



Engineering

Technical Standard

TS 0711.0 - Concrete Remedial Works: General Requirements

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Only the current revision of this Technical Standard should be used, which is available for download from the SA Water website.

Significant/Major Changes Incorporated in This Edition

This is the first issue of this Technical Standard. However, it supersedes the following SA Water documents:

- a) SAW-ENG-STR-TEM-TSB-001 Technical Specification - Concrete Repair Works: General Requirements
- b) TS137 – Rehabilitation of Concrete Wastewater Manholes

Document Controls

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Contents

1	Introduction.....	7
1.1	Purpose	7
1.2	Abbreviations	8
1.3	References	9
1.3.1	Use of Standards and Codes	9
1.3.2	Australian and International Standards.....	9
1.3.3	SA Water Documents.....	14
1.3.4	Technical Guides.....	14
1.4	Definitions	16
2	Scope	25
2.1	Type of Structures.....	25
2.2	Exclusions	26
2.3	Technical Dispensation.....	26
3	Using this Technical Standard.....	27
4	General Project Requirements	28
4.1	Concrete Repair Constructor Pre-qualification	28
4.1.1	Specialist Concrete Repair Constructor Experience	28
4.1.2	Qualifications of Personnel – Site Management.....	28
4.1.3	Qualifications of Personnel – Site Supervisor/Project Engineer	29
4.1.4	Qualifications of Personnel – Operatives.....	30
4.1.5	Qualifications of Personnel - Sub-Constructors	30
4.1.6	Qualifications of Personnel - Constructor Coating Inspectors.....	30
4.2	Independent Quality Control Inspector/Technical Support	30
4.3	Project Specification	31
4.4	Submissions	31
4.4.1	General	31
4.4.2	Applied Coatings	31
4.5	Design Life	32
4.6	Warranties/Guarantees.....	32
4.7	Drawings	32
5	Quality Requirements.....	33
5.1	Quality Management System	33
5.2	Quality System Audits	33
5.3	Quality Plan	33
5.4	Identification & Traceability	34
5.5	Work Method Statement.....	34
5.6	Inspection and Test Plans	35
5.7	Hold Points and Witness Points.....	36
5.7.1	Hold Points	36
5.7.2	Witness Points.....	36

5.8	Non-Conformance	37
5.9	Testing Requirements.....	37
5.9.1	General	37
5.9.2	Quality Assurance Testing.....	37
5.10	Permits and Certificates	38
5.11	Site Records.....	38
5.12	As-Repaired/Constructed Report.....	38
6	Health and Safety Requirements.....	40
6.1	General.....	40
6.2	Works on Existing Sewers.....	40
6.3	Lighting	40
6.4	Concrete Removal	41
6.4.1	General Requirements.....	41
6.4.2	Management of Silicosis Risk	41
6.4.3	Concrete Cutting and Drilling	41
6.4.4	Hydro-Demolition.....	42
6.4.5	Demolition.....	42
6.5	Diving	42
6.6	Traffic Management.....	42
6.7	Barriers and Signs	42
6.8	Equipment	42
6.9	Hazardous Materials	43
6.9.1	Existing Hazardous Materials.....	43
6.9.2	Hazardous Repair Materials.....	43
6.9.3	Fume Control	43
6.9.4	Disposal of Hazardous Materials	43
7	Environmental Requirements.....	44
7.1	Noise Emissions	44
7.2	Compressor Silencing	44
7.3	Hand Tools	44
7.4	Waste Management/Disposal of Contaminants	44
7.5	General Cleaning and Disposal of Refuse	45
7.6	Dust and Water	45
7.7	Existing Flora	45
8	Construction Requirements	46
8.1	Existing Structures	46
8.1.1	Verify Existing Structures and Services	46
8.1.2	Protection and Maintenance of Structures	46
8.1.3	Repair of Structures	46
8.1.4	Salvaged Items.....	46
8.2	Temporary Works.....	46
8.2.1	Temporary Structural Support and Access Systems	46

8.2.2	Plant Isolation.....	47
8.2.3	Temporary Services	47
8.3	Extent of Works Identification.....	47
8.3.1	General	47
8.3.2	Pre-Repair Survey	48
8.3.3	Destructive and Non-Destructive Testing	48
8.3.4	Recording of Inspection Results	48
8.3.5	Marking Repair Areas.....	49
8.4	Materials Requirements.....	49
8.4.1	General	49
8.4.2	Repair Systems	49
8.4.3	Proprietary Items.....	49
8.4.4	Manufacturer's Recommendations	50
8.4.5	Product Supplier	50
8.4.6	Compliance with AS/NZS 4020	50
8.4.7	Materials Submissions	51
8.4.8	Storage and Use of Materials	51
8.5	Trials.....	52
8.5.1	Purpose	52
8.5.2	Trial Requirements	52
8.5.3	Trial Repair Report	53
8.6	Pre Start Meeting	53
8.7	Commissioning and Water Quality Monitoring	54

Appendix A : Schedules of Hold Points, Witness Points and Identified Records.. 55

A1	Schedule of Hold Points.....	55
A2	Schedule of Witness Points	55
A3	Schedule of Identified Records	55

List of tables

Table 1:	SAWS-ENG-0711 Suite Overview.....	7
Table 2:	Abbreviations.....	8
Table 3:	Australian and International Standards.....	10
Table 4:	SA Water Technical Standards.....	14
Table 5:	Australian and International Technical Guides	14
Table 6:	Glossary of Terminology Definitions.....	16
Table 7:	Glossary of Technical Definitions.....	18
Table 8:	TS 0711 Interface with Typical Concrete Remediation Phases.....	27
Table 9:	Minimum Design Life and Warranties	32
Table 10:	Lighting Illumination Requirements	41

1 Introduction

1.1 Purpose

SA Water is responsible for operation and maintenance of an extensive amount of engineering infrastructure. Concrete rehabilitation is a core aspect of managing SA Water's existing water and wastewater infrastructure to maximise the service life of these assets.

This Technical Standard "SAWS-ENG-0711 Concrete Remedial Works" has been developed to assist in the maintenance and management of SA Water's concrete assets, to ensure that remedial works are completed to consistent standards to attain the specified asset life.

The purpose of Technical Standard SAWS-ENG-0711 Concrete Remedial Works is to detail the minimum technical requirements of remedial works for SA Water's reinforced concrete water and wastewater assets, and comprises the following suite of sub-documents:

TS 0711.0: General Requirements (This Document)

TS 0711.1: Concrete repairs

TS 0711.2: Joint sealant replacement

TS 0711.3: Concrete crack repair

TS 0711.4: Structural bonding and strengthening

TS 0711.5: Surface protection and lining of concrete

Table 1 summarises the scope of each sub-document.

The purpose of TS 0711.0: General Requirements (this document) is to detail the interface between each Technical Standard sub-document, and to provide general technical requirements that are applicable to all SA Water's water and wastewater structure concrete repair projects.

All sub-documents of the Technical Standard must be read together, in particular with this document TS 0711.0: General Requirements.

Table 1: SAWS-ENG-0711 Suite Overview

TS 0711.0: Concrete Remedial Works				
Outline of the Technical Standard and general requirements for the works				
TS 0711.1 Concrete Repairs	TS 0711.2 Joint Sealant Replacement	TS 0711.3 Concrete Crack Repair	TS 0711.4 Structural Bonding and Strengthening	TS 0711.5 Surface Protection and Lining of Concrete
<i>Concrete patch repairs (structural and non-structural) as specified to identified areas of concrete degradation, delamination, spalling and localised loss of cover to reinforcement.</i>	<i>Removal of defective/failed joint sealant and replacement for applications such as general/ trafficable, water retaining structures and aggressive chemical exposures.</i>	<i>Resin injection of cracks in concrete of structural, water tightness, and/or durability consequence in either static or dynamic loadings. Topical treatments to seal or bandage cracks. Crack routing and sealing.</i>	<i>Supplementing structural capacity via fibre reinforced composites.</i>	<i>Coating systems and surface applied impregnating treatments for the protection and waterproofing of the concrete substrate.</i>

1.2 Abbreviations

Abbreviations used in this suite of Technical Standards are listed in Table 2.

Table 2: Abbreviations

Abbreviation	Description
AAR	Alkali aggregate reaction
ACA	Australasian Corrosion Association
ACI	American Concrete Institute
ACRA	Australian Concrete Repair Association
AMPP	Association for Materials Protection and Performance
AMSA	Australian Maritime Safety Authority
APAS	Australian Paint Approval Scheme
AS	Australian Standards
ASTM	American Society for Testing and Materials
BRE	(United Kingdom) Building Research Establishment
BS	British Standard
BS EN	British Standard European Norm
CAC	Calcium Aluminate Cement
CIA	Concrete Institute of Australia
COSHH	Control of Substances Hazardous to Health
CPF	Controlled permeability formwork
DEF	Delayed ettringite formation
DFT	Dry Film Thickness
EMP	Environmental Management Plan
EN	European Norm (European Standard)
EPA	Environmental Protection Agency
EWP	Elevating Work Platform
FRP	Fibre Reinforced Polymer
FTB	Film tear bond
HDPE	High Density Polyethylene
HSE	(United Kingdom) Health and Safety Executive
ICRI	International Concrete Repair Institute
ISO	International Standard Organisation
ITP	Inspection and Test Plan
JSEA	Job Safety and Environmental Analysis
MCI	Migrating Corrosion Inhibitor
MPa	Mega Pascal
MSDS	Material Safety Data Sheet
NACE	National Association of Corrosion Engineers International
NATA	National Association of Testing Authorities
NDFT	Nominal Dry Film Thickness

Abbreviation	Description
NZS	New Zealand Standards
OHS	Occupational Health and Safety
PE	Polyethylene
PVC	Polyvinylchloride
QA/QC	Quality Assurance / Quality Control
QMS	Quality Management System
SACP	Sacrificial Anode Cathodic Protection
SA Water	South Australian Water Corporation
SSD	Saturated Surface Dry
SSPC	The Society for Protective Coatings
SWA	Safe Work Australia
TDS	Technical Data Sheet
TG	SA Water Technical Guideline
TS	SA Water Technical Standard
WFT	Wet Film Thickness
WMS	Work Method Statement
WRS	Water retaining/excluding structure
WSAA	Water Services Association of Australia
WWPS	Wastewater Pump Station

1.3 References

1.3.1 Use of Standards and Codes

Unless otherwise specified in the Contract, and where applicable, materials and workmanship is to be in accordance with the relevant Standard or Code.

Unless otherwise specified use the most current published edition (prior to the closing date for tenders) of Standards and Codes applicable to the Works.

Use Standards and Codes consistently throughout the design, supply and installation process without interchanging between different Standards.

Overseas standards and other standard documents named in the Technical Standard are applicable in the same manner as Australian Standards to relevant materials and workmanship.

In the event of there being no relevant Australian Standard or Code at the date of invitation to tender, use the relevant code or standard of the British Standards Institution or the American Society for Testing and Materials in that order of precedence.

1.3.2 Australian and International Standards

Table 3 identifies Australian and International Standards referenced in parts of this Technical Standard suite of documents.

Table 3: Australian and International Standards

Number	Title
AS 1012.9	Methods of testing concrete - Compressive strength tests - Concrete, mortar and grout specimens
AS 1012.13	Methods of testing concrete - Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1012.14	Methods of testing concrete - Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume
AS 1012.20	Methods of testing concrete - Determination of chloride and sulfate in hardened concrete and concrete aggregates
AS 1012.21	Methods of testing concrete - Determination of water absorption and apparent volume of permeable voids in hardened concrete
AS 1012.24	Methods of testing concrete - Determination of the tensile bond strength of concrete - Repairs and strengthening systems
AS 1170.0 to 5	Structural design actions
AS 1281	Cement mortar lining of steel pipes and fittings
AS 1379	Specification and supply of concrete
AS 1478.2	Chemical admixtures for concrete, mortar and grout - Methods of sampling and testing admixtures for concrete, mortar and grout
AS 1530.4	Methods for fire tests on building materials, components and structures
AS 1580	Paints and related materials - Methods of test
AS 1580.108.2	Paints and related materials - Methods of test dry film thickness - Paint inspection gauge
AS 1580.408.2	Paints and related materials - Methods of test - Adhesion - Knife test
AS 1627.1	Metal finishing - Preparation and pre-treatment of surfaces – Removal of oil, grease and related contamination
AS 1627.2	Metal finishing - Preparation and pre-treatment of surfaces – Power tool cleaning
AS 1627.4	Metal finishing - Preparation and pre-treatment of surfaces – Abrasive blast cleaning of steel
AS 1627.9	Metal finishing - Preparation and pre-treatment of surfaces – Pictorial surface preparation standards for painting steel surfaces
AS 1940	The storage and handling of flammable and combustible liquids
	Occupational diving operations - Standard operational practice
AS 2350.13	Methods of testing Portland, blended and masonry cements Method 13: Determination of drying shrinkage of cement mortars
AS 2436	Guide to noise and vibration control on construction, demolition and maintenance sites
AS 2601	The demolition of structures
AS 2700	Colour standards for general purposes
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS 3700	Masonry structures
AS 3735	Concrete structures for retaining liquids
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3894.1	Site testing of protective coatings Non-conductive coatings - Continuity testing - High voltage ('brush') method

Number	Title
AS 3894.3	Site testing of protective coatings - Determination of dry film thickness
AS 3894.5	Site testing of protective coatings - Determination of surface profile
AS 3894.6 Section 7 Method B	Site testing of protective coatings - Determination of oil or water droplet contamination for the presence of oil and grease
AS 3894.9	Site testing of protective coatings - Determination of adhesion
AS 3894.10	Site testing of protective coatings - Inspection report – Daily surface and ambient conditions
AS 3894.11	Site testing of protective coatings - Equipment report
AS 3894.12	Site testing of protective coatings - Inspection report - Coating
AS 3894.13	Site testing of protective coatings - Inspection report – Daily
AS 3894.14	Site testing of protective coatings - Inspection report – Daily painting
AS 4072.1	Components for the protection of openings in fire-resistant separating elements Service penetrations and control joints
AS 4131	Polyethylene (PE) compounds for pressure pipes and fittings
AS 5100.5	Bridge design Part 5: Concrete
AS 5100.8	Bridge design Part 8: Rehabilitation and strengthening of existing bridges
AS Handbook HB 84	Guide to concrete repair and protection
AS Handbook HB 198	Guide to the specification and testing of slip resistance of pedestrian surfaces
AS/NZS 1314	Prestressing anchorages
AS/NZS 1516	The cement mortar lining of pipelines
AS/NZS 1554.3	Structural steel welding - Welding of reinforcing steel
AS/NZS 1554.6	Structural steel welding - Welding stainless steels for structural purposes
AS/NZS 1580. 601.1.	Paints and related materials - Methods of test Method 601.1: Colour - Visual comparison
AS/NZS 1680.2.4	Interior and workplace lighting Industrial tasks and processes
AS/NZS 1716	Respiratory protective devices
AS/NZS 2280	Ductile iron pipes and fittings
AS/NZS 2312.1	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings Paint coatings
AS/NZS 2425	Bar chairs in reinforced concrete - Product requirements and test methods
AS/NZS 2865	Confined spaces
AS/NZS 3730	Guide to the properties of paints for buildings
AS/NZS 3750.14	Paints for steel structures High-build epoxy (two-pack)
AS/NZS 4020	Testing of products for use in contact with drinking water
AS/NZS 4548.1	Guide to long-life coatings for concrete and masonry - Wall coatings - Latex extensible
AS/NZS 4548.5	Guide to long-life coatings for concrete and masonry Guidelines to methods of test
AS/NZS 4586	Slip resistance classification of new pedestrian surface materials
AS/NZS 4671	Steel reinforcing materials

Number	Title
AS/NZS 4672.1	Steel prestressing materials - General requirements
AS/NZS 4672.2-7	Steel prestressing materials - Testing requirements
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS ISO 9001	Quality management systems - Requirements
AASHTO 358-19	Surface resistivity indication of concrete's ability to resist chloride ion penetration.
ACI 224.1	Causes, evaluation, and repair of cracks in concrete structures
ACI 440.1	Guide for the design and construction of structural concrete reinforced with fiber-reinforced polymer (FRP) bars
ACI 440.2	Guide for the design and construction of externally bonded FRP systems for strengthening concrete structures
ACI 440.8	Specification for carbon and glass fiber-reinforced polymer materials made by wet layup for external strengthening
ACI 503.7	Specification for crack repair by epoxy injection
ACI 515.2	Guide to selecting protective treatments for concrete
ACI 546	Guide to concrete repair
ACI 546.2	Guide to underwater repair of concrete
ACI 546.3	Guide to materials selection for concrete repair
ACI 548.11	Guide for the application of epoxy and latex adhesives for bonding freshly mixed and hardened concretes
ACI 548.12	Specification for bonding hardened concrete and steel to hardened concrete with an epoxy adhesive
ACI 548.13	Specification for bonding fresh concrete to hardened concrete with a multi-component epoxy adhesive
ACI 548.14	Specification for repairing concrete with epoxy mortar
ACI 549.4	Guide to design and construction of externally bonded fabric-reinforced cementitious matrix and steel-reinforced grout systems for repair and strengthening of concrete structures
ACI 562	Assessment, repair, and rehabilitation of existing concrete structures - Code and commentary
ACI 563	Specifications for repair of concrete in buildings
ASTM C267	Standard test methods for chemical resistance of mortars, grouts, and monolithic surfacings and polymer concretes
ASTM C805	Standard test method for rebound number of hardened concrete
ASTM C1581	Standard test method for determining age at cracking and induced tensile stress characteristics of mortar and concrete under restrained shrinkage
ASTM C1583/ C1583M	Standard test method for tensile strength of concrete surfaces and the bond strength or tensile strength of concrete repair and overlay materials by direct tension (pull-off method)
ASTM C939	Standard test method for flow of grout for preplaced-aggregate concrete (flow cone method)
ASTM C940	Standard test method for expansion and bleeding of freshly mixed grouts for preplaced-aggregate concrete in the laboratory
ASTM D1248	Standard specification for polyethylene plastics extrusion materials for wire and cable
ASTM D3895	Standard test method for oxidative-induction time of polyolefins by differential scanning calorimetry

Number	Title
ASTM D4258	Standard practice for surface cleaning concrete for coating
ASTM D4262	Standard test method for pH of chemically cleaned or etched concrete surfaces
ASTM D4263	Standard test method for indicating moisture in concrete by the plastic sheet method
ASTM D4437 / D4437M	Standard practice for non-destructive testing (NDT) for determining the integrity of seams used in joining flexible polymeric sheet geomembranes
ASTM D5641 / D5641M	Standard practice for geomembrane seam evaluation by vacuum chamber
ASTM D5989	Standard specification for extruded and monomer cast shapes made from nylon (PA)
ASTM D6132	Standard test method for non-destructive measurement of dry film thickness of applied organic coatings using an ultrasonic coating thickness gage
ASTM D6392	Standard test method for determining the integrity of non-reinforced geomembrane seams produced using thermo-fusion methods
ASTM F1869	Standard test method for measuring moisture vapor emission rate of concrete subfloor using anhydrous calcium chloride
ASTM F2136	Standard test method for notched, constant ligament-stress (NCLS) test to determine slow-crack-growth resistance of HDPE resins or HDPE corrugated pipe
ASTM F2170	Standard test method for determining relative humidity in concrete floor slabs using in situ probes
ASTM F22	Standard test method for hydrophobic surface films by the water-break test
BS 6319.2	Testing of resin and polymer/cement compositions for use in construction. Method for measurement of compressive strength
BS 6319.3	Testing of resin and polymer/cement compositions for use in construction. Method for measurement of modulus of elasticity in flexure and flexural strength
BS 6319.7	Testing of resin and polymer/cement compositions for use in construction. Method for measurement of tensile strength
BS 8204-6+A1	Screeds, bases and in situ floorings. Synthetic resin floorings. Code of practice
BS EN 14647	Calcium aluminate cement – Composition, specifications and conformity criteria
BS EN 1504(1-10)	Products and systems for the protection and repair of structures – Definitions, requirements, quality control and evaluation
EN 1504-2	Products and systems for the protection and repair of concrete structures – definitions, requirements, quality control and evaluation of conformity – Part 2: Surface protection systems for concrete
EN 12311-2	Flexible sheets for waterproofing - Determination of tensile properties - Part 2: Plastic and rubber sheets for roof waterproofing
ISO 16311(1-4)	Maintenance and repair of concrete structures
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 9047	Building construction - Jointing products - Determination of adhesion/cohesion properties of sealants at variable temperatures
GRI-GM13	Standard specification for "test methods, test properties and testing frequency for high density polyethylene (HDPE) smooth and textured geomembranes"
RILEM CPC 18	Measurement of hardened concrete carbonation depth.

1.3.3 SA Water Documents

Table 4 identifies SA Water Technical Standards referenced in all parts of this Technical Standard suite of documents.

Table 4: SA Water Technical Standards

Number	Title
SAWG-RM-0001	SA Water corporate risk management methodology
TS 0100	Requirements for technical drawings
TS 0101	Safety in Design
TS 0103	Survey requirement specification
TS 0109	Design Life (when released)
TS 0420	Welding requirements (Metals)
TS 0421	Stainless Steel Durability, Fabrication and Erection (when released)
TS 0600	Watertightness Testing of Liquid Retaining Structures
TS 0710	Concrete
TS 0800	Materials in Contact with Drinking Water

1.3.4 Technical Guides

Table 5 identifies Australian and International Technical Guide documents and other similar documents referenced in all parts of this Technical Standard suite of documents.

Refer to AMPP for current version of NACE and SSPC documents and certified merged training course titles.

Table 5: Australian and International Technical Guides

Number	Title
APAS 0156	Epoxy mastic high build 2-pack coating for rusted steel
APAS 0171	Solvent borne sealer for concrete & masonry (buildings)
APAS 0280	Exterior water based paint for buildings
APAS 2911	Polyurethane coatings for the protection of steel in atmosphere
APAS 2917	Catalysed polyester coating for protection of steel
APAS 2920	Siloxane and Polysiloxane coatings for the long term protection of steel and masonry
APAS 2973	Medium build 2-pack epoxy coating for the long term protection of steel
APAS 2974	Medium build solventless two-pack epoxy coating for the long term protection of steel
APAS 2977	Slow drying/high volume solids two-pack epoxy mastic coating for the long term protection of steel
BRE Digest 444	Corrosion of steel in concrete durability of reinforced concrete structures Parts 1-3
CIA Z5	Shotcreting in Australia
CIA Z7/04	Good practice through design, concrete supply and construction
CIA Z7/07	Performance tests to assess concrete durability
CIA Z9	Curing of concrete
CIA Z12	Pumped concrete

Number	Title
Concrete Society TR54	Diagnosis of deterioration in concrete structures: Identification of defects, evaluation and development of remedial action
Concrete Society TR68	Assessment, design and repair of fire-damaged concrete structures
Concrete Society TR69	Repair of concrete structures with reference to BS EN 1504
ICRI Technical Guideline No 310.2R	Selecting and specifying concrete surface preparation for sealers, coatings, and polymer overlays guide
ICRI Technical Guideline No. 210.3	Guide for using in-situ tensile pull-off tests to evaluate bond of concrete surface materials
InstStrucEng	Institution of Structural Engineers - Appraisal of existing structures 2nd Edition
NACE 6A192 -SSPC-TR 3-2000-SG	Dehumidification and temperature control during surface preparation, application, and curing for coatings/linings of steel tanks, vessels, and other enclosed spaces
NACE 6A198	Introduction to thick-film polyurethanes, polyureas and blends
NACE SP0188	Discontinuity (Holiday) testing of new protective coatings on conductive substrates
SSPC Paint 39	Two-component aliphatic polyurea topcoat fast or moderate drying, performance-based
SSPC-PA 7	Paint application specification No. 7, applying thin film coatings to concrete
SSPC-SP 13/NACE No. 6	Surface preparation of concrete
SSPC-TU 2/NACE 6G197	Design, installation, and maintenance of coating systems for concrete used in secondary containment
Safe Work Australia	Confined spaces code of practice
	General guide for working in the vicinity of overhead and underground electric lines
	Guide for managing risks from high pressure water jetting
	Working with silica and silica containing products: National guidance material
	Demolition work code of practice
UK HSE COSHH essentials in construction: Silica	CN0 Advice for managers
	CN1 Scabbling or grinding
	CN2 Chasing with hand-held power tools
	CN3 Drilling with hand-held rotary power tools
	CN4 Crushing and screening demolition material
	CN5 Small scale clearing of rubble, dust and debris
	CN6 Cutting blocks, paving and kerbstones with a cut-off saw
	CN7 Abrasive blasting
	CN8 Diamond coring/hole cutting
CN9 Breaking in enclosed spaces	
WaterCorp 11963553	Concrete structures condition assessment guideline
Worksafe Victoria	Safe concrete cutting and drilling, Edition No. 3
WSA 05	Conduit inspection reporting code of Australia 3rd ed.

Number	Title
WSA 201 version 2.1	Manual for selection and application of protective coatings
WSAA	Condition assessment guideline for civil structures
WSAA	Tank inspection reporting code

1.4 Definitions

Glossaries of terminology and technical definitions applicable to this Technical Standard suite of documents are listed in Table 6 and Table 7.

Table 6: Glossary of Terminology Definitions

Term	Description
Accepted	Determined to be satisfactory by SA Water's Representative
Constructor	The organisation responsible for constructing and installing infrastructure for SA Water whether it be a third party under contract to SA Water or an in-house entity.
Constructor's Operative	Constructor's directly employed or sub-contracted site worker undertaking the repair works.
Constructor's Project Director	Constructor's representative with overall responsibility for the repair works.
Constructor's Site Manager	Constructor's representative with responsibility for management of the day to day on-site repair works.
Constructor's Site Supervisor	Constructor's representative/s with responsibility for day to day direction, training and supervision of site operatives for the repair works and their achievement of QA/QC compliance.
Constructor's Technical Director/Quality Manager	Constructor's representative/s with responsibility for all technical aspects and quality of the repair works, staff training and achievement of QA/QC compliance.
Contract Documents	A set of documents supplied to Constructor as the basis for construction; these documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes
Designer	The organisation responsible for designing infrastructure for SA Water whether it be a third party under contract to SA Water or a Constructor, or an in-house entity
Manufacturer	A person, group, or company that owns and operates a manufacturing facility that provides materials for use in SA Water infrastructure
Principal (e.g. in AS/NZS 1554.3 and AS/NZS 1554.6)	The term "Principal" shall mean SA Water's Representative.
Quality Control Engineer	An independent engineer or consultant responsible for undertaking all quality control testing and inspections to ensure compliance with this Technical Standard.
Repair Works	All works related to repair of the structure.
Responsible Discipline Lead	The engineering discipline expert responsible for TS 0711 defined on page 3 Approval (via SA Water's Representative).
SA Water's Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): <ul style="list-style-type: none"> • Superintendent's Representative (e.g. AS 4300 & AS 2124 etc.) • SA Water Project Manager • SA Water nominated contact person

Term	Description
"Shall" and "Should"	In this Standard the word "shall" indicates a requirement that is to be adopted in order to comply with the Standard. The word "should" indicates practices which are advised or recommended.
Supplier	A person, group or company that provides goods for use in SA Water infrastructure
TDRF	<p>Technical Dispensation Request Form.</p> <p>This form is part of SA Water's Technical Dispensation Request Procedure which details the process by which those required to comply, or ensure compliance, with SA Water's technical requirements may seek dispensation from those requirements.</p>
Terminology	<ul style="list-style-type: none"> • Where an obligation is given and it is not stated who is to undertake these obligations, they are to be undertaken by the Constructor. • Directions, instructions and the like, whether or not they include the expression "the Constructor shall" or equivalent, shall be directions to the Constructor, unless otherwise specifically stated. • Where a submission, request, proposal is required and it is not stated who the recipient should be, it is to be provided to SA Water's Representative for review. • Each word imparting the plural shall be construed as if the said word were preceded by the word "all". • Each word implying persons shall, where appropriate, also be construed as including corporations. • "Authorised", "approval", "approved", "selected", "directed" and similar words shall be construed as referring to the authorisation, approval, selection or direction of SA Water's Representative in writing. • "Allow" shall mean that the cost of the item referred to is the responsibility of the Constructor. • "Provide" shall mean "supply and install". • "Submit" shall mean "submit to SA Water's Representative or their nominated delegate". • Submissions, requests, proposals are to be provided at least 7 working days prior to work commencing or material ordering (unless noted otherwise). • "Informative" shall mean "provided for information and guidance"
Works	Elements of a project which require design and/or construction

Table 7: Glossary of Technical Definitions

Term	Definition
Active cracks	Live cracks, which are subject to further movement (i.e. opening up).
Alkali aggregate reaction	Disruptive chemical reaction within the concrete matrix between the alkali hydroxides (sodium and potassium) and susceptible aggregates (characterized by unstable silica minerals) in the presence of moisture, which produces an expansive alkali silica gel which subsequently exerts excessive tensile stresses that results in cracking of the concrete structure.
Anode	A metal that is placed in or in contact with an electrolyte and connected to the steel reinforcement to apply cathodic protection (CP) to a reinforcement within a concrete structure.
Anti-carbonation coating	Coating applied to concrete and other cement-based substrates to retard their carbonation by atmospheric carbon dioxide (CO ₂).
Bandage	A flexible and elastic waterproofing tape installed across static or high movement crack or joints adhered to the concrete using epoxy resin adhesive.
Blowholes	Small regular or irregular cavities, usually not exceeding 15 mm in diameter or 5 mm in depth, resulting from entrapment of air bubbles in the surface of formed concrete during placement and consolidation.
Bond	The chemical and/or mechanical adherence between a repair material or coating and a concrete substrate.
Bond strength (or pull-off strength)	The resistance to separation of an adhered repair material or coating from a concrete substrate via the mechanical application of a tensile stress.
Breakout	Removal of a limited area of concrete. Typically from or adjacent to a damaged area, but may also occur for testing purposes.
Calcium aluminate cement	A hydraulic cement predominately comprising calcium aluminate characterised by high early strength development, high abrasion resistance, high temperature resistance and biogenic corrosion resistance.
Carbonation	The reaction of atmospheric CO ₂ with alkaline materials such as concrete, and cement which lowers the alkalinity (pH) and thus protection to steel reinforcement.
Cathode	The negative pole of an electric circuit. In a cathodic protection system, the metal protected against corrosion due to the presence of a sacrificial anode.
Cathodic protection	The prevention or reduction of corrosion of steel in concrete by the distribution of sufficient direct current to the steel to make it the cathode in a galvanic or electrolytic cell.
Chloride	As these occur in calcium chloride (used as a cement-setting accelerator in the past) and sodium chloride (in seawater, wind-blown sea spray), they combine with water to form an aggressive agent leading to accelerated corrosion of reinforcement
Coat	A continuous layer of a coating material resulting from a single application.
Coating over cracks	Application of coatings with a crack bridging capability.
Coating system	Can be either protective or decorative coating system.
Coating	An interchangeable term, meaning either the actual process of covering the concrete surface with a layer(s) of paint, or representing a protective or decorative coating to produce a continuous protective layer on the surface of concrete.

Term	Definition
Compatible	The ability of two or more materials to be placed in contact or in sufficiently close proximity to interact with no significant detrimental results with respect to the intended service life.
Concrete surface profile	Concrete Surface Profile (CSP) is the measure of the average distance from the peaks of the surface to the valleys as seen through a cross-sectional view of the concrete surface. The standards are rated 1-9 with 1 being the smoothest and 9 being the roughest concrete surface profile.
Corrosion deteriorated concrete	Concrete with deterioration, delamination, degradation, cracking or spalling due to contamination by deleterious substances such as chlorides and carbon dioxide associated with the overall mechanism of corrosion of steel reinforcement, or acids and sulphates associated with chemical attack.
Corrosion of steel reinforcement	Deterioration of steel reinforcement in concrete when the passivity (pH of about 12) around the steel, which protects it, is lost or breaks down, or when the concrete is cracked or delaminated sufficiently to allow easier access of water and oxygen.
Crack	A complete or partial separation of concrete into two or more parts with or without a readily visible opening produced by breaking or fracturing.
Crack filling material	Material used to fill the crack that may be a resin (or resin adhesive or adhesive) or sealant or cementitious material applied into a crack for the purpose of filling and closing the crack.
Curing	Application of water, or retention of water using sheet or liquid applied membranes to control the rate and extent of moisture loss from a newly formed concrete surface exposed to air during the initial setting and hardening cement hydration phase.
Damage	A decrease in the capacity of an existing member or structure resulting from events, such as loads and displacements, or as a result of deterioration of the structure.
Dampness	Presence of unwanted moisture in the structure, either the result of intrusion from outside or condensation from within the structure.
Decorative coating system(s)	These can be either film-forming coatings, surface treatments or combinations of these which can improve the aesthetic appearance of a concrete surface.
Delamination	The separation of a section of one material from another which is identified by a drummy or hollow sound instead of a clear ringing sound when the material is tapped.
Deterioration	Manifestation of defects or failure of a component or associated material (cracking, delamination, spalling, staining, etc.), due to influencing factors of an internal and/or external origin.
Dry film thickness (DFT)	The dry film thickness of a coating remaining on the surface and above the peaks of the surface profile when the coating or system has hardened and cured.
Dry surface	Concrete residual moisture after surface preparation does not exceed the limits for successful coating application, bonding and curing in ASTM D4263, ASTM F1869 or ASTM F2170.
Durability	Ability of a material or structure to resist weathering action, chemical attack, abrasion, and other conditions of service and maintain serviceability over a specified time or service life.
Efflorescence	A white deposit on the surface of the concrete arises when the water that results from excessive permeation of water through the concrete evaporates and leaves calcium carbonate deposited on the surface

Term	Definition
Elastomeric sealant	Elastomer for sealing gaps comprising a macromolecular material that rapidly regains its approximate original dimensions after the release of a weak stress that has caused its substantial deformation.
Electrochemical chloride extraction	A temporary treatment to permanently draw chloride ions out chloride contaminated concrete using an external anode system in an electrolyte medium, electrically connected to the reinforcement with a direct current DC operated for a fixed time period.
Electrochemical realkalisation	A temporary treatment to permanently create high alkalinity conditions in carbonated concrete in the vicinity of reinforcement using an external anode system in an electrolyte medium, electrically connected to the reinforcement with a direct current DC operated for a fixed time period.
Entry port / injection port	A device or passageway in the surface seal through which the resin adhesive is introduced into a crack.
Fairing coat	A thin layer of cementitious material used to render large surface areas and cover, fill or smooth blowholes and surface imperfections flush with the finished concrete surface.
Featheredging	Cementitious repair material applied to the edge of the repair in a very thin layer instead of a thicker layer which is contained at the edge with a square cut.
Fibre Fabric	A material formed of fibres orientated in the required direction in a woven or non-woven form and made available in blankets or various widths, weights, thicknesses and lengths.
Fibre Laminate	Fibre-reinforced polymer composite comprising two or more layers of fibres, bound together in a resin matrix and produced in the form of a sheet, plate of required widths, thicknesses, lengths and physical properties.
Fibre-reinforced polymer (FRP)	Composite material comprised of a resin matrix such as epoxy or other adhesive materials reinforced with high strength fibres such as carbon, aramid or glass, moulded and hardened to form the required shape including fibre fabric and laminates, which can act in composite to enhance the structural capacity of concrete structures.
Film-forming coating(s)	Viscous materials which form a pinhole - free film on the concrete surface to improve its aesthetic appearance or provide protection by acting as a barrier to the ingress of aggressive agents. Coatings are generally applied in two or more layers. Thin coatings have a dry film thickness (DFT) of 100-300 micron, high build coatings generally exceed 1 mm, whereas cementitious coatings are generally thick applications ranging from 1 mm to 20 mm thick.
Flexible sealing	Use of suitable flexible sealants to seal active cracks in the same manner as flexible joints.
Fugitive dye	An impermanent pigment that lightens, darkens, or otherwise changes in appearance or physicality over time when exposed to environmental conditions.
Galvanic cathodic protection	A permanent treatment to provide direct current using a sacrificial anode system embedded within or external to reinforced concrete that acts as an electrolyte medium, and is electrically connected to the steel reinforcement, that reduces the rate or halts corrosion of the steel.
Geopolymer	Aluminosilicate concrete binder system comprising aluminate and silicate powders such as fly ash and slag mixed with aqueous alkalis such as sodium/potassium hydroxide and sodium/potassium silicate. Properties include higher acid, sulfate and chloride resistance than Portland cement based concrete.

Term	Definition
Gravity feed	Filling and sealing of horizontally positioned cracks using low viscosity resins by pouring and spreading onto surface or placing into purposely formed reservoirs.
Hydrophilic crystalline cementitious material	A proprietary material used as an additive in a slurry coating and in mortar materials that reacts with water and chemicals within hardened concrete to form a non-soluble crystalline compound within the concrete pores, capillary tracts and cracks as part of a hydrophilic, durable, waterproofing system.
Hydrophobic impregnation	Treatment of concrete to produce a water-repellent surface. The pores and capillaries are internally coated, but they are not filled. There is no film on the surface of the concrete and there is little or no change in its appearance.
Impregnation	Treatment of concrete to reduce the surface porosity and to strengthen the surface. The pores and capillaries are partially or totally filled.
Impressed current cathodic protection	A permanent treatment to provide direct current using an external power system via an anode system in an electrolyte medium, electrically connected to the steel reinforcement, that reduces the rate or halts corrosion of the steel.
Inactive cracks	Dormant or dead cracks which do not open, close or extend further.
Joint gap	Joint width at sealant location irrespective of the width of the joint below or above the sealant.
Maximum dry film thickness	The highest acceptable dry film thickness for each coating layer or for the whole coating system above which the performance of the coating layer or system could be impaired.
Micro-concrete	A self-compacting and consolidating flowable shrinkage compensated repair concrete used for larger volume cast-insitu concrete repairs.
Minimum dry film thickness	The minimum acceptable dry film thickness for each coating layer or for the whole coating system.
Moist surface	Concrete surface has a matt moist appearance with no shiny water film, the pores are not water saturated, indicated by a drop of water being readily absorbed, restoring the surface to a matt appearance.
Movement capability	Cyclic strain of a magnitude that can be accommodated by a sealant without damage where tested according to ASTM C719 with cement mortar substrate.
Near surface mounted FRP	FRP laminate that is installed into slots that have been prepared in the cover region of a concrete component.
Nominal dry film thickness (NDFT)	The dry film thickness specified for each coating layer or for the whole coating system.
Non-corrosion deteriorated or defective concrete	Concrete with deterioration, damage or defects due to accidental or physical loadings, temporary overloading, impact and other mechanical or uncontaminated damage, excessive early shrinkage or thermal stresses and low quality honeycombed or off form voided concrete.
Non-sag sealant	Sealant that does not flow in vertical or inverted joints when applied at a temperature between 5°C and 50°C.
Patch repair	Localised repair to defective concrete using a proprietary repair system usually incorporating hand placed cementitious repair mortar, or spray applied mortar for larger repair areas.
Pore-lining penetrant(s) (Hydrophobic Impregnation(s))	These are low viscosity fluids (i.e. silane, silane/siloxane, siloxane, solid silane or silane cream) which react with the available hydroxyl group of the silicate structure of the concrete substrate in the presence of moisture, thus depositing water-repellent silicone resins chemically

Term	Definition
	bonded to the walls of the concrete pore structure. These hydrophobic products can penetrate the concrete by several millimetres and work by repelling water and waterborne chloride ions.
Primer	The first coat of a coating system applied to an uncoated concrete substrate designed to enhance adhesion of the coating system onto the surface and/or impart a surface binding and toughening effect on the substrate.
Protective coating system	Either film-forming coatings, surface treatments or combinations of these which can impart protective qualities to the concrete surface against the ingress of aggressive agents.
Resin	A resin system based on epoxy materials comprising a thermosetting polymer that is the reaction of an epoxy resin and amino hardener, including primer, saturant, adhesive and putty filler in a FRP system.
Crack injection resin	The crack filling material that is injected or introduced into a crack for the purpose of re-bonding the separated edges to allow the transfer of tensile stress across the crack.
Reference electrode	A monitoring sensor (i.e. Ag/AgCl, Mn/MnO ₂ , Cu/CuSO ₄) which is permanently fixed (embedded) within an electrolyte, such as concrete, and close to the steel reinforcement, and used to measure the electrical potential of that portion of the steel reinforcement.
Rehabilitation	The process of restoring a structure (or part thereof) to its original or required level of service by undertaking repairs or modifications that are remedial in nature, and which are less frequent than maintenance activity.
Repair	The process of restoring a damaged or deteriorated structure or structural component to a serviceable and operating condition by replacing or rectifying faulty materials, components, or elements.
Repair system	The combination of existing and new components, which may include existing reinforcement, repair materials, supplementary reinforcement and supplemental structural members.
Resin injection	Crack filling under pressure using a selected polymer resin adhesive such as epoxy or polyurethane to restore structural soundness and penetrability of concrete where cracks are inactive or can be prevented from moving further.
Routing and sealing	Enlarging the crack along its exposed face and filling with a suitable joint sealant to produce a repair method for cracks that are inactive and not structurally significant.
Sacrificial anode	A cast piece of metal lower in the galvanic series than steel, that forms the main component of a galvanic cathodic protection system.
Saturated Surface Dry (SSD)	The concrete substrate pores are saturated with water to a depth of several millimetres, the concrete surface may have a wet sheen, but there is no dripping/ ponded/free water on the surface, as if it had been dried with a cloth.
Scrub coat	A gloved or stiff brushed application of neat mortar material scrubbed onto the SSD concrete substrate to ensure small voids, indentations and pores are filled to aid in the bonding process.
Sealant	The crack filling material that has adhesive and cohesive properties that forms a seal to prevent the ingress of liquid or gases into the concrete.
Sealant joint width	Sealant joint width calculated in accordance with ASTM C1472.
Sealer	These are viscous fluids which are intermediate between pore-lining penetrants and film-forming coatings. They can penetrate and block the pores of the concrete substrate and also form a thin film on its surface.

Term	Definition
Self-levelling sealant	Sealant that flows sufficiently under gravity at a temperature not less than 5°C to become level when applied in a horizontal joint or to become smooth when applied to a joint on a cross fall.
Service life of repair/strengthening	The period for which a repair or strengthening system is expected to remain in a useful and serviceable state, prior to the onset of distress or deterioration, assuming continued exposure to given in-service conditions.
Shrinkage-compensating	A characteristic of grout, mortar, or concrete made using an expansive cement in which volume increases after setting and, if properly elastically restrained, induces compressive stresses which are intended to approximately offset the tendency of drying shrinkage to induce tensile stresses.
Spall	A fragment of concrete broken off or detached from the edge of solid concrete due to the corrosion of steel reinforcement or due to accidental, physical or mechanical damage.
Stitching of cracks	Anchoring of U-shaped metal legs or proprietary fibre composite band in predrilled holes on both sides of cracks to restore the tensile strength of the crack affected concrete.
Strengthening	The process of increasing the capacity of a structure or structural components in terms of increased flexural, shear or axial strength or ductility or restoring the capacity of weakened elements of structure to their original design capacity, using either active or passive strengthening systems or both.
Active strengthening	Systems that engage the structure or structural component in composite action immediately upon installation, through the introduction of an external force, such as the application of anchored reinforcing or post-tensioning systems and the construction of deck overlays, section enlargement and the like.
Passive strengthening	Systems that engage the structure or a structural component in composite action only when additional loads, beyond those existing at the time of installation, are applied to the structure, including steel plate or fibre-reinforced polymer (FRP) composite systems bonded to structural members.
Sulfide aggregate reaction	Deleterious expansive reaction involving solubility or oxidation of ferrous sulfide containing aggregates in concrete in concrete.
Surface bonded FRP	FRP that is directly bonded to the outside surface a concrete component.
Surface imperfections	Surface voids or cavities not exceeding 5 mm in depth left on the concrete surface (in the form of surface honeycomb), due to failure of the mortar to effectively fill the spaces among coarse aggregate particles during placement and consolidation.
Surface seal	Material used to confine the injection adhesive in the fissure during injection and cure.
Surface treatment(s)	Viscous materials such as pore-lining penetrants (hydrophobic impregnations) and sealers which can penetrate the concrete or block the pores of the concrete to improve its aesthetic or protective qualities.
Temporary bracing	Non-permanent supplemental members added to an existing structure to prevent local or global instability during assessment and repair construction.
Undercoat	Highly pigmented coating which can serve as a first coat or intermediate coat before the finish coating to provide hiding power and improved adhesion of a top coat to the substrate.
Wet film thickness (WFT)	The thickness of the wet coating immediately after application.

Term	Definition
Wet surface	The concrete surface has dripping or standing water.

2 Scope

2.1 Type of Structures

SA Water has a wide range of water supply and waste water concrete assets of varying construction and purpose.

Concrete assets which are subject to this Technical Standard include component parts (e.g. floors, columns, walls, piers, roofs, beams, channels, aprons, sumps, gates, stop-logs, weir crests) of the following types of structure, but not limited to:

Raw Water Assets

- Channels and embankments
- Raw water Intake structures
- River locks and weirs
- Valve chambers, access chambers, maintenance holes
- Pipes, drains and conduits, outfalls, tunnels and shafts.

Treated Water Assets

- Water treatment plant tanks and channels
- Concrete water storage tanks and water pumping stations
- Steel tanks' concrete ring beams and floors
- Earthen bank storage's concrete floor lining and roof system
- Valve chambers, access chambers and maintenance holes
- Pipes, drains and conduits, outfalls, tunnels and shafts.

Waste Water and Recycled Water Assets

- Waste water treatment plant: inlet, primary/secondary sedimentation, aeration, thickeners, digesters, outlets, baffles, conduits and channels and pipe galleries
- Concrete water storage tanks
- Water and sewage pump stations (Wet wells, Dry wells, Platforms)
- Emergency Storage Tanks and lagoons
- Valve chambers, access chambers, maintenance holes
- Pipes, drains and conduits, outfalls, tunnels and shafts.

General Structures

- Retaining walls, drainage channels, aprons and pits, steps
- Operational buildings
- Equipment and pipe supports
- Secondary containment structures.

2.2 Exclusions

This Technical Standard is not to be applied to the following reinforced concrete assets:

- Mass concrete components in structures such as dams, other than as part of a dam structural safety risk assessment
- Replacement of whole elements (Refer TS 0710)
- Slab or structure re-levelling.

2.3 Technical Dispensation

Departure from any requirement of this Technical Standard shall require the submission of Technical Dispensation Request Form (TDRF) for the review and approval (or otherwise) of SA Water Principal Engineer listed in Page 3, on a case-by-case basis.

The Designer shall not proceed to document/incorporate the non-conforming work before the Principal Engineer has approved of the proposed action in writing via the Technical Dispensation Request Form (TDRF).

SA Water requires sufficient information to assess dispensation requests and their potential impact. The onus is therefore on the proponent to justify dispensation request submissions and provide suitable evidence to support them.

Design works that are carried out without being appropriately sanctioned by SA Water shall be liable to rejection by SA Water and retrospective rectification by the designer/constructor.

3 Using this Technical Standard

The typical phases of the concrete repair and protection process are defined in Table 8 with the corresponding interface with the sub-sections of this Technical Standard.

The sub-sections of the Technical Standard specify the minimum technical requirements for undertaking concrete remedial works.

Each project requires an individual design, standalone specification, definition of scope and specification of the applicable parts or sections of this Technical Standard suite.

The particular scope and requirements of each project is to be developed from the diagnosis of deterioration mechanism(s) and particular site constraints and considerations.

Table 8: TS 0711 Interface with Typical Concrete Remediation Phases

Phase.	Scope	Interface with TS 0711	Document / Design Phase
1	Identification of requirement for repair/protection.	Condition assessment guidance.	Concept to D&C Phase
2	Diagnosis of deterioration mechanism(s).	Background information of typical deterioration mechanism(s) and common diagnostic tests.	Concept to D&C Phase
3	Decision of management strategy.	Undertaken separately, this considers factors unique to the particular asset and business considerations.	Concept to D&C Phase
4	Design/specification of remedial works.	Developed in accordance with the requirements defined within this Technical Standard.	TS0711.0 to TS0711.5
5	Undertake remedial works.	Carried out to the general project requirements defined in TS 0711.0 and technical performance requirements defined in the relevant sub-standards (TS 0711.1 to TS 0711.5). Particular project requirements may be added by SA Water or its delegate as required.	TS0711.0 to TS0711.5
6	Inspection and acceptance of remedial works.	Performed to and meeting the requirements defined in the relevant sub-standards (TS 0711.1 to TS 0711.5).	TS0711.0 to TS0711.5

4 General Project Requirements

4.1 Concrete Repair Constructor Pre-qualification

These requirements do not apply to the Head Constructor unless the Head Constructor is also the specialist concrete repair constructor.

The specialist concrete repair constructor and any additional specialist remedial works sub-constructors shall be pre-qualified by the SA Water Representative before undertaking any works.

within 30 working days of the Date of Acceptance of Tender, provide evidence as part of pre-qualification to demonstrate competency relevant to the size and complexity of the works.

HOLD POINT

The evidence shall include but not limited to the following:

- a) Number and years of experience or professional qualifications/certifications of nominated management personnel, site team and quality inspectors
- b) Evidence of past-project compliance with the Constructors Quality and Environmental Management system
- c) Number of permanently employed site operatives to be used on the project
- d) Written past-project Client references that demonstrate experience of similar project size, scope, complexity, and compliance with quality system requirements as the proposed remedial works.

4.1.1 Specialist Concrete Repair Constructor Experience

The specialist concrete repair Constructor shall have demonstrated experience in the management and undertaking of comparable type and complexity of reinforced concrete structure remediation works.

The specialist concrete repair Constructor's site team shall have greater than 65% permanently employed site operatives.

The specialist concrete repair Constructor shall hold current membership of a recognised registered association specialising in concrete repair, such as the Australian Concrete Repair Association (ACRA) or the Australasian Corrosion Association (ACA) and be able to demonstrate at least 3 years recent active membership of these organisations.

Provide documented evidence of all training, certifications, and experience for all site personnel relevant to their site role as listed below and have a system in place that ensures their knowledge and training is up to date.

4.1.2 Qualifications of Personnel – Site Management

Site Manager

The Site Manager works at and is responsible for running the work site and ensuring that the remedial construction work is completed in accordance with this Technical Standard.

Alternative job titles for Site Manager, depending on size of project, include Construction Manager, Contracts Manager, Project Manager, Project Engineer and Site Agent.

The nominated Constructor's Site Manager shall be a qualified engineer with a relevant degree (such as civil/structural/construction management/building/materials/chemical) with demonstrated 5 years or greater experience commensurate with the project type and complexity.

The Site Manager shall hold one or more of the following memberships/certifications:

- a) Member of Engineers Australia or equivalent
- b) Chartered Engineer/Registered Professional Engineer, or be registered on a training scheme to become a Chartered Engineer/Registered Professional Engineer
- c) Diploma of Project Management or Construction Management
- d) ACA/ACRA/AMPP/CIA membership or certification, or equivalent industry or academic corrosion training.

Technical Manager/Quality Manager

The Technical/Quality Manager is responsible for auditing internal and external processes, communications, and policies on behalf of the specialist concrete repair Constructor and ensuring that the quality criteria of the project are met.

The nominated specialist concrete repair Constructor's Technical/Quality Manager shall be a degree qualified civil/structural/construction management/ building/materials/chemical engineer with demonstrated experience in a technical oversight/quality role in comparable construction and concrete remediation projects.

Minimum certifications are to be appropriate for concrete repair projects and may include:

- a) Member of Engineers Australia or equivalent
- b) Chartered Engineer/Registered Professional Engineer, or be registered on a training scheme to become a Chartered Engineer/Registered Professional Engineer
- c) ACA/ACRA/AMPP/CIA membership or certification, or equivalent industry or academic corrosion training.

4.1.3 Qualifications of Personnel – Site Supervisor/Project Engineer

The Site Supervisor and/or Project Engineer assigned to a permanent site role is/are responsible for coordinating and instructing site crews to construct the works and ensuring that the remedial construction work is completed in accordance with this Technical Standard.

The nominated Site Supervisor shall be a permanent employee of the specialist concrete repair Constructor and have demonstrated concrete remediation experience greater than 5 years and competency relevant to all aspects of the specified works and shall actively always supervise the works, for the duration of the remediation project.

The Project Engineer shall be a permanent employee of the specialist concrete repair Constructor and have demonstrated concrete remediation experience greater than 2 years and competency relevant to all aspects of the specified works and shall actively supervise the works, for the duration of the remediation project.

The Site Supervisor and Project Engineer shall hold appropriate certifications for the works they are responsible for in addition to any required OHS certifications that may include:

- a) ACA/ACRA/AMPP/CIA membership or certification, or equivalent industry or academic corrosion training
- b) Concrete remedial works that include sacrificial anodes: ACA Accredited Corrosion Technologist or NACE/AMPP CP1 or equivalent
- c) Protective coatings: NACE/SSPC/AMPP Concrete Coating Inspector CCI Level 1 or equivalent.

4.1.4 Qualifications of Personnel – Operatives

Each site operative shall be adequately trained and demonstrate competency in the specific remedial work being undertaken and materials used by completion of a trial remedial material application to the satisfaction of the material manufacturer's Technical Representative (refer Clause 8.4.5) and SA Water's Representative, in addition to any required OHS certifications.

specific competencies required as listed in the relevant Technical Standards sub-documents.

4.1.5 Qualifications of Personnel - Sub-Constructors

Any specialist Sub-Constructor company engaged by the specialist concrete repair Constructor to undertake part or the whole of the remediation works shall have demonstrated experience in the management and undertaking of its specialist remediation works on projects of comparable type and complexity, supported by written project references, in addition to any required OHS certifications.

The specialist Sub-Constructor's site team shall have greater than 65% permanently employed site operatives.

Sub-Constructor site personnel shall comply with the minimum requirements in Clauses 4.1.3 and 0.

4.1.6 Qualifications of Personnel - Constructor Coating Inspectors

Site QC coating inspector shall hold a current coating inspection certificate from NACE/SSPC/AMPP or equivalent qualified to the following levels:

- a) For coatings over concrete in extreme and immersion exposure class conditions, the coating inspector shall hold a NACE/SSPC/AMPP CCI Level 2
- b) For all other coatings applied to concrete, the coating inspector shall hold NACE/SSPC/AMPP CCI Level 1.

4.2 Independent Quality Control Inspector/Technical Support

At the discretion of the SA Water's Representative, and subject to the project size and complexity, an approved Independent Quality Control Inspector shall be appointed by the Constructor for the works.

The Independent Quality Control Inspector shall witness and monitor operations to ensure that they meet the specified requirements and standards, inspect, test, or measure materials to the prescribed criteria or standard, and audit the Constructor's quality documentation.

The Constructor is not relieved of its own Quality Assurance/Quality Control and remediation/coating system performance responsibilities.

The Independent Quality Control Inspector shall be a professionally qualified engineer or consultant with at least 5 years relevant experience, and hold the following minimum current certifications or SA Water's Representatives agreed alternative, for the works they are responsible for inspecting:

- a) Member or eligible for membership of Engineers Australia or equivalent professional body
- b) Concrete remedial works: ACA/ACRA Corrosion and Protection of Concrete Structure and Buildings, or equivalent industry or academic corrosion training
- c) Concrete remedial works that include sacrificial or impressed current anodes: NACE/AMPP CP2 or equivalent
- d) Protective coatings: NACE/SSPC/AMPP Concrete Coating Inspector (CCI) Level 2 or equivalent.

4.3 Project Specification

Each concrete structure remediation project shall have a Project Specification document which is to include:

- a) SA Water Contract Preliminaries
- b) Purpose, scope, type and extent of known remedial works accurately shown on drawings to scale or otherwise accurately described and quantified
- c) The relevant requirements and sub-parts (01-05) of this Technical Standard, as determined by the condition investigation report
- d) Construction sequence, demolition requirement and temporary works (as applicable)
- e) Where applicable, nominated SA Water pre-approved products to the relevant sub-parts (01-05) of this Technical Standard
- f) Safety in Design assessment to TS 0101
- g) Assessment of deteriorated concrete impact on asset load capacity
- h) Requirement for compliance with TS0800 (which contains SA Water's requirements with respect to AS/NZS 4020:2018) where in contact with drinking water.

4.4 Submissions

4.4.1 General

Supply the following information concerning the proposed concrete structure repair systems 30 days prior to commencing work:

- a) Product designations and name of Manufacturers (Product names, Company names and addresses)
- b) Number of system components and number of applications of each component typically required
- c) Methods Statements, fully describing the methods of application
- d) Design basis report for structural repairs and temporary works
- e) Reference to previous local Australian examples of application, if not a nominated product in this Standard
- f) Test certificates showing compliance with any specified product requirements. The date of issue of the test certificates to not be more than three years prior to the date of submission.

All test certificates must be from a National Association of Testing Authorities, Australia (NATA) accredited laboratory or international equivalent for the quoted test method.

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4.4.2 Applied Coatings

For each protective coating, primer or bonding agent, include details of the following in the Work Method Statement:

- a) Generic and specific composition
- b) Number of components and package size
- c) Recommended application temperature range
- d) Pot life at application temperature
- e) Drying (tack free) time

- f) No. of coatings required
- g) Time between coatings
- h) Maximum, minimum and recommended dry film thickness
- i) Proposed methods of application.

4.5 Design Life

All rehabilitated and/or strengthened elements shall achieve the design life specified in Table 9. If concrete repairs are undertaken to remedy defects during construction of new assets the minimum design life of the repairs shall be consistent with the concrete element design life.

Table 9: Minimum Design Life and Warranties

Concrete Remedial Works	Minimum Design Life (Years)	Minimum Material Warranty Period (Years)	Minimum Workmanship Warranty Period (Years)
All concrete remedial works complying with TS0711.0 to TS0711.5	As per TS 0109	10	10

4.6 Warranties/Guarantees

All rehabilitated and/or strengthened elements shall comply with minimum material and workmanship warranties specified in Table 9.

Obtain and ensure that SA Water will have the benefit of any warranties or guarantees, including warranties or guarantees that are obtained by the Sub-Constructors of the Constructor, for the period stated in the warranties or guarantee.

Unless otherwise specified or agreed, warranties or guarantees shall name SA Water as warrantee and shall be furnished by the warrantor direct to SA Water's Representative.

Lodge copies of all warranties or guarantees prior to the issue of the Certificate of Practical Completion.

Reference shall be made to product supplier issued letters for their proposed material design life and warranty period.

4.7 Drawings

Where dimensions may have been taken from the original design drawings, the Constructor shall verify all dimensions prior to works starting.

Under no circumstances shall dimensions be scaled from the Drawings unless authorised, in writing, by SA Water's Representative. No claim for additional costs arising from failure to obtain measurements and other information on site will be allowed.

All new drawings shall comply with TS 0100 requirements.

Drawings made to larger scale (i.e. 1:100 is larger than 1:1000) and those showing particular parts of the Works shall take precedence over Drawings made to smaller scales and those for more general purposes. Where any discrepancy exists between figure and scaled dimensions, the figured dimensions shall prevail, pending confirmation in-situ.

5 Quality Requirements

5.1 Quality Management System

The Constructor shall establish and maintain a Quality Assurance System in accordance with AS/NZS ISO 9001.

The Constructor and its major Sub-Constructors and suppliers shall, from the commencement of the Contract until the Date of Practical Completion, establish, file and maintain quality records that demonstrate implementation of the Constructor's Quality Management System (QMS), for inspection by SA Water's Representative.

5.2 Quality System Audits

Internal audits in accordance with the requirements of AS/NZS ISO 9001 shall be undertaken by the Constructor to ensure compliance with the Quality Management System.

SA Water's Representative may also carry out audits of the Constructor's quality system and/or site records by way of review and verification of Constructor's documentation, quality assurance measures or inspection and testing records.

5.3 Quality Plan

The Constructor shall submit, within 10 working days of the Date of Acceptance of Tender, a draft Quality Plan. This document is to include details of the Constructor's proposals for the management and control of quality for the Contract.

HOLD POINT

A finalised Quality Plan shall be submitted within 10 working days of receiving comments from SA Water's Representative.

The Quality Plan shall provide for quality assurance activities on site, and provide for dedicated site quality control resources (that do not undertake the remediation works) to plan, manage and undertake quality control testing of the entire works.

This Quality Plan shall, as a minimum:

- a) Include the repair material Manufacturer's recommended inspection and test program
- b) Address specific minimum testing requirements listed in the various sub-parts of this Technical Standard
- c) Provide for submission of test results to confirm compliance or non-compliance with the Technical Standard
- d) Include all test results in the As-Repaired/Constructed Report.

SA Water reserves the right to instruct the Constructor to complete additional testing, or to engage an independent testing authority to undertake additional testing at the Constructor's cost if testing is not performed to the SA Water's Representative's satisfaction.

5.4 Identification & Traceability

The Constructor shall divide the works into lots for the purpose of:

- a) Positive identification and traceability of all work activities, measurements and tests
- b) Monitoring the quality of product
- c) Submission of work to the SA Water Representative via a conformance/non-conformance report
- d) Rejection of work
- e) Submission of dispensation requests for any proposed deviation from a requirement(s) of this standard.

The Constructor shall define a system of lot numbering which is practical for the Works and which shall be logical, suit the specific application and be consistent with any specified computerised system.

All work and/or activities shall be able to be readily identified with the relevant lot.

The lot identification system, site records and sample numbering system shall allow test results to be positively identified with the lot they represent.

5.5 Work Method Statement

The Constructor shall prepare and submit a detailed work method statement (WMS) for all construction processes, which details controls to be exercised to ensure satisfactory achievement of Contract requirements, where the absence of such procedures could adversely affect quality of the work.

Where appropriate, such procedures may be included in the Inspection and Test Plans (ITPs) or other documentation.

Work Method Statements shall be submitted to the SA Water Representative at least 10 working days before construction of the relevant work commences, unless alternative times are specified elsewhere in the Contract.

HOLD POINT

The work method statement shall include, but is not limited to, the following:

- a) Purpose and scope of the activity
- b) Work item or work lot identification
- c) Details of when, where, how and by whom the work will be done
- d) The sequence of operations, in accordance with the construction sequence as nominated in this Technical Standard
- e) Plant, equipment and materials proposed
- f) Detailed requirements applicable to the materials being used
- g) Quality Assurance (including testing) measures to be implemented per Section 5.9
- h) Details of any temporary works associated with the project, including general arrangements, dimensions, and relevant design details and certifications
- i) All matters affecting the safety of the site including control of access to the site, isolations and management of vehicles and other plant
- j) How the activity will be controlled and recorded.

The work method statement shall include identification of hazards/risks associated with the works or the site, and corresponding measures to eliminate the hazards. Where the risks cannot be eliminated, risk control and/or manage method shall be specified to reduce them so far as is reasonably practicable. The work method statement and hazard/risk identification shall encompass all site works and temporary works required to facilitate the intended activities.

Construction of the work shall be undertaken in accordance with the submitted work method statement. Any revisions to the accepted WMS shall be submitted to the SA Water Representative for review and acceptance with details including, but not limited to, the following:

- a) Why the Work Method Statement has required alteration
- b) Assessment of any new hazards (whether safety, quality or others) associated with any change to the work method
- c) Actions to be taken to mitigate hazards identified in point b) above

5.6 Inspection and Test Plans

The Constructor shall prepare and submit inspection and test plan(s) (ITPs) for all significant construction activities, where the absence of such procedures could adversely affect quality of the work.

ITPs shall explicitly reference acceptance criteria and all performance requirements of the Contract and be prepared by suitably qualified and experience personnel.

Personnel involved in preparation of ITPs should include product suppliers, applicators and design engineers as appropriate to the works being undertaken.

Constructors are encouraged to standardise ITPs for commonly encountered work activities or for projects/programs across which the same work activities are repeated.

The Constructor shall submit ITPs to the SA Water Representative not less than 10 working days before the work activity commences.

HOLD POINT

The content of ITPs shall include, but not be limited to, the following:

- a) Description of the work activity/sequence of activities
- b) Work item or work lot identification
- c) Standard requirements/reference
- d) Title of the person responsible for activity and verification of an ITP item
- e) Witness, hold and surveillance points
- f) Relevant checklists, forms or procedures
- g) Quality assurance activities, including inspection/test type, tolerances or other acceptance criteria
- h) Identification of relevant test procedure/s and quality records
- i) Details of test equipment to be used for specified tests
- j) Sequence and frequency of inspections/tests
- k) Identification of records (including photographic records) to be maintained of particular tests, inspections and trials
- l) Details of representative samples to be used in order to demonstrate acceptable standards of workmanship for activities where subjective assessment of quality may be required, e.g. finishes.

The Constructor shall provide SA Water's Representative with one copy of each signed off ITP (including accompanying records) within 5 working days of completion of the activity to which the ITP relates.

5.7 Hold Points and Witness Points

5.7.1 Hold Points

The minimum required Hold Points are detailed within Appendix A of this Technical Standard. Additional Hold Points are at the discretion of SA Water's Representative or the Constructor.

Hold points represent a critical stage of the work that requires release by the SA Water Representative before works can proceed further. The process for hold point release is provided below:

- 1) For Hold Points associated with design or documentation submissions, these shall be submitted to the SA Water Representative for release within the nominated timeframes
- 2) For Hold Points associated with inspections, the Constructor shall submit a request for a Hold Point inspection when work is at such a stage and is ready for inspection. A minimum of 48 hours' notice shall be provided before the hold point is reached
 - a) This request should also contain photographic evidence of the works that:
 - i) Consist of "jpg" files with a minimum resolution of 4 megapixels
 - ii) Clearly denote where the image was taken
 - iii) Are provided with a time and date stamp.
 - b) Submission of photographic evidence may allow the hold point to be released without physical inspection having to occur, at the discretion of the SA Water Representative.
- 3) If after the Hold Point inspection further work is required prior to proceeding, submit a request for re-inspection by SA Water's Representative prior to written approval being given
- 4) Subject to prior approval from the SA Water Representative, the Constructor-nominated Quality Representative may be authorised to release the project-specific hold points. This is conditional on all records (including photographic evidence) being retained and furnished for later inspection. SA Water also reserves the right to undertake a random audit inspection of works being delivered.

5.7.2 Witness Points

The minimum required Witness Points are detailed within Appendix A of this Technical Standard. Additional Witness Points are at the discretion of SA Water's Representative or the Constructor.

Witness points represent a point at which compliance of the constructed works with the drawings, WMS or ITP is to be verified.

The Constructor shall provide a minimum of 24 hours' notice to the SA Water Representative of a witness point being reached, with attendance by the SA Water Representative to be at their discretion.

5.8 Non-Conformance

The Constructor shall promptly advise the SA Water Representative of any non-conformance, together with its location and proposals for corrective action where:

- a) There is potential for progress of the work to be seriously affected
- b) The proposed action to correct the non-conformance will result in work not complying with the requirements of the Technical Standard
- c) The time requirements of the Technical Standard have not been complied with
- d) The non-conformance may cause a health and safety hazard
- e) The non-conformance has resulted from a deficiency in the drawings or Technical Standard; and/or
- f) Material or serious environmental harm has occurred.

Each such notification shall include details of:

- g) The action proposed for correction of the non-conformance or the arrangements made for its disposition
- h) The amendments to the quality system to mitigate recurrence of the non-conformance.

The Constructor shall not proceed to cover up or otherwise incorporate the non-conforming work before the SA Water Representative has approved of the proposed action in writing via Technical Dispensation Request Form (TDRF), completion and submission of which shall be undertaken by the Designer's Representative.

Works that are carried out without being appropriately sanctioned by SA Water's Representative may be classed as defective work. Such work or material is liable to rejection by SA Water's Representative who may require the defective work to be removed and replaced.

5.9 Testing Requirements

5.9.1 General

The Constructor shall provide test data that confirms materials comply with the requirements of this Technical Standard applicable to the works being undertaken, with all tests undertaken in a NATA-accredited laboratory and submitted to the SA Water Representative at least 10 working days prior to works commencing on site.

HOLD POINT

5.9.2 Quality Assurance Testing

The Constructor shall ensure that testing required, as specified in Clause 5.6, are undertaken in a NATA-accredited laboratory and that results are:

- a) Provided to the SA Water Representative within 2 working days of receipt
- b) Included in completed ITP documentation all test results in the Materials Testing
- c) Treat all nominated tests as **WITNESS POINTS** for the SA Water Representative to attend, at their discretion, as per the requirements of Clause 5.7.2.

Provide assistance as required to SA Water's Representative including access, coring and making good for any tests specifically designated to be performed by SA Water's Representative.

5.10 Permits and Certificates

Obtain all necessary permits, certificates and other like consents from SA Water, government and other relevant authorities required to carry out the Works and submit copies of all such permits to SA Water's Representative.

5.11 Site Records

Throughout the progress of the work the Constructor should:

- a) Keep at least one copy of any standard or other document quoted or referred to in the Technical Standard on site readily available to personnel for reference purposes
- b) Maintain a complete set of all up-to-date Drawings, Quality Documents and Specification(s), together with copies of all variations and additional drawings issued after the date of commencement
- c) Maintain records of any change to working drawings or shop drawings which may have been approved for construction purposes such that on completion of the works accurate "as constructed" information is available.

The Constructor shall also provide to the SA Water Representative, for monthly site meetings, a summary report listing completed ITPs, and number of status of all non-compliance reports.

5.12 As-Repaired/Constructed Report

Within four weeks of the issue of the Certificate of Practical Completion, the Constructor shall submit a draft As-Repaired/Constructed Report.

HOLD POINT

The report shall be in a format acceptable to the SA Water Representative, for review and acceptance that includes the following records:

- a) The lot register that clearly allows forensic location of a lot as described in the project Technical Specification for Work under the Contract
- b) Full details of the remedial and construction works undertaken (inclusive of completed ITP's, test results, analyses, reports, measurements, photographic records, drawings, manuals, trial repair reports and all non-conformance reports for the purpose of recording the repair and construction works
- c) Complete set of as-constructed record drawings and surveys duly signed certifying their completeness and accuracy. For construction drawings not prepared by the Constructor, record drawings shall be in the form of marked up prints
- d) A complete set of any shop drawings, Manufacturer product and safety data sheets and the like
- e) Warrant that the required repairs have been completed in accordance with the Work Method Statement and material Manufacturer's specification/s.

The As-Repaired/Constructed Report shall also include items, as detailed below, for each of the Sub-Sections of this Technical Standard including, but not limited to:

- a) Drawings
 - i. Record of repair type/material used including batch information, location and extent on marked up scaled plan and elevation drawings
 - ii. Plan and elevation drawings identifying inspection and test locations.

- b) Materials
 - i. Record of materials used, including repair batch information, material product data and materials safety data sheets
 - ii. Material test certificates (as appropriate) that verify claimed material properties as per Clause 4.4.1.
- c) Progress Photographs
 - i. Provide colour photographs for the purposes of recording the overall progress of the works and detailing specific aspects of each stage of work, including general views and close up details
 - ii. Provide appropriate identification markings and/or sub-titles within each photograph to identify specific structural components and the remedial activity
 - iii. Take particular photographs as recommended by SA Water's Representative but the Constructor shall be responsible for adequate recording of the works
 - iv. Accurately record the works at no limitation to the number of photos.
 - v. Provide one set of photographs (approximately one set per week) as "jpg" electronic files in logical sub-sets of sufficient quality and quantity to clearly provide a record of the works, with the date taken automatically recorded onto the jpg image
 - vi. Provide a schedule of all photographs including but not limited to filenames, date taken, structural component details and remedial activity.
- d) Quality Assurance Records
 - i. Complete all tests (including materials, components, Manufacturers' approvals and commissioning) in accordance with requirements of this Technical Standard.
- e) Inspection and test record sheets
 - i. Summary data tables for all quality control testing completed.
- f) Certifications
 - i. Provide a legible copy of all warranties, guarantees and certifications
 - ii. Include a summary table that lists all warranties, guarantees and certifications.

Upon completion of the SA Water review of the draft As-Repaired/Constructed Report, the Constructor shall finalise the document and submit final copies comprising two (2) original hard documents and one (1) electronic document. A finalised Report shall be submitted within 10 working days of receiving comments from SA Water's Representative.

6 Health and Safety Requirements

6.1 General

Conduct the work in a safe manner in conformity with all applicable statute regulations, by-laws or rules.

Comply with the South Australian Occupational Health and Safety Act including associated Regulations and Codes of Practice appropriate to the work.

Comply with SA Water's OHS Policy and latest version of the SA Water's Constructor OHS Induction Booklet.

Comply with specific provisions for the material manufacturer's work health and safety provisions in its technical data sheets, materials safety data sheets and system installation guidance document if available for storage, handling, use and disposal of the products.

All personnel performing high risk or potentially hazardous work shall have appropriate training, instruction, experience and certifications for application of the repair materials, and the correct use of equipment and working procedures issued within two years of commencement of the works and maintained current through the duration of the works, in accordance with SA Water's OHS Policy.

Conduct start-up meetings and develop procedures, SWM and Job Safety and Environmental Analysis (JSEA) for all work items to be performed.

Maintain a safe working environment at all times.

Provide Health and Safety plans that include procedures and equipment that as a minimum consider first aid for eyes, skin, inhalation, ingestion and fire.

6.2 Works on Existing Sewers

Comply with SA Water safety regulations relating to all works carried out on existing sewerage assets where live sewage is flowing or sewer gases are likely to be present.

Seek SA Water permit to work on a live sewer.

Do not commence any works that involves entry into live sewerage assets unless authorised by SA Water's Representative.

Give SA Water's Representative at least 1 days' notice before entering a live sewerage environment.

6.3 Lighting

Provide and use lighting systems as necessary to safely undertake the works.

Use light fixtures encased in a non-conductive, shatterproof casing and suited to the work site atmospheric conditions and hazards.

Use a light meter with readings in lux to verify the adequacy of the illumination for all remediation operations.

For general work area measurements, place the meter on a horizontal plane parallel with the work surface (e.g., walking across staging).

For task specific measurements, hold or place the meter on the surface, with the sensor aligned perpendicular to the surface.

Comply with minimum lighting requirements for SSPC Guide 12 for coating works and AS/NZS 1680.2.4 Table E1 for general construction and repair works as listed in Table 10.

Remove lighting systems from the direct spray of paint, abrasives, or other remedial materials.

Consider the impact of airflow patterns from any operating ventilation system on the quality of the lighting.

Note: Paint overspray accumulations on fixtures reduces the amount of light emitted and restricts heat dissipation from the light, which may cause premature failure or overheating.

Table 10: Lighting Illumination Requirements

Area	SSPC-Guide 12 Minimum	AS/NZS 1680.2.4 Table E1	SSPC-Guide 12 Recommended
General work area	100 lux	160 lux	200 lux
Surface preparation and material application	200 lux	400 lux	500 lux
Inspection	500 lux	800 lux	2000 lux

6.4 Concrete Removal

6.4.1 General Requirements

Provide a temporary support system to allow safe support of the structure during partial or full concrete demolition works as deemed appropriate, while taking into account expected demolition techniques and loads, and anticipated maximum loads from operation of the asset.

If required provide a flow diversion system.

Submit a Safe Work Method Statement for demolition works at least 30 days prior to commencing demolition works. Use intrinsically safe demolition equipment.

Take adequate protection measures to prevent demolition debris from entering into the operating asset.

Design flow diversion or containment measures as required to allow safe conduct of the demolition works.

Remove all demolished materials from Site as contaminated waste.

6.4.2 Management of Silicosis Risk

Comply with Safe Work Australia document "Working with silica and silica containing products".

Take into account guidance on managing silica dust as part of concrete repair works as provided in the HSE COSHH essentials in construction: Silica CN0 to CN09 series of documents in planning and undertaking the works.

6.4.3 Concrete Cutting and Drilling

Comply with "Work Safe Industry Standard – Safe concrete cutting and drilling":

- Develop safe procedures in accordance with Section 2 of the Standard
- Identify site specific hazards for inverted cutting/coring, control of dust/gas/noise/vibration, manual handling, working at heights, electricity, damage to structures and services, loss of vacuum pressure, working alone and entanglement in accordance with Section 3 of the Standard
- Undertake non-submerged coring operations in accordance with Section 4 of the Standard
- Undertake submerged coring operations in general accordance with Section 4 of the Standard and site specific safe work methods.

6.4.4 Hydro-Demolition

Comply with Safe Work Australia, Guide for managing risks from high pressure water jetting.

6.4.5 Demolition

Undertake all demolition works in a safe manner using methods complying with the relevant requirements of AS 2601: The demolition of structures and Safework Australia Demolition Work.

Explosives are not to be used.

6.5 Diving

Conduct any diving work in accordance with AS 2299.1.

Boats used for diving works shall comply with SA Water's requirements and all relevant AMSA Regulations, South Australia Marine Safety (Domestic Commercial Vessel) National Law (Application) Act 2013, and be operated by a qualified coxswain/master.

6.6 Traffic Management

For works in the vicinity of traffic, prepare and implement a traffic management plan in accordance with the SA Water's requirements, and other applicable compliance codes, field guides and regulatory requirements.

6.7 Barriers and Signs

Install barriers and warning signs for control of pedestrians and traffic, dust, dangerous fumes and the like, during the works.

Barriers and signs shall not hinder or prevent the operation of emergency response equipment, such as; gas detection sensors, Emergency Shut Down Stations and firefighting and sensing equipment.

Remove all barriers, signs and materials used to protect adjacent areas upon completion.

6.8 Equipment

Comply with the SA Water's requirements, and other applicable compliance codes and regulatory requirements, for all equipment used including, but not necessarily limited to, ladders, scaffolds, lifting devices, dust collectors, air compressors, electrical and pneumatic breaking and blasting equipment, coring machines, and grinders.

Properly maintain the equipment as per Manufacturers' recommendations and use it in strict accordance with any safety regulations or requirements pertaining to such use.

Use intrinsically safe access equipment in hazardous areas.

Use anti-static type and safety wired air supply hoses and couplings.

Install and maintain operational at all times dead man switches on high pressure cleaning equipment. Confirm operation at the start of each shift or when the equipment is located to a new work area. The use of an observer does not relieve the requirement to have an operational switch.

Suitably filter compressed air used for abrasive blast cleaning to remove all traces of grease, oil and dirt.

Use waterproof lighting, video camera and recorder for underwater works.

6.9 Hazardous Materials

Comply with the SA Water's requirements, and other applicable compliance codes and regulatory requirements, for identification, management and control of hazardous materials.

6.9.1 Existing Hazardous Materials

Assess the area of the structure to be repaired for the presence of any hazardous materials.

Take extreme care when removing or abrading old and cured coatings. In particular the following materials require appropriate precautions to be undertaken during their removal or disturbance by drilling or coring:

- a) Coatings containing any proportion of coal tar such as a coal tar epoxy
- b) Coatings containing any proportion of bitumen or asphalt, such as a bitumastic enamels or asphaltic compounds
- c) Coatings containing zinc chromates
- d) Coatings that contain lead. Test any surface, which is suspected to be lead containing, for the presence of lead before the coating is disturbed
- e) Materials containing asbestos, including coatings, sealants and asbestos cement materials.

6.9.2 Hazardous Repair Materials

Store and handle flammable and combustible liquids in accordance with AS 1940.

Comply with requirements in Clause 6.1 and use suitable personal protective equipment at all times.

Clean up any leaks, spillages, equipment and tools in a timely manner.

6.9.3 Fume Control

Implement controls to manage any aerosols, fumes or dust arising from removal or use of materials, including necessary precautions against injury to installation personnel, SA Water site operatives, adjacent building occupants or the general public during application of solvent containing materials such as epoxy resin materials, etc.

Ensure that the work area is well vented with fresh air.

Locate and protect nearby building air intakes that might be affected during material application.

6.9.4 Disposal of Hazardous Materials

Collect and dispose of hazardous wastes as approved by the EPA, with appropriate documentation for the waste collected, and disposed of.

Obtain all necessary approvals, licences and permits relating to hazardous waste material management or use a specialist sub-constructor that has obtained such necessary approvals and licences. Licences to be obtained must include, but not necessarily be limited to, licences for storage and transport of hazardous / industrial / prescribed wastes in accordance with local regulations and requirements.

Provide copies of documentation that verify the proper transport and disposal of all hazardous waste according to the appropriate environmental management authority licences.

7 Environmental Requirements

Comply with the Environmental Protection Act 1970, EPA Guidelines and SA Water's requirements.

Provide an Environmental Management Plan (EMP) 14 days prior to commencement of work. Implement the EMP during works to manage and mitigate potential environmental health and safety issues during works.

The EMP will include (but not necessarily limited to) the following:

- a) Management of air and noise environments including dusts
- b) Management of water, stormwater and wastewater
- c) Management of wastes (including litter)
- d) Vegetation management
- e) Pavement management.

7.1 Noise Emissions

Take all practicable precautions to minimise noise resulting from all work activities. Fit all equipment with noise suppressors and use so that noise in public areas is minimised and complies with the Noise Control Act, 1976/1977 and Regulations under the Noise Control Act, 1976-1977 and EPA Noise Control Guidelines.

7.2 Compressor Silencing

Fit compressor sets with effective acoustic canopies and special exhaust silencers of a type as recommended by the compressor manufacturer. Alternatively, use compressor sets specially designed for quiet operations. Keep compressor sets and canopies in first class condition at all times.

7.3 Hand Tools

Fit jackhammers, grinders and other noisy hand-held tools used in the performance of the work with effective silencers of a type recommended by the jackhammer manufacturer. Keep tools and silencers in first class condition. Supervise operators of jackhammers to ensure that the silencers are always in place while the tools are being used.

7.4 Waste Management/Disposal of Contaminants

Use control measures to collect, and to protect adjacent areas and equipment from, water and waste material such as concrete slurry, fragments and dust.

Subject to statutory and local requirements, liquid contaminants may be diluted with water to a level of quality acceptable in the sewer system. If this is not permitted, store in approved vessels for disposal offsite.

Provide containment where necessary in environmentally sensitive areas when directed by SA Water's Representative. Provide containment that does not compromise the integrity of the structure due to excessive dead or live loads or the method of attachment of the containment to the structure.

Suspend work if spills or emissions are observed entering into a river or waterway. Collect all wash down water, filter, test and dispose of wastewater to the satisfaction of the receiving Authority.

Discharge gaseous contaminants in such a manner that they will be sufficiently diluted with fresh air to reduce toxicity to an acceptable level.

Clean up the site on completion of the works.

Collect and arrange for the proper disposal from site of all waste material in accordance with all statutory and SA Water requirements using:

- a) Waste transport companies licensed by the appropriate environmental management authority
- b) Waste facilities licensed by the appropriate environmental management authority to accept the class of waste generated from the site, and authorised to issue consignment authorisation numbers.

Advise SA Water's Representative of any changes to transport of waste or receipt of waste or recycling of waste.

7.5 General Cleaning and Disposal of Refuse

Do not allow common rubbish/debris to accumulate to an unacceptable level at any time.

Remove from the site refuse (including food scraps and the like) resulting from works. Handle site refuse in a manner so as to confine the material completely and prevent dust and odour emission. Allow for minimum daily cleaning.

7.6 Dust and Water

Control all particulate debris, airborne dust and water spray arising from the works by use of appropriate sheeting and tenting of work areas. Prevent the ingress of water from any source into worksite areas. Prevent debris from falling onto SA Water or public areas. Clean surfaces affected by the Works regularly to prevent the accumulation of laitance including dust, mortar, paint, etc.

Install effective "bundling" to prevent unsuitable material entering the stormwater system if required.

7.7 Existing Flora

Adequately protect from damage all trees, plants, lawns and other vegetation.

8 Construction Requirements

8.1 Existing Structures

8.1.1 Verify Existing Structures and Services

Inspect and verify through testing if required the presence and location of all existing structures and connecting pipework, and the presence of any services (electrical, water, gas, process) on or embedded within the concrete structure, for operation of the facility to be remediated whether shown on the drawings or not.

Update the project drawings to show the location of verified features.

Notify SA Water's Representative immediately upon the discovery of damage to any existing structures or services.

8.1.2 Protection and Maintenance of Structures

Take all actions and provide all things necessary to protect and keep in operation existing structures and services to the satisfaction of SA Water's Representative. This may include arranging or performing relocation, temporary diversion or support of the structure or service obstructing the Works.

8.1.3 Repair of Structures

If a structure or service is damaged in the course of performing the work, or presents a safety hazard during the works, arrange or perform repair to the satisfaction of SA Water's Representative.

8.1.4 Salvaged Items

Unless otherwise specified, and subject to the provisions of the General Conditions of Contract, materials, plant, equipment or other things salvaged from the Works shall become the property of the Constructor who shall remove them from the site.

8.2 Temporary Works

8.2.1 Temporary Structural Support and Access Systems

Design, supply and install temporary works and access systems to support all construction activities additional to the systems used for concrete demolition and removal, such as props, ladders, beams, rails, connections, man box, fall restraint, scaffold or temporary hoists as deemed appropriate:

- a) Design the temporary works to carry anticipated loads to be applied during construction of the repairs taking into account the repair structural design requirements, expected construction techniques and staging, and not over-stressing the existing structure or repaired components
- b) Use propping to remove live load during structural repairs to enable the completed repair to be structurally effective
- c) All temporary works must comply with all relevant design codes, Australian Standards, statutory requirements and SA Water's OHS requirements
- d) Have the structural design, and design/proof checks, of any required temporary works (including temporary structural support, and containment structures) undertaken by a chartered professional structural engineer who is eligible for Corporate Membership of the Institution of Engineers, Australia, and who is registered as a professional engineer

- on the National Engineering Register (NER), with appropriate experience in structural design, safety, scaffolding, industrial ventilation and containment systems
- e) Prior to construction of temporary works, produce design drawings for use during the work. Include in the drawings all details and instructions necessary for the fabrication, erection and operation of the temporary works. Detail the design loads on the drawings. The drawings must be approved and signed by the Structural Design Engineer
 - f) Arrange for the temporary works design and drawings to be proof-checked by an independent chartered professional structural engineer who is eligible for Corporate Membership of the Institution of Engineers, Australia
 - g) Do not drill or core holes in the structure without SA Water's Representative's prior approval
 - h) Do not weld or cut off any part of the structure for the attachment of the containment or for any other purpose
 - i) Remove any temporary works components that are not part of the permanent works at the completion of construction.

8.2.2 Plant Isolation

Where isolation and de-isolations of electrical power, water, wastewater/sewer, or other services are required for the works to proceed, submit the requirement to SA Water's Representative for approval.

Once approved, arrange for and undertake isolations and de-isolations of electrical power and water and wastewater/sewer as required.

Before proceeding with any isolations or de-isolations that would cause any of SA Water's operations to cease functioning, obtain in writing from SA Water's Representative an agreed time and duration.

8.2.3 Temporary Services

Provide and maintain temporary services necessary for the execution of the work. Install such services in accordance with the requirements of the relevant authorities. On completion, disconnect temporary services and clear away all traces.

8.3 Extent of Works Identification

8.3.1 General

Detailed condition assessment of structures are required to enable identification and quantification of defects and enable determination of the remediation requirements.

If the project includes undertaking of such an investigation directly followed by repair work, SA Water's Representative may agree to waiving the requirement to undertake all or part of the pre-repair survey in Clause 8.3.2.

Otherwise, clearly identify the full extent of the repair area as identified in this Technical Standard and project specifications.

Submit a mark-up plan of the work extent on the Detailed Design Drawing, for SA Water's Representative review and approval, 5 working days prior to commencement of the pre-repair survey.

HOLD POINT

8.3.2 Pre-Repair Survey

Identify defect areas to be repaired as follows:

- a) Undertake sufficient cleaning of the structure as deemed necessary and install safe access systems to enable a visual inspection
- b) Carry out a visual inspection and any other type of inspection survey procedures, as required, to determine the extent of works, typical defects include but are not limited to:
 - i. General condition observations.
 - ii. Cracks wider than 0.3 mm with crack location, width and length measured.
 - iii. Rust stains
 - iv. Corrosion damage (for example concrete spalling or delamination)
 - v. Loose and/or missing elements
 - vi. Joint sealant defects
 - vii. Prior repair areas
 - viii. Wet/damp/leaking surface patches
 - ix. Surface deposits including white leaching
 - x. Rotting
 - xi. Peeling, flaking coatings
 - xii. Any other defects requiring remediation.
- c) Undertake removal of selected protective coatings with the prior approval of SA Water's Representative for substrate visual inspection and other testing
- d) Inspect mechanical, electrical or other services that will have any impact on repair works.

8.3.3 Destructive and Non-Destructive Testing

Complete further testing as required by the Technical Standard sub-sections.

Test for latent defects by hammer tapping, pH tests and additional testing as required.

8.3.4 Recording of Inspection Results

The recording of the inspections shall include:

- a) Agreed report format for the defects visual inspection
- b) Digital photographs of all identified visible defect positions with a unique number and brief description of each photo
- c) Plot all defects and proposed repair works on elevation and plan drawings of the surface with a defects legend, including taped dimensions (Defect Map)
- d) Note of access conditions and any problems to complete an acceptable inspection
- e) Submit inspection records as two (2) original hardcopy documents and one (1) electronic copy. SA Water's Representative will review the test results, inspect selective test positions with the Constructor and recommend additional testing to be completed by the Sub-constructor, if required
- f) SA Water's Representative will review the test results and identify any additional areas for repair.

8.3.5 Marking Repair Areas

Visibly mark out all defects within the repair area, or areas for application of other protective treatments, as applicable, on site using a permanent marking medium.

Contact SA Water's Representative to arrange for a joint inspection in order to obtain approval to proceed with repair, at the discretion of SA Water's Representative.

Following site agreement of marked defects, enter the location, number of defects and the required repair works into record sheets and drawing plans, for review and acceptance by SA Water's Representative, 5 working days prior to commencement of works.

HOLD POINT

The original shall be kept by SA Water's Representative and the duplicate by the Constructor and shall be used as a record for the purposes of measuring the works. In cases where there is doubt SA Water's Representative's decision shall be final.

8.4 Materials Requirements

8.4.1 General

Undertake all repair works to SA Water assets using materials listed in the Technical Standard sub-sections TS 0711.1 to TS 0711.5, for the purposes specified to meet the specified performance requirements, or be SA Water approved materials.

Unless specified otherwise, apply all materials in accordance with the manufacturer's standard application instructions. Make no addition or alteration to the materials unless specifically permitted by the Technical Standard, and written consent to any proposed change to standard manufacturers specifications must be obtained from the manufacturer.

8.4.2 Repair Systems

Repair works that involve application of multiple materials shall require all materials within a given repair system (i.e. for patch repair works the reinforcement primer, bond coat, cementitious repair material, and curing compound applied to the repair material) to be supplied by the same manufacturer.

Part systems shall not be accepted and should not be used to create alternative repair system solutions unless approved in writing as a proven, compatible system by each manufacturer.

If multiple repair systems are required, i.e. concrete repair followed by installation of a waterproof lining material, each repair system manufacturer shall provide written confirmation of compatibility of its materials with all other materials in the repair process.

For the whole quantity of each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

8.4.3 Proprietary Items

Use proprietary repair materials.

A proprietary item shall be any item identified by graphic representation on the drawings, or by naming in a Technical Standard one or more of the following: manufacturer, supplier, installer, trade name, brand name, catalogue or reference number, and the like.

Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified, but may indicate the necessary properties of the item such as type, quality, appearance, finish, method of construction, performance and the like.

The Constructor may offer a similar alternative item having the required properties. SA Water's Representative may in his absolute discretion adopt or reject the alternative.

No claim shall arise from any rejection, nor, unless otherwise agreed, shall adoption of an alternative be ground for any claim for variation to cost or time.

When offering an alternative for approval, provide all available technical information and include samples, reasons for proposed substitutions, cost and any other relevant information requested by SA Water's Representative. If so requested, obtain and submit reports on relevant tests by an independent testing authority. If necessary, provide an English translation.

State whether the use of the alternative will require alteration to any other part of the Works. If the alternative is adopted, carry out any such alteration without extra charge.

8.4.4 Manufacturer's Recommendations

Select, if no selection is given, and transport, deliver, store, handle, protect, finish, adjust, prepare for use, and provide manufactured items and products in accordance with the current written recommendations and instructions of the manufacturer or supplier relevant to such use at the time of undertaking the works, unless otherwise specified.

Use materials in accordance with the Manufacturer's Technical Data Sheet and Materials Safety Data Sheet.

Submit the recommendations and instructions, and advise of conflicts with other requirements.

Advise of activities that supplement, or are contrary to, manufacturer's or suppliers' written recommendations and instructions.

If products must comply with product certification schemes, provide them in accordance with the certification requirements.

Include all manufacturer's written confirmations in the Work Method Statements.

8.4.5 Product Supplier

Each manufacturer of proprietary concrete structure remediation materials system, or their nominated Australian Agent/Technical Representative supplying the material (Product Supplier), shall:

- a) Provide certificate(s) of compliance to material performance requirements
- b) Provide training to the application personnel
- c) Review and comment on the WMS and ITP
- d) Attend the first product installation and issue a written inspection report to verify that the material's applicators are competent, and that the installed material fully complies with its requirements
- e) Attend site and respond to queries, as required
- f) Undertake a final walkover with SA Water's Representative
- g) Provide the material warranty as specified.

Provide documented evidence to demonstrate compliance with the above requirements.

8.4.6 Compliance with AS/NZS 4020

All materials that form part of a repair system proposed for installation in a water tank interior, or to be in contact with drinking water, shall comply with the current version of AS/NZS 4020.

Provide a compliance certificate not less than 5 years old for all materials before proceeding with the works.

Reference shall be made to SA Water TS 0800 Materials in Contact with Drinking Water.

8.4.7 Materials Submissions

Submit a summary table listing all material products proposed to be used, information including, at a minimum:

- a) Name and generic type of the proposed material
- b) List of all manufacturer nominated component parts required to install the material, e.g. primer, bond coat, fillers, etc. for a proprietary system
- c) Manufacturer's name and address
- d) Manufacturer's product data including technical data sheets and materials safety data sheets indicating product standards, physical and chemical characteristics, technical specifications, limitations, installation instructions, maintenance instructions and general recommendations for all products/component parts to be used
- e) SA Water's Representative may request submission of documentation from an approved independent testing authority to confirm performance criteria stated on product data sheets. It is expected the material Manufacturer will have such documents readily available for submission and to be no more than three years old unless a longer validity period is specified in the test method to confirm performance criteria
- f) Project usage list to confirm track record of successful application in South Australia region or similar water/waste water environments (i.e. including project name, date, client, repair scope, quantity of material used, etc.)
- g) For each batch or consignment of material:
 - i. Product reference/batch number identification and expiry date
 - ii. Quantity manufactured in the batch
 - iii. Manufacturer's certificate of date of manufacture
 - iv. Supplier's name and address.
- h) Surface preparation and material application techniques to be used, inclusive of all materials Manufacturer's recommendations.

8.4.8 Storage and Use of Materials

Storage of Materials

If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

Original containers or packages shall be clearly labelled with the manufacturer's name, product type and name, reference number, batch number and date of manufacture.

Keep and store materials until the time of use in strict accordance with the Manufacturer's specifications, including:

- a) in dry conditions not exposed to direct sunlight
- b) not in contact with a damp floor or ground
- c) in their original sealed containers or packaging
- d) within the manufacturer's specified temperature range
- e) kept in a controlled environment (where necessary)

Use of Materials

Use in the order of delivery.

Do not use open or part full bags or containers of material unless permitted by the Manufacturer's technical specification.

Do not use materials stored beyond the Manufacturer's recommended shelf life date unless expressly approved by the Manufacturer in writing with reference to the specific batch records and intended purpose.

Do not use materials that have deteriorated in any way.

Dispose of out-of-date materials or deteriorated materials in accordance with Clause 7.4.

8.5 Trials

8.5.1 Purpose

Each sub-part of this Technical Standard (01-05) specifies the aspects of the works that require trials, samples or prototypes.

The intent of these processes is to confirm some or all of the following:

- a) Visual appearance of the works
- b) Compatibility of materials and performance of the works
- c) Workmanship procedures and sequencing of works
- d) Establish a quality benchmark for the project;
- e) Other as required by the Technical Standard and Drawings.

8.5.2 Trial Requirements

Where trials, samples or prototypes are required, allow sufficient program time to satisfy the assessment process prior to the ordering of bulk materials or commencement of relevant works on site.

Allow sufficient program time to resubmit, reapply, retest rejected trials, samples or prototypes and obtain SA Water's Representative approval thereof without affecting the time or costs of the works.

Trial repair requirements include:

- a) Complete a trial repair for each type of repair on each structure to establish the quality of work that will apply to the full scale works, to achieve workmanship compliant with the Technical Standard and Drawings
- b) The first area of repair shall be a trial repair to prove the repair materials and methods stated in the approved Work Method Statement are acceptable before proceeding with full-scale repair works. If the work method used deviates from the approved Work Method Statement, a new Work Method Statement and trial repair shall be required
- c) The trial repair shall be conducted using the materials, workmanship and quality control testing in the applicable Technical Standard

- d) Where applicable obtain test samples for testing to verify compliance with specified requirements
- e) Inform the SA Water's Representative in writing, the time and location of any trial repair or tests on trials repairs at least 5 working days in advance
- f) SA Water's Representative shall witness the trial application process, and witness tests conducted on the trial, at their discretion
- g) Submit a Trial Repair Report as per Clause 8.5.3, containing all details of the trial repair to SA Water's Representative for review and acceptance, 10 working days before full scale application works start. **HOLD POINT**

8.5.3 Trial Repair Report

The Trial Repair Report shall include the following details:

- a) Detailed description on how the repair works were undertaken in the trial and variations from the approved Work Method Statement
- b) High resolution, sharp progress photographs of each sub-stage and step of the repair process (including progress photographs of all hold point items) that fully document the quality of workmanship achieved and compliance to the Standard
- c) High resolution, sharp video footage of the trial application process
- d) Quality control testing records
- e) Any amendments to the Work Method Statement proposed by the Sub-constructor to be used in the works based on the trial
- f) Conclusions on trial repair achieving Technical Standard compliance (i.e. full compliance or not).

Include the completed Trial Repair Report in the As Repaired/Constructed Reports.

8.6 Pre Start Meeting

Prior to the commencement of concrete repair works conduct a prestart meeting comprising the following:

SA Water Superintendent or SA Water's Representative

Main Constructor

Concrete Repair Constructor

Key Sub-Constructor Applicators

Quality Control Inspector

Key Manufacturers

Other relevant parties.

This meeting is to discuss the communication plan, roles and responsibilities, specification and clarification of issues arising, fabrication, difficult to access areas, surface preparation, inspection and test plan, report formats, products to be used, lead times, project program, repairs and on site defect touch ups or repairs.

HOLD POINT

8.7 Commissioning and Water Quality Monitoring

Submit to SA Water's for approval a Commissioning and Water Quality Monitoring Plan with least 30 working days' notice.

HOLD POINT

Constructors shall comply with SA Water's water quality and monitoring requirements for commissioning refurbished assets, which are available from SA Water's Water Quality team.

Commissioning should be conducted such that there is no risk of customers receiving potentially contaminated commissioning water.

Consult with relevant Water Quality (WQ) Representative prior to commissioning activities being undertaken.

Water quality testing must comply with Australian Drinking Water Guidelines (ADWG) or be within acceptable limits if no applicable ADWG value exists. There may also be necessary operational targets that are applicable. The WQ representative can advise on any applicable SA Water limits or operational targets.

If there is no other option but to bring infrastructure online prior to test results being available, any ADWG or operational exceedances must be managed by the WQ representative according to WQ_M08 WQ Incident and Emergency Management Protocol (SA Water Protocol).

Appendix A : Schedules of Hold Points, Witness Points and Identified Records

A1 Schedule of Hold Points

Clause	Type	Description
4.1	Hold	Concrete repair constructor pre-qualification - within 30 working days of the Date of Acceptance of Tender
4.4.1	Hold	Submissions of the proposed concrete structure repair systems 30 days prior to commencing work
5.3	Hold	Draft Quality Plan - within 10 working days of the Date of Acceptance of Tender
5.5	Hold	Work Method Statement – 10 working days' notice, in writing, is required
5.6	Hold	Inspection and Test Plan – 10 working days before the relevant work commences
5.6	Hold	Signed ITP - within 5 working days of completing relevant activity
5.9.1	Hold	Materials Testing (NATA Endorsed) – 10 working days before the relevant work commences
5.12	Hold	Draft As-Built/Constructed Report - within 4 weeks of the issue of the Certificate of Practical Completion
8.3.1	Hold	Mark-up Plan of Work Extent – 5 working days prior to undertaking the pre-repair survey as per Clause 8.3.2
8.3.5	Hold	Record Sheets and Drawing Plans – after site agreement of marked defects and 5 working days prior to commencement of works
8.5.2	Hold	Trial Repair Report – 10 working days prior to commencement of full scale application
8.6	Hold	Pre Start Meeting
8.7	Hold	Commissioning and Water Quality Monitoring Plan - 30 working days prior to commissioning activities

A2 Schedule of Witness Points

Clause	Type	Description
5.9.2	Witness	Quality Assurance Testing – To be witnessed at discretion of SA Water's Representative
8.2	Witness	Temporary works design, drawings and certification - 10 working days notice

A3 Schedule of Identified Records

Clause	Description of Identified Record
4.6	Warranties/Guarantees
5.3	Final Quality Plan - within 10 working days of receiving comments from SA Water's Representative
5.12	Final As-Built/Constructed Report - within 10 working days of receiving comments from SA Water's Representative