all laboratories and other facilities used for quality control tests to verify that specified requirements are being met.

2.2 PERSONNEL QUALIFICATIONS

Supervision of the handling, laying, jointing, trench filling and testing of all water mains, construction and testing of associated structures and installation of appurtenances shall be carried out by acceptably qualified and/or accredited personnel.

Personnel shall hold minimum qualifications or specialist accreditation appropriate for the work undertaken.

3 GENERAL CONSTRUCTION

3.1 GENERAL

Construct the water supply transfer, distribution and reticulation Works to the lines, levels, grades and in the locations using the materials and methods as specified.

If insufficient detail or instruction is provided in the Design Drawings or Specification, obtain instruction from the Engineer prior to commencement.

Use only the types, materials, sizes, lengths, classes, jointing methods and corrosion protection systems for the pipes, fittings and maintenance structures as specified. Use only manufacturers' products and product range authorised by the SWA.

Keep on site at all times a copy of the Specification, all relevant Design Drawings, Standard Drawings and Purchase Specifications and the SWA's manual or catalogue or listing of authorised products and materials.

3.2 ORDER OF CONSTRUCTION, TESTING AND COMMISSIONING

Undertake and complete all Works in accordance with the following process:

a) Install all Works in accordance with the Design Drawings and the Specification.

b) Clean main(s) by either swabbing and flushing, air scouring or high velocity flushing.

c) Conduct acceptance testing

d) Disinfect the main(s) and conduct acceptance testing.

e) Connect the main(s)

f) Charge and commission the new main(s).

3.3 CONTRACT INTERFACES

The Contract Interfaces shall be as indicated on the Design Drawings and/or Specification. If in doubt, obtain clarification from the Engineer. Where the Contractor is required to connect or fit to existing infrastructure provided by SWA, check all relevant measurements on site, notwithstanding the dimensions shown on the Design Drawings, and adjust work to fit as required. The Contractor shall not be entitled to any claim for loss or damage directly or indirectly due to its failure to take such measurements.

3.4 CUSTOMER FOCUS

3.4.1 General

Ensure that the execution of the Works complies with the SWA's requirements for customer service.

Fully brief all affected customers and property owners about the impact of the Works on buildings, garden features, trees and vegetation, noise levels, out of hours work, traffic restrictions, etc before commencing work.

Keep documented evidence of contact details with all affected customers.

It is the aim of the SWA to achieve a high level of customer understanding and co-operation in the construction process.

3.4.2 Resolution of complaints

Establish a single point of contact for all customer queries and complaints relating to the Works being executed.

Resolve enquiries and complaints promptly, sensitively and in accordance with the SWA's requirements for customer service.

Keep the Engineer informed and fully briefed of any contentious issues raised about the Works.

3.5 PROTECTION OF PEOPLE, PROPERTY AND ENVIRONMENT

3.5.1 Safety of people

Protect the safety of all employees and people on or adjacent to the Works in accordance with the relevant legislation, statutory requirements, regulations and codes of practice, including the Water Act 2003.

All people on the site shall wear the appropriate safety apparel.

Comply with the relevant power authority requirements when operating near overhead power lines. Provide an observer when working below or within 6 m of power lines to advise on proximity. Maintain a clearance of at least 3 m at all times between plant and power line.

Store or leave unattended equipment, tools and materials in a condition that minimises hazards.

3.5.2 Protection of other services

Implement special precautions where excavations are to be undertaken near any other services including petroleum pipelines, gas pipelines, overhead and buried electricity and communication cables, drains, sewers and water mains. For these assets and any other services:

a) Obtain all relevant permits from service utilities and comply with requirements of each permit.

b) Comply with the notification requirements and construction conditions as specified.

c) Prove the location of all underground services e.g. by potholing.

d) Take special care to ensure that other services are protected in accordance with the conditions specified by the service Owner.

e) As appropriate for critical service, arrange for a representative from the service Owner to be present, unless the service Owner directs otherwise.

f) Arrange for isolation and subsequent restoration of any service that needs to be removed from service while the Works are in progress.

g) Adopt an appropriate method for exposing and protecting the service from damage if the service is to be exposed. Industry practice is generally to hand dig and locate underground services prior to machine digging.

h) Immediately notify the owner or responsible authority of any damage or interference to any service, structure or property.

   If a service is damaged during construction, arrange or perform repair to the satisfaction of the Owner. Obtain from the Owner, a certificate stating that the repair has been carried out to the satisfaction.

   If the Owner cannot be located within a reasonable time, report the damage to the Engineer, and arrange or perform repair to an approved standard. Do not backfill, cover up or make the repair inaccessible prior to obtaining authorisation from the Engineer.

i) Notify the Engineer of any interference to the Works caused by an existing service and the proposed action.

3.5.3 Disused / redundant water mains

Take action regarding disused water mains e.g. removal if come across while trenching or capping at points of disconnection and removing surface fittings as approved by Manager, Technical Division.

3.5.4 Road reserves or other thoroughfares

Treatment of pavements and other surfaces

Any pavement or surface of any road, driveway, footway, nature strip, median strip, kerbing, channelling or any other thoroughfare disturbed as a result of the Works, shall be:

a) Continuously maintained as far as practicable, for the duration of the Works.

b) Restored to its original surface and material condition and to the satisfaction of the Owner.

Restore the surface of unpaved streets before they are reopened to traffic.

Restore the surface of any excavation in a sealed road, footway or other pavement or provide a temporary bituminous seal before being reopening it to the public.

Traffic Management

Where advised otherwise by the SWA, prepare a traffic management system for traffic diversion and control in accordance with the requirements of the Land and Transport Authority, and Ministry of Works, Transport and Infrastructure guidelines on Traffic Management. The system shall provide for the access requirements for all developed properties, and include proposals for continued access to these properties.

Construction within any public road will generally not be permitted until the traffic management system has been authorised by the relevant road Owner.

Ensure all personnel working on or adjacent to roadways wear safety vests and are suitably trained in traffic management.

Adhere to traffic management practices as follows:

a) Provide a flagman, temporary traffic lights and /or protection by hurdles, barricades or safety cones where traffic is restricted or roads closed.

b) Place detour and warning signs or devices on the hurdles or barricades, in accordance with the responsible road authority signage code of practice.

c) As appropriate, notify the relevant road Owner, traffic authority, police, fire services, ambulance services, bus companies, and any other service whose operations may be affected by the change to the regular traffic flow pattern in the vicinity of the Works.

d) Provide and alternative means of access to all rights of way, buildings and property where the Works disrupt access.

e) Ensure that pedestrians are kept clear of the work area and are provided with safe alternative means of passing the Works.

f) Complete any work involving the opening of street pavements without delay.

The Traffic Management Plan shall be submitted either on its own or as part of the Safety Plan as specified in the SSWS.

Cleanliness of roads, paths, accesses and drainage paths

Keep the surface of all roads, footways, drainage paths and any access through public and private lands clear of any build-up of debris such as clay, sand and the like, resulting from plant used on the site.

Storage of products, materials and equipment

Store all products, materials, equipment and excavated material in accordance with the requirements of the relevant storage site Owner.

Obstruction of street drainage

Protect all drains, channels or gutters from any obstruction using silt traps, sediment control and other means as appropriate.

3.5.5 Private and public properties

Where work is carried out in private property or lands owned by other authorities, whether in an easement, reserve or otherwise:

a) As far as practicable confine operations to easements or reserves. If there are no easements or reserves, or the area of the easement or reserve is inadequate, confine operations to an area agreed upon with the Owner.

b) Comply with the SWA requirements for resolution of any dispute associated with access or entry rights to the Works.

c) Minimise damage to existing vegetation and improvements.

d) Obtain the Owner's written permission for storage of materials, equipment or excavated material for Works on any of Owner's land.

e) Replace damaged conduits with the same, or agree equivalent, material and authorised connectors. Repair and/or replace all property and environmental damage caused by the Works.

f) Remove all facilities for the Works from the site within the time frame specified or agreed.

g) Restore all services, drains, fences, structures, surfaces and improvements affected by the Works to the original surface and condition to the satisfaction of the Owner, and within the time frame specified or agreed.

3.5.6 Protection of the environment.

General

Take all necessary measures to protect the environment and heritage areas in accordance with current environmental protection legislation. Water supply construction projects should pay particular attention to the following elements of environmental protection.

Collection and disposal of wastes

Provide, operate and maintain adequate facilities for the collection, transportation and disposal of liquid wastes including portable toilet wastes, fuels, lubricants, oils and greases.

On no account allow any untreated liquid waste to discharge to the ground surface of the site or into any drain or open area. Ensure that no contamination of the soil occurs and that all sludge and solid material is removed and disposed of safely and lawfully.

On Works completion, completely remove all the storage and treatment facilities.

If soil pollution occurs, remove all contaminated material from the site and dispose of in accordance with the requirements of the SWA and relevant Regulators.

Protection of adjacent lands and vegetation

Confine all operations associated with the construction Works to the designated Works area either within roadway reserves or enclosed by temporary and existing fences.

Fence all area stockpile areas.

Make every attempt to minimise impact of the Works on adjacent areas and cooperate with the owners / occupiers of adjacent land to minimise inconvenience.

Protect trees, shrubs and grasses outside the Works area by appropriate site management and fencing.

Only remove or trim trees and shrubs if essential for the Works.

Do not remove trees and shrubs on or adjacent to the Works without obtaining prior written permission from the Owner and replace as required / agreed.

Suitably dispose of all debris from the cutting, pruning, lopping of trees and shrubs, including removing trunks and roots.

Control of Water pollution

Carry out the works to ensure:

a) Measures are taken to minimise erosion and to trap sediment in any water leaving the site.

b) Access locations to the worksite are clearly defined.

c) Location of stockpiles of excavated materials, fill and other erodable materials are clearly defined.

d) Construction and rehabilitation activities minimise erosion and sediment transport.

e) Procedures are in place to trap and dispose of excess water during testing, disinfection and swabbing of the completed Works.

Implement the requirements and comply with all applicable Samoan regulations.

Control of noise and atmospheric pollution

Comply with relevant Regulator requirements for mitigating noise and atmospheric pollution.

Operate all plant and construction equipment such that it does not cause undue noise and atmospheric pollution.

Fit compressors, air tools, generators and other plant as necessary with appropriate silencers.

Take all necessary measures to prevent dust generation on the site and in particular its spread to adjacent areas. Preventative measures shall include, but not be limited to, regular watering of the Works area and the access tracks and roads.

3.6 AFFECTED PARTY NOTIFICATIONS

Ensure that all owners and residents of property directly an indirectly affected by the Works are notified in writing of the proposed Works before their commencement.

Notify commencement of Works to the Engineer. The period of notice shall comply with the relevant notification requirement specified in the contract or by the SWA.

Comply with the notification requirements of all affected, services and other owners having care, management or control over streets, services and/or property affected by the Works

Retain copies of all notices for audit purposes.

3.7 SURVEY MARKS

Maintain all national survey marks in their correct position.

When such survey marks are disturbed, re-establish or reinstate the marks to the requirement of the relevant Regulator.

3.8 LATENT CONDITIONS

Obtain instruction from the Engineer regarding latent site conditions and obstacles that impact on the project, such as:

a) Where mains cannot be laid to achieve the minimum specified cover over the top of the pipe barrel.

b) Poor ground conditions

c) A building approval that has been given to construct a structure over the water main.

d) Disuse pipelines.

e) Cultural and/or natural heritage items.

4 PRODUCTS AND MATERIALS

4.1 AUTHORISED PRODUCTS AND MATERIALS

Use only products and materials authorised by the SWA. Suppliers of products are to provide written evidence that all products and materials supplied comply with the nominated Purchase Specifications.

(Note: The Specification writer shall insert the relevant materials specifications from SWAES Part 3 in this section and add additional materials or details as required, e.g. specific pump model, or PRV model etc)

4.2 REJECTED PRODUCTS AND MATERIALS

Reject any damaged or defective product or material or part thereof. Do not use any rejected product or material in the Works.

Place rejected product or materials in a separate area and remove them from the site at earliest opportunity.

4.3 TRANSPORT, HANDLING, STORAGE OF PRODUCT AND MATERIALS.

Transport, handle and store all products and materials in accordance with the manufacturers' recommendations and in a manner that prevents damage or deterioration or excessive distortion.

Pay particular attention to the protection of product and material coatings and linings and those surfaces that will be in contact with drinking water.

Stack all pipe in a manner that minimises pipe ovalisation.

Do not store plastic pipe and fittings and plastic coated pipe and fittings near generators or other heat emitting equipment.

Store rubber sealing rings, lip seals and gaskets away from sunlight and in an unstrained condition.

Do not store PVC or non-black PE pipe and fittings uncovered in direct sunlight for more than twelve (12) months. If storage periods are likely to exceed twelve (12) months, cover and store pipe in a manner that allows ventilation and prevents heat entrapment.

Except for checking against the purchase order, keep pipe, fittings, valves, seals and other components delivered within protective crating or packaging, until immediately prior to use.

Keep the ends of plastic pipe and fittings free of loading.

Use PVC and non-black PE pipe and fittings within two (2) years of manufacture.

Limit outside storage of black PE pipe with blue or lilac stripes to a maximum of two (2) years from the date of pipe manufacture as marked on the pipe.

4.4 DELIVERY INSPECTION OF PRODUCTS AND MATERIALS.

Inspect all products and materials at the time of delivery for damage and excessive distortion.

Replace products and materials that are damaged, excessively distorted, outside their use by date or storage period and indelibly mark or tag with wording such as “Do not use” or other identification.

Do not use:

a) PE pipes and fittings scored deeper than 10% of the wall thickness.

b) Faded / discoloured PVC, PE and plastic coated pipes and fittings.

c) PVC pipes and fittings scored deeper than 0.5mm.

Remove rejected products and materials and store separately from useable products to prevent inadvertent use.

4.5 CONCRETE WORKS

(Note: This section on concrete is only suitable for routine concrete works associated with main laying. A more detailed concrete specification would be required for more complex concrete structures such as reservoirs or Water Treatment Plant.)

4.5.1 Delivery

Concrete shall be delivered to site for use within 90 minutes of commencement of mixing.

4.5.2 Transportation of concrete

Use pneumatic and pumping or other methods for conveying and placing concrete when nominated in the Specification or when authorised by the Engineer. Where concrete is conveyed by wheeled vehicles or barrows, the equipment used and the distance travelled shall be authorised by the Engineer.

If concrete is conveyed by chute, the equipment shall be of such size, slope and type as to ensure the continuous flow of concrete without segregation of materials. The delivery end of the chute shall be as near as possible to the final position of the concrete and it shall be provided with effective baffle. If the chuting operation is not continuous, the chute shall discharge the concrete into a hopper.

4.5.3 Formwork

Formwork, including all temporary supporting structures and precast members, shall comply with the requirements of AS 3610 and the additional requirements of this Document, and Design Drawings.

Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Form surfaces shall be smooth and free from holes or irregularities detrimental to the finished concrete surface.

Before placing the concrete, coat the forms with a suitable, non-staining coating, which will facilitate their release.

Finish surfaces as specified. If not specified, it shall be appropriate to the project and method of placement.

4.5.4 Reinforcement

Supply, fix and place reinforcement in accordance with **NZS 3109 Concrete Construction** and **AS/NZS 4671 Steel Reinforcing materials**. Ensure the specified minimum cover is achievable between ends of members and / or construction joints. Continuously monitor placement.

4.5.5 Placement

General

Place concrete in discrete layers in one continuous operation between ends of members and/or construction joints. Continuously monitor placement.

Surfaces upon or against which concrete is to be placed shall be free of standing water, mud and debris.

Prior to placing concrete on concrete that has set, prepare the surface of the set concrete by scabbing to expose aggregate, clean off loose material and dampen and apply a bonding agent recommended by the concrete supplier.

In the placement of vertical elements, do not allow free fall of concrete to exceed 1.6 m.

4.5.6 Slump

The nominated slump at the point of acceptance shall be as specified. If not specified, it shall be appropriate to the project and method of placement. No additional water shall be added on site, unless approved in writing by the concrete supplier.

If the nominated slump in not specified, the Contractor should liaise with the concrete supplier to determine the appropriate value. The addition of excess water on site can adversely affect the strength and durability of the concrete.

(Note: The Specification writer shall insert the relevant requirements for slump if required)

4.5.7 Compaction

Immediately compact concrete after placing. Use internal and/or external vibration in a systematic manner to ensure that all concrete is thoroughly compacted. Vibrate to the full depth of each layer and extend into the top 100 mm of the underlying layer. Do not vibrate to the point where segregation of the ingredients occurs.

Use rotary out of balance vibrators.

Where internal vibrators are used, insert them vertically at successive locations and at spacing not exceeding the manufacturer's state zone of influence. Do not allow vibrators to contact partially hardened concrete or reinforcement embedded in it.

In regions of closely spaced horizontal reinforcement, ensure full compaction directly beneath the closely spaced horizontal reinforcement prior to encasing the reinforcement with concrete.

4.5.8 Stripping

Ensure that concrete has adequate strength before stripping formwork.

Remove forms in a manner that will not injure the concrete. Provide temporary support to the concrete structure so as to protect freshly stripped concrete from construction loads.

4.5.9 Curing

Cure concrete as specified. If not specified, it shall be appropriate to the project and method of placement.

(Note: The Specification writer shall insert the relevant requirements for curing if required)

4.5.10 Repair of blemishes

Fill surface holes and damage exceeding specified limits by filling with cement mortar bonded to the concrete.

4.6 SUPPLY OF WATER TO THE WORKS.

Obtain an authorisation from the Engineer for the supply of SWA piped water for construction purposes, or the relevant owner for privately owned water supplies.

Do not take water from any metered or private supply without the Owner's permission.

Maintain all hydrants to protect the quality of water supplies.

Introduction of water supply restrictions over the designated Works area may prohibit the supply of piped water to the site. The SWA should be consulted to confirm the availability of water supply during the construction period. Alternative sources of supply may need to be sought in the case of restrictions.

4.7 ON-SITE STOCKPILES

Store only sufficient materials on-site as are necessary to allow timely and efficient progress of the work. Locate stockpiles of excavated or imported material where they cause no interference to the public, drainage routes or vehicular or pedestrian traffic.

Do not obstruct clear lines of sight for drivers.

Do not stack materials against structures, fences, trees or other property improvements. Leave a clear path between the edge of any excavation and the inner toe of any stockpile or spoil banks such that no loading is imposed on the trench wall.

Do not stack or stockpile materials under overhead electrical conductors.

Obtain written permission of the Owner for storage of materials, equipment and/or excavated material for the Works on the Owner's land.

5 EXCAVATION

5.1 SAFETY

Do not commence any excavation until all equipment and materials necessary to make the excavation safe are on site and available for use. This includes any necessary fencing and barriers, as well as trench support systems.

Assess site for prior excavations and consider their impact on the new excavation, including any potential hazards.

5.2 LIMITS OF EXCAVATION

Keep the extent of excavation to the minimum possible to allow efficient construction of the Works while meeting the requirements shown on relevant Design Drawings.

Unless specified otherwise, keep the sides of excavations vertical to at least 150mm above the main.

Ensure that the minimum cover requirement shown on relevant Design Drawings and Standard Drawings are satisfied following any earthworks that may occur in the area of the water main. This is particularly relevant in new subdivisions or developments where earthworks are expected to form roads, driveways, footways and for general shaping of the surfaces. If minimum cover requirements cannot be achieved, submit a proposal to the Engineer to overcome the problem.

5.3 EXCAVATION ACROSS IMPROVED SURFACES

Obtain written permission of the Owner prior to commencing any excavation across improved surfaces.

If excavation is required across improved surfaces such as pavements, driveways, kerbs and gutters, where the surfaces cannot be satisfactorily reinstated, use tunnelling or boring.

For open excavations across improved surfaces, keep the trench width to the minimum allowed. Saw cut neat straight lines at least 150 mm beyond the outer limits of the excavation through bitumen, asphalt and concrete. Remove pavers, blocks or brick pavements by hand, clean them and set them aside for later replacement. Ensure trench fill is compacted to requirements of the relevant clauses.

5.4 BLASTING

Use alternative methods of excavation to blasting wherever achievable.

Obtain prior authorisation from the Engineer, relevant Regulator and affected Owners of assets within the vicinity before undertaking blasting.

Where authorisation is granted, prepare a blasting plan that includes management of the blasting and means to be used to satisfy the requirements of AS 2187 and the authorising parties.

5.5 SUPPORT OF EXCAVATIONS

Support all trenches of depth 1.5 m or greater.

Ensure that adjacent structures and services are not subject to disturbance by the trench support system.

When removing, raising or withdrawing supports, prevent slips or falls and ensure that no damage, disturbance or displacement occurs to the pipes, fittings, geotextile filter fabric, pipe embedment and trench fill already installed. Fill the trench simultaneously with the raising or withdrawal of trench supports. Ensure that compaction of pipe embedment and trench fill material occurs below such trench support and against native ground.

Where specified, leave the trench support system in place as permanent support. Cut off the support system at a depth below ground surface that will satisfy the structural and development requirements of the site.

5.6 DRAINAGE AND DEWATERING

Keep all excavations free of water. Provide, maintain and operate intercepting Works to prevent surface water from entering the excavations. Provide all equipment necessary for dewatering the excavations and keeping the Works free from water.

Only lower the water table by well points or other external dewatering methods if no damage is likely to be caused to adjacent structures and services or the environment.

Ensure that all downstream Works that are under construction, completed or in use are protected at all times against the effects of any drainage that is discharged or likely to be discharged from the Works.

Do not discharge dewatering to sewers, storm water drains or watercourses without appropriate authorisation and without complying with the Owner's or Regulator's requirements.

5.7 FOUNDATIONS AND FOUNDATION STABILISATION

The bottom of the excavated trench is required to provide a foundation suitable for the adopted construction method.

Where the bottom of an excavation is unable to provide a firm foundation with minimum bearing capacity of 50 kPa at the required level (tolerance +0, -50 mm) without abrupt irregularities or undulation, obtain written instruction from the Engineer on the means for providing a satisfactory foundation.

The Engineer will seek the instruction from the Designer in most instances.

Construct special supports in accordance with the Design Drawings.

5.8 SURPLUS EXCAVATED MATERIAL

Surplus material is the property of the Owner of the excavation site.

Where the spoil from trench excavation is to be used for trench fill, isolate the topsoil for later use in restoration.

Promptly remove and dispose of excavated material that is not required for reuse. Dispose of lawfully and in accordance with project requirements.

6 INSTALLATION OF PIPE SYSTEMS

6.1 GENERAL

6.1.1 PVC Pipelines

PVC pipe and fittings shall be used only where minimum cover requirements can be achieved (see SWAES Standard drawings). PVC pipe is not approved for use above ground or where minimum cover cannot be achieved due to rock or proximity of other services. The minimum size mPVC pipes are 50mm, Rubber Ring Jointed.

Unless stated otherwise, PVC Pipelines shall be installed in accordance with **AS 2032 Installation of mPVC pipe systems**.

6.1.2 DICL Pipelines

Ductile Iron Cement Lined (DICL) Pipes shall be used for above ground applications, for high-pressure applications or may be used in certain areas where minimum cover requirements for PVC pipe cannot be achieved due to rock or other obstructions.

Unless stated otherwise, DICL pipelines shall be installed in accordance with the manufacturer's recommendations.

6.1.3 Polyethylene Pipelines

Unless otherwise approved, polyethylene pipe and fittings shall be used for customer services from the water main to the meter assembly.

Unless stated otherwise, Polyethylene shall be installed in accordance with **AS 2033 Installation of polyethylene pipe systems**, using electrofusion welding jointing method.

6.1.4 Galvanised Steel Pipelines

Because of its relatively short economic life, Galvanised Steel Pipe and Fittings will not generally be approved on SWA managed water supply systems in future, with the exception and above ground manifold pipe-work around reservoirs, bores etc.

6.2 EMBEDMENT MATERIALS

6.2.1 General

Embedment is the material surrounding a pipe and is composed of the following zones:

(a) Bedding – between the foundation and the bottom of the pipe

(b) Side support – between the bottom and top of the pipe

(c) Overlay - between the side support and the trench fill

The Contractor shall supply details of the proposed embedment materials for the written approval of the Engineer prior to their use in the Works. The Engineer may direct the

Contractor to provide test results to confirm that the materials comply with the requirements of this specification and Table 6.4. If at any time the Engineer considers the material proposed for use or being used by the Contractor is not similar to that originally approved, the Engineer may direct the Contractor to provide additional test results. All costs of these tests shall be borne by the Contractor.

6.2.2 Sand

Sand for use in the embedment shall be free of organic materials and materials that would be harmful to a pipe or its protective coating or sleeving, including angular aggregate and it shall have a pH not less than 5.5 when tested in accordance with **AS 1289.4.3.1 Methods of Testing Soil for Engineering Purposes** and shall comply with following grading:

Table 6.1

Sand Embedment Material Size Requirements

AS 1152 Sieve Size mm	**Percentage Passing by Mass**
9.5	100
4.75	90-100
2.36	60-100
1.18	30-90
0.600	15-59
0.300	5-30
0.150	0-10

6.2.3 Granular Material

Granular material for use as embedment shall be a crushed aggregate of 7 mm nominal size, free from organic material and shall be inert to ground water acids and sulphates.

When tested in accordance with AS 1141.22, the aggregate wet strength shall be not less than 1.5 Bar and the wet/dry strength variation shall not exceed 35 per cent.

Aggregates which deteriorate rapidly, either in stockpiles or at the quarry face, even though complying with the specified requirements when quarried, shall not be accepted.

The granular material shall comply with the following grading:

Table 6.2

Granular Material Embedment Material Size Requirements

AS 1152 Sieve Size	Percentage Passing by Mass
9.50	100
6.70	85-100
4.75	0-30
2.36	0-10
1.18	0-5

6.2.4 Heavy Gravel Bedding

Heavy gravel bedding shall be used where directed by the Engineer for replacement of unsuitable material from the trench foundation or excess excavation of the trench foundation. Heavy gravel bedding shall be a 40 mm nominal size aggregate complying with the following grading:

Table 6.3

Heavy Gravel Bedding Material Size Requirements

AS 1152 Sieve Size	Percentage Passing by Mass
54.00	100
37.50	40-80
26.50	2-3
19.00	0-5
9.50	0-0.5

6.2.5 Embedment Compaction Requirements

TABLE 6.4

MINIMUM COMPACTION OF EMBEDMENT AND TRENCH / EMBANKMENT / OTHER FILLS

		Minimum value (%)

Material type	Test method	Trafficable areas		Non-trafficable areas	
		Embedment	Trench/ embankment fill	Embedment	Trench/ embankment fill
Non-cohesive i.e. granular	Density index (I_D) AS 1259.5.6.1	70 (Note 1)	70 (Note 2, 3)	60 (Note 3)	60 (Note 4, 5)
Cohesive	Dry density ratio (RD) AS 1289.5.4.1 and AS 1289.5.1.1 (Note 6)	95	95	90	90 (Note 5, 6)

NOTES:

1. *Single size coarse aggregates of sizes 7, 10 and 14 mm shall be deemed "self-compacting" and do not require compaction testing when used for pipe embedment.*
2. *The road Owner may specify alternative values.*
3. *Degree of compaction of the trench fill in trafficable areas depends on:*
   (a) *the backfill zone – higher degrees of compaction is required in the zones closer to the surface; and*
   (b) *the road type – freeways and arterial roads carrying greater loads require higher degrees of compaction.*
4. *The value given is a default where excessive initial surface settlement is not permitted. Specification of an alternative degree of compaction of the trench fill in non-trafficable areas depends on the site requirements.*
5. *Compaction shall be to the degree specified in the project Specification or the default value in Table 6.4 if not specified.*
6. *Graded gravels and sands having fines (silts and clays) greater than 5% have their compaction determined by dry density ration.*

6.3 BEDDING UNDERLAY FOR PIPES

6.3.1 Trench Floor Preparation

Inspect the trench floor on excavation for rock outcrops and soft and loose areas. Take appropriate action to ensure that the pipe or fitting or valve or other appurtenance or structure will not be subject to differential settlement in the future.

Where rock outcrops are present, trim the trench floor and fill with granular material to restore the design trench floor level limits.

Compact all fill and all disturbed areas to not less than the density of the natural ground.

Remove all debris and water before bedding is places.

6.3.2 Placement of Bedding

Provide bedding of the type shown on relevant Design Drawings. Place and rake-in the bedding to support the pipe uniformly along the whole length of the barrel with chases provided for sockets, couplings and other appurtenances.

Do not walk on the centre of the bedding either during or after placement.

6.4 PIPE LAYING AND JOINTING

6.4.1 General

After preparing pipe bedding, lay and joint pipes in locations and sizes as specified. Use methods, materials, tools and equipment in accordance with manufacturer's and/or supplier's instructions and recommendations, relevant Standards and requirements of this Part.

Items such as pipes, fittings, valves and any other product that will contact the drinking water shall not be stored in any location where pollution due to rain run-off or any other cause can occur.

In accordance with SWA's requirements, clean and disinfect any items that have become polluted or replace with new items.

Maintain the inside of all items clean and dry during the construction of the water main. Use exclusion caps, plugs or blank flanges of a suitable design to deal open ends of times as necessary to prevent contamination during pipe laying operations.

6.4.2 Cleaning, inspection and joint preparation

Clean and examine all pipeline system items before installation. Inspect each joint seal for fit and flaws before making the joint in accordance with the manufacturer's instructions. Do not use damaged, dirty or incorrect seals. Ensure that the correct joint lubricant is used for rubber seals.

Inspect all items just prior to use. Remove damaged items from the Works site and replace.

Chamfer, if required, and provide witness marks on the unmarked length of any cut pipes. Do not score pipes when providing the witness mark.

Treat cut pipe ends in accordance with pipe manufacturer's recommendation.

6.4.3 Laying

Firmly and evenly embed the barrels on the bedding material. Form chases in the bedding to accommodate the pipe sockets and/or couplings to allow even bearing along the full length of the pipe barrel.

To prevent movement, restrain pipes already laid before the next joint is made. Prevent flotation of pipes during laying.

Lay the water main on continuously rising grades from scour valve to local high point, notwithstanding any minor irregularities in the ground surface. Make gradual changes in

alignment or grade by deflecting at flexible joints after the joints have been made. Comply with the manufacturer's recommendations in respect of maximum deflection for each joint.

When jointing plastic pipes such as PVC to ductile iron and steel pipe and fittings, do not join a metal spigot to a plastic socket.

At the end of each day's laying, seal the end of the pipe to prevent ingress of vermin, trench material, water and other foreign material.

6.4.4 Horizontal and Vertical Deflections Of Pipes

Minor deflections of a pipeline may be achieved by cumulative deflections at the joint of elastomeric ring seal jointed pipes. Flexible pipes e.g. PE and PVC may be deflected by controlled bending along the length of the pipe. Limits of deflection are specified by the pipe manufacturer.

Removal of temporary pegs or stakes is essential to avoid point loading of the pipes. Non-removal may result in pipe failures.

Make the pipeline joint in a straight line before deflecting the joint. Do not exceed the pipe manufacturer's specified maximum deflection.

Remove temporary pegs or stakes for restraining or holding curved pipes after completion of pipe laying and placement of embedment material.

6.4.5 Separation of Crossing Pipelines

Maintain minimum separation of crossing pipelines as specified. Fill the separation with embedment material and compact.

6.4.6 Flotation Control

Prevent floatation of pipes by:

a) Using trench stops; and/or

b) Placing and compacting sufficient height of fill material; and/or

c) Filling the pipeline with water, where authorised; and/or

d) Other appropriate method authorised by the Engineer

Where trench dewatering is necessary, fully place and compact embedment and fill material while dewatering systems are operating.

6.4.7 Thrust and Anchor Blocks and Restrained Joints

Construct thrust or anchor blocks at valves, flexibly jointed bends, tees, enlargers and reducers of the type and size indicated in the relevant Design Drawings.

Position thrust and anchor blocks to bear against undisturbed material in the direction of the thrust and over the specified bearing area.

Provide sufficient concrete curing time to withstand any thrust load.

Check that anchorage does not interfere with other services.

Where restrained joints are specified for ductile iron pipeline adhere to the manufacturer's installation procedures.

6.4.8 Property Services and Water Meters

At the time of construction of reticulation main, install connectors, property services and water meters as specified in the Design drawings.

No services will be provided for buildings greater than 30 meters from an existing water main.

Water service meters will be installed either a maximum of 5 meters inside a property boundary of 30 meters from a water main, whichever is the lesser distance.

Embed, trench fill and compact as specified for the reticulation main.

6.4.9 Corrosion Protection of Ductile Iron

When specified in the design, sleeve bitumen coated buried cast iron items with polyethylene, fixed with PVC tape complying with AS 3680. Install sleeving to AS 3681. Do not allow sleeved items to be exposed to sunlight for more than seven (7) days.

6.4.10 Marking Tapes

Non-detectable marking tape

When specified, lay detectable marking tape on top of the pipe embedment material before trench filling.

Detectable marking tape

When specified, lay detectable marking tape on top of the pipe embedment material before trench filling. Lay the tape over the embedment to form a continuous connection between valves and/or hydrants. Strip the ends of the tape to expose its conducting wires. Connect bare wires to a nut or bolt of a valve or hydrant to form and electrical connection of the wire to the valve or hydrant.

6.4.11 Valves, Hydrants and Surface Fittings

Install valves, hydrants and surface fittings, including by-pass, covers and surrounds, of the type, size and locations shown in the Design Drawings.

Consult the Engineer for instruction if the Design Drawings show the location of a valve, hydrant, chamber or surface fitting to be in a roadway, driveway, paved area or any other area which may restrict access for operation and maintenance purposes or endanger operation and maintenance staff or damage the water main when in service.

Construct valve chambers and install covers of the type, size and locations shown in the Design Drawings.

6.4.12 Washouts

Construct scours of the type, size and locations shown in the Design Drawings.

6.4.13 Marker Posts

Install location marker plates and other markers for the location of hydrants, valves and other fittings at the locations shown in the Design Drawings and in accordance with SWA practice.

6.4.14 Flanged Joints

Flanged joints for spun and cast iron pipes and specials, for steel pipes, and for valves shall be made, unless specified otherwise, with rubber insertions and galvanised bolts, nuts and washers. The Contractor shall provide two washers per bolt. Joint rings shall be made from 3 mm thick insertion rubber fabric reinforced and of such width as to cover the machined face of the joint inside the bolt holes.

The joint rings shall be of such physical properties as to be capable of forming a permanent watertight joint against pressures up to the maximum test pressure. The use of jointing paste or grease will not be permitted. The bores of abutting pipes or fittings shall be concentric and no jointing material is to be left protruding into the bore.

6.4.15 Welding Of Steel Water Mains

Any proposal to weld steel pipes in the field must be submitted to SWA for prior approval.

Apply corrosion protection to welded joints, internal and/or external, where specified.

Reinstate cement mortar linings as specified.

6.5 PIPE EMBEDMENT AND SUPPORT

6.5.1 General

Provide embedment and support of the type shown in the Design Drawings and Specification.

Place embedment material uniformly along and around the whole length of the pipe barrel, couplings and other appurtenances in a manner to ensure uniform density of side support and overlay with no distortion, dislodgment or damage to the water main.

Ensure that the depth of bedding material below the pipe collar is not less than 50% of the minimum bedding specified for the pipe.

Where the water main is supported on concrete, do not place overlay material until the concrete has obtained its initial set.

6.5.2 Methods

Following placement, compact embedment material to achieve the density specified and to uniformly support the pipe. Compact in layers to achieve the required density uniformly throughout the depth of each layer and the degree of compaction specified in Table 6.4.

When choosing compaction equipment, the number of passes and the thickness of layer to be compacted, take account of the material to be compacted and the pipe to be installed.

Do not employ compaction equipment or methods that produce horizontal or vertical earth pressures that may cause damage to or excessive distortion of the water main.

Do not use flooding compaction unless specifically authorised by the Engineer.

If flood compaction is authorised:

(a) only use in situations where embedment material is non-cohesive i.e. no clays and the surrounding native soil and the embedment material are completely free draining;

(b) only use beneath non-trafficable areas where compaction trials have been undertaken and proven successful; and

(c) do not use beneath trafficable areas

6.5.3 Concrete Embedment and Encasement

Concrete embed or encase pipes as specified and in accordance with relevant concrete Clauses.

Set pipes to line and level on either bags of natural fibre filled with sand and cement mix or on concrete blocks or saddles cast to the outside diameter of the barrel and located near the socket. Ensure that pipes do not move, float or deform while pouring concrete.

Provide rubber-ring jointed pipe "shorts" 600 – 1000 mm long immediately upstream and downstream of the concrete embedment or encasement to allow for differential movement.

6.6 FILL

6.6.1 Placement

Place trench fill as specified. Use appropriate methods of compaction to achieve the compaction requirements of the Design Drawings and Specification.

Avoid impact loading of the water main during placement of trench fill material.

Do not place trench fill material within 24 hours of placing concrete embedment or encasement, or longer period if shown in the Design Drawings or Specification.

Fill voids behind timber ground support in close-timbered tunnels, drives and shafts by pressure grouting or other authorised means.

Take special care to prevent displacement of any valve or hydrant access cover assembly or support.

Correct any deficiencies of trench filling exposed by settlement.

6.6.2 Material Requirements

The trench fill material shall comply with the Specification and relevant Design Drawing.

Where the filled trench will be subjected to traffic loading, the fill material shall comply with the requirements of the road Owner. In the absence of a directive, use one of the following:

(a) Compaction sand; or

(b) Fine crushed rock; or

(c) 75 mm crushed rock.

6.6.3 Compaction of Trench Fill

The degree of trench fill compaction shall conform to Table 6.4

Compact trench fill material in layers to achieve the required density uniformly throughout the depth of each layer. Where settlement of the finished surface is to be controlled, use a fill material that can be compacted to the required high degree of compaction.

Do not commence mechanical compaction of fill material directly above the pipe until the total depth of cover above the pipe is adequate to prevent damage top the main.

The depth of fill material required before mechanical compaction can be used depends on the type of compaction device. For hand-held or walk-behind equipment, provide at least 150mm cover and for larger "ride-on" machines operating within the trench.

6.6.4 Embankment Fill

Where the route of a main requires filling or construction of an embankment, provide fill along the route of the type shown in the Design Drawings.

Proceed as follows:

(a) Prepare the foundation for the fill by cleaning away all debris, vegetation, organic material and topsoil for the full width of the fill area.

(b) Place the fill in layers not exceeding 150 mm thickness and compact each layer to not less than 95% of its standard maximum dry density (AS 1289.5.1.1). Bring the compacted fill level up to a height of at least 300 mm above the design level of the top of the pipe.

(c) Place the remainder of the fill in layers not exceeding 300 mm thickness and compact each layer to not less than 95% of its standard maximum dry density.

6.7 SWABBING

6.7.1 General

Upon completion of all construction activity, flush and clean all water mains to minimise the risk of contamination.

Where directed by the Engineer, subject the total length of all newly constructed water mains >DN 100 to at least one swab run to ensure that the mains are free of deleterious material.

If directed by the Engineer, swab after the satisfactory completion of all pipework and prior to the commissioning of the main, and prior to disinfection where disinfection has been specified.

Carry out swabbing of mains as a series of swab runs.

Insert swabs clear of any fittings into the main downstream of the controlling valve used to make the connection to the existing main or to the previously swabbed new main.

Install a discharge assembly at the end of the swab run and set up so as to direct discharge water clear of the trench and to prevent scouring or flooding of the surrounding area. For mains DN225 diameter and larger, fit a swab discharge control unit at the discharge end.

If swab entry point and directions are not indicated in the Design Drawings obtain instructions from the Engineer.

Where practicable, the longest length and/or the largest diameter main(s) should be swabbed in the first of the required series of swab runs.

6.7.2 Swabs

A swab is typically a section of foam that is inserted into the water main and using the flow of water, pushed towards a discharge point, forcing deleterious material from the system.

Use new pre-packaged swabs

Store and handle swabs hygienically.

Use at least two swabs for each swab run.

Select swabs of a size appropriate to the main size in accordance with Table 6.5

Insert swabs during construction into the main at connection point(s) of new mains to existing mains or into previously swabbed new mains.

For DN 100 to DN 150 mains inclusive, swabs may be inserted at hydrants

TABLE 6.5

DIMENSIONS OF SWABS AND DISCHARGE UNITS

Maximum internal pipe diameter mm	Swab diameter Mm	Swab length mm	Minimum length of swab discharge control unit mm
100	130	250	Not required
150	200	300	Not required
200	250	350	Not required
225	300	400	1500
250	350	425	1600
300	400	450	1600
400	500	500	1800
450	550	600	2000
600	750	900	2600
850	1000	1100	3000

6.7.3 Swabbing Procedure

Use the following swabbing procedure:

(b) Insert swabs using a clean plunger.

(c) Isolate the length of water main subject to swabbing by closing appropriate valves, including valves on offtake mains, gate valves on copper and polyethylene sub-mains and large size service connections where applicable. Close all hydrants within the limits of the swab run. Carry out swab runs prior to charging and flushing the mains(s).

(d) Operate the controlling valve to propel the swab along the water main swab route at a velocity of between 0.5 and 1.0 m/s.

(e) Upon removal of the swabs, flush the main until the discharged water is clear and then close the controlling valve.

(f) Repeat procedures (a) to (d) using new clean swabs as directed by the Engineer if a large amount of debris is discharged or if after a reasonable flushing time the discharging water remains discoloured.

(g) Only remove the discharge assembly when it is sure that entry into the main of deleterious matter or discharged water has been prevented and the results of bacteriological testing are satisfactory.

(h) Dispose of swabbing wastewater in accordance with the relevant Regulator and SWA requirements.

7 ACCEPTANCE TESTING

7.1 GENERAL

Acceptance testing is required to test the capability of the pipeline assembly to satisfy design requirements as specified. It is not intended to test the material capability. Testing is intended to:

(a) Reveal the existence of any assembly and structural faults.

(b) Ensure the water main can sustain pressures greater than the maximum operating pressure without leakage.

Undertake acceptance testing of all water mains and structures in accordance with the Specification and in the following order:

1. Visual inspection
2. Pressure testing

The Engineer will supervise all acceptance tests. All test results, including unsatisfactory results, shall be documented and reported to the Engineer.

Where specified, clean pipes, fittings and structures before any test is performed.

If any of the tests prove to be unsatisfactory, detect and rectify the fault. Continue to rectify and retest the water main until a satisfactory test result is obtained. Even if testing produces satisfactory results, rectify any water main, structure or appurtenance that has a visible or detectable leak, blockage, malfunction or other defect

7.2 VISUAL INSPECTION

Visually inspect all water mains and their component markers to ensure the pipeline assembly and the type and location of markers are as specified.

7.3 PRESSURE TESTING

7.3.1 General

Pressure test all water mains after trench filling and compaction and any concrete that has cured for not less than 7 days.

If any of the tests prove to be unsatisfactory, detect and rectify the fault, and re-test. Continue to rectify and re-test until a satisfactory test result is achieved. Even if testing produces satisfactory results, rectify any water main or conduit in which their is a visible or detectable leak or blockage.

Base the rate of filling on a maximum velocity of 0.05 m/s.

Allow between 3 and 24 hours for the test water temperature to stabilise and dissolved air to vent from the system. Fill cement-lined pipes 24 hours prior to testing to allow for saturation of the lining.

Unless otherwise permitted by the Engineer, adopt a maximum test length of 1000 m.

Acceptance testing may be conducted progressively with the authorisation of the Engineer. Testing may be carried out as soon as the Works are completed and where thrust restraint curing times have lapsed.

Where isolation is available, the water main may be progressively tested in sections of at least 100 m, or in its entirely if the main is less than 100 m.

7.3.2 System test pressure

A test pressure of 1.5 x maximum static head on the main or the manufacturers test pressure, whichever is the lesser, shall be applied over the test length.

7.3.3 Maximum allowable loss

The quantity of water consumed during the test shall not exceed 3 litres per 100mm of pipe diameter per 1000 meters length over 4 hours.

For example, for a 200mm pipe, test length of 750 metres the maximum allowable loss (MAL) is calculated as follows:

e.g. MAL (over 4 hours) = 3 litres x 200mm/100mm x 750m/1000m

= 4.5 litres

7.3.4 Test procedure

Use a test rig that has two calibrated pressure gauges. Each gauge shall have a range of 0-2500 kPa and shall have a current calibration certificate. Both gauges shall read within +5% of the test head and 5% of each other. Use the gauge recording the lower of the two readings. Before testing a water main section, clean the section and then slowly fill it with water, ensuring that air has been completely expelled.

With the exception of polyethylene, which is to be tested in accordance with WSA 01-2001, test all water mains as follows:

(a) Install blank flanges or caps at each end of the test section. Do not test against closed valves unless they are fully restrained and it is possible to check for leakage past the valve seat. Temporarily strut or anchor mechanical ends that are not end load resistant to withstand the test pressures without movement.

(b) Pressurise the line to 75% of the test pressure and leave for a minimum of 12 hours.

The preliminary pressurisation is intended to:

j) stabilised the water main by allowing most of the time-dependent movement to occur;

ii) achieve saturation in absorbent materials; and

iii) allow pressure-dependent increase in volume of flexible pipes prior to the main test.

(c) Provided there is no obvious leak in the water main, steadily raise the pressure in the water main until the specified test pressure is reached.

(d) Maintain the test pressure for minimum four (4) hours. Measure and record, at half hour intervals, the quantity of water added in order to maintain the pressure during the period of testing.

(e) Visually inspect the line for leaks. If a leak is suspected but is not visible, use leak detection equipment.

(f) Do not remove temporary supports until the test section has been depressurised.

(g) Dispose of test water in accordance with the relevant environmental Regulator and SWA requirements.

7.3.5 Satisfactory Pressure Test

Accept the pressure test on a section of water main if:

(a) There is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component,

(b) There is no visible leakage;

(c) The measured loss rate for the relevant test period of the pressure testing does not exceed the maximum allowable loss rate as determined in accordance with relevant Clause; and

(d) For polyethylene water mains, compliance with the requirements of Clause 2.13.5 of WSA 01-2001 is achieved for all mains except property services, which shall comply with the requirements of Clause 2.13.4 or Clause 2.13.5 of WSA 01-2001.

8 DISINFECTION

8.1 GENERAL

When instructed to do so by the Engineer, the Contractor shall disinfect the pipeline by chlorination either in sections or as a whole. The Contractor shall provide a suitable chlorine dose pump and chlorine which is capable of accurately injecting the required concentration of chlorine solution at a steady rate into the pipeline.

The Contractor shall introduce at least 20 p.p.m. of chlorine or such greater quantity of chlorine as will produce a residual of at least 1 p.p.m. of free chlorine at any point along the pipeline being sterilised 2 hours after the section of pipeline has been filled with water.

During the disinfection process operate all valves, hydrants, water meter ball valves (where fitted) and other fittings to ensure complete disinfection.

If after 24 hours, the residual chlorine is 1 p.p.m. or greater, then disinfection shall be deemed to be complete and the chlorinated water shall be drained and flushed away to a suitable outlet where no harm will result from the flow or its contents. Dispose of disinfected wastewater to meet relevant Regulator and the SWA requirements.

Upon completion of disinfection, the Contractor shall close off access to the pipeline and no further work will be permitted affecting the interior of the pipelines. Should any unauthorised access occur and if the Principal rules that contamination may have resulted, the Contractor shall carry out at his own expense re-disinfection measures required by the Engineer.

9 TOLERANCES ON AS-CONSTRUCTED WORK

9.1 GENERAL

Construct all water mains, associated structures and appurtenances in the positions shown on the Design Drawings in accordance with the tolerances specified.

9.2 HORIZONTAL TOLERANCES

Water mains and in-line structures

Do not exceed the following positional tolerances:

(a) Water mains - +100 mm lateral displacement from the design water main alignment.

(b) Water meters - +100 mm displacement from the position as specified.

9.3 VERTICAL TOLERANCES

9.3.1 Water mains, property connections and structures

Do not deviate the inverts of new water mains, property connections and structures from the specified design level (or interpolated design level) by more than 50 mm higher or lower, providing the depth from final ground surface level to the top of the pipe exceeds the minimum cover stated in Standard Drawings.

Link up to existing water mains or structures at the design levels equal to or greater than the minimum acceptable cover.

9.3.2 Vertical ("plumb")

For hydrant risers, access chambers, shrouds and aqueduct piers, apply a tolerance at any point on the pipe or structure as follows:

(a) 30 mm deviation (from vertical) per meter rise in any direction; and

(b) limited to a maximum 50 mm cumulative deviation (from vertical) in any one particular direction for structures higher than 5 m.

9.4 TOLERANCES ON FINISHED SURFACE STRUCTURES AND FITTINGS

For structures and fittings designed flush with the ground / pavement surface or proud of the surface, apply a vertical tolerance on the finished surface levels as follows:

(a) +10 mm in roads reserves, including sealed pavements, road verges, driveways, footways, and pedestrian thoroughfares.

(b) +10 mm in sealed and trafficable areas within private properties (pedestrian and/or vehicular traffic).

(c) +50 mm, -20 mm in private property including garden areas, unsealed areas, non-trafficable areas and areas of occasional traffic (pedestrian and/or vehicular traffic).

9.5 CAST IN-SITU CONCRETE STRUCTURES AND SLABS

Apply a construction tolerance of +5%-2% on the specified internal dimensions (e.g. diameter, length, width, depth etc.) for cast in-situ concrete structures and the external dimensions of slabs.

Apply a construction tolerance on all thicknesses specified of +50 mm, -0.

10 CONNECTIONS TO EXISTING WATER MAINS

10.1 GENERAL

Undertake connection of new works to existing water supply systems using authorised methods and equipment unless the Engineer has given prior authorisation to do otherwise.

Comply with the relevant SWA's requirements for Works on live water supply assets. Do not make connections until all other Works are completed.

Select a method of connection and time connection Works as necessary to meet operational needs of the existing water supply system and customer service requirements.

Have all the necessary materials and equipment available on site prior to commencement of connection Works. Minimise the interruption to the operation of the existing water supply system.

Temporary water supply systems may be required to maintain continuity of customer supply.

Carry out all preparatory and trench filling work, which may include, but not be limited to:

(a) Excavate a shaft over the existing main to determine whether there will be difficulty in making the connection, any special pipework required or excessive depth will be encountered. Backfill the shaft until the day of connection unless directed otherwise by the Engineer.

(b) Ensure the excavation at the point of connection is kept free of water during the connection process to eliminate contamination of the mains.

(c) Provide necessary materials and fittings required for the connection.

(d) Carry out the connection after the SWA has isolated the mains.

(e) Ensure that specified minimum cover over the new main is maintained at connections by lowering existing mains as necessary or providing a suitable form of vertical connection.

10.2 UNDER PRESSURE CONNECTIONS

When specified in the Design Drawings, undertake connections involving cut-ins under pressure to water mains by the SWA or Contractor in accordance with the Design Drawings.

Where the work is to be carried out by the SWA:

(a) Provide all necessary materials and fittings required for the connection.

(b) Carry out all necessary excavations to the minimum dimensions shown in the Design Drawings and provide all shoring, barriers, lighting, traffic control and safety measures required to ensure worker and public safety during the operation.

(c) Provide suitable equipment for lifting the tapping machine and valve into position and removing the tapping machine.

(d) Pressure test the connection when installed.

Following the installation and pressure testing of the connection, place embedment and trench fill in accordance with relevant specifications.

10.3 INSERTED TEE CONNECTIONS

Where specified in the Design Drawings, connection to water mains involving the insertion of a tee using mechanical couplings shall be undertaken by the SWA or Contractor in accordance with the Design Drawings.

Shutdown of the SWA's existing mains may not completely prevent the inflow of water into the isolated sections.

Following the installation and pressure testing of the connection, place embedment and support, construct a thrust block and backfill as specified in accordance with Design Drawings and relevant clauses.

11 REINSTATEMENT

11.1 GENERAL

The requirement to restore surfaces shall apply to construction by means of trenching, tunnelling and/or boring.

Restore to pre-existing condition or to the requirements of the SWA and the Owner(s) all surfaces, services and/or improvements disturbed, destroyed, removed or damaged during construction of the Works and/or during installation of temporary Works such as access roads.

The SWA's relationship with its customers may be significantly enhanced by providing excellent service, particularly in the area of site restoration. Consequently, there is an expectation that restoration should be to the highest standards.

The site shall be:

(a) Kept in a safe, clean and tidy manner during construction; unsightly items such as spoil stockpiles and barricades shall be kept to a minimum; site debris and excess materials shall be regularly cleaned up, removed and properly disposed.

(b) Restored progressively and as soon as possible; restoration work shall not be deferred.

(c) Left in a tidy and presentable condition.

11.2 PAVEMENTS

Immediately the filling of a trench excavation through a pavement has been completed, restore the pavement to a trafficable condition. Where the initial restoration is of a temporary nature, use a pre-mixed asphalt material.

Maintain temporary restoration until final restoration is carried out. Carry out final restoration of the pavement to restore both pavement and sub-base to no less than their pre-existing condition. If appropriate, remove temporary restoration when carrying out final restoration work.

After their initial temporary restoration, maintain pavements of other than bitumen or concrete with crushed metal, gravel or equivalent material, making due allowance for consolidation, and then restore to a condition equivalent to that of the original pavement.

Complete the final restoration of bitumen and concrete pavements within one (1) month of temporary restoration.

11.3 LAWNS

Reinstate lawns with turf sods cut and set aside from the original surface or with similar turf imported for the purpose.

For areas to be turfed, ensure topsoil is graded to achieve a smooth surface, is free from lumps, stones and other debris, conforms to finished levels, blends gradually into the adjoining undisturbed ground and finishes flush with kerbs, footpaths and other paved surfaces.

11.4 GRASS VERGES

For grassed areas that are not lawns, restore by replacing the pre-existing topsoil and maintaining the disturbed area in a condition that will promote re-growth of pre-existing grasses.

11.5 BUSHLAND

Carry out all works in accordance with the requirements of the environmental Regulator.

Restore the works are as near as practicable to the pre-existing condition and leave the site in such condition as will promote the rapid re-growth of native bush plant species prevalent in the immediate vicinity.

Return stockpiled topsoil to its pre-construction location and place it in such a way that erosion will be minimised, e.g. by the use of small contour bands.

11.6 PROVISION FOR SETTLEMENT

Through other than pavements, lawns or other improved surfaces, place trench fill sufficiently high to compensate for expected settlement. Subsequently, carry out further filling or trim the original trench fill, in order that the surface level of the completed trench conforms to the adjacent surface.

Remove all surplus material and dispose of without breaching applicable regulations and laws. Do not dispose of surplus on any property without he property owner's written permission.

11.7 MAINTENANCE OF RESTORED SURFACES

Maintain all restored surfaces and improvements in a satisfactory condition until the end of the defects liability period.

12 WORK AS CONSTRUCTED DETAILS

Prepare Work As-Constructed drawings and documentation to the requirements of the SWA.

Note: Specification Writer to insert SWA's As-Construction Drawing requirements depending on the nature of the project. For example, hand marked up Design Drawings, or corrected design drawings using AutoCAD 2014 (2 x hardcopy, 1 x electronic copy) or corrected GIS Plans using MapInfo software, (2 x Hardcopy, 1 x electronic copy).