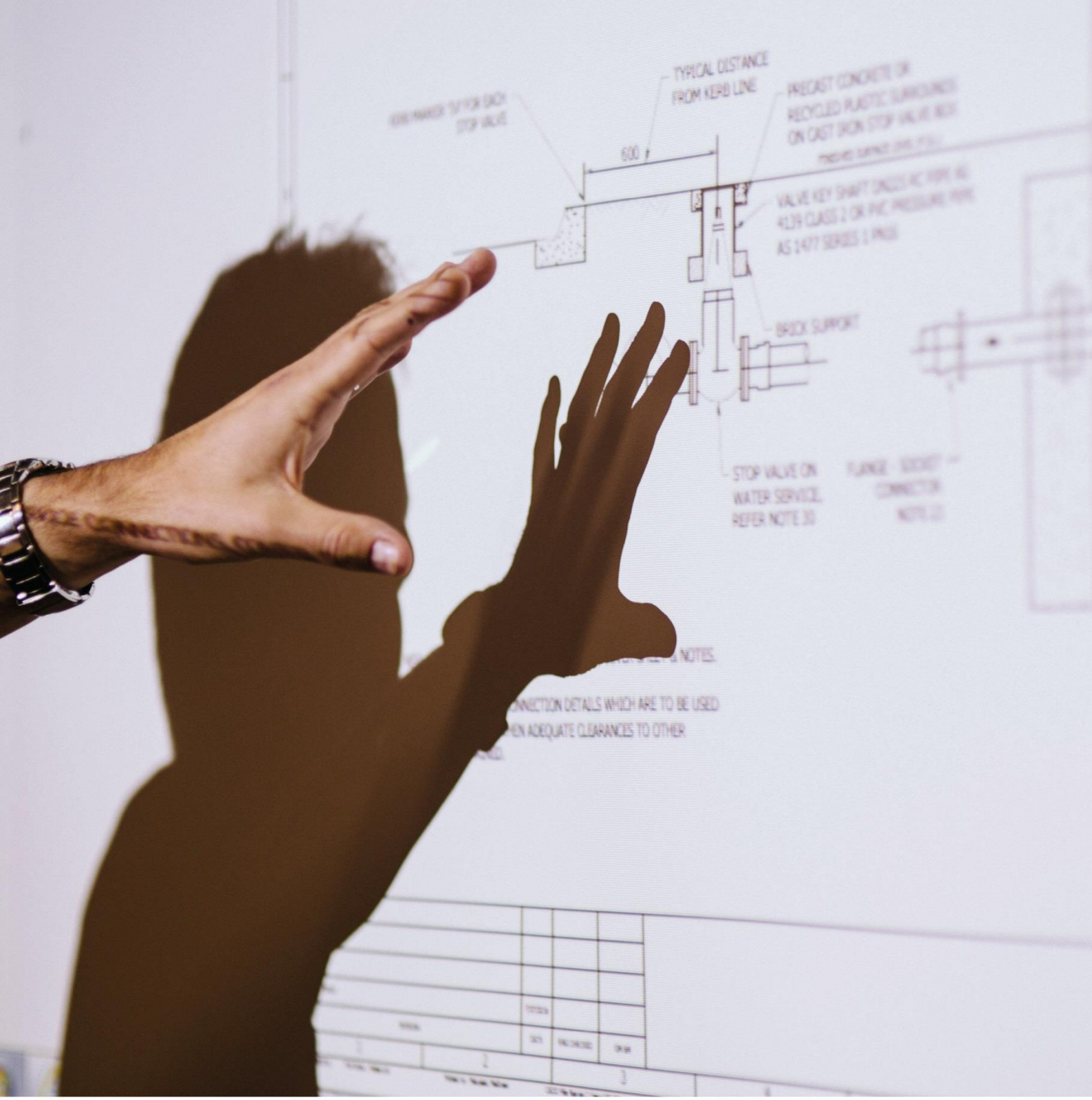

STD-SPE-C-001
TECHNICAL SPECIFICATION
CIVIL AND STRUCTURAL WORKS

icon
WATER

talktous@iconwater.com.au | (02) 6248 3111 | @iconwater | **iconwater.com.au**

Document management

Document authorisation table

Issue	Date	Author	Reviewer	Approver
C	04/11/16	M. Panvelkar (MWH) J. van Herel (MWH)	J. Ciccotelli (MWH)	Ian McRae
1	20/04/18	G. de Leeuw	K. Danenbergsons	D. Eager
2	03/09/21	G. de Leeuw	S. Bursle	K.Danenbergsons

Version control table

Issue	Date	Reason for issue
C	04/11/16	Initial issue for use by Stantec (formerly MWH) for works at LMWQCC only.
1	20/04/18	Updated and re-issued for works across all Icon Water asset areas.
2	03/09/21	Updated and re-issued with minor amendments.

Document applicability table

Asset area	Applicable (Yes/No)	Asset area	Applicable (Yes/No)
Dams (DAM)	*	Water Network (WAT)	*
Bulk Water Supply (BWS)	*	Sewerage Network (SEW)	*
Water Treatment Plants (WTP)	Yes	Sewage Pump Stations (SPS)	*
Water Pump Stations (WPS)	*	Sewage Treatment Plants (STP)	Yes
Reservoirs (RES)	Yes	Recycled Water Systems (REC)	Yes

***** Applicable to some, not all civil and structural works. Refer to Section 2 (Table 2.1) for specific applicability details.

Table of Contents

Abbreviations

ACT	Australian Capital Territory
ARI	Annual Recurrence Interval
ABS	Acrylonitrile butadiene styrene
ASTM	American Society for Testing and Materials
ASSDA	Australian Stainless Steel Development Association
CBR	California Bearing Ratio
EPDM	Ethylene propylene diene monomer
GRP	Glass reinforced plastic
HDPE and PE	High density polyethylene
ITP	Inspection and test plan
NATA	National Association of Testing Authorities, Australia
NSW	New South Wales
PTFE	Polytetrafluoroethylene
RC	Reinforced concrete
STP	Sewage treatment plant or facility
WAE	Work as Executed

Definitions

Contractor	The person or organisation responsible for construction of the works including testing, commissioning and handover.
Chartered Engineer	A Professional Civil Engineer with chartered (CPEng) membership of Engineers Australia. A Registered Professional Engineer of Professionals Australia (RPEng) is considered equivalent to a CPEng.
Designer	The individual person or organisation responsible for design of the works. The Designer may be Icon Water personnel or an external engineering consultant, a vendor/supplier or an installation Contractor.
Developer	As per the definition provided in *STD-SPE-G-019 Asset Creation and Approval*.
Icon Water	The owner and operator of the constructed works.
Icon Water Representative	The nominated person or organisation that has written authority to act on Icon Water's behalf. This may be an Icon Water employee (or employees) such as an Icon Water Inspector or Icon Water Site Surveillance Officer, or a third party engaged to act on Icon Water's behalf.
Principal	Shall be as defined in project specific contract documentation. For assets "gifted" to Icon Water, the Principal may be the Developer. Otherwise, for assets which are not "gifted", Icon Water or its alliance partner (if applicable) will be the Principal.
Qualified Surveyor	A surveyor with formal qualifications and experience that meets or exceeds the requirements detailed in Icon Water specification *STD-SPE-C-004 Survey and Tolerancing Requirements*.
Superintendent	The individual appointed by either the Developer (in the case of "gifted" network assets) or appointed by Icon Water (for "non-gifted" assets) as an independent arbiter of contract directions, issues, claims and variations. In some instances, the Superintendent may also be the Icon Water Representative. Refer to the project specific contract documentation for the entity named as the Superintendent. Note: Where the "Icon Water Representative" has been nominated in this document, the "Superintendent" may be substituted via prior written approval from Icon Water for "gifted assets. Regardless, the "Superintendent" and/or "Icon Water Representative" must be clearly shown in the Contractor's Inspection and Test Plans.
Supplier	As per the definition for "Vendor".

Vendor	The person or organisation responsible for the fabrication or manufacture and supply of products, materials, equipment and components described herein.

NOTICE:

Icon Water does not allow the use of NATSPEC (National Building Specification) or similar in lieu of this technical specification.

Any departures from this specification for the design and construction of Icon Water assets must be pre-approved in writing by the relevant Icon Water Principal Engineer and applications for such departures must be fully detailed with clear statements of justification.

1 Background

Icon Water has standardised on the requirements for the design and construction for all asset types (regardless of location) through the publication of a suite of specifications and standard drawings. This has been done to provide better clarity for Designers and Contractors on Icon Water requirements which in-turn leads to a greater consistency in the operations and maintenance tasks undertaken by workers at Icon Water sites. This specification forms part of Icon Water's suite of design and construction standards (aka "Icon Water Standards").

Additional technical specifications specific to individual projects are described in a Project Specification for each separate contract.

2 Scope

This specification shall apply to the design, manufacture, fabrication, supply, installation, construction, testing, commissioning and handover of all civil and structural works within the asset areas indicated in Table 2.1, and shall include:

- Earthworks;
- Piling;
- Reinforced concrete;
- Precast concrete;
- Metalwork;
- Roadworks;
- Buildings.

Table 2.1 Specific Applicability – By Asset Area or Asset Type

Item	Asset area	Applicability of this specification
1	Dams (DAM)	Not applicable to any civil or structural works influencing the structural integrity of a dam structure. Otherwise, this specification is applicable without limitation (e.g. access roads, site drainage, utility buildings and fencing etc.)
2	Bulk Water Supply (BWS)	Applicable without limitation.
3	Water Treatment Plants (WTP)	Applicable without limitation.
4	Water Pump Stations (WPS)	Applicable without limitation.
5	Reservoirs (RES)	Applicable without limitation.
6	Potable Water Network (WAT)	The potable water network shall comply with the requirements of WSAA code *WSA 03 Water Supply Code of Australia* as amended by Icon Water in *STD-SPE-G-012.* Should *WSA 03* or *STD-SPE-G-012* be "silent" with regards to the requirements for a particular design or construction element then the relevant Sections of this specification shall apply.

Item	Asset area	Applicability of this specification
7	Sewerage Network (SEW)	The sewerage network shall comply with the requirements of WSAA code *WSA 02 Gravity Sewerage Code of Australia* as amended by Icon Water in *STD-SPE-G-011*. Should *WSA 02* or *STD-SPE-G-011* be "silent" with regards to the requirements for a particular design or construction element then the relevant Sections of this specification shall apply.
8	Sewage Pump Stations (SPS)	Sewage pump stations shall comply with the requirements of WSAA code *WSA 04 Sewage Pumping Station Code of Australia* as amended by Icon Water in *STD-SPE-G-010*. Should *WSA 04* or *STD-SPE-G-010* be "silent" with regards to the requirements for a particular design or construction element then the relevant Sections of this specification shall apply.
9	Sewage Treatment Plants (STP)	Applicable without limitation.
10	Recycled Water Systems (REC)	Applicable without limitation.

3 Purpose

The purpose of this specification is to provide technical requirements for the design, manufacture, fabrication, supply, installation, construction, testing, commissioning and handover of civil and structural works for use within the asset areas detailed in Table 2.1.

4 Standards and Codes

All civil and structural works carried out shall be in accordance with the requirements of:

- This specification, including all documents referenced by each section of the specification:
  - Section 6 Earthworks - Table 6.2.1
  - Section 7 Piling - Table 7.2.1
  - Section 8 Reinforced Concrete - Table 8.2.1
  - Section 9 Precast Concrete - Table 9.2.1
  - Section 10 Metalwork - Table 10.2.1
  - Section 11 Roadworks - Table 11.2.1
  - Section 12 Buildings - Table 12.2.1
- The documents listed in Table 4.1.
- The relevant Icon Water Work Instructions (which will be provided where applicable on a project-by-project basis).
- The relevant WorkSafe ACT, WorkCover NSW and SafeWork Australia codes of practice.

The work shall also comply with the requirements of all relevant legislation, bodies and codes.

The Designer or Contractor (as applicable) shall notify the Icon Water Representative of any ambiguity or discrepancy discovered. In the event of an ambiguity or discrepancy the Icon Water Representative shall direct the Vendor or Contractor as to the interpretation to be followed in carrying out the work.

Drawings are not to be scaled. Where any discrepancy exists between figured and scaled dimensions the figured dimensions shall prevail.

Table 4.1 Referenced Documents

Item	Document number	Title
Australian standards		
-	Refer to each individual section (6 through 13 inclusive) of this document for a detailed listing	
WSAA codes and publications		
1	WSA 02	Gravity Sewerage Code of Australia
2	WSA 03	Water Supply Code of Australia
3	WSA 04	Sewage Pumping Station Code of Australia
4	WSA 201	Manual for the Selection and Application of Protective Coatings
Icon Water standards		
5	SD Series	Standard Drawings
6	STD-SPE-C-004	Survey and Tolerancing Requirements
7	STD-SPE-C-005	Technical Specification, Pipelines
8	STD-SPE-G-001	General Specification, Testing and Commissioning
9	STD-SPE-G-002	General Specification, Decommissioning and Demolition
10	STD-SPE-G-005	Supplement to WSA 201 Manual for the Selection and Application of Protective Coatings
11	STD-SPE-G-006	Approved Products List
12	STD-SPE-G-007	WSA Product Specifications, Icon Water Edition
13	STD-SPE-G-008	Technical Specification - Design Requirements for Safe Access, egress and working at heights
14	STD-SPE-G-009	Supplement to AS 1657 Fixed Platforms, Walkways and Stairways…
15	STD-SPE-G-010	Supplement to WSA 04 Sewage Pumping Station Code of Australia
16	STD-SPE-G-011	Supplement to WSA 02 Gravity Sewerage Code of Australia
17	STD-SPE-G-012	Supplement to WSA 03 Water Supply Code of Australia
18	STD-SPE-G-017	Water and Sewerage Service and Installation Rules
19	STD-SPE-G-018	General Specification, Drafting Standards

Item	Document number	Title
20	STD-SPE-G-019	Asset Creation and Approval Process
21	STD-SPE-G-020	Asset Records
22	STD-SPE-M-002	Technical Specification, Piping and Valves
23	STD-SPE-M-003	Technical Specification, Hydraulically Operated Automatic Water Control (Globe) Valves
24	STD-SPE-M-004	Technical Specification, Compendium of Piping Specification Sheets
25	STD-SPE-M-005	Technical Specification, Penstocks
26	STD-SPE-S-001	Technical Specification, Tankage
27	STD-SPE-S-002	Technical Specification, Reservoirs

Note: The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

5 General Requirements

5.1 Designer Qualifications and Experience

The Designer shall meet the qualification and experience requirements detailed in Table 5.1.1 where the qualifications and experience requirements are defined as follows:

- Type 1: The Designer must be able to demonstrate that they are suitably qualified and experienced or directly supervised by a suitably qualified and experienced engineer.
- Type 2: The Designer, or the engineer directly supervising the Designer, must hold either (i) chartered (CPEng) status with Engineers Australia or (ii) chartered status with an international body that Engineers Australia deems to be equivalent (e.g. the Institution of Civil Engineers UK), or (iii) registered professional (RPEng) status with Professionals Australia. The engineer holding such status must be able to demonstrate that they are suitably experienced and they shall certify in writing that the design complies with the relevant codes, standards, legislative requirements and the requirements of this specification.

Table 5.1.1 Designer Requirements

Item	System or Asset Type	Designer Qualifications and Experience Requirements
1 Earthworks		
1.1	• Bulk earthworks of a general nature less than 1.5m deep • Bulk earthworks for overland drainage, erosion and sediment control	Type 1
1.2	• Bulk earthworks of a general nature equal to or deeper than 1.5m • Earthworks resulting in a slope steeper than 1:3 • Engineered fill • Earthwork requiring any shoring or presenting a risk to safety	Type 2
2 Piling		
2.1	• All works relating to the design of any piling system	Type 2
3 Reinforced Concrete		
3.1	• All works relating to the design of any reinforced concrete system	Type 2
4 Precast Concrete		
4.1	• All works relating to the design of any precast concrete system	Type 2
5 Metalwork		
5.1	• All non-structural (i.e. non-load bearing) metalwork	Type 1
5.2	• All structural (i.e. load bearing) works relating to the design of any metalwork	Type 2

Item	System or Asset Type	Designer Qualifications and Experience Requirements
7 Roadworks		
7.1	• Bulk earthworks of a general nature less than 1.5m deep • Manhole excavation less than 1.5m deep • Bulk earthworks for overland drainage, erosion and sediment control	Type 1
7.2	• Bulk earthworks of general nature equal to or deeper than 1.5m • Earthworks resulting in a slope steeper than 1:3 • Engineered fill • Pavement layer design • Foundation design • Earthwork requiring any shoring or presenting a risk to safety	Type 2
8 Buildings		
8.1	• All works relating to the design of any structural building element	Type 2

5.2 Extent of Design Documentation

5.2.1 Design Calculations

Design calculations shall be documented, checked and verified by competent Designers as detailed in Section 5.1.

Design calculations shall clearly show the following:

- Applicability of codes and standards.
- Aim of design.
- Basis of design including strength and serviceability performance, design assumptions, economic, physical, aesthetic and other constraints.
- Design life.
- Design actions or loads.
- Design resistance or strength.
- Analytical methods and software used.
- Safety considerations.
- Environmental considerations.

5.2.2 Design Drawings and Documentation

The Designer shall prepare design drawings in discrete and complete packages for elements or components of the works, in accordance with the requirements detailed in Table 5.2.2.1.

Each drawing shall be complete and shall have been checked for accuracy and verified fit for purpose prior to submission.

All drawings shall be prepared in accordance with Icon Water's *STD-SPE-G-018 General Specification, Drafting Standards*.

The requirements specified in Table 5.2.2.1 are minimum mandatory requirements.

Table 5.2.2.1 Minimum Mandatory Requirements for Civil and Structural Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1 General Drawings and Documents		
1.1	Site Plan	Site plans shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Symbols shall comply with the Icon Water SD series of drawings.
1.2	General Arrangement	General arrangement and elevation drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. All general arrangement plans shall show contours at 0.25m intervals maximum, unless otherwise agreed with the Icon Water Representative. Minor details such as cut-off drains or embankment details may be shown on the plans. Existing utilities and new utilities shall be shown in plan view on the general arrangement plan. Symbols shall comply with the Icon Water SD series of drawings.
1.3	Erosion and Sediment Control	Erosion and sediment control drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. A plan view shall be prepared showing drainage lines with erosion mitigation measures in place. Section details of any berm or cut-off drain shall be produced showing dimensions and slopes. Symbols shall comply with the Icon Water SD series of drawings.

Item	Drawing or Document Type	Minimum Mandatory Requirements
1.4	Landscape and Soilworks	Landscape and soilworks drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall show a sectional view of the landscaped area with dimensions, slopes and any layer works that may be needed. A plan view shall also be prepared showing the area to be landscaped, with details of plants and restoration vegetation. Symbols shall comply with the Icon Water SD series of drawings.
1.5	Symbol and Legend Drawings	The Designer shall reference the relevant Icon Water SD series drawings for earthworks symbols. Should a symbol not be available in the Icon Water SD series drawing set which the Designer wants to use, they shall contact the Icon Water Representative to gain approval prior to submitting the relevant drawings for their milestone reviews.
1.6	Design Calculations and Models	The Designer shall furnish all design calculations, analysis and modelling upon request from the Icon Water Representative.
1.7	Project Specification (and Scope of Work)	When requested as part of the Designer's scope of work, the Designer shall produce a specification customised for the project which is based on this specification, Icon Water's SD series of drawings and any other relevant Icon Water specifications. Icon Water does not allow the use of NATSPEC (National Building Specification) as the basis for any civil or structural specification unless approved in writing by Icon Water's Principal Civil Engineer. The inclusions of such a specification will be determined on a project-by-project basis but shall include: • Reference to this specification and other relevant Icon Water specifications • Reference to specific Icon Water SD series drawings • Project specific civil and structural requirements • Existing Icon Water WAE drawings (if applicable) • Contractor scope of works • Work by others and works excluded from the Contractor scope of works

Item	Drawing or Document Type	Minimum Mandatory Requirements
1.8	Project Design Report	The Designer shall provide a design report which meets industry accepted norms as well as meeting the Safework Australia and Worksafe ACT requirements for safety in design. That is, the Designer shall inform Icon Water (and the Contractor as appropriate) via the design report, all atypical hazards associated with the fabrication, construction, installation, commissioning, testing, operation, maintenance and demolition of the works so designed. Mitigation measures to reduce the level of risk to as low as reasonably practicable shall also be provided.
2 Earthworks		
2.1	Refer Section 6.3.3 of this specification	
3 Piling		
3.1	Refer Section 7.3.3 of this specification	
4 Reinforced Concrete		
4.1	Refer Section 8.3.3 of this specification	
5 Precast Concrete		
5.1	Refer Section 9.3.3 of this specification	
6 Metalwork		
6.1	Refer Section 10.3.3 of this specification	
7 Roadwork		
7.1	Refer Section 12.3.3 of this specification	
8 Buildings		
8.1	Refer Section 13.3.3 of this specification	

5.3 Safety in Design

The Designer shall comply with the requirements of the Work Health and Safety Act and Regulations 2011 in regard to the duties of Designers.

The Designer shall ensure that structures are designed to be without risks to the health and safety of persons who use, construct or demolish the structure throughout its life cycle. The Designer shall carry out all necessary calculations and testing relating to safety risks and shall prepare a written safe design report. The report shall state the purpose of the structure and the conditions for which the structure is to be used without risks.

The Designer shall consult with all stakeholders and integrate a risk management approach into the design process. The Designer shall follow the Model Code of Practice titled *Safe Design of Structures* published by SafeWork Australia, or other equivalent procedures. The Designer shall also follow other

technical and engineering standards relating to safety, health and amenity. If the design involves risks outside that contemplated in technical publications, the Designer shall show all reasonable steps in adequately addressing and controlling these risks.

5.4 Survey

Unless otherwise specified, the Contractor shall arrange for all necessary survey and setting out to the dimensions and levels shown on the drawings. All site setout and survey work, where survey work also includes the production of WAE records, shall be conducted in accordance with this specification as well as the requirements of the Icon Water specification titled *STD-SPE-C-004 Survey and Tolerancing*.

All survey work shall be undertaken by a Qualified Surveyor.

5.5 Environmental Protection Measures

The Contractor shall carry out all work in accordance with the requirements and conditions set out in environmental documents included in the Contract and environmental protection requirements in this specification.

In addition to overall compliance as noted above, an Environmental Management Plan (EMP) shall be prepared prior to the commencement of construction. A draft of the EMP shall be submitted to the Icon Water Representative in electronic (MS Word) format for review. Site establishment cannot commence until either the Icon Water Representative agrees that the content of the EMP is sufficient for construction work to proceed or 4 weeks after submission of the draft EMP. Within two weeks of agreement of the draft EMP or within 6 weeks of submission of the draft EMP, the Contractor shall prepare a final electronic (PDF) version of the EMP (as a standalone document).

The EMP documents will be distributed as follows:

- 1 electronic copy to the Icon Water Representative;
- 1 hardcopy at the construction site to be readily available to the all parties on a day to day basis;
- 1 electronic (and/or hardcopy) kept at Contractor's administrative office.

Agreement to the EMP does not release the Contractor from full responsibility for adopting all necessary environmental protection measures for the duration of the Contract, whether or not such measures are explicitly or implicitly included in the EMP.

5.6 Existing Services and Location of Services

Any details of services provided are not to be taken as indicating all existing services or their exact locations. Irrespective of any information provided, it is the Contractor's obligation and responsibility to verify the exact location of all services which may be affected by construction activities. If services are located which conflict with information already provided by the Principal or Icon Water Representative, the Contractor shall give notice to the Icon Water Representative at least three (3) working days prior to commencement of any construction activity that may affect the service.

The location and depth or dimension of services are not to be determined by scaling from any drawing.

5.7 Protection and Maintenance of Services

The Contractor shall take all actions and provide all things necessary to protect and maintain existing services to the satisfaction of the relevant authority or owner. This may include arranging or performing relocation, temporary diversion or support of the service.

5.8 Repair of Services

If a service is damaged during construction, repairs shall be done to the satisfaction of the controlling authority or owner. Upon completion, a certificate stating that the repair has been carried out to their satisfaction shall be obtained by the Contractor.

If the service is not under the control of an authority and the owner cannot be located within a reasonable time, the damage shall be reported, and arrangements made for repairs. No backfill, cover up or making the repair inaccessible prior to obtaining approval are to be done.

5.9 Visual Records

The visual record of the work consists of an Initial Record showing the site prior to commencement of the work and a Final Record showing the completed work.

5.9.1 Initial Record

A detailed photographic record of all areas that will be affected by construction including stockpile areas, storage areas and access tracks shall be provided. Details must include, but not be limited to: structures, roads, pavements, reserves, kerb and gutter, fences, drains and pits. Special attention is to be given to all existing improvements within 5 metres of the proposed works.

A record of notable details and existing damage or faults relating to improvements in the vicinity of the works shall be prepared.

This record will be used in the resolution of disputes between property owners and the Contractor and/or Icon Water and accordingly should be comprehensive in its coverage of the areas affected by construction activities.

The Initial Record shall be completed and submitted prior to commencing work on the site.

The Contractor shall add to the Initial Record as work proceeds if additional areas will be affected by construction activity and the condition has not been previously recorded or if site conditions change.

5.9.2 Final Record

The photographic record shall be updated to show all of the completed works. The Final Record shall be submitted prior to the return of any security due for release at Practical Completion.

5.9.3 Format

The photographic records are to be presented in an electronic document which has pages sized at A4. Each photograph (i.e. digital image) shall be at least 150 x 100 mm when the document is printed at 1:1 scale and each print shall display the date of photography and have a resolution of at least 220 dpi. Note: A camera (or smartphone with camera function) with a resolution of 3.0 megapixels or more is capable of producing digital images of the required resolution when sized at 150 x 100 mm.

The photographs are to be grouped in document chapters or sections which are representative of each section of the work. Each chapter/section is to be referenced/indexed such that particular properties and/or chainages can be examined.

Each chapter/section shall carry notation indicating:

- Chainage at start and finish
- Comments on any existing damage or faults, particularly where they are not obviously visible in the photographs.

Note: Digital video records may be substituted for photographic records if approved in writing by the Icon Water Representative prior to enacting the Initial Record. If digital video is to be used, the video resolution shall be a minimum of 1080p @ 30 fps.

5.10 Temporary Fencing and Signage

The Contractor shall erect suitable temporary fencing and signage on-site and at all excavations and shall comply with all statutory regulations in regard to excavation and excavation safety signage.

Project signage shall be in accordance with the Icon Water *SD Series* of drawings.

5.11 Approved Products

5.11.1 Requirements for Designers

Icon Water requires Designers to specify products and materials which are specifically listed in the Icon Water Approved Products List (*STD-SPE-G-006)*. Products and materials not specifically listed in the Icon Water Approved Products List shall not be specified by Designers unless written authorisation has been obtained from Icon Water. For some projects, depending upon the circumstances, Icon Water will provide a project specific list of products and materials to supplement the Icon Water Approved Products List. This will typically be provided early in the design phase of the project. Designers shall treat such a project specific list in the same way that they are required to treat the Icon Water Approved Products List.

Designers shall not use the words “or equivalent” in specifications or on drawings as Designers are required to specifically name the chosen product or material in sufficient detail so that it can be easily procured by the Contractor and easily checked for compliance by the Icon Water Representative during construction. Otherwise, if this cannot be done for some compelling reason, the words “or approved equivalent” shall be used.

5.11.2 Requirements for Contractors

Icon Water requires Contractors to construct in accordance with the project specific design documentation package which will include specifications and drawings. The Contractor shall only use products and materials specifically shown/detailed in the project specific drawings and specifications.

If the specifications and drawings do not nominate a product or material specifically (e.g. by make and model) then the Contractor shall refer to the Icon Water Approved Products List and only purchase and install a product or material specifically detailed in the Icon Water Approved Products List for the relevant product or material type.

If the design drawings or specification show the words “or equivalent” when referring to a particular product or material, the Contractor shall treat this as an error on behalf of the Designer and shall interpret these words as “or approved equivalent”. The words “or approved equivalent” indicate that the Contractor must use the product or material specifically nominated by the Designer unless a written approval is obtained from Icon Water prior to installation of an alternative product or material.

If an exceptional circumstance arises such as the design documentation package and the Icon Water Approved Products List are both “silent” for a particular product or material type, then the Contractor shall contact the Icon Water Representative as soon as possible (and prior to procuring and/or installing such a product or material type) so that Icon Water can provide a written approval or rejection.

In the event that the Contractor installs an unapproved product, Icon Water shall consider this a defect and the Contractor shall be required to rectify such defects at their cost and to the satisfaction of the Icon Water Representative using approved products and materials. Rectification shall include but not be limited to complete removal of the product or material from the site and replacement with an approved product or material.

Icon Water is not obliged to provide retrospective approvals for unapproved products and materials already installed by the Contractor and is not obliged to provide any requested retrospective approval in a timeframe that suits the Contractor’s project schedule.

The Contractor shall not be entitled to make a claim for delay or damages if they install an unapproved product or material which is rejected by Icon Water.

6 Earthworks

6.1 Scope

This specification covers the minimum requirements for the design, construction and acceptance testing of earthworks. The scope of works includes, but is not necessarily limited to, the following work:

- Geotechnical site investigations and monitoring
- Erosion, sedimentation and environmental control
- Surface drainage and runoff control
- Clearing and grubbing
- Stripping, removal, stockpiling and reclamation of topsoil
- Excavation, stockpiling and removal of unusable, surplus and / or contaminated soils and materials
- Bulk earthworks – cut to fill
- Embankment earthworks
- Excavation and backfilling for structures
- Excavation in watercourses
- Excavation in water charged ground
- Shoring and earth retention
- Earthworks, inspection and testing
- Soiling, grassing, turfing and general surface restoration
- Spreading of excess useable materials
- Restoration
- Earthworks records

Note that (i) earthworks relating to trenches for buried pipeworks (ii) earthworks associated with roadworks, and (iii) earthworks for buildings are detailed elsewhere in this specification.

6.2 Referenced documents

The documents listed in Table 6.2.1 are either referenced by Section 6 of this specification, or shall be read in-conjunction with Section 6 of this specification.

Table 6.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 1141	Methods for Sampling and Testing Aggregates
2	AS 1289	Methods for Testing Soils for Engineering Purposes
3	AS 1726	Geotechnical Site Investigation
4	AS 3798	Guidelines for Earthworks for Commercial and Residential Developments

Item	Document number	Title
TCCS		
5	MIS02	Earthworks and Site Grading
6	09	Standard Specification – 09 Landscape
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
7	Not provided	Excavation Work Code of Practice
Icon Water standards		
8	SD Series Drawings	Standard Drawing Set
9	STD-SPE-C-004	Survey and Tolerancing Requirements
10	STD-SPE-G-006	Approved Products List
10	STD-SPE-G-010	Supplement to WSA 04 Sewage Pumping Station Code of Australia
11	STD-SPE-G-011	Supplement to WSA 02 Gravity Sewerage Code of Australia
12	STD-SPE-G-012	Supplement to WSA 03 Water Supply Code of Australia
13	STD-SPE-G-018	Drafting Standards

6.3 Design and Specification

6.3.1 General

The details provided in Section 6.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 6.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

6.3.2 Referenced Documents

The documents listed in Table 6.2.1 are either referenced by Section 6 of this specification, or shall be complied with and read in-conjunction with Section 6 of this specification. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

6.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 6.3.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water Standards (e.g. *STD-SPE-G-018).*

The requirements specified in Table 5.2.2.1 and Table 6.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed

and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 6.3.3.1 Minimum Mandatory Requirements for Earthworks Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, items 1.1 to 1.8 inclusive.
2	Bulk Earthworks and Setting Out	Bulk Earthworks and Setting Out drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall show as a minimum: • contours to 0.25m interval maximum • setting out points with a table with coordinates • elevations and RLs of terraces • site drainage lines • project boundary lines • cadastral information • existing structures • proposed structures Symbols shall comply with the Icon Water SD Series of drawings.
3	Cross Section	Cross section drawings of the earthworks shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Excavation lines (cut), backfilled layers (fill) and finished layers shall be clearly shown. Where appropriate, information such as battered slopes, dimensioned layers and finished levels, as a minimum, shall be shown. All existing and proposed utilities shall be shown on the drawings. For major project sites, separate utility drawings shall be prepared. Symbols shall comply with the Icon Water SD Series of drawings.

6.3.4 Site Investigation

Site investigation shall be carried out for each site by a geotechnical engineer in accordance with AS 1726. The investigation shall provide sufficient information on site conditions to allow design and construction details to be finalised.

In particular the investigation shall:

- Describe the topography of the area and report on any site conditions which may affect the design or construction of the proposed structure.
- Determine the subsurface soil profile using boreholes and test pits as necessary.

- Sample, test and classify the strata.
- Determine the groundwater conditions.
- Determine the soil and groundwater chemical characteristics.
- Determine the net allowable bearing capacity of the soils at the proposed founding levels of structures.
- Provide an estimate of the anticipated total and differential settlements for the proposed imposed dead and live loads.
- Provide recommendations on the type(s) of foundations.
- Provide recommendations on construction procedures and any difficulties likely to be encountered.
- Provide recommendations on earth pressure coefficients for design actions (upper bound values) and design resistance (lower bound values).

6.3.5 Design Tolerances

The location and final design elevations shall be determined to the following levels of design accuracy and specified in the design drawings:

(a) In plan, to 0.01 m.

(b) In level where the grade is < 0.5% (1 :200); to the nearest 0.005 m.

(c) In level where the grade is > 0.5% (1 :200); to the nearest 0.01 m.

6.4 Construction and Testing

6.4.1 General

Surfaces shall be completely free of depressions, potholes and loose materials in readiness for structure or pavement construction.

Unless otherwise specified, the Contractor shall arrange for all necessary setting out to the dimensions and levels shown in the drawings. Levels shall be set out from the benchmark provided in the drawing.

Greatest care shall be taken to avoid interference with any benchmark, survey or level peg or supplementary reference mark. Before any pegs are affected by earthwork operations the Contractor shall obtain the approval of the Superintendent and shall transfer such pegs to side positions clear of operations and shall note the extent of the movement, in distance and level.

Where applicable, the Contractor shall carry out all earthworks in accordance with the requirements and conditions set down in environmental documents included in the Contract Documents.

6.4.2 Safe Undertaking of Earthworks

The Contractor shall carry out all excavation work in accordance with the requirements of all relevant legislation and statutory requirements.

Prior to undertaking any excavation, the Contractor shall identify the hazards involved with the work, assess the risks and implement control measures. A work method statement shall be prepared for all excavation work.

Suitable shoring, benching and/or battering shall be provided where required. The advice of the independent geotechnical engineer shall be sought where appropriate.

No excavation shall occur until the Contractor has acquired comprehensive up-to-date services searches and has located all identified services affected by the earthworks, and has taken all necessary precautions to protect, isolate or secure the services.

All excavation shall be secured, and hazardous areas isolated, by the use of fencing, barricades, railings and/or covers.

6.4.3 Geotechnical Work

6.4.3.1 Geotechnical site investigations

The Contractor shall be responsible for determining all necessary site specific geotechnical information required for the successful undertaking of the works.

Icon Water may provide site investigation reports for the site. However, Icon Water accepts no responsibility for the accuracy or relevancy of such reports or the information contained therein. The Contractor may choose to use part or all of the information supplied by Icon Water.

If the Contractor requires additional assessment or extra information for the successful undertaking of the works, the Contractor shall determine the type and amount of information that is required and shall commission the appropriate investigations to acquire such information at his own expense.

6.4.3.2 Independent geotechnical engineer

The Contractor shall appoint an independent geotechnical engineer to oversee all aspects of the earthworks under the Contract, such as foundation preparations, material suitability and all testing required.

The person appointed to carry out the testing shall be responsible for determining the location of all tests to achieve the essential requirements under the Contract. All soil testing shall be undertaken by a NATA registered testing authority.

The Contractor shall adopt AS 3798 commercial criteria (“Level 1 inspection & testing”) for guidelines on all earthworks at the site including engineered fill.

The independent geotechnical engineer shall determine the location for compaction density testing. Frequency of testing for engineered fill areas is to be, as a minimum, as per AS 3798 Table 8.1 being “Type 1” for general engineered fill and “Type 4” for engineered fill behind structures. The level 1 inspector shall provide detailed documentation of the works in accordance with the requirements of AS 3798 ensuring a quantifiable account of daily activities (as a minimum in hourly increments) along with photographs.

Prior to the commencement of the earthworks, the Contractor shall ensure that the independent geotechnical engineer nominates the methodology for the identification of test locations to be adopted during the earthworks construction. The intention being for the geotechnical engineer to communicate to all relevant parties an independent and transparent process for choosing the location of the earthworks compliance verification and sampling during the earthworks. The procedure/s shall consider the full extent of earthworks including the following tasks: cut to fill, general and specified filling, engineered fill, road construction, trenching backfill, etc. The Contractor shall ensure that the geotechnical engineer continues to oversee the process whilst earthworks compliance verification is being performed.

The Contractor shall obtain from the independent geotechnical engineer a signed statement certifying that the manner of construction and the soil testing program is sufficient to ensure that all earthworks (including roadworks) have been performed in accordance with the Contract and relevant standards.

Copies of all geotechnical testing and certification statements produced by the independent geotechnical engineer are to be maintained by the Contractor and provided to Icon Water upon request during construction and as part of the WAE records at the conclusion of the project.

6.4.4 Erosion and Sedimentation Control

Temporary erosion and sediment control measures are those which are required in areas currently being worked and are to be provided, as and when required, on a day-to-day basis as the work progresses. They shall remain in place for the duration of a particular phase of the work until

revegetation is established. They will include any interim control measures required between different phases of the work where the disturbed areas will not be reworked for a period of not less than one month.

Temporary erosion and sediment control measures shall be coordinated with the construction of permanent drainage and other permanent control measures. Such structures shall be constructed prior to commencement of topsoil stripping to ensure effective erosion and sediment control.

At least five working days before the natural surface is disturbed in an area, the Contractor shall prepare an Erosion and Sedimentation Control Plan for the area. The Plan shall be superimposed on the appropriate drawings.

The Erosion and Sedimentation Control Plan shall consist of diagrams and supporting documentation indicating the following:

- The catchment drainage lines and inlets;
- Construction details of all erosion and sedimentation control structures;
- All proposed permanent and temporary erosion sedimentation control measures;
- The proposed location of material stockpiles.

No work is to proceed until this plan has been reviewed by the Icon Water Representative.

Temporary erosion and sediment control measures shall be coordinated with the construction of permanent drainage and other permanent control measures and shall be constructed prior to commencement of the stripping of topsoil, to ensure effective and continuous erosion and sediment control.

All temporary erosion and sediment control works are to be maintained in an operative condition at all times. Silt shall be disposed of in such a manner so as not to cause further erosion and sedimentation of the site.

Unless otherwise directed by the Icon Water Representative, temporary control measures are to be removed prior to the end of the Contract and all materials used therein removed from the site.

In order to control erosion, progressive revegetation of disturbed areas shall be undertaken.

6.4.5 Surface Drainage and Runoff Control

Unless otherwise specified in the drawings, the Contractor shall not alter the existing pattern of surface drainage. Safeguards such as straw bales wrapped with geotextile fabric shall be placed and anchored along drainage lines or where runoff collects or disperses to minimise the risk of polluted or turbid runoff affecting adjacent watercourses or grounds.

To prevent contamination of the site or the surrounds, no chemical, fuels and/or wastes shall be stored within or adjacent to any natural drainage lines. All substances shall be appropriately contained in sealed vessels and where necessary stored in bunds.

6.4.6 Clearing and Grubbing

Removal or clearing vegetation or surface improvements shall be limited to an extent no greater than absolutely necessary for the execution of works. Subject to agreement, approval from relevant authorities shall be obtained where required for the removal of any trees. Protection shall be provided to prevent damage to trees that are not to be removed. Vegetative matter shall be mulched and stockpiled on site subject to Icon Water Representative approval and site restoration requirements in accordance with Section 6.4.20.

6.4.7 Stripping, Removal, Stockpiling and Reclamation of Topsoil

The work area shall be stripped of all bitumen, grass, vegetative matter, fibrous roots and loose material. Stripped materials shall be stored separately.

Topsoil shall be the surface or top layer of soil including fine roots characterised by a clearly visible percentage of humus material.

Topsoil shall be stripped to a depth of up to 300 mm below natural surface or to foundation level, whichever is the lower and stockpiled separately from the above grass and mulch material.

Subsoil shall not be mixed with topsoil that is intended to be re-spread. Topsoil that is contaminated with subsoil, or any other contamination, shall be removed from the site.

All topsoil from stripping operations on site shall be stockpiled and used to make good the surface after backfilling. Stockpiles shall not exceed 2.0 metres in height. Stockpile areas are to be confirmed by the Superintendent.

Hay bales and/or silt stop fencing shall be provided around stockpiles to prevent washout or otherwise loss of stockpiled materials.

Adequate watering, drainage and aeration shall be applied. No traffic is allowed on stockpiles. Two weeks prior to commencement of topsoil spreading, the surface shall be sprayed with a broad spectrum non-residual herbicide.

Excess topsoil is not to be used for landscaping and shall be treated as per the requirements of Section 6.4.8.

6.4.8 Removal of Unusable, Contaminated or Surplus Soils and Materials

All unusable, surplus and contaminated soil and other material shall be excavated, temporarily stockpiled and removed from the work area. All materials are to be stored separately.

All material removed from the site shall be loaded, hauled and deposited at a landfill area approved for the type of material being disposed of.

Unsuitable material include:

- all excavated material not satisfying the requirements for use in construction of the works;
- all disused materials due to clearing (such as trees, stumps, brush, fencing and structural debris);
- all rubbish;
- soil or rock which have been contaminated with organic matter such as sludge, screenings, trees, stumps, leaves or other foreign matter;
- soils contaminated with harmful substances including hydrocarbons, asbestos, cement and chemicals;

6.4.9 Bulk Earthworks – Cut To Fill

The area over which filling is to be placed and spread shall first be cleared of all vegetation, topsoil and debris in accordance with Section 6.4.7.

Bulk earthworks cut to fill shall be undertaken as required to conform to the lines and levels shown on the drawings. Cut materials shall be deposited and spread directly to fill areas.

Placement of fill material from cut areas shall be in layers not greater than 300 mm loose thickness and compacted to a dry density ratio as per Section 6.4.16.

All shattered, disturbed or loosened material shall be removed or re-compacted and the surface of the excavation shall be trimmed to the required foundation levels. Re-compaction shall be approved by the independent geotechnical engineer

Excess cut material shall be stockpiled on-site for final earthworks restoration work as required, or, if surplus to needs at the end of the works, shall be removed from the site to an approved location for disposal.

6.4.9.1 On-site stockpiles

Stockpiles of excavated or imported material shall be located where they cause no interference to the existing operation of existing infrastructure. Materials shall not be stacked against structures, fences or trees. Material shall not be stockpiled in areas being protected as retained vegetation. Stockpiles may be located in areas designated for landscaping or regeneration but not located under the drip line of trees.

Onsite stockpiles shall have adequate effective erosion and sediment controls implemented.

6.4.10 Embankment Earthworks

The area over which filling and embankments are to be built shall first be cleared of all vegetation, topsoil and debris in accordance with Section 6.4.7.

Bulk fill for embankments shall be selected excavated cohesive material, free from trash, roots, lumber and other debris. Selected excavated cohesive shall comprise well graded material with maximum plasticity index 35% and maximum particle size determined by location and layer thickness, but not exceeding two-thirds of the uncompacted layer thickness. Bulk fill shall be compacted in layers not exceeding 300 mm in loose thickness, or as recommended by the geotechnical engineer, to achieve the minimum density as per Section 6.4.16. The testing shall be in compliance with AS 1289 Part E. Testing shall be performed by an Independent NATA Registered Testing Authority. All tests performed, including location details and results for each in-situ test, shall be recorded.

The embankment shall be compacted and constructed to a profile slightly steeper and larger than required such that when the batter slopes are trimmed back they shall achieve the designed profiles.

Provision for benching of the surface of the natural ground shall be provided to ensure a key for placement of engineered fill.

The surfaces of the embankments shall be smooth and free of stones, rocks, roots, sticks and sharp objects so as to provide a firm unyielding uniform base suitable for any lining system as required.

Unless noted otherwise on the drawings, embankment batters shall have a maximum slope of 1V:3H. Embankment batters adjacent to watercourses shall be provided with suitable scour protection consistent with a minimum flow velocity of 2 m/s at the face of the embankment.

6.4.11 Excavations and Backfilling for Structures

Foundations for structures shall be prepared by excavating to the required levels of the underside of structures or as necessary to reach a satisfactory foundation material. The exposed subgrade shall be proof rolled and compaction tested to the density nominated in Section 6.4.16. Any unsuitable materials including roots, boulders, silt or organic matter encountered shall be removed to a depth of at least 300 mm below the bottom of the structure. Backfill with selected fill and compact to the requirements nominated in Section 6.4.16. The foundation shall be graded and trimmed to the design levels as shown on the drawings.

Table 6.4.12.1 - Select Fill: Granular material complying with the following properties

Property	Criteria
Particle size:	75 mm maximum
Proportion passing 0.075 mm sieve:	25% maximum
Plasticity index:	≥ 2%, ≤ 15%
Soaked CBR:	Not less than 15

For areas where reactive soils have been identified, ground works for slabs and footings shall be prepared in accordance with AS 2870 Residential Slabs and Footings – Construction.

If an extra depth of excavation is deemed necessary by the independent geotechnical engineer, a supporting statement, with all necessary calculations and test results, recommending extra depth excavation shall be submitted for approval. No extra excavation shall be commenced or undertaken prior to approval by the Icon Water Representative.

Prior to backfilling of structures, all forms shall be removed and the excavation shall be cleaned of all trash and debris. Backfill shall only be placed following the subsequent approval by the Icon Water Representative.

The method of compaction of backfill adjacent to any existing structure shall be such as to ensure that the structure will not be damaged by compaction equipment.

Backfill shall not be placed against a concrete structure until the concrete has been in place for at least 21 days. For water retaining structures, backfilling shall not be undertaken until the structure has passed the requirements for hydrostatic testing.

The sides of excavations shall be supported as necessary to ensure safe working and protection of any existing adjacent structures. Guard against the formation of voids outside sheeting or sheet piling if used. Should any voids form, fill and compact them to a dry density similar to that of the surrounding material. Remove temporary supports progressively as backfilling proceeds.

6.4.12 Excavations in Watercourses

Excavations carried out in watercourses shall include the construction of cofferdams and the operation of any necessary equipment to divert and/or manage the flow of water. All work shall be undertaken in accordance with the requirements of the relevant authorities and environmental constraints.

The bed and slopes of the watercourses shall be protected against erosion from the action of water in the vicinity of, and due to the undertaking of the works.

6.4.13 Excavation in Water Charged Ground

The Contractor shall construct drains, sumps, pits, water channels and the like, and shall provide, maintain and operate any pumping plant as may be necessary to prevent water from entering or to remove water from an excavation.

The Contractor shall employ dewatering methods such as pumping, spear points, deep wells or other approved dewatering systems to adequately control the inflow of groundwater into any excavation. Where necessary, protective filters shall be used at pumping locations to prevent the removal of fine materials from the surrounding ground.

The Contractor shall submit a dewatering proposal to the Icon Water Representative for acceptance and the Contractor shall not commence any such operation until such acceptance has been given. The greatest care shall be exercised when altering existing groundwater regimes in and around structures,

buildings and roadways. The Contractor shall carry out investigations and undertake measures to avoid damaging such structures, buildings and roadways.

Water from excavations shall be discharged to the nearest suitable discharge points approved by the relevant authorities and by the Icon Water Representative. Water shall be disposed in a suitable manner without damage to the works or adjacent property.

Adequate standby dewatering equipment shall be provided. In critical areas where failure of the system could lead to danger to life or damage to partially completed structures, complete standby equipment shall be provided.

If foundation soils are disturbed or loosened by the upward seepage or uncontrolled flow of water, the affected areas shall be excavated and replaced with granular fill.

No concrete or masonry footings, foundations, or floors shall be laid in water, nor shall water be allowed to rise over them until the concrete or mortar has set for at least 24 hours. Water shall not be allowed to rise unequally against walls for a period of 14 days after concrete has been placed.

Any portions of the in-ground works that may potentially have become damaged as a consequence of water inundation shall be assessed by the independent geotechnical engineer for installation integrity prior to recommencement of the works.

6.4.14 Shoring and Earth Retention

Where necessary, excavations shall be supported and braced to furnish acceptable working conditions. All support systems shall be designed and installed in a manner to provide safety to persons working in the excavation and to prevent damage to existing services, structures, buildings and roadways in the vicinity.

At least 14 days prior to the commencement of excavation, the Contractor shall submit to the Icon Water Representative the details of the support system for acceptance. The design of the support system shall be prepared or certified by a suitably qualified engineer with relevant experience and competence in such works.

Shoring or sheet piling shall be installed to ensure that any structures immediately adjacent to the excavation do not suffer distress in any form. Where supports are required to prevent slippage of ground into the excavation, such supports shall be placed in positions where practicable that will enable subsequent withdrawal. Should the withdrawal of the supports constitute a danger to adjacent structures or property, the Icon Water Representative may allow the supports to be left in place. Any occurrence of this nature shall be formally recorded.

Existing utilities and services shall be suitably supported by temporary struts, slings or piers to enable excavation to proceed without disturbance or damage.

Where batter slopes are proposed instead of shoring, they too shall ensure that distress in any form or shape does not occur to structures immediately adjacent to the excavation site.

A work method statement shall be provided on procedures to shore and make safe all construction activities.

6.4.15 Compaction and Testing

All fill and backfill material shall be selected excavated material, free from roots, lumber and other debris. Where not specified herein, the fill layer thickness shall be verified by the geotechnical engineer to achieve the required compaction commensurate with the compaction equipment to be used.

The minimum compaction standard to be achieved is as shown in Table 6.4.15.1.

Table 6.4.15.1 – Minimum Compaction Requirements

Minimum Compaction	Cohesive Soils : Dry Density Ratio (RD) Standard Compaction to AS1289	Cohesionless Soils : Density Index (ID) to AS1289
General filling around site	90%	70%
Cut or fill supporting structural loads: (i) greater than 0.5m below foundations (ii) top 0.5m below foundations	 95% 98%	 75% 80%
Water impounding embankments	98%	75%
Backfill to/and around structures	95%	70%
Pavement Materials	Refer Section 12.4.4	Refer Section 12.4.4

6.4.16 Earthworks Inspection and Testing

The Contractor shall obtain from the independent geotechnical engineer a signed statement to the effect that the manner of construction and the soil testing program is sufficient to ensure that all earthworks, including roadworks are performed in accordance with this specification.

The Contractor shall have the following items of work inspected and certified as complying with the specification by the independent geotechnical engineer:

- All foundation preparation work
- Material suitability
- Earthworks compaction

The Contractor shall provide certification evidence with each progress claim relating to these items of work.

Unless otherwise specified by the independent geotechnical engineer, the minimum compaction testing frequency shall be:

- Fill under structures: one test per layer per 400 m^2 of floor area, or part thereof with a minimum of two tests under any structure;
- Embankment fill: one test per 200 m^3 of compacted fill;
- Roadworks: refer Sections 11.4.4.

If any test fails to meet the minimum compaction requirements, the Contractor shall submit a work method statement outlining additional testing to determine the extent of the non-conforming area. This statement shall be submitted a minimum of 2 working days before implementing the work method. Further testing shall be performed in accordance with the relevant Australian Standard, to demonstrate that minimum compaction requirements are satisfied. This procedure shall be repeated until all test results indicate compaction requirements have been met.

6.4.17 Surface Restoration

All surfaces disturbed during the course of the work shall be restored to the same condition or better as that which existed before the work commenced.

Backfilling shall be completed within 24 hours of pipelaying and removal of surplus materials. All road pavements and paved areas shall be cleared and surfaces made good and flush with the surrounding surfaces. Pavement material and asphalt restoration to line and level for trenches excavated in existing roads shall be provided.

In locations other than road carriageways and paved areas, filling may be left sufficiently high at the outset to allow for settlement where the reasonable convenience of persons and safety of stock will permit. In any event, any subsequent settlement shall be restored and surplus material disposed of from the site.

6.4.18 Spreading or Removal of Excess Useable Material

Where excess material is to be respread within the site, it shall be compacted in layers not exceeding 300 mm or as recommended by the geotechnical engineer to achieve a minimum density of 90% standard maximum dry density ratio. Compaction testing shall be in compliance with AS 1289. Testing shall be performed by an NATA registered independent testing authority. Record all tests performed, including location details and results for each in-situ test.

If a test fails, the relevant section of work shall be considered to be defective. Elect to either rectify the work or undertake two further tests in the section deemed to have failed within one week of the failed test. The locations of the additional tests shall be where directed. If both additional tests pass, the section shall be accepted. If one or both of the additional tests fail, the work shall be rectified.

Within 2 weeks of the completion of any rectification work, 2 more tests shall be conducted where directed. If one or both of the tests fail, the work shall be rectified and continue to retest and rework until all test results are satisfactory.

If it is required to remove material from site, this will be the total responsibility of the Contractor.

Where it is required to remove spoil from sites and where such spoil may be subjected to environmental constraints, this will be the total responsibility of the Contractor.

6.4.19 Restoration Works

6.4.19.1 General

All surfaces, services and improvements disturbed, destroyed, removed or damaged during construction of the works and during installation of temporary works such as access roads, shall be restored as near as practicable to their pre-existing condition. Improvements shall be deemed to include trees and shrubs, mulched areas, gardens, paving, flagging, proprietary finished areas such as 'pebblecrete' and the like, retaining walls, fences and all other structures.

When necessary for the restoration of surfaces, stockpile existing topsoil separately and replace it over the areas where it was previously located when completing backfilling operations. Where there is a shortfall of existing topsoil, use approved imported topsoil.

6.4.19.2 Timing of restoration

Restoration shall be done to surfaces, services and improvements progressively as the work proceeds. Services shall be maintained at all times. Restoration and repair work shall be completed within 5 calendar days after completion of backfilling of each section of the works unless specifically stated otherwise in the project specific documentation.

Undertake any maintenance of the restoration within 2 calendar days of the need for such maintenance becoming apparent.

6.4.19.3 Pavements

Immediately after backfilling of a trench excavated through a pavement, the surface shall be temporarily restored and maintained in a trafficable condition until final restoration is completed. Where the original pavement was bitumen or asphalt, use a pre-mixed asphaltic material for the temporary restoration. Otherwise use crushed metal or gravel. Final restoration of pavements shall be completed within one month of temporary restoration.

Unless otherwise specified, bituminous pavements shall be replaced with the same type and thicknesses of surface and base courses as the original pavement. Unless otherwise specified, concrete pavement shall be replaced with the same type of surfacing and base courses as existing. Steel reinforcement of 10 mm diameter running in both directions and spaced not more than 300 mm on centres shall be provided whether the original pavement is reinforced or not. Pavement surfaces shall be cut with concrete sawing equipment and shall be at least 150 mm beyond the sides of the trench.

Unless otherwise specified in the drawing, concrete pathways, curbs and gutters, and paving blocks shall be replaced with the same type of surfacing and base courses as the original construction. All concrete cutting shall be carried out using sawing equipment.

6.4.19.4 Provision for settlement

Any settlement of trenches during the Defects Liability Period shall be made good by placing additional approved fill such that the finished surface level conforms with the adjacent surface.

For trenches through other than pavements, turf areas, grassed areas or other improved surfaces, backfill may be placed sufficiently high to compensate for expected settlement unless it would create a hazard or inconvenience to the public. At the end of the Defects Liability Period, excess material shall be trimmed back to conform with the adjacent surface and surplus disposed.

6.4.19.5 Tunnelling

Where tunnelling has been used in lieu of trenching to avoid improved surfaces, all tunnels shall be backfilled such as to restore full support to the surface. Any damage to the improved surface which occurs due to settlement of the backfill shall be repaired.

6.4.19.6 Maintenance of restored surfaces

All restored surfaces and improvements shall be maintained in a satisfactory condition until expiry of the Defects Liability Period notwithstanding that any deterioration may or may not be due to defects which become apparent or arise from events which occur during that period.

6.4.19.7 Certification

Certificates issued by the relevant public authorities certifying that all roads, footpaths and surfaces in public places under their control have been satisfactorily restored shall be provided.

Notwithstanding any other provision, the Defects Liability Period shall not be completed until such certification is submitted unless it is agreed that the public authority has unreasonably withheld issue of the certificate.

The issue of such certificates shall not relieve any responsibility for any defect.

6.4.20 Landscaping

The Contractor shall landscape all areas that have been disturbed by the work and requires backfilling. Landscaping includes replacing topsoil, ground levelling or contouring and application of seed and hydro-mulch.

The rehabilitated site shall be left with an even grade, with no ruts, hollows, or uneven spots, and shall be free-draining. The area shall be entirely suitable for on-going maintenance requirements, including mowing with a ride-on mower and free of surface debris, such as rocks, pieces of timber, roots, rubbish and rubble.

Any ruts, hollows, uneven spots, holes or depressions shall be filled in a similar manner as for backfilling around structures finished with a 100 mm layer of topsoil and turf.

Imported topsoil shall be sandy loam topsoil, imported from an approved off site source, free from stumps, roots, large stones, clay, silt, toxic substances, noxious weeds and unwanted plants such as nutgrass, onion weed, oxalis, couch and kikuyu.

Site topsoil shall be soil excavated from the site after removing not less than the bottom of the grass root zone, which contains organic matter, supports plant life, is free from unwanted matter such as stones over 25 mm diameter, clay lumps, weeds and tree roots, sticks and rubbish and is approved for reuse on site as topsoil.

Compost shall be well-rotted vegetative material or animal manure, or other approved material, free from harmful chemicals, grass and weed growth, and with a neutral pH value. Provide a certificate of proof of compost pH value.

Site topsoil mixture shall be site topsoil and compost and other approved additives, thoroughly mixed before placing. Mixing rate shall be 3:1, topsoil to compost.

Site topsoil shall be stockpiled separately from other material during excavation and other works associated with the Contract. Stockpiles shall be established and maintained to sizes, in locations and in a manner as specified in the Construction Plan. Adequate drainage and aeration shall be provided. Do not burn off or remove plant growth which may occur during storage. Do not allow traffic on stockpiles. If a stockpile is to remain for more than 4 weeks, it shall be sown with an annual cover crop. Topsoil stockpiles shall not exceed a maximum height of 2.0 metres.

Appropriate topsoil shall be placed on the prepared subsoil. Spread and grade evenly, making the necessary allowances so that:

a) the required finished levels and contours may be achieved after light compaction as specified;

b) allowances are made for depth of surface finishes; and

c) surfaces are graded to allow free drainage of all areas, consistent with the landscape rehabilitation drawings.

The route of vehicles and plant passing over newly scarified or topsoiled areas shall be varied to avoid developing areas of excess compaction.

A seed mix consisting of native seeds with an F1 sterile cover crop shall be used. The native species used should be species locally endemic. The specified seed mix shall not introduce any non-native species to the area which are not already established.

Any areas that have suffered compaction during the earthworks shall be cultivated, ensuring weed eradication has been sufficiently successful before commencing application. Ensure all topsoil has been placed, ground works are completed and surfaces have been smoothly graded and final contouring completed.

The application of hydro mulch shall be commenced immediately after topsoil has been placed or the surface prepared.

Seed, fertiliser, wood fibre mulch, water and binder shall be thoroughly mixed together with water to provide a slurry and then applied under pressure onto the area to be treated by means of hydro mulching equipment specifically designed for this purpose and by operators trained on the use of this equipment.

The works shall be inspected after 4 weeks' establishment to determine the success of the application. Areas of turf that have not established well shall be oversewn with additional grass seed (of the same variety as that used in the hydro mulch mix) and topsoil mixture. Water and maintain all areas until the grass is established and/or until full germination occurs, providing a good grass cover to all areas treated.

Achievement of Practical Completion requires, but is not limited to:

a) the establishment of all grassed areas; and

b) replacement of plants that have not established, been damaged or stolen during the works.

6.4.20.1 Planting

The Contractor shall:

a) provide the quantities and types of plants as required by the landscaping areas shown on the project specific documentation package;

b) place orders at an appropriate time such that the plants are available for planting at a time appropriate to carrying out the work and shall take due account of the requirements of on-site storage; and

c) notify the Icon Water Representative of the names of the growers, details of the orders and any difficulty in obtaining the plants required, with substitution of species not permitted.

Eucalypts shall be grown by a system that prevents roots curling. Such a system will involve air root pruning of the tap root and lateral roots at the seedling stage. This may involve in-ground growing with geotextile fabric bag which allows root tips to penetrate but restricts their growth outside the bag. If field grown, the plants must then be transferred to a container which provides air root pruning while the plant acclimatises and increases root growth, and which will allow the plant to be transported without damage to the root system. If container grown above ground, the plant must at all stages be grown in a container which provides air root pruning.

Eucalyptus plants grown in circular solid-walled containers, such as plastic bags or circular plastic pots, are not acceptable.

The Eucalypts supplied by the Contractor, shall be not less than 1.0 m tall when planted and supplied in minimum 200 mm diameter spring-ring containers. Where Eucalypts larger than those described above are specified the container shall be related to the height and calliper and shall be within the limits set out in the tables in the Project Delivery Documents.

The Contractor shall ensure that all plants in transit between the point of supply and the site are properly covered and adequately protected from wind and other mechanical damage and handled in a manner that will not be harmful to the plants. The Contractor shall obtain a guarantee from the Supplier that all plants are true to species and type. Plants shall be name-tagged.

6.4.20.2 On-Site Storage

All plant material shall be planted immediately after delivery to the site or heeled in or covered with moist soil or sawdust or stored. Should the Contractor require an on-site nursery for holding the plants prior to planting, it shall be a vermin proof compound of sufficient size with provision for watering of the plants.

All plants shall be adequately protected from frost, wind and sun.

6.4.20.3 Site Preparation

Prior to planting the site shall be made weed free. Where serious infestations of perennial weeds are present, e.g. Phalaris, the planting lines must be slashed. All weeds must be sprayed with the herbicide Glyphosate in any of its registered formulations at the maximum rate specified by the manufacturer, at least 2 weeks prior to planting.

Physical removal of weeds is also acceptable. Where soil disturbance is extensive, for example by use of a power grader, back-blade or scraper, the requirements of the Environment Protection Act 1997 (ACT or NSW depending upon jurisdiction) must be adhered to.

6.4.20.4 Excavation for Planting

For holes dug by hand or backhoe, individual holes shall be excavated to a diameter of 400 mm for container sizes up to 150 mm diameter. Where larger plants are used, the holes must be at least twice the diameter of the container. Depth of holes must be at least 100 mm greater than the depth of the container. Post-hole borers shall not be used to excavate planting holes. The sides of all holes shall be broken or loosened as necessary by means of a bar or other suitable tool to prevent confinement of root growth.

In rip-line planting areas, all areas to be ripped shall be sprayed with Glyphosate at the rate of 3 L/ha active ingredient two weeks prior to ripping. Rip-lines shall be ripped to a minimum depth of 450 mm. The rip-line shall follow contours. Multiple rip-lines are preferred. Where three rip-lines are used, plants should be planted in the middle line. After ripping, all regrowth shall be sprayed with Glyphosate at the rate of 3 L/ha 2 weeks prior to planting.

After ripping, the site shall be left in a mowable condition, free of stones larger than 25 mm, clods of earth larger than 50 mm and free from ponding. Minimum distance between drip-line planting rows shall be 3.0 metres in areas which are not mulched.

6.4.20.5 Planting

Plants shall be removed from containers with minimum disturbance to their root ball. Prior to planting roots shall be teased out at the base and around the sides of the root ball. Plants shall be positioned in the centre of the hole, set plum and at such a level that, after firming and settlement, a normal and natural relationship of the plant with the ground surface will be established. Plant root systems must be moist at the time of removal from the containers and not allowed to dry out.

Planting operations shall be suspended in periods of drought or when the soil is very wet or waterlogged or during periods of frost.

6.4.20.6 Pruning

The Contractor shall prune only those trees planted by the Contractor. The Contractor shall make clean cuts, avoiding long stubs and flush cuts to remove broken, bruised or dead branches. All other pruning and tree surgery, unless otherwise specified or detailed, will be carried out by others.

6.4.20.7 Staking

Stakes shall be of durable hardwood, straight, free from knots or twists, and pointed at one end. Ties shall be proprietary brand, purpose made, and broad, with flat webbing. Ties shall be fixed securely to the stakes. Ties shall be positioned to support the tree between ¼ and ½ of its height from the ground. The tension of the ties shall be such that the trunk is able to move to and fro at least 25 mm at the point of support.

Stakes are to be driven to final level prior to the tree being positioned, or in such manner as to avoid damage to the root system of the tree.

6.4.20.8 Backfilling

Unless otherwise detailed, holes shall be backfilled with site topsoil. At each planting position add moisture gels or super absorbents equal to ‘Terrasorb’ in accordance with the manufacturer’s written requirements. Backfilling shall be free from perennial weeds, stones, clods of subsoil or other extraneous matter.

Soil shall be firmed progressively during backfilling to avoid air pockets both below and above the base of the root ball.

6.4.20.9 Watering Basins

Except in irrigated grass areas and planting beds, a raised ring of soil, 750 mm in diameter and 75 mm high, capable of holding a minimum of 20 litres of water, shall be constructed at the base of each tree to provide a basin for watering.

Soil used for the construction of watering basins shall be free from rocks, weeds and debris.

6.4.20.10 Watering

The Contractor shall water trees by water cart, or other means and ensure uninterrupted access to sufficient quantities of water to complete the planting satisfactorily.

All plants shall be watered in immediately after planting to ensure thorough wetting of the root ball and settling of disturbed soil. Plants shall be watered at such times before construction completion as required to maintain growth free of water stress.

6.4.20.11 Fertilising

At the time of planting, spread Osmocote N:P:K 4:2:1, or approved equivalent, on the surface of the backfilling within the watering basin but not closer than 100 mm to the stem or trunk of the plant and prior to the application of the mulch within the basin.

6.4.21 Landscape Consolidation

6.4.21.1 General

The Contractor shall provide continuous care and maintenance of the areas disturbed by the horticultural practices regardless of time of year or inclement weather and rectify any defects.

The duration of the landscaping consolidation period is 52 weeks from construction completion.

In liaison with the Icon Water Representative, the Contractor shall prepare an agreed landscaping consolidation program, prior to commencement of landscaping consolidation. This program shall detail work required during landscaping consolidation in particular:

a) rectification of defects;

b) provision of materials, labour and equipment;

c) provision of 14 days' notice of intent to place work on landscaping consolidation;

d) watering;

e) control of weed growth in watering basins by means of suitable selective herbicides; and

f) replacement of dead plants.

6.4.21.2 Placing of work on landscaping consolidation

The Contractor shall give 14 days' notice that the work is ready to enter landscaping consolidation. The Icon Water Representative shall inspect the work and, if any defects or deficiencies are found, they shall be rectified within 7 days.

Before requesting the work to enter landscaping consolidation, the Contractor shall ensure that all work is complete and that all landscaped areas have coverage of at least 90 percent so that the landscaping is well-established and does not require replanting.

6.4.21.3 Work during landscaping consolidation

The Contractor shall carry out work in accordance with the agreed landscaping consolidation program.

Native dry land grass areas shall have a healthy and vigorous growth appropriate to the area. Trees and shrubs shall show signs of healthy vigorous growth. Trees shall be appropriately staked and, in dry land grass areas, have a suitably sized watering basin intact and weed free.

Weed growth shall be controlled in watering basins manually or by means of suitable herbicides approved by the ACT Government.

Dead plants shall be replaced on a fortnightly basis up 6 weeks before the end of the consolidation period, and weekly thereafter.

6.4.21.4 Grassed and prepared areas

The Contractor shall reinstate all grassed surfaces within irrigated and dry land areas in accordance with the generic reinstatement plans and the TCCS Standard Specification for Urban Infrastructure Works – 09 Landscape. The Contractor shall utilise the stockpiled site topsoil where the material is deemed suitable, and shall otherwise supplement or replace with imported topsoil where required.

Where seeding occurs, the finished surface shall be covered with bitumen and straw mulch.

Where trenches cross areas which have been prepared for sowing, the Contractor is to separate the topsoil and place to one side of trench and place all other excavated material on the opposite side of the trench. On completion of backfilling, replace topsoil and restore surface to original condition.

6.4.22 Witness Points and Hold Points

The Contractor's inspection and test plans (ITPs) for the works are to include, but not be limited to, the following witness and hold points. The Icon Water Representative may identify the need for other witness and hold points following receipt of the Contractor's ITPs.

(a) Earthworks

- Inspection of prepared foundation for all structures, and road pavements subgrade, including inspection of test results - hold point
- Embankment construction, including inspection of test results - hold point
- Proof roll assessments - hold point
- Inspection of compaction of sub base course material over the sub grade including inspection of the test results - hold point
- Inspection of compaction of base course material over the subgrade sub-base course material before bitumen sealing, including inspection of the test results - hold point

(b) Service Trenching

- Inspection of excavated service trenches before laying the service - hold point
- Inspection of services laid in trenches and ready for backfilling - hold point
- Following installation of protection barrier/s and warning/identification tape prior to subsequent backfilling - hold point

Hold points for testing are to include at the completion of compacted layers both in cut and fill layers to the frequency specified by the independent geotechnical engineer.

6.4.23 Records

The Contractor shall keep records during construction including conditions encountered, testing and inspection.

These records shall show the following:

- Extent of excavated and fill areas.
- Line and levels of excavation and filling area.
- Type of excavated and fill materials.
- Details of compaction trials, if required.
- Location and level of acceptance tests and results.

The Icon Water Representative may request copies of the records to be submitted.

7 Piling

7.1 Scope

This specification sets out the minimum requirements for the design, construction and testing of piling systems to support permanent structures.

The piling systems shall generally be of the following types:

- Timber piles.
- Driven reinforced concrete piles.
- Driven prestressed concrete piles.
- Driven H-section or tubular steel piles.
- Driven cast-in-place concrete piles.
- Bored cast-in-place concrete piles.

7.2 Referenced Documents

The documents referred to in Section 7 of this specification are listed in Table 7.2.1.

Table 7.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 1163	Structural steel hollow sections
2	AS 1379	Specification and supply of concrete
3	AS 1450	Steel tubes for mechanical purposes
4	AS 1604	Specification for preservative treatment – Sawn and round timber
5	AS 1726	Geotechnical site investigations
6	AS 2159	Piling – Design and installation
7	AS 2832	Cathodic protection of metals – Pipes and cables
8	AS 3600	Concrete Structures
9	AS/NZS 3678	Structural steel – Hot-rolled plates, floor plates and slabs
10	AS/NZS 3679.1	Structural Steel – Hot rolled bars and sections
11	AS/NZS 3679.2	Structural steel – Welded I sections
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
12	Not provided	Excavation Work Code of Practice
Icon Water standards and work instructions		
13	SD Series Drawings	Standard Drawing Set

Item	Document number	Title
14	STD-SPE-G-018	Drafting Standards

7.3 Design and Specification

7.3.1 General

The details provided in Section 7.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 7.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

7.3.2 Referenced Documents

The documents listed in Table 7.2.1 are either referenced by Section 7 of this specification, or shall be complied with and read in-conjunction with this specification section. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

7.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 7.3.3.1.

The requirements specified in Table 5.2.2.1 and Table 7.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 7.3.3.1 Minimum Mandatory Requirements for Piling Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, items 1.1 to 1.8 inclusive.
2	Layout and Setting Out	A Pile Layout and Setting Out drawing shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawing shall show the position, pile length, cut-off level, founding level and positional tolerances of the piles. Symbols shall comply with the Icon Water SD series of drawings.

Item	Drawing or Document Type	Minimum Mandatory Requirements
3	Structural details	A drawing shall be produced for all new and major augmentations to existing Icon Water assets showing the structural details of the pile. The drawing shall detail the structural grade of material, material properties and strength, reinforcement (in case of concrete piles) and dimensions. The pile cap shall also be detailed.

7.3.4 Site Investigation

For any piling system, a site investigation shall be carried out according to AS 1726 to provide information on:

- The assessment of geotechnical conditions for the design, construction and installation.
- Specific characteristics of vibration, groundwater, expansive soil, ground heave, negative skin friction effects and slope stability.
- The potential effect of site conditions on pile durability.

7.3.5 Pile Design

The piling system shall generally be designed in accordance with AS 2159.

The design shall take into account the ultimate strength, serviceability, durability and other special design criteria such as stability, soil movement, fatigue, cyclic loading or seismic loading as required.

The geotechnical design shall take into consideration the strength, serviceability and soil-pile interaction.

The type, number, arrangement, and spacing of piles shall be such that the most severe combinations of loadings can be carried safely by the piles.

7.3.6 Durability

The design life of piling systems shall be compatible with the design life of the permanent structure that is to be supported by the piling system.

Exposure classification for concrete piles in Table 6.1, AS 2159 shall apply for the range of chemical conditions in the soil surrounding the piles.

Exposure classification for steel piles in Table 6.3, AS 2159 shall apply for the range of chemical conditions in the soil surrounding the piles. Corrosion allowance for steel piles shall be in accordance with Table 6.4, AS 2159.

Where cathodic protection is applied to steel piles, it shall conform to AS 2832.

7.3.7 Materials

All materials used in pile construction shall comply with the appropriate Australian Standard.

Timber for piles shall comply with the requirements of AS 1604. Timber piles shall be treated and preserved to Hazard Level H5 as a minimum.

Concrete for plain, reinforced and prestressed concrete piles shall comply with the requirement of AS 3600, AS 2159 and AS 1379.

Steel for piles and pile fitments shall comply with the requirements of AS 1163, AS 1450, AS 3678, AS 3679.1 and AS3679.2.

7.3.8 Submissions

The Contractor shall, prior to commencing piling operations on site, submit to the Icon Water Representative the following details, as applicable, of the proposed piling system:

- Type of proposed piling system.
- Geotechnical information relevant to the design of the piling system.
- Design calculations in accordance with AS 2159 including loads and load combination calculations for strength, serviceability and durability.
- Material specifications for all components of the system.
- Protective treatment to the piles against corrosion.
- Pile splices, welding procedures.
- Relevant drawings as per Table 7.3.3.1.
- Handling and storage of piles on site.
- Proposed driving equipment including pile hammer, pile helmet, cushion assembly, driving rig, crane and other lifting machinery.
- Calculations of pile driving energy and set to achieve the required pile resistance.
- Driving method and procedure, and/or construction method.
- Equipment and methods to be used for pre-boring if required.
- Number and location of Test Piles.
- Testing systems and acceptance criteria to be used for the proposed piling system including static loading, dynamic loading and integrity testing, as applicable.
- Proposed driving record sheet.

7.4 Construction and Testing

7.4.1 Testing Of Driven Concrete and Steel Piles

Dynamic testing of driven reinforced concrete, prestressed concrete and steel piles shall be carried out on each Test Pile selected to verify the efficiency of the driving equipment and to determine the relationship between driving energy, resistance and set.

The driving conditions of the Test Pile shall be consistent with the driving conditions of the pile groups that they represent. In uniform ground conditions, at least two Test Piles shall be selected. In ground conditions that are not uniform, sufficient Test Piles shall be selected for each different pile group and each different piling equipment set-up.

Dynamic testing shall be carried out in accordance with AS 2159 by firms approved by the Icon Water Representative. Analysis of the test results shall be done using appropriate wave equation programs.

Piles other than the Test Piles shall be driven to the driving parameters determined from the dynamic analysis.

7.4.2 Testing Of Driven Cast-In-Place Concrete Piles

All Test Piles shall be constructed and tested before the construction of the remaining piles. Test Piles shall be selected at the rate of 1 per 100 piles or part thereof in uniform ground conditions, or at least 1 for each type of ground conditions.

For each Test Pile, both integrity testing and static load testing in accordance with AS 2159 shall be carried out.

For all piles, integrity testing in accordance with AS 2159 shall be required.

7.4.3 Examination of Bored Cast-In-Place Concrete Piles

Once the pile holes have been excavated and formed, the Contractor shall notify the Icon Water Representative that the founding material has been reached at the bottom of the pile and the holes have been cleaned and ready for inspection.

The Contractor shall not commence the placing of steel reinforcement and concrete until the bottom of the hole is inspected.

Integrity testing in accordance with AS 2159 shall be required for all bored piles unless otherwise agreed by the Icon Water Representative.

7.4.4 Casting Piles In Water Charged Ground

Where the rate of water ingress into the pile hole is such as to preclude dewatering, the pile concrete shall be placed by tremie or other method as approved by the Icon Water Representative.

At least 14 working days prior to the placement of concrete, the Contractor shall submit details to the Icon Water Representative of the proposed method of placement verified by a specialist in this area of work.

Concreting using tremie methods shall not commence until the pile hole is filled with such head of water as to equalise the external water pressure from the surrounding ground.

Where tremie is used, the hopper and pipe of the tremie shall be clean and watertight throughout. The tremie pipe shall be sealed with a greased rubber ball or with a plate taped to its outlet to prevent direct contact between the first charge of concrete in the pipe of the tremie and the water. The tremie pipe shall extend to the base of the pile hole before the tremie is charged with concrete.

Where a pump is used, a sponge shall be inserted in the discharge line before the discharge hopper is loaded so that water and air in the line are prevented from mixing with the advancing column of fresh concrete. The end of the discharge hose shall be held against the bottom of the hole until the sponge is released and the whole operation controlled to ensure that no voids are trapped in the pile concrete.

During concreting, the outlet of the tremie pipe or pump discharge hose shall be kept a minimum of two metres below the top of the concrete at all times. Concreting shall be continued until sound concrete appears a minimum of 400 mm above the required pile cut-off level. The pile concrete shall not be cut back to its required level until a minimum of 24 hours after completion of placement of concrete.

The proposed mix shall be self-compacting, with a nominal slump of not less than 180 mm and no more than 200 mm. The tremie concrete shall not be vibrated.

The concrete shall be of such consistency and shall be placed in such a manner that pockets of air or water or ground materials are not entrapped in the concrete, and the space between the reinforcement and the side walls of the hole are completely filled compacted concrete.

8 Reinforced Concrete

8.1 Scope

This specification covers the minimum requirements for the design, construction and testing of concrete works. The scope of works for concrete works includes, but is not necessarily limited to, the following work:

- Materials and mix design;
- The supply and delivery of all concrete;
- The design, construction, erection and removal of all formwork;
- The supply, fabrication and fixing of reinforcing steel and other embedded items;
- The testing, placing, compacting, finishing, and curing of concrete, cement mortar and grout;
- The repair of faulty concrete work and cracks.

8.2 Relevant Standards and Codes

The documents listed in Table 8.2.1 are either referenced by Section 8 of this specification, or shall be read in-conjunction with this specification section.

Table 8.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 1012	Methods of Testing Concrete
2	AS 1141	Methods for Sampling and Testing Aggregates
3	AS 1379	Specification and Supply of Concrete
4	AS 1391	Metallic Materials –Tensile Testing at ambient temperature
5	AS 1478	Chemical admixtures for Concrete, Mortar and Grout
6	AS/NZS 1554	Structural Steel Welding
7	AS 2758	Aggregates and Rock for Engineering Purposes
8	AS 3582	Supplementary Cementitious Materials for Use with Portland and Blended Cement
9	AS 3600	Concrete Structures
10	AS 3610	Formwork for Concrete
11	AS 3735	Concrete Structures for Retaining Liquids
12	AS 3799	Liquid Membrane Forming Curing Compounds for Concrete
13	AS 3972	General Purpose and Blended Cements

Item	Document number	Title
14	AS/NZS 4671	Steel Reinforcing Materials
BS Standards		
15	BS 1881	Testing Concrete
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
16	Not provided	Safe Design of Structures
Icon Water standards and work instructions		
17	SD Series Drawings	Standard Drawing Set
18	STD-SPE-G-006	Approved Products List
19	STD-SPE-G-018	Drafting Standards

8.3 Design and Specification

8.3.1 General

The details provided in Section 8.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 8.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

8.3.2 Referenced Documents

The documents listed in Table 8.2.1 are either referenced by Section 8 of this specification, or shall be complied with and read in-conjunction with this specification section. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

8.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 8.3.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water standards (e.g. *STD-SPE-G-018).*

The requirements specified in Table 5.2.2.1 and Table 8.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 8.3.3.1 Minimum Mandatory Requirements for Reinforced Concrete Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, items 1.1 to 1.8 inclusive

2	Structural Design Criteria	A structural design criteria and notes drawing shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets.
		
		The drawing shall contain the following information as a minimum, as appropriate to the structure:
		
		<u>General:</u>
		• General construction notes
		• Loading of structural components (e.g. wind load and live loads)
		
		<u>Foundations:</u>
		• Geotechnical conditions
		• Subsurface drainage requirements
		• Design bearing capacity of the soil
		
		<u>Concrete</u>:
		• Materials and workmanship
		• Concrete strength
		  ○ Mass concrete
		  ○ Structural concrete
		• Curing
		
		<u>Formwork</u>:
		• Information on the design and installation of formwork
		
		<u>Reinforcement</u>:
		• Reinforcement grade
		• Concrete cover
		
		<u>Surface finish</u>:
		• Final surface finishes

3	Elevations	Elevation drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall show the structure in different elevation profiles with appropriate dimensions. For a multi-level structure, the RLs shall be provided for each component elevation.

Item	Drawing or Document Type	Minimum Mandatory Requirements
4	Section Drawings	Section drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Sections shall be taken at appropriate locations to detail cross sectional dimensions of the structure.
5	Concrete Detail	Concrete detail drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall detail concrete properties of each element and include a table with a member schedule.
6	Reinforcement Detail	Reinforcement detail drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall detail the reinforcement of each element and include a table with a member schedule. The drawing shall show the reinforcement layout, number, diameter, spacing and bar location (e.g. 17-N20-250 EF).

8.3.4 Concrete Materials

8.3.4.1 Cement

Where specified, cement shall be either Type GP – general purpose Portland cement, Type GB – general purpose blended cement, Type SR – sulphate resisting cement, Type SL - shrinkage limited cement, or other types of special purpose cement.

8.3.4.2 Fly Ash

Fly ash shall be fine grade. The maximum amount of fly ash shall be 25% by weight of the total cementitious material.

8.3.4.3 Slag

The maximum amount of slag shall be 50% by weight of the total cementitious material.

8.3.4.4 Silica Fume

The maximum amount of silica fume shall be 10% by weight of the total cementitious material.

8.3.4.5 Supplementary cementitious materials

The total amount of supplementary cementitious materials shall not be more than 60% by weight of the total cement material.

8.3.4.6 Aggregates

The maximum nominal size of aggregate shall be 20 mm in reinforced concrete and 40 mm in unreinforced concrete.

Recycled materials or slag shall not be used as an aggregate material.

For special class concrete the aggregate shall comply with exposure class “C” of Table 4 of AS 2758.1. For normal class concrete the aggregate shall comply with exposure class “B1” of Table 4 of AS 2758.1.

The water absorption of aggregate shall be less than 3% when tested in accordance with AS 1141.

The alkali reactivity of the aggregate shall be assessed to Section 10 of AS 2758.1. When aggregates are assessed to have a potential for aggregate alkali reaction, they may be used only in normal class concrete with appropriate safeguards subject to the approval of the Designer. Aggregates that are assessed to have a potential for aggregate alkali reaction shall not be used in special class concrete.

8.3.4.7 Water

Water used in the manufacture of concrete shall comply with AS 1379.

8.3.4.8 Chemical admixtures

Admixtures that enhance the workability, reduce the water/cement ratio, control slump, minimise shrinkage and control the setting time of the concrete may be included in the mix in a controlled manner, provided they have been proven not to impair the performance of the concrete. Where two or more admixtures are proposed for a concrete mix, the manufacturers shall certify the compatibility of the admixtures. Air entraining admixtures may be used provided that the air content, determined in accordance with AS 1012, does not exceed 4%.

8.3.5 Concrete Mixes

8.3.5.1 Normal class

Normal class of concrete is denoted by the letter “N” and the following minimum strength grades shall be used unless otherwise specified on the drawings:

- N15 for all over break of excavation and for blinding layers
- N25 for pipeline thrust and anchor blocks, pipeline encasement, screeding and benching, kerb and guttering and road pavement
- N32 for reinforced concrete structures not covered above, excluding prestressed concrete
- N40 for prestressed concrete

8.3.5.2 Special class

Special class of concrete is denoted by the letter “S”. Special class concrete shall be used for all liquid retaining structures including chemical storage bunds, stormwater channels, floors which remain damp for considerable periods, and all concrete in contact with a sewage atmosphere. The minimum strength grade of special class concrete shall be S40.

8.3.6 Concrete Mix Proportions

The mix proportions and characteristics of concrete shall comply with the following Table 8.3.6.1.

Table 8.3.6.1 Concrete Mix Proportions

Concrete Class	Characteristic Strength (f'c) @ 28 days	Minimum cementitious content	Cement Type	Maximum W/C ratio	Maximum shrinkage @ 56 days	Normal slump at point of delivery
N15	15 MPa	NA	GP	-	NA	NA
N25	25 MPa	300 kg/m^3	GP	0.60	900 x 10^{-6}	80 – 120 mm (Note 2)
N32	32 MPa	330 kg/m^3	GP	0.55	900 x 10^{-6}	
N40	40 MPa	380 kg/m^3	GP	0.50	900 x 10^{-6}	
S40	40 MPa	400 kg/m^3	SR/SL (Note 1)	0.45	600 x 10^{-6}	
S50	50 MPa	450 kg/m^3	SR/SL (Note 1)	0.40	600 x 10^{-6}	

Notes:

1. Type SR shall be used for sewerage structures including access chambers. Type SL shall be used for other than sewerage structures.
2. Except for tremie concrete.

8.3.7 No Fines Concrete

No fines concrete shall be proportioned such that the aggregate / cement ratio is in the range of 6:1 to 8:1 by mass and water / cement ratio in the range of 0.35 to 0.45 by mass.

The aggregate grading of no-fines concrete shall conform to the following Table 8.3.7.1

Table 8.3.7.1 No Fines Concrete Aggregate Grading

Sieve Size (mm)	% passing by mass
37.5	100
19	85 – 100
9.5	0 – 20
4.75	0 – 5

8.3.8 Mix Design

8.3.8.1 Submission

At least 14 days prior to commencement of concrete work, the Contractor shall submit to the Icon Water Representative details of each proposed concrete mix, test results of each mix proportions, and certificates from an independent laboratory with appropriate NATA registration, stating that the nominated mix and its mix constituents meet the requirements of this specification.

The concrete mix details shall include the proportion of slag and fly ash used in the mix design.

The submitted mix details shall include the source of the materials to be used, the moisture condition of the aggregates on which the mix is based, the nominated slump and methods of mixing and transportation.

8.3.8.2 Variation

Unless approved, no variation shall be made to the concrete mix in the source of concrete constituents, or in the type, size and grading of the aggregates.

The quantities of the constituents in the mix design may be varied to improve the quality of the concrete. These variations shall not exceed the following:

- Cement: 3% by mass of each constituent.
- Aggregates: 5% by mass of each constituent.
- Water: 3% by volume or mass.
- Admixture: 5% by volume or mass of each admixture and within the manufacturer's recommendations.

The Contractor shall obtain written details of such to the mix design before commencing production.

Notwithstanding the above provisions, the varied concrete mix design shall:

- Not have a water/cement ratio exceeding that nominated for the special class concrete in the Concrete Mix Proportions Table 8.3.6.1
- Conform to the requirements of minimum cement content for the special class concrete in the Concrete Mix Proportions Table 8.3.6.1
- Conform to the requirements of AS 3972.

8.3.9 Post Batch Additions

If the supplier approves the addition of water or admixtures to a mixed batch the conditions of Section 4.2.3 and Section 4.2.4 of AS 1379 shall apply.

The onsite addition of water or admixtures to concrete that takes it out of the allowable tolerance range is not permitted.

8.3.10 Concrete Structures

8.3.10.1 Liquid retaining concrete structures

Concrete structures for the storage and conveyance of liquids such as water, sewage, sludge and stormwater shall be designed to the requirements of AS 3735.

For the purpose of design for serviceability, strength and durability, the structure or member shall be regarded as in contact with the liquid if:

- Surfaces are predominantly submerged (quiescent, agitated or flowing), or subject to alternate wet and dry cycles due to condensation, splashing or washing.

- Buried surfaces that are below the design ground water table.
- Surfaces are used for hardstand area subject to washing and hosing down at least once a week.
- Surfaces are on the inside of bunds including the floor and walls that are constructed to contain spillage of storage tanks.

8.3.10.2 Minimum concrete cover to reinforcement

The cover to reinforcement for other than liquid retaining structures shall generally be appropriate for the exposure classification to AS 3600, but shall not be less than A2.

For liquid retaining structures, the cover to reinforcement shall be appropriate for the exposure classification of AS 3735.

8.3.10.3 Vertical construction joints

Vertical construction joints shall not be permitted in circular liquid retaining structures.

8.3.10.4 Minimum reinforcement in reinforced concrete liquid retaining structures

Minimum reinforcement in reinforced concrete liquid retaining structures shall be in accordance with Table 3.1 of AS 3735.

The minimum reinforcement shall be proportioned for the full thickness of the member irrespective of whether one or both surfaces are designated as liquid retaining structures.

No reduction in the minimum reinforcement shall be permitted irrespective of joint spacing or length.

8.4 Construction and Testing

8.4.1 Supply and Delivery of Concrete

8.4.1.1 General

All supplied concrete shall conform to the mix design accepted by the Icon Water Representative.

8.4.1.2 Production

All concrete shall be produced by batch production process. Manual mixing is not allowed.

The concrete supplier shall comply with the requirements of the production assessment outlined in AS 1379 for each class of concrete produced. The Contractor shall obtain approval records of test results and reports of production assessment for the preceding production interval.

8.4.1.3 Ready mix concrete delivery

Ready mix concrete production method and facilities shall conform to AS1379. Ready mix concrete shall be transported to the point of discharge by truck mounted drum mixers conforming to the requirements of AS 1379. On completion of batching, the concrete shall be continuously agitated until it is thoroughly mixed. On completion of mixing, the concrete shall be continually agitated until it is fully discharged.

Each batch of concrete delivered to site shall be accompanied by an identification docket that shall be supplied containing the following information:

- Name of supplier
- Serial Number

- Date of delivery and climatic condition
- Project name and location
- Delivery vehicle identification
- Quantity of concrete
- Class and strength grade
- Designed slump
- Admixtures, if any
- Amount of water added on site

No concrete shall be placed that is supplied without a completed identification certificate.

8.4.1.4 Delivery time

The time that elapses between the wetting of the mix and discharge of the mix at the site shall not exceed the following:

Table 8.4.1.4.1 Concrete Delivery Time

Concrete temperature at Time of Discharge (°C)	Maximum Elapsed Time (h)
5 - 23	2.0
24 - 26	1.5
27 - 29	1.0
30 - 35	0.75

The Icon Water Representative may extend these times in certain circumstances provided that the concrete complies with the specified performance requirements, including slump and where workability is not impaired.

8.4.1.5 Temperature at point of delivery

Concrete shall not be delivered if its temperature at the point of discharge from the transport vehicle is less than 5 °C or greater than 35 °C.

8.4.2 Sampling and Testing Of Concrete

8.4.2.1 Location of sampling

All concrete samples shall be taken from the point of discharge from the agitator. Where required, additional sampling shall be carried out at the points of discharge into the forms.

8.4.2.2 Method of sampling

Sampling and identification shall be carried out in accordance with AS 1012.1.

8.4.2.3 Frequency of sampling

For each concrete class supplied to site from a concrete batch, sampling of plastic concrete shall be at least one sample per 25 m^3, or part thereof. For each sample, two 100 mm diameter by 200 mm high standard cylinder specimens shall be made and cured in accordance with AS 1012.8.

A batch is defined as concrete mixed in one mixer load or delivered in one truck or agitator to AS 1012.3 Method 1.

A slump test shall be performed on each sample of fresh concrete in accordance with AS 1012.3.

8.4.2.4 Tolerance on slump

The concrete represented by the samples shall be deemed to be satisfactory if the measured slump is within the limits given below:

Table 8.4.2.4.1 Tolerance on Slump

Specified nominal slump (mm)	Tolerance (mm)
80 – 120	± 20

If the measured slump is not within the specified limits, one repeat test shall be made immediately from another portion of the sample. If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample is deemed to conform. Otherwise it shall be rejected.

8.4.2.5 Compressive strength of concrete specimens

The compressive strength of each cylinder specimen determined, recorded and reported in accordance with AS 1012.9 by NATA approved laboratory.

The compressive strength of a concrete sample shall be the average strength of the two cylinder specimens taken from the sample and tested at the same age. If the two results differ by more than 10% of the average, the cause for such excessive difference shall be investigated.

The compressive strength of any concrete sample shall not be less than the characteristic strength of the concrete class.

Where the strength of a sample is less than the characteristic strength, the Contractor shall investigate the cause of the non-compliance and submit an engineering assessment report for approval.

Acceptance of the concrete represented by the sample shall be at the discretion of the Icon Water Representative. Concrete with strength less than 85% of the characteristic strength shall be rejected. All concrete test results are to be provided to the Icon Water Representative.

8.4.3 Placing and Compaction of Concrete

Concrete shall be placed and compacted finished and cured so as to:

- Prevent segregation or loss of material;
- Prevent premature stiffening;
- Prevent non-conforming displacement of reinforcement, fitments or embedment;
- Produce a dense homogeneous product which is monolithic between planned joints and the extremities of members;
- Provide the specified finishes;
- Control cracking, including that caused by plastic and drying shrinkage, concrete slumping, plastic settlement, crusting and thermal gradients.

Water, contaminants, debris, excess concrete, and other materials from concrete placement, compaction and curing operations shall be disposed of in an environmentally adequate manner.

Concreting shall be carried out in one continuous operation between ends of members and/or specified joint locations. Fresh concrete shall not be placed against concrete that has taken its initial set, except at properly formed specified joint locations.

Under conditions of rain, the placing of concrete shall not commence or shall be stopped unless adequate protection is provided to prevent damage to the concrete and the washing of the concrete surface. Concrete exposed to rain before it has set shall be liable to rejection.

Concrete shall be supplied at a rate that ensures that all concrete in the form is kept plastic until placed in its final position and compacted so that no cold joints are formed. Equipment and personnel shall be adequate to maintain the adopted rate of concrete placement.

In vertical forms the free fall of concrete shall be limited to a maximum of 300 mm using enclosed chutes or access hatches built into the formwork. As far as practicable, chutes or hoses of concrete pumps shall be kept full of concrete during placement with the ends immersed in the placed concrete and withdrawn as the form is filled. Concrete shall not be moved by the use of vibrators along the forms.

In horizontal forms, such as slabs, concrete shall not be allowed to drop into place from a height exceeding 1.5 m. Concrete shall not be moved horizontally by the use of vibrators.

Concrete shall be placed in layers not exceeding 500 mm in depth. Concrete shall be compacted immediately after placing by means of internal and external vibration. Vibration shall be carried out in a regular and systematic manner to ensure that all concrete is thoroughly compacted. Vibration shall be applied for the full depth of each layer and extended into the top 100 mm of the underlying layer. Concrete shall not be vibrated to the extent where segregation of constituents occurs.

Vibrators shall be of the rotary out of balance type and shall be checked prior to use to ensure proper working order. Internal vibrators shall have a minimum diameter of 50 mm and an operating frequency range between 130 Hz and 200 Hz.

The number of working vibrators in use for compacting concrete during a concrete pour shall be not less than one for each 10 m^3 of concrete placed per hour, with a minimum of two. The number of standby vibrators shall not be less than one quarter of the number of vibrators in use with a minimum of one. The vibrators used for spreading concrete shall not be counted in the number of vibrators used for compaction.

Ensure concrete is fully compacted and entrapped air removed. Do not allow vibrators to come into contact with partially hardened concrete or any reinforcement embedded within it. Insert at points maximum 500 mm apart. The vibrator shall be left in place for at least 7 seconds until air bubbles cease to break the surface of the concrete, and then withdrawn slowly.

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

8.4.4 Sequence of Pours

The Contractor shall prepare details of the proposed methods of placement, the sequence of pours, and the proposed construction joints, including a detailed staging plan for each concrete structure.

Minimise shrinkage effects by pouring the sections of the work between construction joints in a sequence such that there will be suitable time delays between adjacent pours.

If pour strips or stitch joints are to be used, full details shall be provided of the pour strips and stitch joints, including, but not limited to, the age of all adjacent slab prior to casting pour strips / stitch joints, reinforcement details, jointing details etc.

8.4.5 Cold Weather Concreting

Concrete shall not be placed if the ambient temperature is below 5 °C or expected to fall below 5 °C in the 24 hours after placement. If such conditions are expected to prevail for longer durations, the Contractor shall minimise the effects of low temperatures by implementing measures such as heating the water or aggregates and taking on-site precautions to avoid damage to the concrete works.

8.4.6 Hot Weather Concreting

The placing of concrete in hot weather shall be regulated by approved methods to avoid premature stiffening. Concrete shall not be placed if the ambient temperature is above 35 °C.

8.4.7 Formwork and Tolerances

8.4.7.1 General

All formwork, including all supporting members, shall comply with the requirements of AS 3610.

Formwork shall be designed by the Contractor to account for all load cases in accordance with AS 3610. The design and details shall also account for traffic impact, ground condition, flooding and any other applicable conditions. Where formwork is re-used, the design shall allow for the deterioration of the materials through use and handling.

Formwork shall be so constructed such that the concrete can be properly placed and thoroughly compacted and that the hardened concrete shall conform accurately to the required shape, position and level, and to the finishes specified. Care shall be taken in the tightness of the joints during concreting and vibrating operations. All joints in formwork, as erected, shall be made mortar-tight.

Unless shown otherwise in design drawings, top edges of the exposed surfaces shall be chamfered to 25mm x 25mm by using chamfer strips.

Formwork openings or removable panels shall be provided in vertical forms where necessary for inspection and cleaning.

Coat the forms with a suitable non staining oil that will not discolour the concrete and will facilitate their release. Surface retarding agents shall not be used.

Formwork bolts shall be designed so that they may be extracted without damaging the surrounding concrete. The embedded part of all form ties shall be located no closer than 50 mm to the surface of the finished concrete. All holes left by the form shall be filled with epoxy grout to match the concrete grade.

8.4.7.2 Formwork documentation and certification

The Contractor shall be responsible for the design of all formwork. All relevant construction requirements listed in the Project Documentation, including the design assumptions, shall be noted on the formwork drawings. Pre-camber diagrams where required shall be included in the formwork documentation. The formwork drawings shall be sufficiently comprehensive so that erection and inspection can be carried out without reference to any other documentation.

The Contractor shall prepare formwork documentation. The documentation shall be certified by a professionally qualified structural engineer with relevant experience in the design of formwork.

8.4.7.3 Test panels

When test panels are required, they shall be designed and constructed in accordance with AS 3610. The method of constructing test panels shall simulate concreting operations under conditions which reasonably represent the field conditions.

8.4.7.4 Tolerances

All formwork shall be constructed to the following dimensional requirements.

The tolerances given are for individual measurements and are not cumulative:

- Absolute position: 25 mm horizontal and 6 mm vertical from specified location and level.
- Surfaces to AS 3610.1-2010, Section 3.4. Substitute AS 3600-2009, Section 17.5 tolerances for the asterisks in Table 3.3.2 of AS 3610.1-2010.
- Depressions on flat surfaces, and reverse slopes on sloping surfaces, are prohibited.
- Matching alignment and/or elevation: For relative positions of adjacent edges or points specified as being on the same level or alignment:

Table 8.4.7.4.1 Tolerances for Relative Positions

Separation (mm)	Tolerance (mm)
Below 150	± 3
Over 150	± 6

Table 8.4.7.4.2 Tolerances for cross-sectional dimensions of columns, beams and similar, and thickness of slabs and walls

Dimension (mm)	Tolerance (mm)
Below 150	0, +5
150 to 1000	±5
Over 1000	1/200 times the dimension

Other dimensions: Any specified dimension not included above (including plumbness of vertical formwork):

Table 8.4.7.4.3 Tolerances for Other Dimensions

Dimension	Tolerance (mm)
Below 300 mm	± 3
300 mm to 3 m	± 6
Over 3 m to 6 m	± 12
Over 6 m to 12m	± 18
Over 12 m	± 25

8.4.7.5 Formwork removal

Formwork removal shall be to the requirements of AS 3600-2009, Section 17.6.2. The formwork shall be removed in such a way and such a time as to achieve the specified characteristics of the concrete, prevent damage to the concrete and maintain safety at all stages of removal.

Superimposed loads to any part of the structure shall not be applied until the design concrete strength has been achieved.

Do not remove support from any span until all the concrete in adjacent spans has gained the specified characteristic strength.

Where the formwork requires a release treatment for ease of formwork removal and to minimise the formation of bug holes and dusting an approved release agent shall be used.

Form release agents shall be compatible with any subsequently applied coating, or readily removable prior to coating application. The form release agent shall be approved by the Designer before use and the method of application shall be in accordance with the manufacturer's instructions.

Formwork design and installation shall be independently certified by a qualified and suitably experienced engineer.

The minimum time for the stripping of formwork shall be as stated in the following table:

Table 8.4.7.5.1 Minimum Time for Stripping of Formwork

Member Type	Member	Effective span (m)	Form Stripping time (days) for Avg. Air Temp (°C)		
			>= 20	>= 10, < 20	> 5, < 10
Vertical Unloaded	Wall, Beam Side	NA	2	3	5
Vertical Load Bearing	Wall, Column or Load Bearing Structure	NA	4	7	8
Horizontal Slab		Under 3	7	9	14
		3 to 6	9	11	16
		Over 6	11	14	20
Horizontal Beam		Under 3	6	8	12
		3 to 6	8	10	14
		Over 6	10	12	18

A concrete cover inspection shall be carried out after construction on a representative number of exterior areas instructed by the Icon Water Representative using a cover meter complying with BS 1881. Should more than 2% of cover measurements be less than specified then a durability review will be required at the Contractor's expense and any necessary rectification works to be carried out to the Icon Water Representative's satisfaction.

8.4.8 Finishes to Unformed Surfaces

The finishes to unformed concrete surfaces shall be as follows:

- Broom finish for footpaths. The surface shall be placed, consolidated, levelled and finished to a coarse transverse scored texture by drawing a broom or hessian belt across the surface. This operation shall occur immediately after floating.
- Screed finish for structural members covered by backfill, and all other unformed concrete surfaces. The surface shall be placed, consolidated and levelled to a Class C tolerance (as per below).
- Float finish for building roofs. The surface shall be placed, consolidated and levelled to a Class B tolerance (as per below) and finished by power float after the water sheen has disappeared and when the mix has stiffened sufficiently to permit proper operation. Hand floating shall be used only in areas which are inaccessible to the power float. The surface shall be planed during this procedure to a uniform, smooth, granular texture.
- Steel trowel finish for process tank floors, top of walls, copings and exposed surfaces. The surface shall be placed, consolidated and levelled to a Class A tolerance (as per below) and finished firstly with power floats, then with power trowels and finally with hand trowels such that the surface shall be free from trowel marks, uniform in texture and appearance.

8.4.9 Finishes to Formed Surfaces

All formed surfaces, except where permanently concealed by backfill material, shall have a minimum Class 2 surface finish to AS 3610.

All formed finishes that are permanently concealed by backfill material, shall have a minimum Class 3 surface finish to AS 3610.

8.4.10 Tolerances

The tolerance for unformed concrete surfaces, as determined by straight edge placed on the plane of the concrete surface in any direction, shall be as follows:

- Class A: 3 mm maximum deviation from a 3 m straight edge.
- Class B: 6 mm maximum deviation from a 3 m straight edge.
- Class C: 3 mm maximum deviation from a 0.6 m straight edge.

8.4.11 Curing

8.4.11.1 General

Curing shall be undertaken to prevent plastic cracking of the concrete and to enhance the hydration process of the cement paste. Freshly placed concrete shall be protected from premature drying and excessive hot and cold temperatures. The concrete shall be maintained at a reasonably constant temperature with minimum moisture loss for the duration of the curing period.

In windy conditions, windbreaks shall be erected to shield the concrete surfaces during and after placement.

Freshly placed concrete shall not be subjected to external vibration such as pile driving or dynamic ground compaction.

8.4.11.2 Curing methods

Curing of concrete shall be to AS 3600, Section 17.1.5 using the following methods:

- Ponding or continuous sprinkling with clean water (moist curing);
- The use of an absorptive cover kept continuously wet;
- Low pressure steam curing;
- The use of an impermeable membrane fixed and lapped over the moistened concrete surface to exclude air circulation;
- Membrane curing compound

Curing shall commence immediately after finishing, and continuously in air between 5°C and 35°C (except steam curing) until the concrete has both attained 75% of its 28 day compressive strength as determined from trial mixes, and has cured for a minimum of 7 days. If a curing compound is used, the curing period shall be not less than 14 days. Keep exposed concrete surfaces (and absorbent forms) wet for the curing period.

8.4.11.3 Curing compounds

Curing compound shall conform to the requirements of AS 3799. The curing compound shall be sprayed to give a uniform cover. The sprayer shall incorporate a device for continuous agitation and mixing of the compound in its container during spraying.

The Contractor shall submit a certificate of conformity from the supplier, supported by test certificates from a NATA approved laboratory certifying that the curing compound conforms to the specification.

The curing compound shall be applied using a fine spray at the rate stated on the certificate of conformity, or at the rate of 0.2 L/m^2, whichever is greater. A minimum of two coats shall be applied at the full rate.

The time between the first coat and the second coat shall be in accordance with the manufacturer's recommendation, or on the basis of trial application.

The curing compound shall be applied to unformed surfaces immediately after completion of all finishing operations, and to formed surfaces within half an hour of the removal of formwork from the section.

The curing membrane shall be maintained intact after its application for the required period. Any damage to the curing membrane shall be made good by respraying of the affected areas.

8.4.11.4 Curing of wall concrete in forms

Consideration shall be given to wall concrete in forms ensuring the heat of hydration being kept under control to avoid cracks associated with early thermal contraction. This may involve the selection of appropriate material for the forms and/or loosening the forms slightly at an appropriate time to allow the curing water to reach the concrete surface.

8.4.12 Reinforcement

8.4.12.1 General

Unless specified otherwise, all steel bars and welded mesh reinforcement shall be deformed bars, Grade 500 and shall comply with the requirements of AS/NZS 4671. The designation and placing of bars shall comply with the requirements of AS 3600.

Manufacturers and producers of steel reinforcement shall hold a valid certificate of approval issued by Australian Certification Authority for Reinforcing Steel (ACRS) or by an equivalent certification body. The Contractor shall obtain all of the certification documentation prior to the delivery of any reinforcement.

Symbols to be shown on design drawings for grade and type of reinforcement are as follows:

- N Grade 500 deformed bar
- SL Grade 500 welded wire fabric (also referred to as 'F')
- R Grade 250 Hot rolled plain round bar
- All reinforcement shall be inspected for compliance prior to concreting by the Icon Water Representative.

8.4.12.2 Protective coating

Unless specified otherwise on the drawings, reinforcement with protective coatings shall not be used.

8.4.12.3 Fabrication and bending

All reinforcement shall be fabricated to the shape and dimensions shown on the drawings and within the tolerances of AS 3600.

Reinforcement shall not be straightened or bent again on-site once having been bent, unless specific details have been approved in writing in advance, in which case only “cold” bending shall be permitted. Reinforcement already bent and straightened or bent in the reverse direction shall not be bent again within 20 diameters of the previous bend.

Reinforcement partially embedded in concrete and bent again, shall be cleaned thoroughly and free of any mortar before depositing concrete against it. The Contractor shall forward specific details before commencing any straightening or re-bending of reinforcement.

8.4.12.4 Splicing

Splicing of reinforcement shall be made as shown on the drawings. Additional splices or splices at other locations shall require the prior approval of the Icon Water Representative.

Mechanical splices shall be of the type specified. The installation of splices shall be in accordance with the manufacturer’s recommendations. When tested in accordance with AS 1391, mechanical splices shall develop the nominal ultimate tensile or compressive strength of the bar being tested. The Contractor is to submit all details and test certificates for each size and type of bar to be spliced.

Additional splices than those shown on design drawings shall be at the Contractor’s expense and shall constitute a change in design detail requiring approval of the Designer.

8.4.12.5 Welding of reinforcement

Welding of reinforcing steel shall conform to the requirements of AS 1554.3.

Reinforcement shall not be welded unless it is of a weldable grade. Welding procedures shall conform to the manufacturer’s recommendations for control of heat input.

The Contractor shall provide 48 hours’ notice before welding of any reinforcement. Welding of reinforcement is not permitted within 75 mm of a section which has been affected by bending or re-bending.

8.4.12.6 Storage of reinforcement

Steel reinforcement shall be stored above the ground surface and protected from damage and deterioration due to exposure.

8.4.12.7 Surface condition of reinforcement

At the time it is placed, reinforcement shall be clean, free from mortar, rust, mill scale, oil, grease and other non-metallic substances that can impair its bond to concrete or its performance in the member.

8.4.12.8 Support for reinforcement

All reinforcement, including fabric, shall be fully supported on bar chairs or spacers of the same strength as the concrete element and of a shape appropriate to the location to achieve the specified cover to reinforcement and to ensure there is nil deflection of the reinforcement during casting and finishing of the concrete.

Bar chairs and spacers shall be adequate to withstand construction traffic and shall be spaced sufficiently close to maintain the reinforcement in its correct position. Chairs shall be spaced generally at no more than 750 mm centres for bars and 450 mm centres for fabric, both ways.

Damage to waterproofing membranes or vapour barriers shall be prevented by placing plastic plates under each support to prevent puncturing of the membrane or the vapour barrier.

8.4.12.9 Fixing reinforcement

Reinforcement shall be fixed within the tolerances set out in Section 17.2 of AS 3600.

All reinforcement shall be secure against displacement by tying at intersections with either annealed steel wire ties (minimum 1.2 mm diameter), or clips. Wire shall be bent away from nearby faces of forms so that the ties do not project into the concrete cover.

For bar reinforcement in the form of a mat, secure each bar at alternate intersections, and at other points as required.

All stirrups and ties shall be tied to all major reinforcement at every bar intersection.

Secure longitudinal column reinforcement to all ligatures at every intersection.

Bundled bars shall be tied together so that the bars are in closest possible contact. Use tie wire at least 2.5 mm diameter at centres less than 12 times the diameter of the smallest bar in the bundle.

8.4.12.10 Tolerances

Tolerance of reinforcement shall be as follows:

- Between bars in a row: ± 10% of specified spacing, or 15 mm, whichever is greater;
- Between rows of bars: ±6 mm;
- Cover to reinforcement: 0, + 10 mm;
- Restriction: To AS 3600-2001: requirements for spacing of bars.

8.4.13 Protection of Concrete

The Contractor shall protect the concrete from damage due to load overstress, heavy shock and excessive vibration, particularly during the curing period.

Finished concrete surfaces shall be protected from damage due to any cause, including mortar splashes and stains, timber stains, rust stains, chemical attack, additives, curing compounds, protective coatings, rain, running water, and the like.

Concrete is liable to be rejected if surfaces are damaged. Rectification of any damaged concrete surface may be attempted only if prior approval is given by the Icon Water Representative. The Icon Water Representative may refuse approval, or, if approval is given, may reject the concrete if the attempt to satisfactorily repair the damaged concrete fails.

8.4.14 Corrosion Protection

Corrosion protection coatings or linings shall be applied in accordance with manufacturer's recommendations. For an equivalent product approval request, the Contractor shall provide all the material data, certification and reference projects.

8.4.15 Concrete Repairs

8.4.15.1 General

The Contractor shall repair all faulty concrete work and cracks which exceed the limits in this specification. The finish and the appearance of the repaired sections shall match the adjacent sound concrete.

At least 14 working days prior to commencing any rectification work, the Contractor shall submit a proposal detailing the non-conforming areas, extent of areas to be repaired and the proposed methodology for repairs including details of repair materials, data sheets, performance safety, application and testing procedures, and compliance with the manufacturer's details for any repair products.

The proposal shall be certified by a structural engineer with the relevant experience to determine that the repaired structure will meet the design performance, life and durability requirements.

8.4.15.2 Surface preparation of faulty concrete work

Areas of concrete scheduled for repair shall be prepared prior to the application of repair materials.

In areas of spalling or areas which require reforming, surface preparation of concrete shall include removal of all loose, cracked, drummy or softened concrete to ensure the prepared surface is comprised of exposed aggregate and sound concrete. The cleaning shall where necessary include the use of portable hand-held percussive tools such as "scabblers" and "needle guns".

To avoid feathered edges, the area to be repaired shall be power saw cut around its perimeter to a depth of 10 mm. The saw cutting of the repair area shall be formed by straight lines so that the edges of the repair area are parallel to the general outlines of the structure adjacent to the repair. The saw cut shall be made such that the width at the base of the saw cut is greater than the width at the surface of the saw cut, such as to provide a keying action into the existing concrete work. Concrete shall be removed from across the whole repair area such that the repair is at all points at least 10 mm deep.

8.4.15.3 Patch repairs

Where required, patch repairs shall be carried out to reinstate areas of defective concrete to the original surface profile. Patch repair material shall be a high build polymer modified cementitious mortar having a drying shrinkage strain of not more than 400 x 10^{-6} at 56 days.

The repair material shall be compatible with the existing surface in terms of minimum differential shrinkage to repair cracking.

The prepared concrete surface to be patched shall be soaked with clean fresh water, allowed to dissipate and then primed with a priming agent which will enhance bonding and prevent excessive loss of moisture into the substrate below. While the primer is still tacky, the repair material shall be applied without voids and compacted to obtain a uniform consistency. In deeper sections, the repair material shall be built up in layers as required to eliminate slumping. The mortar shall be cured by moist curing for a minimum period of 4 days. All work shall be carried out strictly in accordance with the manufacturer's instructions.

The colour of the final layer of repair mortar and the texture of the surface finish shall match the cleaned surfaces adjacent to the repair.

8.4.15.4 Crack repairs by epoxy injection

All cracks that exceed the limits of this specification shall be repaired by epoxy injection.

The epoxy adhesive used for injection shall consist of a two component structural epoxy adhesive, processed through continuous positive displacement in-line metering and in-line mixing equipment.

Sufficient epoxy adhesive shall be made available prior to the commencement of each crack injection to ensure that it is completed in a single continuous operation.

The locations of all crack injection points shall be designed and certified by the supplier of the epoxy adhesive system as adequate to completely fill the crack and restore the strength of section. Epoxy injection shall only be carried out by applicators that are approved by the suppliers of the system.

8.4.16 Construction Joints

8.4.16.1 General

The location of all construction joints shall be as nominated on the drawings.

All construction joints shall be formed perpendicular to the main axis of the member. The deviation of any point on the construction joint from a straight line joining any two points on the joint shall not exceed 1/250th of the distance between the points or 5 mm whichever is the greater.

Vertical construction joints shall not be permitted in the walls of reinforced concrete liquid retaining circular tanks.

All construction joints shall be equal in strength to the elements being joined.

All construction joints shall be constructed as detailed in the standard structural details on the drawings.

8.4.16.2 Surface preparation at construction joints

Roughen and clean the hardened concrete surface of the joint, so that all loose or soft material, foreign matter and laitance is removed to expose clean coarse aggregates to a depth of at least 3 mm. Coarse aggregate that does not remain firmly embedded in the mortar matrix and laitance from projecting reinforcement from previous pour shall be removed.

Immediately prior to the placement of adjoining concrete, the surface of the construction joint and the projecting reinforcement shall be washed clean, and the concrete surface shall be saturated with water, following which all excess water and loose material shall be removed.

The Contractor shall also give notice of any additional construction joints made necessary due to unforeseen interruptions to any concrete pour.

8.4.17 Movement Joints

8.4.17.1 Water retaining structures

Movement joints are compulsory joints and their positions shall not be altered to those locations shown on the drawings.

All movement joints shall have adequate shear strength in the transverse direction to prevent differential movement either by an adequately proportioned concrete shear key or galvanised mild steel/Grade 316 stainless steel dowels as detailed in the standard structural details on the drawings.

All dowels shall be accurately positioned at right angles to the mating surface and rigidly held in position prior to depositing concrete. The dowels shall not be supported on or attached to the reinforcement within 5 times the required cover away from any surface in contact with liquid. A tolerance of not more than 1:100 shall be permitted on the alignment and location of the dowels. The unbonded end of the dowels shall be coated with an approved bond breaker such as hot 60-70 grade bitumen. At expansion joints the unbonded end of the dowel shall also be sheathed with a dowel cap containing a minimum of 15 mm compressible packer.

All movement joints in water retaining structures shall incorporate waterstops and joint sealants in a preformed groove on the liquid faces, as shown on the drawings. Expansion joints shall also be provided with compressible cork filler.

All waterstops and dowels shall be accurately positioned and rigidly held in position prior to pouring concrete. All dowels shall be positioned at right angles to the mating surfaces. The sealant to be used in all wall and floor joints shall be as specified on the drawings, mixed and applied strictly in accordance with the manufacturer's instructions.

The joint recesses shall be constructed to a tolerance of 10% to + 20%.

All defects in the joint recesses such as abrupt irregularities and honey comb concrete shall be cut out and repaired as necessary using an epoxy repair mortar applied strictly in accordance with the manufacturer's instructions.

All joint recesses shall be cleaned and dried as directed by the sealant manufacturer's instructions. Provide polyethylene bond breaker tape under sealants. Do not contaminate joint sealing faces within the recess with any bitumen or other product.

8.4.17.2 Footpaths and paving

For all footpaths and minor paving, joints shall be straight, continuous and normal to the surface of the pavement. Weakened plane joints shall be formed by making a cut 3 mm wide for at least one quarter of the depth of the paving. Arises shall be tooled to a suitable radius. Unless otherwise specified or detailed, the spacing of the weakened plane joints shall approximate the width of the path with minor adjustments to avoid short closing lengths. Spacing shall not normally exceed 2 m.

Movement joints shall be constructed for the full depth of the paving using 15 mm wide preformed self-expanding joint filler. They shall be provided wherever the paving abuts fixed structures, such as buildings and pits, transversely at maximum intervals of 15m along path and at path intersections. Joint filler shall be bonded to the first placed concrete using a suitable contact adhesive. Joint arises abutting cork joint sealer shall not be tooled off.

8.4.18 Waterstops

8.4.18.1 Hydrophilic waterstops

Hydrophilic waterstops shall be either set in a groove or fixed so that they remain securely in their correct positions during concreting.

8.4.18.2 PVC waterstops

PVC Waterstops shall have a minimum width of 230 mm and a minimum of four flange internal ribs or bulbs. On vertical joints, internal type waterstops shall extend vertically to 50 mm below the coping level.

The material shall be free from surface imperfections, blisters, porosity or other blemishes.

The waterstop material shall have properties at least equal to those listed below:

i) Minimum properties at 25 °C:

- Tensile Strength 13.8 MPa
- Elongation at Break 285% minimum
- Softness (BS 2571) 42-52;

ii) Movement accommodation:

- Minimum Extension 10 mm
- Minimum Transverse Shear 20 mm.

Waterstops shall be fabricated into the longest practical units at the supplier's works and shall be continuous throughout the structure below highest water level. Intersections and joints shall be factory made where possible.

No holes are to be made through the body of the waterstop. Jointing other than by welding in accordance with the manufacturer's recommended system will not be permitted.

The installation and jointing of waterstops shall be strictly in accordance with the manufacturer's specification. The jointing of PVC waterstop and repairs to damaged waterstop shall only be undertaken using heat welding.

The PVC waterstops shall be installed so that they are securely held in their correct positions (with the centre of the waterstop placed immediately under the line of the two concrete pours) during the placing

of the concrete, which shall be fully compacted around the waterstop so that no void or porous areas are left. Where reinforcement is present, a minimum clearance of 50 mm shall be maintained between the waterstop and the nearest face of reinforcement.

8.4.19 Fillers and Sealants in Joints

Fillers and sealants for joints in water retaining structures shall be applied strictly in accordance with the manufacturer's written instructions. If these are not adhered to, including directions regarding mixing, pot life, placing temperature, surface preparation etc., the Contractor shall discard any affected material not yet placed and/or remove any affected material. Where priming is specified, the primer shall be compatible with the sealant as recommended by the manufacturer.

Unless shown otherwise on the drawings, joint filler shall be a self-expanding cork joint filler of cork granules bound by suitable resins and moulded to form strips. It must expand in contact with moisture. It must be capable of recovering at least 90% of its original thickness after compression.

The joint filler shall be fixed to the required dimensions of the joint cross section and shall provide a firm base for the joint sealer. It shall be placed immediately before placing concrete. Any filler swollen by water or moisture prior to placing concrete shall be rejected.

Prior to the application of sealant, all joint grooves shall be cleaned for the full depth to ensure the groove faces are clean and free of any loose particles or other defects that would impair bond with the sealant. Any excess mortar or concrete shall be removed from the joint and any defects repaired, prior to the application of the sealant.

The applicator installing fillers and sealants shall be trained, accredited and approved by the sealant manufacturer. Evidence of such accreditation shall be obtained by the Contractor.

All exposed joints shall be taped prior to application of primer and sealants to give straight edges to applied sealant upon completion. All joints in liquid retaining structures shall be considered exposed.

8.4.20 Cracks in Concrete

A crack inspection shall be carried out on all interior and exterior concrete surfaces after concreting.

At the completion of works, concrete shall not have cracks of width exceeding the following:

- Special Class Concrete (liquid retaining structures) : in accordance with Table C3.1 AS 3735 Supp1-2001
- Normal Class Concrete : 0.2 mm

8.4.21 Cast-In-Bolts and Chemical Anchors

As detailed in the drawings, cast-in bolts and masonry anchor sets shall be manufactured from either hot dipped galvanised mild steel or stainless steel Grade 316, depending on location, the environment and the material to be fixed. All bolt threads shall be smeared with a suitable anti-seize / lubricant compound prior to assembly.

Stainless steel bolts and anchors shall be provided to the inside surfaces of all water retaining structures and to all stainless steel and aluminium materials being fixed to concrete unless specified otherwise on drawings. Galvanised anchors and bolts may be used for the external surfaces of all concrete structures (atmospheric exposure) and to galvanised members being fixed to concrete.

PFTE washers shall be fitted between metal washers and the materials being fixed or joined when parts are of dissimilar materials.

Allowable types of masonry anchors / anchor bolts are:

- Epoxy based chemical anchors in drilled holes;

- Cast in-situ bolts provided that the strength of the fastener is equal to or greater than the chemical anchor equivalent.

Expansive type masonry anchors shall not be used.

Electroplated fasteners shall not be used in any location.

For an equivalent alternative fastening system, the Contractor shall submit full details of the fastener system(s) proposed, prior to construction for approval.

Where drilled holes for chemical anchors strike steel reinforcement, the hole shall be abandoned and relocated. Abandoned drill holes shall be thoroughly cleaned and filled with an approved epoxy grout.

Where fixing bolts to be cast-in are positioned by means of a template they shall be supplied with a backing nut and a face nut for secure fixing of the bolt. The backing nut shall be cast into the concrete.

In fixing penstocks to concrete, set the frame in one plane by adjusting the backing nuts. Fill the space between the wall and the frame with non-shrink grout or a hard setting butyl mastic (not in strip form). Repair or replace any mortar shrinkage.

8.4.22 Pipe Penetrations, Blockouts and Cored Holes

Wherever possible, all pipes and fittings shall be cast into the structure when the structure itself is poured.

For pipe penetrations embedded in the concrete pour, power tool clean and wire brush all pipework to be cast into the concrete to remove all traces of dust, grease, rust and paint prior to the placement of concrete. Additionally for ductile iron pipework, power tool clean and wire brush the manufacturer's external pipe coating from the full surface of the pipe.

Blockouts provided for openings shall be constructed so as to leave a minimum clearance of 100 mm between concrete surface and the outer diameter of the pipe or thrust/puddle flange to be cast-in. Reinforcement shall be constructed continuously through openings as detailed on the reinforcement drawings and shall be trimmed around the item to be cast-in at a maximum distance of 50 mm from the item. Additional trimmer reinforcement shall be provided as detailed in the drawings.

Where cored holes are to be grouted to hold pipework, bolts and other fittings, the cored holes shall be scabbled and treated with a specified epoxy binder in accordance with the manufacturer's instructions. Additional trimmer reinforcement shall be provided as detailed in the drawings.

After placing the pipe and fitting within the blockout or the cored hole, the remaining void shall be carefully filled with non-shrink cementitious grout of equal or higher grade, care being taken to produce a watertight joint with provision of hydrophilic waterstop at the construction joints.

Provide puddle flanges / thrust anchors as detailed on the drawings.

8.4.23 Machinery Bases and Grouting

Concrete plinths and machinery bases shall be constructed for all mechanical and electrical equipment including all in-pour conduits as required. The existing concrete surface shall be scabbled to remove all laitance and weak concrete and reinforcing starter bars shall be cleaned and bent to the required shape. The surface of the concrete shall be coated with specified epoxy adhesive in accordance with the manufacturer's instructions prior to pouring concrete. All concrete items shall be constructed from grade and class of concrete as specified in design drawings.

Before placing the equipment on the plinths or bases, the top surface shall be scabbled to remove all laitance and weak concrete. The surface shall be coated with specified epoxy binder in accordance with the manufacturer's instructions. The equipment to be grouted shall be put in place and levelled using shims and wedges or jacking screws which can later be removed.

The base plates shall be fully grouted using specified non shrink cementitious grout. Shims, wedges and jacking screws shall be removed after the grout has taken its initial set and the grout made good at

these points. The equipment shall not be levelled by using nuts on the underside of the base plates on the anchor bolts.

Anchor bolts shall not be tightened until a minimum of 36 hours after the equipment has been grouted.

8.4.24 Watertightness Test

All liquid retaining structures shall be hydrostatically tested for leakage.

Testing shall be carried out prior to the placing of backfill around each structure and prior to placing any concrete benching, mortar toppings or tiling.

Prior to carrying out watertightness tests, remove all debris and clean all surfaces, install temporary blank flanges, plugs or caps on pipework cast through concrete walls, seal with temporary covers all openings in the concrete below top water level, and generally ensure that each structure is water tight and ready for testing.

Fill each water-retaining structure with water to the overflow level of the structure and test for watertightness. The Contractor shall supply the water for the hydrostatic testing. The Contractor shall be responsible for supplying and installing pumps and pipes to transfer the water and to empty the structures on completion of the hydrostatic tests.

The structure shall be filled with water at a uniform rate of not greater than 2 metres in 24 hours. Note that the filling rate may have to be restricted if this rate cannot be achieved either through the water supply or the ability to supply reclaimed effluent for the filling purpose.

Commence the test period after a 7 day stabilising period to allow for absorption and autogenously healing of the concrete. After the stabilising period, record the level of the liquid surface at 24 hour intervals, for a test period of 7 consecutive calendar days.

The structure shall be deemed to satisfy the test if, at the end of the 7 calendar days, after allowing for evaporation and rainfall, no leakage is apparent from the structure, and the water level has not dropped more than 1/500th of the average water depth of the full tank or 10 mm, whichever is the lesser value.

The Contractor shall determine the evaporation during the testing period by direct measurement of evaporation losses via an approved methodology.

Rainfall shall be measured at the site at a minimum of 12 hour intervals for the duration of the test periods. The rainfall measuring device shall be a proprietary product designed for such use. Locate the rain measuring device to avoid rain shadow effects from structures, trees and the like.

All levels and losses shall be recorded and a leakage report shall be submitted for each structure. Any leaks including visible wet patches on the outside faces of the structures or increased underdrain flow shall be deemed unacceptable and needing rectification. To rectify, empty the structure, detect and repair defects and retest by repeat procedure as above. Continue to repair and retest until a satisfactory test is obtained. No backfilling of the structure shall take place until all these requirements are met.

Minimise the total quantity of tested water by re-using water to test adjacent structures. This is especially applicable to the testing of larger structures.

Any pressure relief valves within the floor of the structure shall be thoroughly cleaned and sealed prior to the commencement of the test.

Upon completion of the tests, the structures shall be emptied, or if feasible, the water retained for further testing or commissioning activities on other structures. Disposal of water shall be at the satisfaction of the Icon Water Representative.

No mechanical equipment shall be installed in any structure before the successful completion of the watertightness test.

9 Precast Concrete

9.1 Scope

This specification sets out minimum requirements for design, manufacture, fabrication, delivery, inspection, handling and erection of precast concrete works.

This document shall be read in conjunction with *Section 8 Reinforced Concrete*.

9.2 Relevant Standards and Codes

The documents listed in Table 9.2.1 are either referenced by this specification section or shall be read in-conjunction with this specification section.

Table 9.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 1012	Methods of Testing Concrete
2	AS 1141	Methods for Sampling and Testing Aggregates
3	AS 1379	Specification and Supply of Concrete
4	AS 1391	Metallic Materials –Tensile Testing at ambient temperature
5	AS 1478	Chemical admixtures for Concrete, Mortar and Grout
6	AS/NZS 1554	Structural Steel Welding
7	AS 2758	Aggregates and Rock for Engineering Purposes
8	AS 3582	Supplementary Cementitious Materials for Use with Portland and Blended Cement
9	AS 3600	Concrete Structures
10	AS 3610	Formwork for Concrete
11	AS 3735	Concrete Structures for Retaining Liquids
12	AS 3799	Liquid Membrane Forming Curing Compounds for Concrete
13	AS 3972	General Purpose and Blended Cements
14	AS/NZS 4671	Steel Reinforcing Materials
BS Standards		
15	BS 1881	Testing Concrete
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
16	Not provided	Safe Design of Structures

Item	Document number	Title
Icon Water standards and work instructions		
17	SD Series Drawings	Standard Drawing Set
18	STD-SPE-G-006	Approved Products List
19	STD-SPE-G-018	Drafting Standards

9.3 Design and Specification

9.3.1 General

The details provided in Section 9.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 9.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

9.3.2 Referenced Documents

The documents listed in Table 9.2.1 are either referenced by this specification, or shall be complied with and read in-conjunction with this specification. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

9.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 9.3.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water standards (e.g. *STD-SPE-G-018).*

The requirements specified in Table 5.2.2.1 and Table 9.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 9.3.3.1 Minimum Mandatory Requirements for Precast Concrete Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, items 1.1 to 1.8
2	Structural Design Criteria	A structural design criteria and notes drawing shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawing shall contain the following information as a minimum, as appropriate to the structure: General:

Item	Drawing or Document Type	Minimum Mandatory Requirements

		• General construction notes
		• Loading of structural components e.g. wind load and live loads
		
		<u>Foundations:</u>
		• Geotechnical conditions
		• Subsurface drainage requirements
		• Design bearing capacity of the soil
		
		<u>Concrete</u>:
		• Materials and workmanship
		• Concrete strength
		  ○ Mass concrete
		  ○ Structural concrete
		• Curing
		
		<u>Reinforcement</u>:
		• Reinforcement grade
		• Concrete cover
		
		<u>Surface finish</u>:
		• Final surface finishes

3	Elevations	Elevation drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall show the structure in different elevation profiles with appropriate dimensions. For a multi-level structure, the RLs shall be provided for each component elevation.
4	Section Drawings	Section drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Sections shall be taken at appropriate locations to detail cross sectional dimensions of the structure.
5	Concrete Detail	Concrete detail drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall detail concrete properties of each element and include a table with a member schedule.

Item	Drawing or Document Type	Minimum Mandatory Requirements
6	Reinforcement Detail	Reinforcement detail drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall detail the reinforcement of each element and include a table with a member schedule. The drawing shall show the reinforcement layout, number, diameter, spacing and bar location (e.g. 17-N20-250 EF).

9.3.4 Supply Requirements

Precast units and components shall be supplied by a manufacturer specialising in this type of work. Each unit or component shall wherever possible, be cast in one continuous operation, and cured as soon as possible after casting. Steam curing maybe used. Curing membranes shall be compatible with any other applied finish to be applied to the precast element and specified elsewhere in the specification or design drawings.

A uniform high standard of work shall be maintained throughout the work. Damaged or cracked units shall not be accepted on site. Any repair work shall not be carried out on precast items without specific approval of the Icon Water Representative.

All precast units are shown on the drawings and it shall be the Contractor's responsibility to ensure that all dimensions are checked on site prior to their fabrication. It is the Contractor's responsibility to ensure that all construction tolerances are maintained in fabrication and erection.

It shall be the Contractor’s responsibility to ensure that the materials comply in all respects with the drawings and specification.

It shall be the Contractor’s responsibility to ensure the correct set out of the precast items, fixings, casting, items, openings etc.

9.3.5 Materials

Materials shall be as specified in *Section 8 Reinforced Concrete* of this specification document.

9.3.6 Design and Fabrication

The precast concrete panels/units, as shown on the drawings, are designed and reinforced to their final place / position on the structure. It shall be the responsibility of the Contractor to ensure that all panels / units are designed and reinforced to meet the requirements of any fabrication, transport, unloading, lifting, handling, stacking, erection situation and to design, document and provide all lifting anchors, strongbacks and devices necessary for the handling of these panels/units. The Contractor shall submit shop drawings and design calculations for the Icon Water Representative’s review and approval at least 14 days prior to commencing fabrication.

The Contractor shall provide adequate means of lifting the units and shall ensure that the units are not damaged or overstressed during any of the lifting operations. The maximum tensile stress in the precast concrete elements resulting from fabrication, handling, stacking or erection shall be 0.5√(f^' c), where, f’c is defined as the specified compressive strength of the concrete. At no time shall the stresses be permitted to develop which will cause cracking in the concrete. Crack prevention remains, however, the responsibility of the Contractor. The design work required for the precast elements and lifting anchors shall be carried out by a chartered structural engineer experienced in his work engaged by the Contractor at the Contractor’s expense, if not already designed as part of the project.

Any additional reinforcement required to meet these requirements shall be located strictly in accordance with concrete cover noted in the design drawings upon approval from the Icon Water Representative and be included at Contractor's expense.

In general, unless noted otherwise in design drawings, tolerances for mould and profile alignment shall comply with Class 2 of table 3.4.2 of AS 3610.

All corners shall have 25mm x 25mm chamfers.

The Contractor shall be responsible for the preparation of the casting programme that shall be submitted to Icon Water Representative at least 14 days before for approval. The casting programme shall include details of rate of casting, finishes, curing period and agents to precast panels/units.

As a minimum, precast panels/units shall be cured after demoulding for a minimum of 14 days, or until a concrete strength of 25 MPa has been achieved, prior to delivery to the site.

The Contractor shall identity each unit with a unique identification number and maintain a detailed report of all precast panels/units to include the following

- Panel Identification.
- Date of casting.
- Weather conditions and temperature at time of casting.
- Method and duration of curing.
- Temperature graphs for steam curing.
- Date of removal from forms.
- Concrete test results.
- All site instructions given by the Icon Water Representative including those relating to making good any damage or deficiencies in workmanship.
- Date of acceptance for transport to site.
- Date of delivery to site.

9.4 Construction and Testing

9.4.1 Inspection during Manufacture

The Contractor shall ensure to provide the Icon Water Representative to have access to the manufacturing yard for the purpose of inspecting all precast units during construction. The Contractor shall provide all necessary equipment for the Icon Water Representative to carry out any inspections.

The Icon Water Representative shall be given a minimum of 24 hours' notice to enable inspection of formwork, reinforcement and construction joints. No concrete shall be placed until the Icon Water Representative is satisfied that all provisions of the specifications and drawings have been complied with.

Where instructed, the Icon Water Representative's instructions shall be carried out before concrete placing commences.

9.4.2 Prestressed Members

Prestressing tendons shall be cut only by use of a high speed flexible carborundum disc or hydraulic or mechanical shears. Flame or gas cutting shall not be permitted.

On completion of stressing and tendon draw-in at ends of units, the ends of the tendons shall be protected with Sika MonoTop Primer and a layer of epoxy mortar. Where visible in the completed structure, form a 5.0 mm deep rebate at the strand ends, treat as above, but fill the rebate with cementitious mortar colour matched to the surrounding concrete.

9.4.3 Handling

On completion of fabrication, the precast units shall be stored so as to ensure that they do not suffer any damage or overstressing of any part of the units.

The Contractor shall ensure that all precast units are stacked or supported on suitable closely spaced bearers in an environment that will ensure slow, uniform curing. The bearers shall be of a material that does not stain or discolour the concrete.

The Contractor shall also ensure that the means of transport from the precasting yard to the site will not damage or overstress the units.

The Contractor shall draw the attention of the Icon Water Representative to any damaged or marked edges and faces before the precast units are finally fixed in position. All repairs arising from damage to the units during handling, storage, transportation or erection shall be made good at the Contractor's expense.

9.4.4 Acceptance on Site

The Contractor shall be responsible for accepting the precast units on site and erecting the units. Where units appear to be inferior to the requirements of this specification, the Contractor shall immediately report any defects or inaccuracies to the Icon Water Representative.

Cracked or damaged precast units will not be accepted on site by the Icon Water Representative for incorporation into any permanent works.

9.4.5 Erection

The Contractor shall be responsible for the erection of all precast units.

Precast units shall be adequately braced and supported during erection to ensure proper alignment and safety. Such bracing or support shall be maintained until adequate permanent connections have been made.

The Contractor shall design, detail and cast in suitable lifting eyes or inserts at appropriate points to provide for handling, erection and temporary support of the items.

The Contractor shall not use any lifting or erection method which places excessive stress on the units.

Post-tensioned curved units shall be seated on multiple layers of proprietary plastic shims which permit inwards movement of the panel during stressing.

Shims used for levelling and temporary support of precast units shall be of proprietary plastic and of a large enough area such that excessive point loads are not applied to the bearing surface which could result in local bearing or crushing failures. Metal or timber shims shall not be used.

Following erection, the Contractor shall fill in all lifting-eye holes, form tie holes and the like. Where visible in the finished works, all such filling shall be colour matched to the concrete of the main pre-cast concrete item.

9.4.6 In-situ Concrete Joints

The Contractor shall ensure that the colour and surface finish achieved from cast in-situ joints matches that of the precast units and components.

9.4.7 Construction Joints

9.4.7.1 General

The location of all construction joints shall be as nominated on the drawings.

All construction joints shall be formed perpendicular to the main axis of the member. The deviation of any point on the construction joint from a straight line joining any two points on the joint shall not exceed 1/250th of the distance between the points or 5 mm whichever is the greater.

Vertical construction joints shall not be permitted in the walls of reinforced concrete liquid retaining circular tanks.

All construction joints shall be equal in strength to the elements being joined.

All construction joints shall be constructed as detailed in the standard structural details on the drawings.

9.4.7.2 Surface preparation at construction joints

Roughen and clean the hardened concrete surface of the joint, so that all loose or soft material, foreign matter and laitance is removed to expose clean coarse aggregates to a depth of at least 3 mm. Coarse aggregate that does not remain firmly embedded in the mortar matrix and laitance from projecting reinforcement from previous pour shall be removed.

Immediately prior to the placement of adjoining concrete, the surface of the construction joint and the projecting reinforcement shall be washed clean, and the concrete surface shall be saturated with water, following which all excess water and loose material shall be removed.

The Contractor shall also give notice of any additional construction joints made necessary due to unforeseen interruptions to any concrete pour.

9.4.8 Minor Embedded Items, Holes, Chases, Rebates

The Contractor shall adequately support prior to concreting, all sleeves, inserts, anchors, holding down bolts, conduits, pipes and other embedded items. Voids in sleeves, inserts and anchor slots shall be plugged, taped or filled temporarily with readily removable material to prevent entry of concrete into the voids.

The Contractor shall accurately form and position all chases, fillets, holes, up-stands and nibs as shown on the drawings, prior to fabrication.

10 Metalwork

10.1 Scope

This specification covers the minimum requirements for the supply of materials, shop detailing and fabrication, marking, packing, handling, surface treatment, transport to site, erection and installation of metalwork.

Metalwork shall include, but not be limited to, structural members, metal plates, anchor bolts, pipe supports, embedded items and any such other metalwork (whether permanent or temporary), as detailed on the drawings or as determined necessary for the construction of the works.

The design and construction of fixed platforms, walkways, stairways and ladders are not covered by this specification and shall fully comply with the requirements of AS 1657 as amended by the Icon Water document titled *STD-SPE-G-009 Supplement to AS 1657 fixed platforms, walkways, stairways and ladders – design, construction and installation*.

10.2 Relevant Standards and Codes

The documents listed in Table 10.2.1 are either referenced by this specification, or shall be read in-conjunction with this specification.

Table 10.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 1100	Technical Drawing
2	AS 1101.3	Graphic Symbols for General Engineering – welding and non-Destructive Examination
3	AS 1110	ISO Metric Hexagon Bolts and Screws – Product Grades A & B (all parts)
4	AS 1111	ISO Metric Hexagon Bolts and Screws – Product Grades C (all parts)
5	AS 1112	ISO Metric Hexagon Nuts (all parts)
6	AS 1163	Cold Formed Structural Steel Hollow Sections
7	AS 1170	SAA Loading Code
8	AS 1214	Hot-dipped Galvanised Coatings on Threaded Fasteners (ISO Metric coarse Thread Series)
9	AS 1237	Plain Washers for Metric bolt, Screws and Nuts for General Purposes
10	AS/NZS 1252	High Strength Steel Bolts with Associated Nuts and Washers for Structural Engineering
11	AS 1275	Metric screw Thread for Fasteners
12	AS 1397	Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium

Item	Document number	Title
13	AS 1554	Structural Steel Welding – all parts
14	AS 1627	Metal finishing – Preparation and pre-treatment of surfaces
15	AS 1657	Fixed Platform, Walkways, Stairways and ladders – Design Construction and Installation
16	AS 1664	Aluminium structures (all parts)
17	AS 1665	Welding of Aluminium Structures
18	AS 1674	Safety in Welding and allied Processes (all parts)
19	AS 1721	General Purpose Metric Screw Threads
20	AS/NZS 1734	Aluminium and Aluminium Alloys – Flat Sheet, Coiled Sheet and Plate
21	AS 1830	Grey Cast Iron
22	AS 1858	Electrodes and Fluxes for Submerged Arc Welding
23	AS 1866	Aluminium and Aluminium Alloys – Extruded Rod Bar Solid and Hollow Shapes
24	AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
25	AS/NZS 2465	Unified Hexagonal Bolts, Screws and Nuts (UNC and UNF threads)
26	AS/NZS 2728	Prefinished/prepainted Sheet Metal Products for Interior/exterior building applications – Performance Requirements
27	AS 2812	Welding, Brazing and Cutting of Metals – Glossary of Terms
28	AS 2837	Wrought Alloy Steels – Stainless Steel Bars and Semi-finished Products
29	AS 3635	Unified ISO (Inch) Screw Threads, Associated Gauges and Gauging Practices
30	AS/NZS 3678	Structural Steel – Hot Rolled Plates, Floor plates and Slabs
31	AS 3679.1	Structural Steel – Hollow Bars and Sections
32	AS 3679.2	Structural Steel – Welded I Sections
33	AS 4020	Testing of products for use in contact with drinking water
34	AS 4100	Steel Structures
35	AS/NZS 4680	Hot-dipped Galvanised (zinc) Coatings on Fabricated Ferrous Articles

Item	Document number	Title
36	AS/NZS 4854	Welding Consumables – Covered Electrodes for Manual Metal Arc Welding of Stainless Steel and Heat Resisting Steels – Classification
37	AS/NZS 4855	Welding Consumables – Covered Electrodes for Manual Metal Arc Welding of Non-alloy and Fine Grain Steels – Classification
38	AS/NZS 4856	Welding Consumables – Covered Electrodes for Manual Metal Arc Welding of Creep resisting Steels – Classification
39	AS/NZS 4857	Welding Consumables – Covered Electrodes for Manual Metal Arc Welding of High Strength Steels – Classification
40	AS/NZS ISO 9001	Quality management systems-Requirements
41	AS/NZS ISO18273	Welding Consumables – Wire Electrodes, Wires and Rods for Welding Aluminium and Aluminium Alloys – Classification
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
42	Not provided	SafeWork Australia Code of Practice – Safe Design of Structures
43	Not provided	Safe Design of Structures
WSAA codes and publications		
44	WSA 201	Manual for the selection and application of protective coatings
Icon standards and work instructions		
45	SD Series Drawings	Standard Drawing Set
46	STD-SPE-G-006	Approved Products List
47	STD-SPE-G-009	Supplement to AS 1657 fixed platforms, walkways, stairways and ladders – design, construction and installation

10.3 Design and Specification

10.3.1 General

The details provided in Section 10.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 10.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

10.3.2 Referenced Documents

The documents listed in Table 10.2.1 are either referenced by this specification, or shall be complied with and read in-conjunction with this specification. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

10.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 10.3.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water standards (e.g. *STD-SPE-G-018).*

The requirements specified in Table 5.2.2.1 and Table 10.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 10.3.3.1 Minimum Mandatory Requirements for Metalwork Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, items 1.1 to 1.8 inclusive.
2	Structural Design Criteria	A structural design criteria and notes drawing shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawing shall contain the following information as a minimum, as appropriate to the structure: <u>General:</u> • General construction notes • Loading of structural components (e.g. wind load and live loads) <u>Foundations:</u> • Geotechnical conditions • Subsurface drainage requirements • Design bearing capacity of the soil <u>Structural Steel:</u> • Materials and workmanship • Grade of steel • Bolt details • Welding details • Corrosion protection
3	Elevations	Elevation drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall show the structure in different elevation profiles with appropriate dimensions. For a multi-level structure, the RLs shall be provided for each component elevation.

Item	Drawing or Document Type	Minimum Mandatory Requirements
4	Steel Framing Drawing	A steel framing drawing shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawing shall: • Show the structure in plan view • Number bays with horizontal and vertical section lines • Show every floor level (e.g. ground floor, first floor, etc.) A table shall be included in the drawing showing member details.
5	Structural Detail and Connection Details	Structural detail drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawing shall detail the structural properties of each member and shall include a table of all members. For significant structures a separate Connection Detail drawing shall be produced showing the different connections. For minor structures, these connection details may be added to the structural detail drawing.

10.3.4 Materials

10.3.4.1 General

All materials supplied shall be manufactured by companies using quality management systems certified to AS/NZS ISO 9001 by a third party accredited by the Joint Accreditation System of Australia and New Zealand. The Contractor shall ensure that all materials comply with the relevant standards. A mill certificate from the material supplier shall constitute documentary evidence of compliance.

10.3.4.2 Steel

Structural steel shall be Grade 250 to AS/NZS 3678 for hot rolled plates and 300 PLUS to AS 3679 for hot rolled sections, and Grade C350 to AS 1163 for cold formed hollow sections.

All metalwork elements and structures shall be fabricated in accordance with AS 4100. Round all cut edges to a 2 mm radius.

For sewage treatment plants: Galvanised steel may only be used on items (e.g. light stands) that can be easily replaced without any interruption to the treatment process or other critical functions. Galvanised steel may also be used for all building/enclosure structural members.

Stainless steel shall be Grade 316 to AS 2837. Passivate all stainless steel after fabrication and prior to installation.

Prefinished and prepainted sheet metal products shall be of the suitable grade, coating class and surface finish to AS 1397 and AS 2728.

10.3.4.3 Aluminium

Aluminium elements and structures shall be of the alloy suitable in all respects for the purpose being used and in accordance with AS 1734 and AS 1866.

Unless notes otherwise, aluminium plate, bar, rod, grating and sections shall be in accordance with the relevant Australian Standards and shall be of the following grades:

- Flat plates (mill finish) - aluminium alloy 5083-H116
- Flat bar (mill finish) - aluminium alloy 6060-T5 and 6063-T6
- Treadplate (5 bar pattern) - aluminium alloy 5251-O
- Extruded section (mill finish) - aluminium alloy 6060-TS, 6063-T6 or 6082-T5
- Grating - aluminium alloy 6063-T6

All aluminium shall be fabricated in accordance with AS 1664 and AS 1665.

All aluminium members shall be bolted with Grade 316 stainless steel bolts and isolation between dissimilar metals shall be provided.

10.3.4.4 Selection of materials

Unless specified otherwise on the drawings, the selection of materials shall be as shown in the Table 10.3.4.4.1 below.

Table 10.3.4.4.1 Selection of Materials

Location		Approved Materials							
		Framing Members and Plates				Roof and Wall Sheeting		Holding Down Bolts	
		Stainless Steel	Hot Rolled Sections	Cold Formed Sections	Aluminium	Aluminium	Prefinished/ prepainted sheet metal	Stainless Steel	Galvanised Steel
Building and Structures	More than 1km from the coast	✓ Grade 316	✓ With appropriate protective coating	✓ With appropriate protective coating	✓	✓	✓	✓ Grade 316	✓
Tanks and Process Compartments	All members in clean water tanks	✓ Grade 316	✓ With appropriate protective coating	×	✓	✓	×	✓ Grade 316	×
	Members permanently and periodically submerged in liquid other than clean water	✓ Grade 316	✓ With appropriate protective coating	×	×	✓	×	✓ Grade 316	×
	Members not submerged in liquid	✓ Grade 316	✓ With appropriate protective coating	×	✓	✓	×	✓ Grade 316	×
	Members in corrosive environments	✓ Grade 316	×	×	×	×	×	✓ Grade 316	×

Note: Corrosive environments include sewage pumping station wet wells and inlet structures of treatment plants or similar areas where there is a concentration of gases from a sewage environment.

10.3.5 Approval of Sub-Contractors

All sub-Contractors engaged to fabricate and erect structural steel and aluminium shall be specialist sub-Contractors with experience in the type of work to be fabricated and erected.

10.3.6 Shop Drawings

The Contractor shall prepare shop drawings for the fabrication of all members. The Contractor shall arrange for these drawings to be verified by suitably qualified personnel other than those directly involved in the drafting of the shop drawings.

The details shown on the shop drawings shall be consistent with the following:

- The marking plan shall show the locations of all members on the contract drawings.
- Shop drawings shall conform to AS 1100. Drawings showing only the cutting dimensions of webs, flanges and the like shall not be considered as shop drawings.
- Welding and cutting definitions shall conform to AS 2812.
- Welding symbols shall conform to AS 1101.3.
- Complete information regarding the location, type, size and extent of all welds shall be clearly shown on the shop drawings. These drawings shall clearly distinguish between shop and field welds.
- Joints or groups of joints in which it is especially important that the welding sequence and technique of welding be carefully controlled to minimize shrinkage stresses and distortion shall be noted in the drawings. Joints where no welding is permitted shall be clearly indicated. Weld lengths specified in the drawings shall be the required effective lengths.
- Each member shall be clearly identified with the identification marks shown in the drawings. Each type of component shall be further identified to readily distinguish it from other types.
- For assemblies, all associated bolting, accessories and/or joining details shall be shown on the shop drawings.
- Details shall be shown of all holes and attachments required for temporary work such as formwork and lifting lugs. Methods of sealing all such holes shall be shown.

The Contractor shall be responsible for the correctness of the shop drawings. Submission of the shop drawings shall not relieve the Contractor of their responsibilities under the Contract.

The Contractor shall prepare two copies of “Works as Executed” shop drawings within 14 days of the completion of erection of the steel members.

10.4 Construction and Testing

10.4.1 Construction Procedure

The Contractor shall be responsible for his construction procedure and shall ensure that every part of the structure has sufficient design capacity and is stable under construction loads produced by his construction procedure or as a result of construction loads that are applied.

The Contractor shall provide calculations for examination if required to justify the adequacy of the structure to sustain any loads and/or any fabrication or construction procedures that he may intend to impose. The Contractor shall supply all temporary bracing or propping that may be necessary.

10.4.2 Workmanship

Finished metalwork shall be true and free from twists, kinks, buckles, open joints and other defects. Accuracy shall be observed throughout to ensure all parts fit together properly on erection. Chipping, sheaving and drilling shall be done accurately and cleanly.

Before being marked off, straightening of any members shall be done as required by methods that will not damage the material or the member. Straightening by hammering is not permitted. In addition, the following requirements apply where flame or heating methods are to be used:

- The temperature of the steel shall not exceed 600 °C and the temperature reached shall be recorded;
- Steel shall not be artificially cooled until the temperature of the steel has dropped below 300 °C;
- Steel shall not be cooled with solid water jets;
- Aluminium shall not be straightened by heating processes, unless carried out as detailed in Section 6.3 of AS/NZS 1664.2;
- All steelwork that will be exposed to view shall have splatter, flux, dags and burrs removed and all weld profile ground smooth prior to surface preparation.

The completed work shall be free of distortions and true to dimensions. Due allowance shall be made for dimensional changes due to welding.

All edges of plates and members shall be neatly machined, sawn or flame cut. Grind smooth all sharp, sheared and flame cut edges to a minimum curvature of 3 mm.

Stainless steel shall not be heated for purposes of bending, shaping or straightening.

10.4.3 Fabrication

10.4.3.1 General

The Contractor shall prepare details of the procedures for fabrication. These procedures shall be comprehensive and shall cover all aspects of the work. The procedures shall include, but not be limited to, the following:

- Fabrication procedures, dimensional control and details of manufacturing jigs;
- Welding procedures;
- Qualification of welds including stud welding;
- Qualification and identification of welders;
- Qualification of welding supervisors;
- System of identification of welders with work;
- Quality control measures;
- Quality control check lists and forms;
- System for identification of components;
- Procedures for trial assembly;
- Procedures for transport, handling and storage, including measures to prevent distortion and damage to metalwork and protective coatings.

The Contractor shall prepare a program showing the proposed sequence of operations before fabrication commences.

10.4.3.2 Certificate of fabrication

The Contractor shall obtain certification that each item fabricated conforms to the requirements of the drawings and specification.

10.4.3.3 Fabrication tolerances

The general tolerance of all dimensions shall be in accordance with Section 14 of AS 4100 for steelwork and any other relevant standard for metalwork. Holes shall be positioned and aligned such that fasteners can be freely inserted through the member's perpendicular to the contact face.

Bolt holes that cannot be aligned other than by damaging the structure or any component thereof, including corrosion protection, shall be rectified.

A structural member shall not deviate from straightness or its intended length by more than that recommended in the relevant section of AS 4100.

Lengths of components shall be such that cumulative variations do not misalign the completed structure. The Contractor shall ensure that all pieces will correctly fit together on assembly. Curving, bending or shaping shall be even and true to the drawings.

Where tolerances are not specified, the absolute tolerance shall be 2.0 mm.

Member dimensions and camber shall be measured for conformance when all fabrication, welding and heating operations are completed and the member has cooled to a uniform temperature.

10.4.3.4 Cutting of steel

Steelwork may be cut by flame cutting, sawing or shearing unless specified otherwise below. Surfaces produced by such cutting shall be representative of good workmanship, finished square (unless a bevelled edge is called for), true to the required dimensions and free from defects, such as excessive roughness, which would impair the service performance or seriously interfere with subsequent fabrication and protective treatment.

Shearing shall not be used for main plates in fabricated girders and in all splice plates except in a direction perpendicular to the direction of their main stresses. Shearing of items over 16 mm thick shall not be carried out when the item is to be galvanised and subject to tensile stresses unless the item is subsequently stress relieved. Distortions caused by shearing shall be removed.

Re-entrant corners shall be smoothly rounded to a radius of 20 mm.

Unless shown otherwise on the drawings, all corners on exposed edges shall be rounded to a radius of approximately 1.5 mm, except where such edges are subsequently to be welded. Rolled edges need to be rounded provided the corners have a similar radius.

Flame cutting shall be carried out wherever possible by machines which are mechanically guided and moved at uniform speed. Hand cutting shall only be used for secondary cuts, hole preparation, repairs and other work where machine cutting is not possible.

Any cut surface to be incorporated in a weld shall comply with AS 1554.1 and the depth of isolated gouges shall not be greater than 2 mm.

Flame cutting of plates, sections, and other components with surfaces which will be used in the "as-cut" condition, shall be carried out with procedures giving minimum reduction in properties at the cut surface and shall satisfy the requirements given below.

Any cut surfaces to be used in the "as-cut" condition shall have a surface quality which will not impair subsequent fabrication and protective coating requirements.

Flame cut surfaces may require a light surface grind to render them suitable for subsequent protective coating requirements.

10.4.3.5 Cutting of aluminium

Aluminium may be cut by plasma arc cutting, sawing, or grinding unless specified otherwise below. Surfaces produced by such cutting shall be representative of good workmanship, finished square (unless a bevelled edge is called for), true to the required dimensions and free from defects, such as excessive roughness, which would impair the service performance or seriously interfere with subsequent fabrication and protective treatment.

Flame cutting or shearing shall not be used.

Grinding shall not be used on surfaces prepared for welding.

Re-entrant corners shall be smoothly rounded to a radius of not less than 3 mm.

Unless shown otherwise on the drawings, all corners on exposed edges shall be rounded to remove sharp edges, except where such edges are to be subsequently welded. Rolled and extruded edges need not be rounded provided the corners are not sharp.

Plasma-arc cutting shall be carried out wherever possible by machines which are mechanically guided and moved at uniform speed. Hand cutting shall only be used for secondary cuts, hole preparation, repairs and other work where machine cutting is not possible.

Any cut surfaces to be incorporated into a weld shall comply with AS 1665.

Plasma-arc cutting of plates, sections, and other components with surfaces which will be used in the “as-cut” condition, shall be carried out with procedures giving minimum reduction in properties at the cut surface.

10.4.3.6 Splices

Shop splices in the component parts of welded members shall be made before the parts are assembled.

Where splice locations are not shown on the drawings or where splices at locations other than shown on the drawings are proposed, details of the design and position of the proposed splices shall be submitted at least 14 working days prior to fabrication.

10.4.3.7 Holes for bolting

The diameters of bolt holes shall be in accordance with the requirements of AS 4100 unless otherwise specified.

Reamed or drilled holes shall be cylindrical and perpendicular to the face of the member unless otherwise shown on the drawings. Reaming and drilling shall be done by mechanical means.

Connecting parts shall be assembled and held securely while being reamed or drilled and shall be match-marked before separating the parts. All burrs shall be removed. Assembled parts shall be taken apart if necessary.

10.4.3.8 Alignment of holes

All matching holes in any contiguous group shall register with each other so that a gauge or drift 2 mm less in diameter than the holes shall pass freely through the assembled contact faces at right angles to them.

The Contractor shall be responsible for the accuracy of all holes regardless of variation in dimensions of rolled sections or tolerances allowed in fabrication.

10.4.3.9 Holes for field connections

Holes for field connections and field splices of main members shall be reamed or drilled with the members assembled in the shop in their correct relative positions.

All adjoining main members in an assembly shall be assembled before reaming or drilling is commenced. All joints and associated splice plates shall be match-marked before the structure is dismantled.

Holes for field connections of minor members may be reamed or drilled with the members assembled.

10.4.3.10 Cambering

Camber in a built up section shall be obtained by cutting webs to the shapes shown in the drawings.

Cambering of rolled sections and adjustment to the camber in built-up sections shall be carried out to the workmanship requirements of this specification.

10.4.3.11 Bending

Bending and forming plates and sections during fabrication shall conform to the manufacturer's recommendations and/or relevant Australian Standards.

10.4.4 Bolted Connections

All metric bolts and nuts shall comply with AS 1110, AS 1111, AS 1112 and AS 1252. The threads shall comply with AS 1275 and AS 1721.

All unified bolts and nuts shall comply with AS 2465. The thread shall comply with AS 3635.

A flat metal washer shall be fitted under each nut. Washers shall comply with AS 1237.

Bolt lengths shall be such that after joints are made up, the bolts shall protrude through the nuts by a minimum of two bolt threads, but not more than 15 mm. As a minimum, all bolts for structural steelwork and mechanical equipment shall be Grade 8.8 to AS 1252 or Grade 8 to AS 2465. Commercial bolts and nuts to AS 1111 are not permitted in steelwork, except for connections of purlins and girts.

Unless noted otherwise, bolts, nuts and washers shall be galvanised to AS 1214. Where steelwork is painted, bolts, nuts and washers shall also be painted on erection.

Grade 316 stainless steel bolts, nuts, screws and washers shall be used where:

- In contact with liquid;
- Buried in the ground;
- Cast into concrete;
- Subject to a corrosive environment;
- In dismantling joints, gland joints and couplings;
- In all proprietary equipment (such as valves, pumps etc.).

The following measures shall be adopted to prevent galling of stainless steel fasteners:

- Bolts and nut threads shall be rolled or buffed smooth before installation;
- Nuts shall be hand tightened at low speed to reduce heat generated by friction;
- Nuts shall be tightened with a torque wrench to prevent over tightening;
- Threads shall be thoroughly coated with a non-corrosive anti seize compound prior to assembly. If in contact with drinking water, the compound shall comply with the requirements of AS 4020.

All bolts in contact with dissimilar metals shall incorporate nylon bushes and washers.

Bolts for connections that are subject to vibration shall incorporate locknuts of the same material and proof load.

10.4.5 Fasteners

Fasteners in structural steelwork and aluminium include screws, studs, rivets, and proprietary anchors, bolts, clips and clamps. The use of proprietary anchors, bolts, clips and clamps shall be approved by the Icon Water Representative.

Screws shall not be used in members and components of thickness of 3 mm or more. Screws shall be Grade 316 to AS 2837 in stainless or aluminium work. Self-tapping and self-drilling screws may be supplied in Grade 316 stainless steel to AS 2837 subject to approval.

Rivets shall not be used in members and components of thickness of 3 mm or more. Rivets shall not be used to connect dissimilar metals together. Rivets joining metal parts shall be of the same type and grade of metal.

10.4.6 Welding

10.4.6.1 General

All welding of structural steel shall be Category SP to AS 1554 unless shown otherwise on the drawings. Welding of aluminium shall comply with the requirements of AS 1665.

All welding shall be continuous and no intermittent welding shall be permitted.

The completed items shall be free from distortions and true to dimensions. All connections shall be welded in a manner such that the finished connections are neat, smooth in appearance, all sharp edges ground and all projections ground smooth suitable for provision of corrosion protection and aesthetic finishes.

Details of welding procedures shall be submitted to the Icon Water Representative prior to fabrication of members utilising the particular procedure.

10.4.6.2 Welding personnel

All welding of steel items shall be carried out by skilled welders possessing the required qualifications as per AS 1554 and qualified in the particular welding procedure, welding position and steel being used. The Contractor shall use supervisors and welders employed by the Contractor who have suitable training and practical experience in the execution of the required grade of work. Welding supervisors shall have the necessary qualifications required by AS 1554.

Welding of aluminium shall be carried out by welders possessing the qualifications as per AS 1665. Welding shall be carried out under the supervision of an appropriately qualified welder in accordance with AS 1665.

The Contractor shall supply details of the qualifications of all welders, together with details of any qualification tests carried out by those welders.

All welders shall have an identification number, and that number shall be marked adjacent to weld runs by the welder. Identification numbers shall not be stamped into metal.

Completed work shall be free from distortions and true to dimensions. Make due allowance for dimensional changes during welding.

Welding shall be inspected by a qualified welding inspector with suitable training and experience in the fabrication and inspection of welded structures satisfying the requirements of:

- Section 7.2 of AS/NZS 1554.1 for structural steel
- Section 7.2 of AS/NZS 1554.6 for stainless steel
- Section 7.2 of AS 1665 for aluminium

The welding inspector is responsible for ensuring that all welding conforms to the requirements of this specification.

All non-destructive testing shall be carried out by suitably qualified and accredited technicians for carrying out the examination method employed satisfying the requirements of:

- Section 7.4 of AS/NZS 1554.1 for structural steel
- Section 7.4.2 of AS/NZS 1554.6 for stainless steel
- Section 7.4.2 of AS 1665 for aluminium

Technicians shall be accredited by the Australian Institute of Non-destructive Testing (AINDT).

The currency of the above qualifications and accreditations shall comply with the requirements of the issuing institution. Lapsed qualifications and accreditations will not be accepted.

All non-destructive test reports shall be prepared by qualified and accredited NDT technicians, and shall contain the NDT technician's signature and registration number of the NDT technician's qualification and accreditation. In such instances, NATA endorsed examination reports will not be required.

10.4.6.3 Welding equipment and safety

All welding machines and equipment shall comply with AS 1674 and the safety requirements of the relevant Statutory Authority. The machines and equipment shall be designed, installed, operated and maintained to such a standard that welds can readily be made by the machine operators.

10.4.6.4 Welding consumables

The Contractor shall supply a Maker's Certificate of Compliance for each batch of consumables used.

Steel electrodes used in all manual arc welding shall conform to and be selected in accordance with AS/NZS 4854, AS/NZS 4855, AS/NZS 4856 and AS/NZS 4857. Electrodes and fluxes for submerged arc welding shall conform to and be selected in accordance with AS 1858.

Welding consumables shall be stored in such a manner which meets the manufacturer's recommendations. Low hydrogen electrodes drawn for use by a welder shall be kept in a suitable heated container until used. Unused low hydrogen electrodes shall be returned to storage and re-baked before further use. The minimum nominal tensile strength of weld metals used shall be 480MPa (e.g. E48xx, W50x, etc. or stronger) for all structural steel unless indicated otherwise in the drawings.

Aluminium welding consumables shall conform to AS/NZS ISO 18273. Welding consumables shall be selected in accordance with Section 2 of AS 1665 and shall only be used in accordance with the manufacturer's recommendations and AS 1665. The Contractor shall obtain certification by a recognised authority satisfying the requirements of AS 1665, that the classification and grade of the welding consumables are suitable for welding the aluminium type nominated in the welding procedures.

10.4.6.5 Alignment

Members to be welded shall be brought into correct alignment and held in position in such a manner to obtain dimensional requirements and uniform gap. Suitable allowances shall be made for warping and shrinkage.

10.4.6.6 Surfaces to be welded

Surfaces to be welded shall be free from loose scale, slag, heavy rust, grease or other material likely to be detrimental to welding or weld properties. The use of weld through primers shall be permitted providing that the welding procedure is qualified using similarly primed plate. Surfaces to be welded shall be smooth, uniform and free from fins, tears, or other defects which adversely affect welding.

10.4.6.7 Tack welds

Tack welds may be used to hold edges in correct alignment for welding. Tack welds shall be the same size as the root run to be used in the joint and not less than four times the thickness of the thicker part or 100 mm, whichever is the smaller in length. Tack welds which are to be incorporated into the final weld or to remain on the completed structure shall be subject to the same quality and workmanship requirements as the final welds.

10.4.6.8 Weld quality

Welds shall show a good even contour, a good penetration and fusion with the parent metal. The surface of the weld along and across the joint shall be reasonably smooth and free from sharp irregularities, grooves and depressions and shall merge smoothly into the plate surface. Unacceptable welds shall be cut out and replaced or otherwise remedied in a manner approved by the Icon Water Representative.

10.4.6.9 Defective welds

Where welds do not meet the surface finish requirements of this specification, they shall be ground smooth free from sharp crests, sharp troughs and pits. Care shall be taken not to reduce the weld below the design size and not to overheat the joint or to introduce grinding cracks. Sharp edges including shear edges shall be ground to a radius of curvature of not less than 2 mm. Weld splatter not capable of being readily removed by subsequent cleaning and blasting shall be removed by mechanical means.

10.4.6.10 Weld procedure

The Contractor shall develop the weld procedures to meet the requirements of Section 4 of AS 1554.1 for structural steel. Such procedures shall be fully documented on an approved form as indicated in Appendix C of AS 1554.1 and accompanied by NATA endorsed Test Certificates for any tests required.

Welding procedures for aluminium structures shall meet the requirements of Section 4 of AS 1665 and documented on an approved form as indicated in Appendix D of AS 1665 and accompanied by NATA endorsed Test Certificates for any tests required.

Welding procedures for stainless steel structures shall meet the requirements of Section 4 of AS 1554.6. Such procedures shall be fully documented on an approved form as indicated in Appendix C of AS 1554.6 and accompanied by NATA endorsed Test Certificates for any tests required.

10.4.6.11 Submission of qualifications for approval

Prior to the commencement of welding, the Contractor shall collate weld qualification test records, weld procedure specification and a weld map, indicating the procedures to be adopted on each welded joint for approval.

10.4.6.12 Weld inspections and testing

The Contractor shall inspect all welds in accordance with AS 1554.1 for structural steel, AS 1554.6 for stainless steel and AS 1665 for aluminium.

The Contractor may access the fabrication workshops, if required, to check records and work progress for the purposes of quality surveillance.

Non-destructive testing (NDT) of welds shall be carried out at the Contractor's expense by an independent inspection authority.

Weld inspection/testing requirements shall be as specified and as shown on the fabrication drawings.

For items fabricated in the shop the testing of SP weld shall be at least 100% visual and 10% NDT. In the case of butt weld, the NDT shall be radiographic.

For field welding, except for reservoirs and tanks, the welds shall be 100% visual and 50% NDT. In the case of butt weld, the NDT shall be radiographic.

For welded floor joints of elevated reservoirs, the minimum testing frequency shall be 100% visual and 50% radiographic NDT.

10.4.6.13 Weld acceptance requirements

Acceptance requirements shall be as detailed in AS 1554 and AS 1665 as appropriate. The weld surface shall be free from excessive weld ripple and smoothly blended with the plate surface. No weld splatter of welding fume shall be permitted on the weld or adjacent plate surfaces.

The Contractor shall obtain a drawing detailing proposed non-destructive test locations for review and approval.

The locations and records of NDT shall be submitted for keeping on completion of the tests.

10.4.6.14 Defective welds

Repairs shall be made using qualified procedures and personnel.

The Contractor shall be responsible for meeting the cost of making repairs and their re-testing. All welds failing the testing shall be rectified prior to hydrostatic testing.

10.4.6.15 Passivation of stainless steel after fabrication

All stainless steel items and fabrications shall be passivated after all welding has been completed to restore corrosion resistance. Passivation of weld areas shall be carried out in the fabrication workshop wherever possible. Where passivation has to be carried out on-site, it shall be undertaken in accordance with the manufacturer's instructions. No waste shall be flushed into existing drainage systems unless satisfactorily neutralised.

Small items such as nuts, bolts, washers, screws shall be passivated by leaving them immersed overnight in a plastic bucket containing 15% - 20% by volume of nitric acid in water. The items shall be thoroughly rinsed in fresh water before use.

Larger items shall be passivated by coating with a proprietary acid paste. The articles shall be coated and left overnight then rinsed thoroughly in fresh water. As this product is highly corrosive and gives off fumes, it must be used in a well-ventilated area and personnel shall use rubber gloves. The manufacturer's safety precautions on the label must be carefully complied with.

After passivation, fabricated components shall have a clean, matt finish free from scale and discolouration caused by welding or heating.

The Contractor shall nominate the proposed stainless steel fabricator to be used for the work and provide details of experience and referees to show the stainless steel fabricator is reputable. The fabricator shall be a member of the ASSDA.

10.4.6.16 Handling and storing structural steel

Care shall be taken in the packing and methods of support and lifting during handling of all structural steelwork to prevent distortion or damage to steelwork and its protective coating.

All open joints, ends and projecting parts shall be protected from damage in transit in such a manner as to stiffen the member and prevent distortion.

All components shall be stored at least 200 mm above the ground on platforms, slabs or other supports, and in a manner to minimise the risk of contamination or corrosion. Each stack shall be located so that it is kept free from accumulation of dust, mud or moisture.

10.4.6.17 Handling and storing stainless steel

All stainless steel components shall be packed in such a manner that they are protected from damage during transport. They shall be handled and transported such as to prevent distortion or fracture, and if necessary, braced to prevent flexing. Self-adhering protective plastic film shall be used for finishes brighter than dull finish.

Bare steel wire rope slings shall not be used in handling stainless steel components. Any minor scores or gouges in the stainless steel surface shall be carefully filed down with mild abrasives and finished smooth. Where such rectification cannot be successfully carried out, the item shall be treated as non-conforming.

Care shall be taken when handling stainless steel before, during and after fabrication to prevent contamination with mild steel materials, dust, shavings and the like. Such care is particularly important after passivation and during transport to site, storage and installation as these small particles rust quickly and will discolour the surface of the stainless steel. This can destroy the protective oxide film and render it liable to pitting corrosion.

The Contractor shall not:

- Clean stainless steel with steel wool, wire brushes, emery paper;
- Clean stainless steel with abrasive compounds containing chlorides;
- Blast clean stainless steel;
- Use muriatic (i.e. hydrochloric) acid as used in solder fluxes, as it contains iron.

10.4.6.18 Handling and storing aluminium

All aluminium components shall be packed in such a manner that they are protected from damage during transport. They shall be handled and transported such as to prevent distortion or fracture, and if necessary, braced to prevent flexing.

Bare steel wire rope slings shall not be used in handling aluminium components. Any minor scores or gouges in the aluminium surface shall be carefully filed down with mild abrasives and finished smooth. Where such rectification cannot be successfully carried out, the item shall be treated as non-conforming.

The Contractor shall inspect each load of aluminium components for damage prior to stacking. All components shall be stored at least 200 mm above the ground on platforms, slabs or other supports, and in a manner to minimise the risk of contamination or corrosion. Each stack shall be located so that it is kept free from accumulation of dust, mud or moisture.

10.4.6.19 Contractor report on completion of fabrication

Following completion of fabrication, the Contractor shall produce four copies of a report which shall include the following documentation, together with any other relevant data:

- Completed inspection and test report;
- Material certificates for plate sections and welding consumables used in construction;
- Weld Procedure Specifications, together with Weld Procedure Test Reports and associated test certificates;
- Copies of all inspection certificates, together with a weld map showing the location of any repairs carried out;
- Inspection and Test Report and Inspection Certificates for corrosion protection procedures employed.

The Contractor shall submit the above documentation within 14 working days of completion of fabrication.

10.4.7 Corrosion Protection

10.4.7.1 General

The extent of steelwork surface preparation for the protective coating specified shall be determined in accordance with WSA 201 as amended by Icon Water in *STD-SPE-G-005* and shall follow the requirements of the relevant standard or standards listed therein. Unless specified otherwise in WSA 201 as amended by Icon Water in *STD-SPE-G-005*, the corrosion protection of structural steel shall be to the following specifications.

10.4.7.2 Galvanising

All fabricated steel members and components (excluding stainless steel) shall be hot-dip galvanised after fabrication to conform to the requirements of AS 4680 and AS 1214.

Prior to galvanising, the steelwork fabricator shall:

- Drill ventilation holes in all enclosed components of any structure. Holes are to be located near the ends of hollow structures.
- Clean the surfaces of all dirt, weld spatter, grease, slag, oil, paint or other deleterious matter.
- Chemically descale the steel surfaces to AS 1627.5 or abrasive blast clean to AS 1627.4 to a Class 3 standard.
- Pre-treat the structural members in accordance with AS 4680.
- Specifically, in the case of guardrails, guardrails shall be tack welded on site, removed and then fully welded. Galvanising shall only be applied after fabrication has been completed.

The zinc coating shall consist of a uniform layer of commercially pure zinc free of abrasions, cracks, chemical spots or other imperfections. The zinc coating shall adhere firmly to the surfaces of the steel.

All galvanising shall conform to the requirements of AS 4680 for quality and thickness of the coating. The average thickness of the zinc coating shall be to AS 4680 or the following, whichever is more stringent:

- Not less than 84 µm for steel 5 mm thick and over (the equivalent coating mass is 600 g/m^2);
- Not less than 63 µm for steel less than 5 mm thick (the equivalent coating mass is 450 g/m^2);
- Not less than 52 µm for fasteners (the equivalent coating mass is 375 g/m^2).

For the purpose of this paragraph "average zinc coating thickness" shall be the average of not less than 10 determinations over a test area of 1 m^2.

If the quality or the thickness is found not to meet the requirements of this specification, make good the quality and thickness. Rectify and repair defective/damaged coatings where the average zinc coating thickness is less than the minimum as specified.

Where the zinc coating has been damaged, the Contractor shall repair such damage only by application of a zinc rich epoxy.

10.4.7.3 Paint coatings

All paint coatings shall conform to the following:

- Paint systems shall be selected in accordance with WSA 201 as amended by Icon Water in *STD-SPE-G-005* and shall follow the requirements of the relevant standard or standards listed therein.
- Prepare steelwork in conditions approved for the application of coatings. All off-site preparation and coating application shall be carried out under cover, in a controlled environment and with adequate lighting.

- Before painting, all surfaces shall be cleaned in accordance with AS/NZS 2312, to the grade as specified in the Project Specification.
- Oil, grease and fine surface dust shall be removed immediately before the application of the paint.
- No paint shall be applied to any surface which is not clean (as above), or perfectly dry, or under weather conditions which, in the opinion of the Designer, are likely to be harmful to paint.
- Sufficient time shall be allowed between coats for the paint to harden.
- Application shall comply fully with the manufacturer's written instructions. Spray application shall be used wherever possible, but may be brush applied to areas which are too small or difficult to spray or when repairing damaged areas.
- Corrosion protection shall be done only by a company approved by the paint manufacturer for such work.

10.4.7.4 Unpainted surfaces

The following shall not be painted:

- Interior enclosed steelwork, unless specified
- Faying surfaces of bolted joints of category 8.8/TB or 8.8/TF
- Surfaces within 75 mm of locations to be welded subsequent to painting
- Surfaces which are to be fully encased in concrete, except where the steel is only partly encased in concrete, in which case the priming shall be extended at least 100 mm into the concrete encasement area
- Surfaces onto which shear studs are to be welded.

10.4.7.5 Site repair

All damaged areas shall be repaired to match the workshop applied coating thickness, quality, surface finish and colour. Areas of weld damage shall be given the extent of steelwork surface preparation specified in AS/NZS 2312. The original paint system shall be reapplied as specified.

10.4.7.6 Inspection and testing

Inspection and testing shall be as follows:

- After the coating has dried, it shall be inspected for any defects and misses. Dry film thickness measurements shall be made.
- The Contractor shall demonstrate that he has achieved the specified film build-up, failing which, he shall, at no extra cost, apply additional paint until the specified minimum film build-up has been achieved.
- 7 days prior to application of any coating, a specification for the extent and frequency of inspection shall be produced by the applicator and submitted for the review. This shall be in accordance with AS/NZS 2312 Section 11.3 and Section 12, and with AS 3894.3.
- For steelwork in external environments or in aggressive internal environments, painting inspectors shall hold Certified Coatings Inspector certification from the Certification Board for Inspection Personnel (CBIP) or an equivalent qualification acceptable to the CBIP.
- Painting inspection shall comply with AS/NZS 2312.
- Welds shall not be painted until weld inspection has been completed.

10.4.8 Erection of Metalwork

10.4.8.1 Transport, handling, delivery to site and storage

All fabricated items shall be handled, loaded, transported, unloaded and stored without causing excessive stress, deformity or damage to members or components. Carefully place, support and store all materials and structural members off the ground.

All structural members shall be handled carefully during erection so that the members or their components are not damaged or distorted.

10.4.8.2 General erection procedure

All members shall be erected, fixed, adjusted and maintained in their intended vertical lateral alignment and level. Members that do not meet the tolerances specified in Section 15.3 of AS 4100 shall be liable to rejection.

The safety requirements, erection cranes, equipment, scaffolding and staging shall meet the requirements of the relevant local Safety Authority or other controlling Authority. The Contractor shall adopt an erection procedure such that all members can be placed and fixed in position without distortion.

The Contractor shall ensure that all structural members are securely fastened and temporarily braced as necessary to keep structures stable during erection. Temporary bracing shall be sufficient to withstand heavy winds, storms and construction loads.

Permanent bolting or welding shall not be carried out until correct alignment and any specified pre-set or cambers have been obtained in each member of the structure.

Additional members used to facilitate erection shall be affixed in a manner which does not weaken or deface permanent metalwork.

Where metalwork is supported in concrete, masonry or a similar material, it shall be set up on packers or wedges of at least 20 mm above the floor level to facilitate alignment and permit subsequent grouting.

Such packers, if permanent, shall be of either solid steel or grout of similar strength to the permanent grout. All other packers shall be removed before completion of grouting. All grouts shall be non-shrink high strength such as Epirez Superflow HF Grout or approved equivalent.

The Contractor shall submit a proposed method of erection. This shall include but not be limited to the following:

- False work details, including design calculations and certification to the appropriate Australian Standards by a qualified civil/structural engineer;
- Method of stabilising or bracing members during storage, assembly and erection;
- Method of determining and adjusting profile;
- Method of alignment of components;
- Method and order of assembly including temporary fixing;
- Welding proposals including welding procedures, temporary locating devices and order of welding;
- Bolting procedures, including method of aligning holes, method of marking bolts, tightening and records;
- Storage of components.

10.4.8.3 Site cutting and drilling

During erection, components and members shall not be cut, burnt, welded or drilled. Drilling shall not be used on galvanised items. Any component damaged, including damage to the protective coating, shall be repaired to the satisfaction of the Icon Water Representative.

Galvanised steelwork shall not be cut, drilled, welded or otherwise altered on-site. Should alterations to galvanised steelwork be required after fabrication and galvanising, the steelwork shall be re-galvanised by hot-dipping after the final alterations.

Damaged galvanised steelwork, which does not require painting, shall be repaired to the satisfaction of the Icon Water Representative.

Purlins shall be erected strictly in accordance with the purlin manufacturer's recommendations and instructions. Purlins shall be fully fabricated prior to receiving a protective coating. On-site cutting of coated purlins is not permitted.

10.4.8.4 Site welding and inspection

For site welded joints, the ends of the members and/or segments shall be held in position during welding by suitable temporary devices. On completion of the joints, the devices shall be carefully removed and the steel surfaces restored by grinding smooth and flush.

No site welding of structures or any of their components shall be permitted unless the structures/components to be site welded have been nominated in the drawings.

The Contractor shall ensure that no stray current from welding will interfere with the electrical, earthing and control system.

Site welding and inspection shall be in accordance with this specification.

10.4.8.5 Assembly of bolted connections

Bolted connections shall be in accordance with the details shown in the drawings.

When assembled, all joint surfaces, including those adjacent to bolt heads, nuts and washers, shall be free from burrs, dirt or other deleterious matter or defects preventing proper seating of the parts.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the nuts and heads of bolts a satisfactory bearing. Load indicator washers shall not be used if they could damage the protective coating.

Where high strength friction grip-type bolts are used, surfaces required to transmit friction shall be specially coated only and kept free of grease, rust, moisture, dust or any other contamination.

Where stainless steel bolts and nuts are used, threads shall be coated with a suitable compound to prevent seizing of the bolt and nut during tightening. Provision of capping to prevent the loss of this compound is required in aggressive environment.

For joints containing more than eight bolts, the "snug tight" condition shall be checked by a second run over the bolts.

Marking of the bolts prior to final tightening shall allow measurement of the true amount of turn of the nut.

Once fully tightened, bolts shall not be released and re-tightened in either the original position or elsewhere.

10.4.8.6 Connection between aluminium and steel roof components

All potential points of contact between aluminium and other metallic members shall be insulated with the following:

- For the connection of roof sheets to rafters or purlins, use 0.25 mm thick "TESA -51482" PVC tapes or approved PTFE equivalent.
- For the connection of galvanised tread plates to roof sheets, use 0.8 mm thick neoprene strips.
- For connections of all structural members use a minimum 1.5 mm thick neoprene sheet.
- The separation tapes or sheets shall be sufficiently wide to provide a minimum overlap of 5 mm on either side of the purlin, beam etc. on which they are stuck.

All fasteners shall be of stainless steel. Nylon bushes and/or nylon washers shall be provided to prevent contact with steel or aluminium parts.

10.4.9 Bedding and Grouting

Metalwork which is to be supported on concrete, masonry or like material, shall be set up on packing or wedges to facilitate alignment and permit subsequent grouting. Either solid steel or cement mortar blocks of similar strength to the permanent grout shall be used for permanent packing. All other temporary packing shall be removed prior to completion of grouting. All grouting shall conform to the requirements of AS 4100.

10.4.10 Built-In Metalwork

The Contractor shall thoroughly clean all metalwork surfaces to be embedded in concrete or masonry of all dirt, rust, mortar and other foreign matter.

All metalwork to be built into concrete shall be firmly held in the correct position while the concrete is being placed.

Where metalwork is to be grouted into cored holes or block outs, thoroughly clean the surfaces of cored holes or block outs and coat metalwork with a bonding compound compatible with the grout. A self-expanding grout shall be used to grout metalwork in concrete.

10.4.11 Weir Strips

Weir strips shall be installed level with a maximum vertical tolerance of ± 1.5 mm.

Weir strips shall be fabricated from stainless steel, grade 316 or marine grade aluminium.

Weir strips shall be provided with slotted holes for levelling adjustment.

10.4.12 Pits and Covers

The Contractor shall comply with Icon Water's minimum requirements (*SD Series* standard drawings) for pits.

All open pits shall be fitted with grates or covers as detailed in *STD-SPE-G-008 Design Requirements for Safe Access, Egress and Working at Heights*.

11 Roadworks

11.1 Scope

This specification covers the minimum requirements for the design, construction and testing of roadworks and stormwater drainage. For the purposes of this specification, road works pertain to lower order roads e.g. access roads and local roads. This specification does not apply to higher order roads (e.g. collector and arterial roads).

The scope of works includes, but is not necessarily limited to, the following work:

- Access roads and driveways;
- Roads within the site including vehicular access to all structures as required,
- Vehicular access to bunding and chemical loading bays;
- Hard stand areas, footpaths and site drainage.
- Site entry / exit and transitions;

11.2 Referenced documents

All road authorities have agreed to adopt the Austroads Guides as the primary technical reference, together with the relevant Australian and New Zealand Standards.

The Australian Capital Territory has adopted the Austroads Guides, and has issued a revised series of documents to reflect this development in standards and specifications for practice in the ACT.

Icon Water has adopted the specifications developed by TCCS for the design and construction of road works within their facilities and in public areas where Icon Water assets are proposed or already exist.

The documents listed in Table 11.2.1 are either referenced by this specification, or shall be read in-conjunction with this specification.

Table 11.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS1012	Methods of Testing Concrete
2	AS1141	Methods for Sampling and Testing Aggregates
3	AS1160	Bituminous Emulsions for the Construction and Maintenance of Pavements
4	AS1214	Hot-dipped Galvanised Coatings on Threaded Fasteners (ISO Metric coarse Thread Series)
5	AS1289	Methods of Testing Soils for Engineering Purposes
6	AS1478	Chemical Admixtures for Concrete, Mortar and Grout
7	AS1604.1	Specification for Preservative Treatment – Sawn and Round Timber
8	AS1743	Road signs – Specifications
9	AS1726	Geotechnical site investigations

Item	Document number	Title
10	AS2150	Hot Mixed Asphalt
11	AS2150	Hot mix asphalt - A Guide to good practice
12	AS2876	Concrete Kerbs and Channels (Gutters) – Manually or Machine placed
13	AS2891	Methods of Sampling and Testing Asphalt
14	AS4283	Cold mix asphalt for maintenance patching
Transport Canberra and City Services (TCCS)		
15	DS 01	Stormwater
16	DS 02	Road Planning
17	DS 03	Road Design
18	DS 04	Verge Design
19	DS 05	Driveways
20	DS 06	Pavement Design
21	DS 07	Bridges and Related Structures
22	DS 08	Guide Signs
23	DS 09	Traffic Control Devices
24	DS 10	Parking Areas
25	DS 11	Guardrails, Fences and Barriers
26	DS 22	Soft Landscape Design
27	DS 23	Plant Species for Urban Landscape Projects
28	MIS 01	Street planning and design
29	MIS 02	Earthworks and site grading
30	MIS 03	Pavement design
31	MIS 04	Subsurface drainage
32	MIS 06	Verges
33	MIS 07	Driveways
34	MIS 08	Stormwater

Item	Document number	Title
35	MIS 09	Bridges and related structures
36	MIS 10	Fences, guardrails and barriers
37	MIS 12	Guide signs
38	MIS 13	Traffic control devices
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
39	Not provided	Excavation Work Code of Practice
Icon Water Standards		
40	SD Series Drawings	Standard Drawing Set
41	STD-SPE-G-006	Approved Products List

11.3 Design and Specification

11.3.1 General

The details provided in Section 11.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 11.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

11.3.2 Referenced Documents

The documents listed in Table 11.2.1 are either referenced by this specification, or shall be complied with and read in-conjunction with this specification. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

11.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 11.3.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water standards (e.g. *STD-SPE-G-018).*

The requirements specified in Table 5.2.2.1 and Table 11.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 11.3.3.1 Minimum Mandatory Requirements for Roadworks Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, item 1.1 to 1.8
2	Bulk Earthworks and Setting Out	Bulk Earthworks and Setting Out drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Symbols shall comply with the Icon Water SD series of drawings.
3	Longitudinal Section	Longitudinal section drawings shall be produced (or updated as appropriate) for all new roads and drainage systems, as well as for major augmentations to existing roads and drainage systems. The following longitudinal data, as a minimum, shall be provided: <u>Roads</u> • Ground level • Horizontal curves • Vertical curves • Design levels • Chainage <u>Drainage</u> • Ground level • Invert level • Pipe diameter • Velocity • Flow • Pipe grade Symbols shall comply with the Icon Water SD series of drawings.
4	Cross Section	Cross section drawings of the earthworks shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Excavation lines (cut), backfilled layers (fill) and finished layers shall be clearly shown. Where appropriate, information such as battered slopes, dimensioned layers and finished levels, as a minimum, shall be shown. All existing and proposed utilities shall be shown on the drawings. For major project sites, separate utility drawings shall be prepared. Symbols shall comply with the Icon Water SD series of drawings.

Item	Drawing or Document Type	Minimum Mandatory Requirements
5	Drainage and Subsurface Drainage	Drainage and Subsurface Drainage drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. The drawings shall show a plan view of the drainage pipes, cut-off trench, berm or channel. Hydrological information such as catchment area, runoff volume, annual recurrence interval and storm duration shall be shown on the plans. Symbols shall comply with the Icon Water SD series of drawings.
6	Pavement Details	Pavement details shall be produced (or updated as appropriate) for all new Icon Water access roads, road repairs, parking areas and laydown areas, as well as for major augmentations to access roads, parking areas and laydown areas. Symbols shall comply with the Icon Water SD series of drawings.

11.3.4 Road access and appurtenant structures

Roads shall be provided to service all buildings, facilities and structures where vehicular access is required. Roads shall extend to locations where installation and removal of heavy equipment requires mobile cranes and truck transportation.

Roads are required to carry traffic for the operation and maintenance of assets including mobile cranes, tankers, articulated vehicles, transportation trucks carrying sludge and chemicals, coaches, vans and passenger cars.

Roads shall be provided with turning areas, passing bays, kerbs and gutters, stormwater surface drainage, sub-surface drainage, trench drains and edge drains.

Hardstand areas shall be provided for the standing of heavy vehicles, mobile lifting equipment such as cranes, and for areas where regular cleaning and washing of the ground surface is required.

Parking areas shall be provided for parking of cars, vans and service vehicles.

Appurtenances such as fencing, railing and vehicular barriers shall be provided to protect facilities and structures from damage and people from injury by vehicles using the road.

Road lighting, road marking and traffic signage shall be provided where appropriate.

11.3.5 Width of Roads

The Design Vehicles shall be in accordance with Section 2.3.4 of *MIS01 Street Planning and Design*.

The carriageway width shall be in accordance with Section 2.3.5.3 of *MIS01 Street Planning and Design*

11.3.6 Pavement Design

The assessment of design input parameters and design methods for both flexible and rigid pavements shall be in accordance with *MIS03 Pavement Design*.

11.3.7 Rigid Pavement

Rigid pavements of reinforced concrete shall be provided for:

- Vehicle washing bays.
- Hardstand area, parking area, loading bay, boom gate approach slabs, etc. for vehicles transporting chemicals, sludge and corrosive materials.

11.3.8 Flooding

Roads shall be designed at levels free from flooding during storm events having an ARI of not less than 100 years. Minor stormwater infrastructure shall be designed in accordance with Section 3.3.2 of *MIS08 Stormwater*.

11.3.9 Stormwater Drainage

11.3.9.1 General

Stormwater drainage shall be provided to protect the built environment from the adverse effect of stormwater flows resulting from storm events. It may comprise of roof drainage systems, surface drainage systems and subsoil drainage systems.

Stormwater drainage systems shall convey stormwater to a point of discharge or connection using gravity flow where possible.

11.3.9.2 Performance Requirements

The estimation of design flood, hydraulic design procedures and hydrological design values shall be in accordance with the latest edition of the “Australian Rainfall and Runoff” published by the Institution of Engineers Australia (refer Section 3.3 of *MIS08 Stormwater*).

11.3.9.3 Treatment of Stormwater

The quality of stormwater at the point of discharge or connection shall not cause any adverse impact on the downstream system and shall be to the satisfaction the appropriate authorities.

Treatment may include gross pollution traps, detention basins, first flush containment systems and other stormwater treatment devices as required.

11.3.9.4 Water Sensitive Urban Drainage

Stormwater drainage, sanitary sewer systems, water re-use and water supply are components of urban drainage design.

In the design of stormwater drainage systems, consideration shall be given to the philosophy and the principles of water sensitive urban drainage. Sustainable solutions underpinned by key sustainability principles of water harvesting, water recycling, waste minimisation and protection of receiving water ecosystems shall be adopted where practical.

11.4 Construction and Testing

11.4.1 General Requirements

The requirements of the local authority in regard to the works to be carried out which will directly or indirectly affect traffic movements as a result of the execution of the works under the Contract shall be complied with.

Throughout the currency of the Contract, maintenance and running repairs on all access and site roads which incur any damage as a result of the construction works, shall be carried out.

11.4.2 Removal of Topsoil

The Contractor shall commence the removal of topsoil only after the proposed erosion and sedimentation controls for the site affected by the proposed works have been implemented and clearing, grubbing of ground vegetation and removal of structures and obstructions completed.

Topsoil shall either be stockpiled on-site for re-use or disposed off-site. Topsoil stockpiles shall be free from contamination materials, refuse, stones, timber and the like. The Contractor shall provide adequate site drainage to protect the stockpiled materials from erosion and washing out.

11.4.3 Subgrade Preparation

The subgrade is defined as the material beneath the road pavement.

If, following the stripping of the topsoil, the stripped surface is suitable to receive the road pavement, the subgrade shall be proof rolled and compaction tested to confirm a minimum dry density ratio of 98% standard (AS 1289 5.1.1) to a depth of 300 mm below the subgrade level is achieved. Any unsuitable material encountered shall be excavated, backfilled with select fill and compacted in layers not greater than 200 mm loose thickness to the same compaction standard. Excavation of all unsuitable materials shall be to the extent directed by the Icon Water Representative. Unsuitable material shall be removed off-site as spoil.

The Icon Water Representative shall witness the proof rolling and compaction of the subgrade and advise the extent of further treatment. The subgrade acceptance criterion shall be the achievement of a soaked CBR of not less than 5.

For subgrade CBR values of less than 5, the Contractor shall undertake works as otherwise directed.

The Contractor shall ensure that the subgrade is drained at all times during subgrade preparation. Temporary drains and pumping of water from depressions shall be undertaken by the Contractor to ensure good drainage. The disposal of water shall be in accordance with the details that the Contractor incorporates into their EMP.

If fill is required to bring the level to the design formation level, it shall consist of graded crushed rock material with a maximum particle size after compaction not greater than 37.5 mm. The fill shall be compacted in maximum 200 mm thick layers (loose thickness) to a minimum dry density of not less than 98 % standard maximum dry density determined in accordance with AS 1289.5.4.1 and AS 1289.5.5.1.

The formation level of the subgrade shall be finished to the design levels within a tolerance of +0 mm / -20 mm.

Testing of subgrade shall be carried out at the rate of 2 tests per 500 m^2 or part thereof laid and compacted each day. Testing shall be undertaken by a NATA registered laboratory.

11.4.4 Pavement Materials

Pavement materials shall be placed and compacted on the prepared subgrade in accordance with the lines, levels and grades shown in the drawings.

Base and sub-base materials shall be unbound materials consisting of hard, durable particles and fragments of either natural or manufactured material that can be compacted readily to form a firm and stable pavement.

Unbound materials are those that have not been modified or stabilised by any added chemical agent. Unbound material may include recycled crushed building material free from foreign matter such as metal, glass, asphalt, ceramics, plaster, clay, rubber, plastic and wood.

Unbound base and sub-base materials are designated as follows:

- DGB20 – 20 mm nominal size densely graded base
- DGS20 – 20 mm nominal size densely graded sub-base
- DGS40 – 40 mm nominal size densely graded sub-base

Pavement materials shall conform to the following requirements:

Table 12.4.4.1 Pavement Materials Requirements

Description	DGB20	DGS20	DGS40
(A) Coarse Particle Grading	Mass percentage passing		
53.0 mm AS Sieve	-	-	100
37.5 mm AS Sieve	-	-	-
26.5 mm AS Sieve	100	100	-
19.0 mm AS Sieve	95 - 100	95 - 100	50 – 85
13.2 mm AS Sieve	70 - 90	70 – 90	-
6.70 mm AS Sieve	50 - 70	45 – 70	30 – 55
2.36 mm AS Sieve	35 - 55	30 – 55	25 – 50
(B) Fine Particle Size	Ratio expressed as percentage		
Passing 425 µm AS Sieve / Passing 2.36 mm AS Sieve	35 - 55	35 – 55	35 - 60
Passing 75 µm AS Sieve / Passing 2.36 mm AS Sieve	35 - 55	35 – 55	
Passing 13.5 µm AS Sieve / Passing 2.36 mm AS Sieve	35 – 60	35 – 60	35 - 65
(C) Liquid Limit (if non-plastic) - AS1289	Material passing 425 µm AS Sieve		
For natural or manufactured material	Max 20	Max 23	Max 23
For recycled building material	Max 27	Max 27	Max 27
(D) Plasticity (if plastic) - AS1289	Material passing 425 µm AS Sieve		
Plastic Limit	Max 20	Max 20	Max 20
Plasticity Index (PI)	Min 1, Max 8	Min 1, Max 12	Min 1, Max 12

Details of material and source of supply shall be obtained at least two weeks prior to its use.

11.4.5 Supply and Transport of Road Base and Sub-Base Materials

The Contractor shall obtain details of the supplied materials together with a certificate signed by the Supplier verifying that the materials meet with the requirements of this specification.

Materials shall be transported to the site in vehicles that are so constructed that loss of material does not occur. Stockpiles, if necessary, shall be formed on clear, even, well-drained, firm ground or constructed floor, and shall be constructed to prevent cross-mixing and segregation.

Non-conforming materials shall be removed from the site and replaced with materials that conform to the specification.

11.4.6 Spreading and Compacting Road Base and Sub-Base Materials

Each course shall be spread and compacted in uniform thickness which, after trimming, shall provide the layer thickness and lines as shown in the drawings. Each course shall achieve a compacted thickness of not more than 150 mm nor less than 100 mm.

The moisture content of the material shall, if necessary, be adjusted prior to compaction by watering or by drying out as required in order to obtain the required compacted density.

Compaction of each layer shall continue until a field dry density of at least 98% of the maximum dry density determined in accordance with AS 1289.5.4.1 and AS 1289.5.5.1 is achieved.

Testing shall be carried out at the rate of 2 tests per 500 m^2 or part thereof laid and compacted each day. Testing shall be undertaken by a NATA registered laboratory.

The allowable deviation from the design level and lines are 10 mm in layer thickness, 10 mm in level at any point, and shall not deviate by more than 10 mm from the bottom of a 3 m long straight edge placed parallel or transverse to the centreline of the road.

11.4.7 Witness Points and Hold Points

The Contractor's Inspection and Test Plans for the works shall include, the following witness and hold points. The Icon Water Representative may identify the need for other witness and hold points following receipt of the Contractor's Inspection and Test Plans.

- Inspection of prepared foundation for all roads - hold point
- Embankment construction at height increments of 1.5m including inspection of testing results - witness point
- Sub base and base course material samples and test certificates - hold point
- Engineered fill materials and test certificates - hold point
- Inspection of compaction of base course material over the sub-base course material before bitumen sealing, including inspection of the test results - hold point

11.4.8 Asphaltic Concrete Wearing Surface

Asphaltic concrete used for a pavement wearing surface shall be dense, continuously graded asphalt generally in accordance with AS 2150.

Asphaltic concrete is designated as AC10, AC20, and AC40 with the following composition and properties:

Table 12.4.8.1 Asphaltic Concrete Wearing Surface

Description	AC10	AC20	AC40
(A) Aggregate grading	Mass percentage passing		
53.0 mm AS Sieve	-	-	100
37.5 mm AS Sieve	-	-	90 – 100
26.5 mm AS Sieve	-	100	72 – 87
19.0 mm AS Sieve	-	90 - 100	59 – 76
13.2 mm AS Sieve	100	71 - 86	-
9.50 mm AS Sieve	90 - 100	58 - 83	38 – 58
6.70 mm AS Sieve	68 - 82	46 - 64	-
4.75 mm AS Sieve	50 - 70	37 - 55	27 – 43
2.36 mm AS Sieve	32 - 51	24 - 42	16 – 33
1.18 mm AS Sieve	22 - 40	15 - 32	11 – 26
0.600 mm AS Sieve	15 - 30	10 - 24	7 – 20
0.300 mm AS Sieve	10 - 22	7 - 17	5 – 14
0.150 mm AS Sieve	6 - 14	4 - 12	4 – 10
0.075 mm AS Sieve	4 - 7	3 - 6	3 – 6
(B) Binder content	Percentage by mass of total mix		
	4.5 - 6.5	3.8 - 5.8	3.0 - 5.0
(C) Air void	Percentage		
	3 - 7	3 - 7	3 – 7
(D) Minimum voids in mineral aggregate	Percentage		
	16	14	12

The grading of the combined aggregate shall be determined in accordance with AS 1141.11. The grading of aggregate and the binder content in an asphalt mix shall be determined in accordance with AS 2891.3.1, AS 2891.3.2 and AS 2891.3.3.

The air void content and the voids in mineral aggregate shall be determined in accordance with AS 2891.8.

Unless noted otherwise on the drawings, use asphalt (AC10) materials with a minimum 40 mm asphaltic concrete wearing surface. Where screwing action of trucks is anticipated, reinforced concrete rigid pavements are to be used.

Unless noted otherwise on the drawings, roads shall be a minimum 4 m wide generally and 6 m where passing traffic is expected.

11.4.9 Manufacturing and Transport of Asphaltic Concrete

The manufacturing plant shall be of sound design and construction and be capable of consistently producing mixes with the specified properties.

The Contractor shall obtain details of the mix design together with a certificate signed by the Supplier verifying that the materials meet the requirements of this specification. Testing shall be carried out by a NATA accredited laboratory.

Asphaltic concrete shall be transported in vehicles suitably covered and insulated to prevent cooling of the mix during transit.

11.4.10 Tack Coat

A tack coat of bitumen emulsion complying with AS 1160 shall be provided to achieve a bond between the granular surface of the base course and the asphalt.

The tack coat shall be sprayed at a nominal rate of between 0.2 and 0.4 litres per m^2. The application rate shall be doubled for joints and chases.

All contact surfaces of kerbs and other structures and all joints shall have a uniform application of tack coat.

The surface to which the tack coat is applied shall be clean and free from loose stones, dirt, oil and foreign materials.

11.4.11 Spreading and Compaction of Asphaltic Concrete

Asphalt concrete shall arrive on-site at a temperature suitable for spreading and compaction for the layer thickness and ambient conditions. Generally, the spreading temperature for dense graded asphalt shall not be less than 145 °C and compaction shall be completed before the mix temperature falls below 90 °C.

Asphalt paving shall not proceed if the surface temperature of the base material is below 10 °C such that spreading and compaction is adversely affected. Asphalt shall not be placed when the surface is wet or while rain is imminent.

The Contractor shall protect the work from damage until the required thickness of asphalt has been placed and compacted sufficiently to carry traffic.

Asphalt shall preferably be spread by self-propelled paving machines. The spread material shall be examined constantly for faults in texture and surface shape. Any segregated, torn or deficient areas shall be corrected whilst the asphalt is still hot.

If hand placing is used, the asphalt shall be deposited in position and spread using rakes. To avoid segregation of particles, the asphalt shall not be thrown or scattered.

The thickness of any compacted layer shall be generally within the limits of 2.5 to 4 times the nominal mix size.

The number and extent of joints in layers shall be kept to a minimum. The density and surface finish at joints shall be the same as in other areas of the layer.

Compaction shall be carried out using static or vibratory steel wheel rollers and/or pneumatic tyre rollers. Impact compactors such as vibratory plates, hand tampers and similar equipment may be used in small inaccessible areas.

The density of the compacted asphalt, determined by the calculation of air void content in accordance with AS 2891.8 shall be within the range of percentage values nominated in this specification. Tests shall be carried out a rate of 2 tests per 500 m^2 or part thereof laid and compacted each day.

Each layer of asphalt shall be finished to a plane surface, parallel to the plane of the finished surface of the wearing course. The finished asphalt pavement shall be to the lines and levels shown on the drawings.

The allowable deviation from the design level and lines are ±10 mm in layer thickness, ±10mm in level at any point, and shall not deviate by more than 10 mm from the bottom of a 3 m long straight edge placed parallel or transverse to the centreline of the road.

11.4.12 Concrete Carriageways

The compressive strength and flexural strength of concrete at 28 days shall not be less than 35.0 MPa and 4.7 MPa respectively.

The Contractor shall obtain details of the concrete mix design together with results of trial mixes to demonstrate that the proposed mix design complies with the specification. Certificates and test results by NATA accredited laboratories certifying the compliance of the mix constituents shall be required.

Chemical admixtures and their use shall comply with AS 1478. Steel reinforcement shall comply with AS 4671 and shall be supplied together with a NATA endorsed test certificate.

Consistencies of the concrete determined by measuring the slump in accordance with AS 1012.3 shall be 55 to 65 mm.

Forms shall be designed and constructed so that they can be removed without damaging the concrete and shall be braced in a substantial and unyielding manner. Forms shall be mortar tight and de-bonded to ensure non-adhesion of concrete to the surface of the forms.

Concrete shall be deposited continuously between the specified joints and spread uniformly in the forms without segregation. The concrete shall then be compacted to the full thickness of the slab in one operation.

The surface texture of the finished concrete surface shall be uniform and shall be effected by brushing evenly across the slab in one direction at right angles to the longitudinal axis of the carriageway.

Brushing shall be carried out using a texturing comb after the moisture film has disappeared from the concrete surface and before the initial set is complete. Texture depth shall be 0.5 mm nominally.

Curing compound shall be applied to the concrete surface immediately after the surface has been textured.

Traffic shall not be allowed on the concrete surface until an in-situ compressive strength of 30 MPa is reached.

Materials for joints shall be used in accordance with the manufacturer’s recommendations or as otherwise shown on the drawings. Dowel bars, tie bars and sleeves shall be securely fixed in position through holes in the formwork. Joints shall be formed perpendicular to the top surface of the slab.

Transverse joints shall be straight and perpendicular to the longitudinal axis of the carriageway and shall be formed at the specified positions. The joints shall be continued through kerbs, edges and gutters and their foundation and backing.

Longitudinal joints shall be formed only at the specified positions.

Grooves in concrete carriageway slabs shall be straight and formed either by sawing to the specified width and depth, or by fixing forming strip to the surface of the adjacent hardened concrete slab.

Immediately before sealing of the groove, dirt and loose material shall be removed from the groove. Caulking material if required shall be firmly packed in the bottom of the groove. Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove. Primer for the joint sealant shall be applied to the sides of the groove. The joint sealer shall be mixed and applied strictly to the manufacturer's recommendations.

The allowable deviation of the finished carriageway from the design level and lines are ±10 mm in layer thickness, ±10mm in level at any point, and shall not deviate from the bottom of a 3 m long straight edge by more than 10 mm when placed parallel or transverse to the centreline of the road.

The difference in level of the concrete surfaces across the joint shall not exceed 3 mm.

Two pairs of 100 mm diameter test cylinders test specimens shall be moulded for compressive strength testing in accordance with AS 1012, one at 7 days and the other at 28 days. The frequency of sampling shall be one sample per 25 m^3 or part thereof of the concrete delivered to the site on the day of concreting.

11.4.13 Kerb and Gutter

Kerb and gutter shall be constructed in fixed forms, extrusion or slip forming in conformity with the lines and grades shown on the drawings, and shall be generally in accordance with AS 2876.

11.4.14 Proprietary Safety Barrier Systems

Safety barrier systems shall be supplied and constructed as shown on the drawings. Proprietary safety barrier systems and devices shall be installed strictly in accordance with the manufacturer's recommendations.

The Contractor shall obtain details of type, manufacturer, strength grade, component materials and the method of installation of the proposed safety barrier systems.

All steel and ferrous metal components shall be hot dipped galvanised in accordance with AS 4680. All ferrous bolts, nuts and washers shall be galvanised in accordance with AS 1214.

Timber posts and blockout pieces shall be strength grade F8 Australian Slash Pine preservative treated to hazard level 4 in accordance with AS 1604.

On completion of construction, the tolerance on the height of the barrier shall be +20 mm. The tolerance for the line of the safety barrier shall be +20mm on the longitudinal axis at the top of the barrier.

11.4.15 Failure to Achieve Compaction Requirements

A registered NATA laboratory shall be used to test roadworks. The Contractor shall provide certified copies of all test results within two (2) weeks of tests been undertaken.

If any test fails to meet the minimum compaction requirements, a work method statement outlining additional testing to determine the extent of the non-conforming area shall be submitted. This statement shall be submitted a minimum of 2 working days before implementing the additional work. Further testing in accordance with the relevant Australian Standard to demonstrate that minimum compaction requirements are satisfied shall be performed. This procedure shall be repeated until all test results indicate that compaction requirements have been met.

11.4.16 Stormwater

Stormwater drainage shall be provided to protect the built environment from the adverse effect of stormwater flows resulting from storm events. The stormwater system shall include roof drainage, surface drainage and piped drainage.

Stormwater drainage systems shall be constructed so as to control discharges and to minimise nuisance damage to the public or to the environment. Surfaces on-site shall be finished so as to ensure the site is free from localised ponding. Ensure adequate slopes to drainage pipes constructed.

Drainage pipes shall be supplied and installed in accordance with *STD-SPE-M-002*.

All road edges within the site not in contact with concrete structures shall have concrete lay back kerbs and gutters drainage to gully pits at the locations shown on the drawings.

Finished surface level of roadworks around process units shall be at least 50 mm below the top level of process unit walls to prevent stormwater and debris entering the process units.

Paving shall be graded to fall evenly away from buildings and all process units to drainage pits. Minimum fall shall be 1:100 and there shall be no localised ponding on the site.

11.4.17 Vehicular Access to Structures, Buildings and Chemical Bunds

For vehicle access to structures, building and chemical bunds, a reinforced concrete drive-on slab with a gradual change in slope that will not cause negotiation problems for the tankers shall be provided. Bunded chemical areas shall drain to an isolated sump with a separate discharge from the stormwater drainage system.

12 Buildings and Structures

12.1 Scope

The purpose of this specification is to set down the requirements for the design and construction of building work to ensure satisfactory quality of materials and workmanship in order to achieve strength, durability, performance and quality of finish. It is appropriate for use on minor single storey buildings.

This specification applies to the provision of all plant, labour and materials and shall include all necessary site earthworks, excavation and backfilling, concrete work, brickwork, blockwork, carpentry, joinery, plumbing, roofing, floor and wall finishes and any other work necessary to complete the whole of works in accordance with this specification and the drawings.

The design and construction of fixed platforms, walkways, stairways and ladders are not covered by this specification and shall fully comply with the requirements of AS 1657 as amended by the Icon Water document titled *STD-SPE-G-009 Supplement to AS 1657 fixed platforms, walkways, stairways and ladders – design, construction and installation*.

12.2 Relevant Standards and Codes

The documents listed in Table 12.2.1 are either referenced by this specification, or shall be read in-conjunction with this specification.

Table 12.2.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 082	Sawn Eastern Australian Hardwoods
2	AS 1163	Cold-formed Structural Steel Hollow Sections
3	AS 1170	SAA Loading Code
4	AS 1221	Fire Hose Reels
5	AS 1254	Unplasticised PVC Pipes and Fittings for Storm and Surface Water Applications
6	AS 1260	PVC-U pipes and fittings for drain, waste and vent application
7	AS 1273	Unplasticised PVC Downpipe and Fittings for Rainwater
8	AS 1288	Glass in buildings - Selection and installation
9	AS 1289	Methods of Testing Soils for Engineering Purposes
10	AS 1316	Masonry cement (metric units)
11	AS 1397	Steel sheet and strip-hot-dipped zinc-coated or aluminium/zinc coated
12	AS 1415	Unplasticised PVC Pipes and Fittings for Soil, Waste and Vent Applications
13	AS 1418	Cranes (Including Hoists and Winches)
14	AS 1432	Copper Tubes for Plumbing, Gasfitting and Drainage Applications

Item	Document number	Title
15	AS 1477	PVC Pipes and Fittings for Pressure Applications
16	AS 1554	SAA Structural Steel Welding Code
17	AS 1562	Design and installation of metal roofing
18	AS 1589	Copper and copper alloy waste fittings
19	AS 1657	Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation
20	AS 1672	Limes and limestones - Limes for building
21	AS 1720	SAA Timber Engineering Code
22	AS 1748	Mechanically Stress-Graded Timber
23	AS 1859	Reconstituted wood based panels
24	AS 1866	Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes
25	AS 1905	SAA Fire Door Code
26	AS 2082	Visually Stress-Graded Hardwood for Structural Purposes
27	AS 2270	Plywood and Blockboard for Interior Use
28	AS 2271	Plywood and Blockboard for exterior use
29	AS 2441	Installation of Fire Hose Reels
30	AS 2592	Gypsum Plaster for Building Purposes
31	AS 2688	Timber Doors
32	AS 2733	Concrete masonry units
33	AS 2796	Timber – Seasoned Hardwood – Milled Products
34	AS 3000	Electrical Installations – Building, Structures and Premises (SAA Wiring Rules)
35	AS 3500	National Plumbing and Drainage Code
36	AS 3610	Formwork for concrete
37	AS 3798	Guidelines on Earthworks for Commercial and Residential Developments
38	AS 3972	General purpose and Blended Cements
39	AS 3700	Masonry in Buildings (SAA Masonry Code)

Item	Document number	Title
40	AS 4100	Steel Structures Code
41	AS 4130	Polyethylene Pipe for Pressure Applications
42	AS 4455	Masonry units and segmental pavers
43	AS 4456	Masonry units and segmental pavers – Methods of tests
44	AS CA 27	Internal Plastering on Solid Backgrounds
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
45	Not provided	Safe Design of Structures
National Construction Code		
46	Not provided	Building Code of Australia
WSAA codes and publications		
47	WSA 201	Manual for the selection and application of protective coatings
Icon Water Standards		
48	SD Series Drawings	Standard Drawing Set
49	STD-SPE-G-005	Supplement to WSA 201, Manual for the selection and application of protective coatings
50	STD-SPE-G-006	Approved Products List
51	STD-SPE-G-008	Design Guidelines for Safe Access, Egress and Working at Heights
52	STD-SPE-G-009	Supplement to AS 1657 fixed platforms, walkways, stairways and ladders – design, construction and installation
53	STD-SPE-M-002	Technical Specification, Piping and Valves

12.3 Design and Specification

12.3.1 General

The details provided in Section 12.3 of this specification provide minimum requirements for the design of the works. It describes the design documentation that the Designer shall produce for the construction of the works. The Designer shall carry out all design work in accordance with the referenced documents in Section 12.3.2 below, with the highest standard of care, due diligence and consideration of technical, economic and safety risks.

12.3.2 Referenced Documents

The documents listed in Table 12.2.1 are either referenced by this specification, or shall be complied with and read in-conjunction with this specification. The documents shall be the latest publication at the time of award of contract for construction of the works unless noted otherwise in the project specific documentation.

12.3.3 Related Drawings and Documentation

The Designer shall produce drawings and documentation in accordance with the requirements detailed in Table 5.2.2.1 and Table 12.3.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water standards (e.g. *STD-SPE-G-018).*

The requirements specified in Table 5.2.2.1 and Table 12.3.3.1 are minimum mandatory requirements. The Designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the works so that it can be constructed and maintained without ambiguity or unnecessary clarifications being asked of the Designer during the tendering phase or construction phase of a project.

Table 12.3.3.1 Minimum Mandatory Requirements for Building Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	General Drawings and Documentation	Refer to Table 5.2.2.1, items 1.1 to 1.8 inclusive
2	Bulk Earthworks and Setting Out	Bulk Earthworks and Setting Out drawings shall be produced (or updated as appropriate) for all new Icon Water assets as well as for major augmentations to existing assets. Symbols shall comply with the Icon Water SD series of drawings.
3	Structural Design Criteria	Refer to Table 8.3.3.1, item 2
4	Elevations	Refer to Table 8.3.3.1, item 3
5	Section Drawings	Refer to Table 8.3.3.1, item 4
6	Concrete Detail (if applicable)	Refer to Table 8.3.3.1, item 5
7	Reinforcement Detail (if applicable)	Refer to Table 8.3.3.1, item 6
8	Steel Framing Drawing (if applicable)	Refer to Table 10.3.3.1, item 4
9	Structural Detail and Connection Details (if applicable)	Refer to Table 10.3.3.1, item 5

12.3.4 Performance Requirements

All buildings shall be designed to satisfy the requirements of the Building Code of Australia, the ACT Government Building (General) Regulations and any other legislative technical requirements applicable to the site on which the buildings are located.

All buildings shall be designed to prevent progressive collapse and minimise local damage and loss of amenity through excessive deformation, vibration and degradation It must be designed to withstand the combination of loads and other actions to which it may reasonably subjected.

All buildings and rooms shall be functional and sized to facilitate easy access to equipment. All doors and passageways shall be designed so that equipment and machinery can be moved in and out of the building.

Natural ventilation shall be provided as far as possible except where odour control is required. Forced air ventilation or air-conditioning shall be provided to underground spaces, galleries and in controlled environment where comfort of people and protection of equipment are required. Building systems and materials shall be selected to suit the environment.

All buildings shall be fit for purpose, secure from weather, vermin and resistant to attack from vandals. All external doors shall be solid core doors with deadlocks.

The interior shall be finished neatly using lined ceilings (except in plant rooms) and face brick or rendered walls with slip resistant floors, unless detailed differently on the drawings. Translucent roof sheeting or skylights may be used to maximise natural lighting.

Flashings, eave gutters, outlets, downpipes and the like shall be provided. Rainwater goods, accessories and fasteners shall be powdered coated aluminium, or zinc/aluminium alloy-coated steel to AS 2179 and shall be designed in accordance with AS 3500

12.3.5 Design Loads

12.3.5.1 Design Ground Water Level

The design ground water level shall be the value assuming the water level is at ground level or, where information is available, the ground water level with an annual probability of exceedance of 1 in 100.

12.3.5.2 Flotation of Structures Founded Below Ground Level

For structures founded below ground level, buoyancy checks shall be carried out when the structure is empty with the external groundwater situated at the design ground water level. The design shall account for the local rise in ground water level caused by the damming effect of the structure on the natural ground water flow regime.

Buoyancy forces shall be resisted by the provision of either sufficient dead load to resist the flotation forces in accordance AS 1170.0, or the provision of an adequately designed pumped subsoil drainage system.

12.3.5.3 Minimum Design Live Load

The minimum design live loads shall comply with AS 1170.1.

12.3.5.4 Importance Levels for Earthquake and Wind Loads

For the assessment of wind and earthquake loads for new structures, the “Importance Level” shall be in accordance with the guidelines in Table F1 of AS 1170.0 and the Building Code of Australia. Unless agreed in advance with the Icon Water Representative, the values for importance levels shall be as in Table 12.3.5.5.1.

12.3.5.5 Hydrostatic pressure loading

All structures shall be designed for imposed hydrostatic forces for all operating conditions and external ground water table.

Table 12.3.5.5.1 Importance levels for structures

Structure Type	Importance Level
Water storage reservoirs required for disaster recovery (such as supplying water for firefighting and to hospitals)	4
Water storage reservoirs not required for disaster recovery	3
All other structures	3

12.3.5.6 Seismic Loads on Liquid Retaining Structures

Seismic loads shall be based on the entire weight of liquid retaining structures and their contents or shall take account of the separate effects of the liquid content, using internationally recognised methods. A recommended code for the above is the New Zealand Standards NZS 3106 : Concrete Structures for the Storage of Liquids.

12.3.5.7 Lateral Soil Loads

For design actions, all structures or parts of structures located below ground level shall be designed for the following soil pressures:

- “Active” soil pressure for walls with adequate wall movement (e.g. cantilever walls).
- ”At Rest” soil pressure for relatively stiff walls (e.g. propped cantilevers, cantilever walls of tanks near corners etc.).
- Earthquake induced additional soil pressure.

For design resistance, a lower bound value for lateral earth pressure coefficient shall be adopted.

12.3.5.8 Vibration Loads

The effect of vibration and torque of the equipment on footings shall be considered in the design.

12.3.5.9 Dynamic Loads from Crane Runways and Monorails

Dynamic loads allowances calculated to AS 1418.1 shall be applied to structural elements for crane runways and monorails.

12.4 Construction and Testing

12.4.1 Site Earthworks

All trees, shrubs, stumps and roots within the area of the site earthworks shall be removed and disposed of and the ground surface restored. All holes made by clearing shall be filled with sound material in an approved manner. The Icon Water Representative may require the Contractor to preserve certain trees or other flora without damage and without interference to their limbs and roots.

Where directed, the Contractor shall carefully cut and stack turf which shall be replaced when the work is completed. In other cases, the Contractor may be required to rehabilitate grassed areas by seeding or sprigging.

Where bulk earthworks are required, the work shall be undertaken in accordance with *Section 6 of this Specification.*

All excavation for structure foundations shall be made to the lines, levels and forms shown on the drawings.

Where the Contractor has excavated a trench deeper than required, the Contractor shall make good the over-excavation with compacted sand, concrete or such other materials as directed. No additional payment shall be made to the Contractor in respect of such work.

The Contractor shall take such precautions as are necessary to ensure that all excavation is made in a careful manner, and that it is rendered secure and safe by sheeting and/or other means. The Contractor shall supply all sheeting, walling, props and wedges which are necessary to secure all open trenches or tunnels. The Icon Water Representative may order the work to cease excavation should there be insufficient materials on site to carry out this work.

The Contractor shall do all work necessary to divert any water interfering with the progress of the works, to keep the excavations free from water while the works are in progress and prevent any injury to the works by water due to floods or other causes. Any work or material damaged by water shall, if ordered, be taken up and replaced with fresh material by the Contractor.

The Contractor shall backfill the excavations to the levels and limits shown on the drawings. Unless shown otherwise on the drawings or specified elsewhere, general backfilling and compaction shall be by methods which shall ensure maximum consolidation without damage to the structure.

Backfill material shall be placed in layers not exceeding 300 mm thickness compacted in accordance with Table 6.4.16 of Section 6, as applicable.

All surplus spoil shall be removed from the site and stacked or spread on-site as directed by the Icon Water Representative.

12.4.2 Concrete

Concrete work shall conform to the requirements of *Section 8 of this Specification.*

12.4.3 Masonry

12.4.3.1 Materials

All masonry units shall be of an approved brand. Concrete masonry units shall be of the thickness indicated on drawings, either hollow or solid as specified and complete with all special blocks where required, such as corners, halves, lintels, sills, jambs and column blocks.

Clay masonry units shall have a texture and colour as approved by the Icon Water Representative prior to procurement, and shall be well burnt, of uniform size, shape and colour, first quality face bricks.

All concrete masonry units shall have a minimum characteristic unconfined compressive strength of 15 MPa. All clay masonry units shall have a minimum characteristic compressive strength of 7 MPa.

All hollow concrete units which are specified to have concrete filling shall have clean open cavity through the full depth of the unit. Blocks with partly obstructed cavities shall be rejected. Clean-out blocks shall have one fully open vertical face.

Broken or damaged units shall not be used in un-rendered walls. Units damaged after laying shall be replaced.

Samples of units shall be submitted and approved before use or delivery. Units which do not conform to the approved texture, colour or standard shall be rejected.

The dry ingredients for mortar shall be thoroughly mixed prior to addition of water which shall be then worked thoroughly through the mixture. The mortar shall be mixed in an approved mixing machine for not less than three minutes. Hand mixing shall not be employed unless specifically approved. Cement shall be Type "GP" general purpose Portland cement of an approved brand and shall comply with AS 3972 – Portland and Blended Cements.

Sand shall be clean, sharp, pit or fresh water sand, free from loam, saline, or vegetable matter or other impurities and shall not contain soft or weathered particles and if directed shall be washed when used with cement.

Mortar which, in the opinion of the Icon Water Representative, has become excessively stiff so as to make placement difficult shall be rejected. Retempering of mortar is permitted for up to one hour after initial mixing.

12.4.3.2 Workmanship

Masonry units shall be laid to straight and vertical lines and to the layout shown on drawings, in accordance to manufacturer's instructions and to AS 3700, SAA Masonry Code.

All concrete masonry units shall be laid dry and blocks stockpiled on the job shall be well protected from weather. The tops of all walls shall be covered upon stoppage of work to prevent moisture penetration.

Prior to being used in the work, clay masonry units shall be thoroughly wetted and the top of all brickwork left overnight shall be thoroughly wetted before recommencement of work.

Except where reinforced concrete filling is required, all cavities which extend below external ground level shall be filled with fine waterproof concrete.

Where concrete masonry walls are built up to the underside of beams, stairs or slabs, unless shown otherwise on the drawings, the walls shall finish with 100 mm high blocks, or cut solid blocks, whichever are required to close the opening.

For concrete masonry walls behind basins, sinks, shelves, showers and similar items, except where reinforced concrete filling is specified, the Contractor shall provide a course of solid blocks. All fixings into blocks shall be with approved brand plugs of the required sizes.

Cutting of masonry units shall be avoided wherever possible. Masonry units shall be cut to rake under stairs and similar positions.

Masonry shall be laid in stretcher bond. Brickwork shall be laid in even courses with 7 courses to each 600 mm height of wall.

Intersecting masonry walls and partition walls shall be bonded as shown on the drawings or by galvanised steel ties at 400 mm centres in the vertical direction. Medium duty wall ties shall be provided in cavity walls in accordance with Section 3.8 of AS 3700 unless otherwise specified or shown on the drawings.

Masonry units shall be bedded in even courses properly levelled and plumbed and bonded and laid with uniform close joints, not exceeding 10 mm thick and not less than 6 mm thick. Vertical joints shall be laid with a sufficiency of mortar to extend across the full face of the masonry. The joints shall be tooled flush with the face of the masonry.

Reinforcement of brickwork shall be provided generally in the bed joint of every fourth course throughout and in the bed joint of the top course of all walls. The reinforcement shall consist of approved fabricated galvanised steel wire mesh at least 60 mm wide in each face. One continuous strand shall be built into the bed joint throughout. Concrete blockwork shall be reinforced as detailed on the drawings.

Hot dip galvanised mild steel arch bars or angles shall be provided above window and door openings.

All workmanship shall be in accordance with Section 8 of AS 3700.

12.4.3.3 Face work

The Contractor shall set out face work to avoid cutting of blocks. Units in single leaf walls with face work both sides shall be specially selected.

The Contractor shall keep perpends in alternate courses in vertical alignment.

12.4.3.4 Wall ties

Ties to concrete shall be provided at every fourth bed joint in brickwork or 90 mm high blockwork, and at every second bed joint in 190 mm high blockwork.

Ties for tying masonry walls to steel columns shall be a minimum of 3.15 mm diameter galvanised steel and shall be specifically designed for each application.

12.4.3.5 Services installation

The Contractor shall:-

- Form all chases necessary for other trades and form any necessary coring, corbelling, over-sailing or set-back courses, splays or rebates as required.
- Provide and build-in all approved patent plugs where practicable and grounds for securing joinery as required.
- Build-in all bolts, plugs, straps and similar items as work proceeds; also door and window frames, angle guards and flashings as specified.
- Build-in all items, including pipes and sleeves, set in position or supplied by sub-Contractors as required.
- Form holes for rainwater and other pipes, Telecom and communications cables and similar items as required and make good after other trades.
- Form holes through walls for mechanical equipment and specialist hydraulic equipment, as shown on the drawings.

Wherever possible, service pipes and conduits shall be built into walls and walls shall not be chased after construction. Particular care shall be taken in setting out conduit and other services so that no pipes are exposed or chased into the face of walls which are finished as face blockwork.

Where chases are required in unfinished work, these shall be made by cuts with an abrasive saw to the required depth, the remainder being chiselled out.

12.4.3.6 Cleaning down

Face blockwork shall be protected during erection from damage and staining and all face work shall be kept clean as work proceeds. Finished work shall be cleaned down after the mortar has hardened by rubbing down with a piece of block, carborundum stone or wire brushing. Only clean water may be used, acid cleaning shall not be permitted. The Contractor shall follow dry cleaning with hosing down.

The whole of the masonry shall finish clean and free from all defects and stains.

12.4.3.7 Damp-proof courses and flashings

Damp-proof courses shall be provided on all walls and under all floors.

Flashings shall be provided at all places necessary to ensure the weather-tightness of the building.

12.4.4 Carpentry

12.4.4.1 Materials

All timber shall be in accordance with the relevant standards and codes with regard to quality, seasoning and species to be used in any particular position within the structures, and in accordance with any strength group specified herein or on the drawings.

Joinery, flooring and mouldings shall be seasoned timber.

Pine shall be "A" grade in the relevant standard. Cypress Pine shall not be used.

Grades of hardwood shall be as described in AS 082.

Hardwood rafters and battens shall not less than strength group B.

All nails, bolts, nuts and washers shall be hot dipped galvanised. All screws for fixing hardware shall be chrome plate brass.

12.4.4.2 Workmanship

All carpentry work shall be carried out in a thorough and tradesman-like manner and shall be erected and fixed in position to the correct level, plumb and straight with all exposed joints close and flush; all in accordance with the best building practice. All timber work shall be subject to the approval of the Icon Water Representative.

All bearings must be solid. No packing shall be allowed.

All timber to be used in the construction of the buildings shall receive adequate cover and protection following its arrival on the sites. All joiner's work must be framed together and inspected before being fixed into position, and together with the carpenter's work must be finished in a most tradesman-like manner with all joints flush and close.

All carpenter's works showing externally must be framed and painted at joints in stiff oil paint. Priming paint shall be kept clear of surfaces to be oiled. All nails in such timber shall be punched below the surface and nail holes stopped prior to painting. Exposed stops shall be primed before fitting, after priming the ends and surfaces they abut.

All exposed timber shall be dressed and neatly arrised.

On completion of the works, all rubbish must be cleared away, all gutters cleaned leaving all work neat and tidy. Doors shall be eased if necessary, locks oiled as required and all left in proper working order.

12.4.5 Joinery

12.4.5.1 Materials

All joinery timber shall be select grade and species free from all defects and thoroughly seasoned. All joinery timber shall be first class of the type as shown on the drawings or as specified herein. All concealed internal joinery timber shall be of selected first class Pine.

All particle board shall be highly moisture resistant. Particle board which has not been treated for moisture resistance shall not be used in any location.

Bench tops, fronts, backs, both sides of doors and drawer fronts and all edges of doors and drawers fronts shall be sheeted with selected laminated plastic sheeting.

12.4.5.2 Workmanship

The whole of the joinery work shall be accurately set out and framed together in accordance with the best practice as soon after the commencement of the work as possible.

Should any joints in joinery or other work open or show themselves in the defects liability period, such joinery shall be replaced with new and all work disturbed in connection therewith shall be made good.

The Contractor shall properly protect all joinery work where liable to injury and replace work which is marred or damaged during the progress of the works.

Site dimensions shall be checked before manufacture.

All joinery work shall be hand dressed and scraped and sanded where considered necessary to provide a first class fine even surface.

Generally, approved waterproof glue shall be used for all work. Work to be painted shall be primed before leaving the workshop.

The Contractor shall conceal fastenings where possible, use a minimum of surface nailing and punch nail heads below surface and fill with putty coloured to match finish.

Adhesives and jointing compounds shall be non-staining and kept off visible faces. Surface screws where necessary shall, if visible, be Phillips head, countersunk flush or be provided with cover caps.

The Contractor shall thoroughly prime the backs and ends of all frames and linings and all exposed work generally before fixing in position.

All visible edges of veneered work including plywood shall be edge stripped.

Visible faces of edge strips shall match the face veneers of the work. Edge strips to external flush doors shall be hardwood. Edge strips to room doors and unlined particle board shelves and divisions shall be solid timber. Edge strips to cupboards shall be of veneer stripping.

12.4.5.3 Doors

Unless noted otherwise in the project specification, doors shall be 40 mm thick, ply lined with a solid core of the dimensions detailed and scheduled. Doors shall be obtained from an approved manufacturer. Framing timbers shall be kiln dried stress free approved softwood, and non-susceptible or treated for immunity to borer or other destructive species.

The core shall be formed from kiln dried, stress free approved softwood core members assembled by the "Torweggie" process and butt jointed and treated with an approved preservative.

Both stiles of each flush door leaf shall be edged with timber edge strips of 12.5 mm (finished) thickness, extending full thickness of door and finishing flush with face.

The strips shall be of an approved timber species and where a decorative veneer is specified or scheduled, of a similar species.

Any door exposed to the elements shall be weatherproof quality and all adhesives used shall be warranted waterproof.

12.4.5.4 Joinery fittings

Fittings shall be plumb and level and neatly scribed to floors, walls, columns, etc.

All work shall be left clean on completion, free of blemishes.

12.4.6 Hardware

12.4.6.1 Materials and workmanship

Door handles, catches, locks, etc. shall be set at heights as directed by the Icon Water Representative.

Hardware unless otherwise described shall have a satin chrome plate finish. Exposed screws shall be chrome plated brass. All other screws shall be brass or stainless steel.

Internal doors to toilets, showers, change rooms etc. shall be fitted with privacy door sets whilst the remaining internal doors shall be fitted with passage sets.

Where trade names and reference numbers are used, fittings of different manufacture but of equivalent performance and quality may be approved.

All hinges shall be stainless steel butt hinges unless extended hinges are shown on the drawings or specified in the project specification. Extended hinges shall also be stainless steel.

12.4.6.2 Keying

Plastic tags shall be fitted to all keys, which shall be labelled appropriately and handed over on completion.

All lock combinations shall be master keyed as provided in the project specification and to Icon Water Security Policy requirements. The Contractor shall supply two duplicates of each master key and stamp each lock cylinder and key with letter and number references. Keys shall be nickel alloy, not brass.

12.4.6.3 Responsibility for performance

The Contractor shall be responsible for ensuring the proper fixing and operation of all hardware. All hardware shall be removed and refixed as required for painting of doors.

12.4.7 Plumbing

12.4.7.1 Materials

Unless shown otherwise on the drawings, materials shall be:

Table 12.4.7.1.1 Plumbing Materials

Application	Material
Soil pipes	Rigid PVC *(refer to STD-SPE-M-002)*
Vents and anti-syphon vents	Rigid PVC *(refer to STD-SPE-M-002)*
Vent cowls	Basket type, bird proof
Water service	External – copper ; Internal – lagged copper

All piping shall be complete with bends, offsets, junctions, inspection openings and lugs as necessary.

Cold water piping laid in ground shall be wrapped with self-adhesive polythene tape.

12.4.7.2 Fixtures

Hand basins and toilet suites (pan and cistern) and wall-hung urinals shall be solid vitreous china of approved brand.

Kitchen sinks and continuous urinals shall be of stainless steel of approved brand.

Fixtures shall be securely fixed to their mounting surfaces using the best tradesman-like practice.

Fixtures shall be fitted flush and plumb and any gaps shall be caulked with an approved elastic silicone sealant, suitable for mating surfaces and having a minimum product warranty of 10 years. The surface of the caulking shall be neatly finished using a suitable tool, to give an even, concave profile between surfaces at right angles.

12.4.7.3 Workmanship

All work shall be carried out by licensed tradesmen in first class manner. The Contractor shall prevent foreign matter from entering pipes and protect piping and fittings from damage.

Wherever possible the Contractor shall conceal pipes. Exposed pipes and fittings internally shall be chrome plated copper or brass complete with chrome plated flanges and fixings.

The Contractor shall build in sleeves where pipes pass through masonry floors and walls.

Chases shall not be permitted in hollow and un-rendered concrete block or "off-form" concrete. Where allowed, all chases shall be formed with sawn grooves.

The Contractor shall flash vents at roof line and securely stay vents. The whole installation shall be subject to approval on completion in accordance with the Building Code of Australia requirements.

12.4.8 Sheet Metal Roofing

12.4.8.1 General

The Contractor shall provide the whole of the buildings where specified to have metal roofing with a fully watertight and bird proof roofing system of the type shown and specified, complete with all necessary accessories, trim and roof plumbing including capping, flashings, gutters, outlets and overflows.

Where shown on the drawings or specified herein, the roof system shall include an insulation blanket supported on wire mesh.

The roof shall be left clean and free from debris on completion. The Contractor shall ensure that no debris is allowed to enter the drainage system.

Materials shall be the best of their respective kinds. All roofing materials shall be "Colorbond" finished.

Roofing shall be installed by tradesmen skilled and experienced in the types specified and in accordance with manufacturer's instructions.

The Contractor shall carry out all necessary operations for the satisfactory performance of the roof, including cutting at junctions, trimming around penetrations and flashings.

Before roofing work commences all work above roof level shall be complete or if not the Contractor shall be responsible for protecting the roof fabric from damage. The Contractor shall avoid construction loads on roof.

12.4.8.2 Materials

Roof sheeting shall be of the profile shown on the drawings or as specified in the project specification and unless otherwise specified shall be "Colorbond" finished. Roof sheets shall be in single lengths to suit each section and to fall from the high point to the gutter with no intermediate joints. Manufacturer's accessories shall be used unless shown or specified otherwise.

Where shown or specified, 50 mm thick roofing blanket, installed in accordance with manufacturer's instructions, shall be provided.

Fascia and wall sheeting shall be of the profile shown on the drawings or as specified in the project specification and unless otherwise specified shall be "Colorbond" finished. Sheets shall be in single lengths to suit each section and to be fixed to supports with approved clips or fasteners in accordance with the manufacturer's recommendations.

Flashings, trims, rib and stops and all sundries unless otherwise specified shall be "Colorbond" finished steel to match adjacent material.

Joint sealants shall be butyl sealing tapes and silicone caulking compounds.

All jointing materials, wedges, holdfasts, tacks, collars and connections as required and necessary shall be of a material compatible with the basic materials used. All rivets and roof and wall screws shall be of a material and type recommended by the roof / wall sheet manufacturer. Specifically for “Colorbond”

roof /wall sheets, the Designer and Contractor shall comply with the latest editions of the following BlueScope Steel technical publications unless BlueScope Steel warrant otherwise:

- *Corrosion Technical Bulletin No. 12 titled "Dissimilar metals"*
- *Technical Bulletin No. 16 titled "Fasteners for roofing, walling and accessory product selection guide".*

Note: These BlueScope Steel technical publications specifically warn against galvanised sheets being fixed with stainless steel fasteners and stainless steel sheets being fixed with galvanised fasteners (i.e. mixed metal interaction shall be prevented).

12.4.8.3 Workmanship

Roof, fascia and wall sheeting shall be laid strictly in accordance with the manufacturer's printed directions to the falls indicated on the project drawings.

Roof sheeting shall be laid in single lengths to roof slope with uniform falls at right angles to purlins.

Should it be necessary to use more than one sheet to provide full-length coverage, the Contractor shall commence sheet laying at the gutter line and lay subsequent sheets over this sheet to the ridge or fascia, allowing a minimum end lap of 150 mm. End laps in roofs of less than five degrees pitch (approximately 1 in 12) shall be sealed with an approved sealant. The minimum end lap for vertical wall cladding shall be 100 mm.

Where roof pitches are less than fifteen degrees, or where the roof is exposed to extreme weather conditions, the Contractor shall turn sheet ends up approximately eighty degrees at the high end of the roof, that is at ridges or fascia, and turn downwards approximately fifteen degrees at gutters, with the turn-up/-down tool.

Sheeting shall be fixed to purlins and girts in strict accordance with the manufacturer's recommendations.

The Contractor shall provide all trims, accessories, etc., required where the roof surface is penetrated by pipes and other services, etc.

The Contractor shall provide all flashings to parapets, upstands, holes and other penetrations and trims required to ensure that the roof is entirely watertight.

12.4.8.4 Insulation and sisalation

Where provided, roofing blanket shall be placed under sheeting before fixing. Insulation projecting past the gutter purlins into the box gutter shall be trimmed off. Roofing blanket shall be supported on wire mesh.

Unless specified to the contrary in the Project Specification, heavy duty sisalation shall be provided on all sheeted surfaces. The sheeting shall be laid over the purlins or girts before the roof sheets are laid.

12.4.8.5 Sealed joints

Where sealed joints are required, the Contractor shall use an approved sealant in conjunction with mechanical fasteners. Sealant to gutter joints shall be compressed between the lap rather than an overlay of sealant at the joint face.

12.4.8.6 Dissimilar metals

The Contractor shall follow Table 2 of AS 1562 as a guide to compatibility of metals and ensure that direct contact between incompatible metals does not occur.

Where in contact with each other, aluminium and steel surfaces shall be coated with 2 coats of alkali-resistant bituminous paint or with an approved adhesive tape.

12.4.8.7 Box gutters

The Contractor shall provide box gutters to roofs where shown. Minimum fall shall be 50 mm to each 5 m length. The gutter shall be folded as shown on the drawings, with stop ends at parapet abutments and expansion joints at high points. Sumps at outlets shall be minimum 100 mm deep tapered with falls to outlets.

Top edges of gutters shall be gauged to the underside of roof sheeting and separated, turned back 25 mm wide at 45 degrees. Similarly, edges shall be turned back at stop ends and capped at expansion joints.

Box gutters shall be laid loosely and held down at edges. An upstand "saddle" joint shall be used at expansion joints. Joinings shall be riveted and sealed and bottoms dressed into outlet sumps at downpipes. The Contractor shall provide outlets to rainwater heads in the positions shown on the drawings. At each end of gutters, the Contractor shall provide 100 mm diameter overflows set to project 25 mm past the external face of walls.

12.4.8.8 Fascia gutters

Fascia gutters shall be prefabricated selected profile "Colorbond" steel or treated aluminium fascia gutter as appropriate, fixed with similar colour treated fascia brackets at 900 mm centres or with approved proprietary fixings.

12.4.8.9 Downpipes

Concealed downpipes shall be Grade 316 stainless steel or 90 mm internal diameter PVC as shown on the drawings. Thimbles from sumps shall be 150 mm long increasing to 25 mm larger opening in the bottom of the gutter.

Joints between downpipes and thimbles shall be sealed and riveted.

Downpipes shall be full length from gutter or outlet to drain and shall be built flush against the structure in positions shown on the drawings. Stack drops shall be vertical at entry of drains.

Unless shown otherwise on the drawings or specified in the project specification, external downpipes shall be 100 mm x 100 mm "Colorbond" finished sheet steel, treated aluminium or Grade 316 stainless steel downpipes as shown.

Downpipes shall discharge into stormwater drains via concrete encased bends.

The Contractor shall securely fix downpipes to the structure using approved straps and guides of the same material to the downpipe.

12.4.8.10 Flashings, trims, etc.

Flashings and trims, including over-flashings, shall be installed at verges, abutments, junctions, etc. and at pipes passing through roofs and wherever necessary, to make the whole installation bird proof and watertight. The material shall be the same as the roof.

Cappings shall be carried over the top of parapet walls and turned down a maximum 150 mm on the internal face of external parapet walls. On the external face, the capping shall be turned down as detailed on the drawings.

Flashings shall be in long lengths with joints lapped 100 mm in the direction of prevailing weather. Joints shall be riveted and sealed.

Flashings shall be notched over roof sheeting ribs and dressed down to trays where angled to ribs and to extend over a minimum number of 2 ribs.

Flashings shall be pop riveted to ribs and set in an approved caulking compound. Expansion joints shall be provided in long flashings, at 6 m maximum centres in approved locations. All expansion joints shall

be separated a minimum of 6 mm and be turned back 35 mm and an expansion cap fitted, turned into the folds. The cap shall follow the profile of the flashing. Joints which are flashed shall have minimum cover of 100 mm vertically and 150 mm horizontally.

Pipe flashings to the roof shall be counter flashed, pop-riveted and set in caulking compound. All roof penetrations shall be counter flashed.

12.4.8.11 Rainwater heads

Rainwater heads shall be provided in positions shown on the drawings and shall be fabricated from 1.0 mm "Colorbond" finished and treated aluminium or Grade 316 stainless steel sheet as shown. Heads shall be approximately 350 mm x 350 mm x 150 mm wide to the profile shown on the drawings and shall be complete with a tapered outlet to suit a 100 mm x 100 mm downpipe with an overflow splitter.

Open-top rainwater heads shall be provided with hail guards fabricated from 0.8 mm wire mesh supported along its perimeter by 6 mm diameter aluminium rods, welded at the corners.

12.4.8.12 Roof lights

Roof lights shall be ventilated commercial roof lights with polycarbonate glazing of the size shown on the project drawings or as specified in the project specification. Roof lights shall be fixed strictly in accordance with the manufacturer's instructions and shall be fully weatherproofed. The Contractor shall provide all necessary timber trimmers and 6 mm linings where opening into fibrous cement or plaster board lined ceilings.

12.4.8.13 Expansion and contraction

The Contractor shall refer to AS 1562 regarding deleterious expansion and make adequate provision for thermal movement in the installation of roof assemblies.

The Contractor shall pay special attention to joints and fastenings, particularly in sheet metal and thin sections.

The Contractor shall prevent all detrimental effects including tearing, buckling, opening of joints, undue stress and fatigue. Any leaks in the roofing and displacement of roofing where due to faulty workmanship or materials shall be rectified by the Contractor.

12.4.9 Aluminium Windows, Doors and Louvres

12.4.9.1 Materials

All aluminium windows, doors and louvres shall be fabricated from alloy 6063 T5 heavy duty extruded framing conforming to AS 1866. The finish of the framing shall be as shown on the drawings or as specified in the project specification.

Glass shall be bronze tinted reflective float glass complying with AS 1288 unless noted or specified otherwise in the project drawings and/or project specification.

12.4.9.2 Workmanship

The Contractor shall supply and install aluminium window, door and louvre units complete with glass, glazing and/or louvre blades, and all fittings including handles, catches, locks and latches.

The Contractor shall protect windows, doors and louvres from damage of any kind and provide / protect such items with a strippable plastic protective film before delivery to site.

Any damaged units shall be made good and all broken, scratched or cracked glass shall be replaced by the Contractor.

The Contractor shall supply and build in window, door and louvre units strictly in accordance with the manufacturer's instructions.

Where the sizes are not standard, window, door and louvre units shall be specially fabricated to suit. All sizes shall be checked on site before manufacture.

Where shown or specified all aluminium shall be anodised to 10 microns thickness to comply with first quality standards.

All doors, frames, louvres and glazing shall comply with the wind loadings shown on the drawings or specified in the project specification and the requirements and intentions of the drawings and specification to achieve waterproof conditions at all times.

Fixed louvered units shall be provided with an approved bird proofing.

12.4.9.3 Fixing

All fixing shall by stainless steel screws or bolts to achieve strength for wind loadings and weatherproofing and to ensure that all stress, weights, dynamic loads, shock loads etc. are transmitted into the structure through such fixings.

12.4.9.4 Tolerances

All necessary allowances shall be made for thermal movement in the design and detail of the fixings. Frames shall be designed and installed to fit and operate without buckling, opening of joints or undue stress on hinges, fasteners, tracks or guides.

12.4.9.5 Dissimilar materials

Aluminium shall be prevented from contacting dissimilar materials by the use of suitable tapes, gaskets, washers, sleeves, etc.

12.4.9.6 Rejections

All aluminium components, units, assemblies, fixings, completed units etc., which do not meet the requirements outlined above, shall be liable to rejection, in which case they shall be removed from the site and replaced by the Contractor.

12.4.9.7 Fabrication

Frames shall be so designed so as to support the weight of the proposed doors without distortion or deflection.

12.4.10 Plastering

12.4.10.1 Definitions

Plastering, plasterwork and rendering are terms which shall be considered synonymous in so far as they mean the range of operations involved in the application of plaster or render as undercoats and/or finishing coats to masonry, concrete or internal lining panels.

12.4.10.2 Materials

The Contractor shall keep materials segregated, clean and dry. Proprietary line materials shall be delivered to the works as despatched from the manufacturer(s), in sealed containers, and shall be used strictly in accordance with their recommendations. The Contractor shall provide material samples for test if required.

Portland cement shall be of approved manufacture complying with AS 3972.

The Contractor shall use an approved brand of hydrated lime delivered in sealed bags. All lime shall comply with AS 1672.

The Contractor shall use hard, clean sand complying with AS CA27, graded according to the appropriate tables in the Appendix to CA27 and complying with samples which shall be submitted for approval before use.

Water shall be clean, fresh and free from vegetable or organic matter in solution or suspension.

12.4.10.3 Workmanship

The Contractor shall clean platforms, tools and mixing machines before each batch is mixed.

Where mixed on-site, the Contractor shall proportion materials by volume in approved measuring devices.

Mixing may be done by hand on a clean platform, or by machine. The ingredients shall be thoroughly mixed until the mixture is uniform in colour and consistency.

Mixes containing cement shall not be used after initial set has occurred and under no circumstances will retempering be permitted after 1 hour of initial mixing. The mix for each successive coat should never be of a type richer in cement than the mix used for the coat to which it is applied.

When permitted, approved admixtures may be used to retard or accelerate setting, improve workability or reduce water content. Admixtures, which in the opinion of the Designer (or Icon Water Representative) may have an adverse effect on the plaster or render or associated materials shall not be used.

Plastering work shall only be carried out by competent tradesmen.

Generally, the Contractor shall delay plasterwork until the risk of damage by building operations and installation of services is at a minimum, consistent with completion of the Contract by the date of practical completion and with due consideration for the maturity of plasterwork before application of paint and other finishes.

The Contractor shall not carry out plasterwork when weather conditions are likely to adversely affect the results and shall protect adjacent work from possible damage caused by plasterwork operations.

The work shall be executed with long rules and straight edges run off temporary screeds to ensure that surfaces finish plumb, true and even and proper thickness of coats is maintained.

With each coat, the Contractor shall finish complete areas where possible in one operation or in one day's work. The Contractor shall continue or match up in such a manner to leave no evidence of a joint in the finished work.

Where applied to expanded metal lathing or over the winds of metal corner beads, the plaster shall be firmly pressed through the apertures.

The Contractor shall thoroughly scratch comb undercoats as they become stiff to form an effective key.

Before applying a subsequent coat, the Contractor shall ensure that the previous coat has thoroughly set, dust down the surface and dampen where necessary.

The Contractor shall finish surfaces free from defects and with angles plumb and straight and finish curved surfaces to true radii.

Any imperfect or drummy work shall be cut out and replastered to the satisfaction of the Icon Water Representative.

Unless specified otherwise, the wood float finish shall provide an even texture obtained by wood floating the screeded surface and finishing with a clean sponge.

Internal wall and ceiling panel joints shall be treated strictly in accordance with the manufacturer's instructions. A three-coat jointing system shall be used on all recessed, butt and external corner joints. A two-coat system shall be used on internal corner joints.

External corner joints shall be protected by a perforated galvanised steel angle fixed to the wall prior to application of the first coat.

All recessed and butt joints shall be taped using perforated paper tape during application of the first coat in accordance with manufacturer's instructions. On internal corner joints self-adhesive fibreglass tape may be used.

Screw and nail heads and scuff marks shall be stopped with plaster during application of the first joint coat. During each subsequent joint coat, cover screw heads overlapping each previous coat by a minimum 25 mm.

The manufacturer's minimum time intervals between coats are to be strictly adhered to in order to ensure a sound, integral coating system.

The edges of all joints and plaster areas shall be neatly feathered flush with the linerboard.

After the recommended drying time, all joints and plaster areas shall be sanded flush and smooth with 150 grit paper or cloth or 220 grit sanding mesh. Care shall be taken not to scuff the linerboard at the joint edges.

12.4.10.4 Tolerances

All surfaces of final coats of plaster and render shall finish to true planes within a tolerance of 3 mm in 3 metres as determined by a 3 m straightedge placed anywhere over the finished surface.

12.4.10.5 Angles and joints

The Contractor shall finish internal and external angles true and square.

Where plaster or render abuts other materials, it shall be cut-in with a neat bevel. Plaster shall finish with a neat bevelled fair edge against adjoining unplastered work such as face brickwork.

12.4.10.6 Protection and curing

The Contractor shall not allow rapid or uneven drying out of plaster and shall not allow coats of gypsum plaster to become damp after setting.

Cement plaster and render shall be cured by keeping it in a damp condition. The Contractor shall allow undercoats to dry out after curing before applying subsequent coats.

The Contractor shall protect external angles with timber boards or other approved means and keep in position until removal is required or permitted.

12.4.10.7 Preparation of surfaces

The Contractor shall make good any defects in the background which may adversely affect the quality of plasterwork before plastering is commenced.

No claim for extras related to the suitability or otherwise of the base, substrate, background, edges and the like will be considered.

Joints of blockwork shall be raked out to provide key.

The Contractor shall thoroughly scabble surfaces of concrete which are not sufficiently rough to provide key and break off any excessive projections and fill voids, hollows and honeycombs with 1:2.5 cement and sand before plaster or render coats are applied.

The Contractor shall ensure that water pipes are sheathed to enable thermal movement and all pipes and conduits which are to be concealed behind plaster or render are chased and fixed in position, and the building in of items from other trades is completed before plastering is commenced. The Contractor shall cover all chased sections or holes greater than 50 mm wide with strips of expanded metal lath

fixed with 25 mm concrete or masonry nails at 150 mm centres or by other approved means, extending lathing a minimum 75 mm beyond each side of chases and holes.

All surfaces shall be thoroughly brushed to remove dust and dampened where necessary to provide even suction.

The Contractor shall apply a dash coat to all surfaces and allow it to harden under damp conditions before subsequent coats are applied. The dash coat shall consist of 1 part cement to 2 parts coarse sand or crushed stone mixed wet and forcibly applied onto surfaces.

12.4.10.8 External render

External render shall be applied in two coats to a minimum 12 mm finished thickness.

The first coat shall comprise cement, sand and lime, mixed in the proportions of 2:8:1, applied to the surface to fill all hollows and to finish to a generally true 8 mm minimum thickness. The Contractor shall scratch the surface whilst green to provide a key.

The second coat shall comprise cement, sand and lime mixed in the proportions of 4:16:1 and finished 4 mm minimum thickness. The Contractor shall trowel off a true plumb, level surface to an approved fine, even finish with a wooden float and clean sponge.

12.4.10.9 Internal render

Internal wall areas which are specified to be rendered shall be provided with a 15 mm minimum finished thickness in two coats. All indents and irregular faces shall be dubbed out and scratched before plastering is commenced, using the same mix as for the first coat.

The first coat shall be composed of fifteen parts sand, four parts cement and one part lime, rendered to a true even thickness with a wood float, and scratched lightly as a key for the second coat. The Contractor shall finish the second coat without joints in the height or length of walls.

The second coat shall be composed of four parts approved silica sand, two parts cement and one part hydrated lime evenly and regularly worked into the whole surface, and finished in its own moisture to an approved fine, even sand finish with a plastic foam pad fixed to a wooden float.

A minimum time of 48 hours shall elapse between coats. Mixes for scrub fines shall be screened through a No. 30 sieve before water is added.

12.4.10.10 Textured coatings

12.4.10.10.1 General

Where specified or shown on the drawings, a textured coating shall be supplied to all external masonry and concrete surfaces of the building. The textured coating shall comprise a decorative coating for application to concrete and masonry surfaces.

A guarantee shall be submitted prior to the issue of the Practical Completion Certificate covering all surfaces to which a decorative coating is applied, against material deterioration or defect or faulty workmanship in application of the material for the period of 10 years from the Date of Practical Completion.

An applied sample shall be provided on the site for approval before proceeding with the work.

An applied sample of not less than 4 m^2 in area shall be applied to a surface where directed, such surface encompassing all the variations likely to be encountered in the coating of the substrate in its entirety. The applied sample shall be as near as practicable in colour and texture to the design or site sample supplied by the coating manufacturer or the agent for the decorative coating which shall be kept on site for reference. When approved, the panel will be used as the standard of finish on the project.

The design or site sample shall have a grainy texture of the applied coating system when dry with the selected colour. The design or site sample shall be supplied by the coating manufacturer or the manufacturer's agent soon after the commencement of construction.

The applied sample shall present the colour, texture and minimum dry film thickness of the completed coating. The applied sample shall be applied no later than one month after sufficient of the substrate has been constructed and made good to provide the range of variations of substrate condition that are likely to be encountered in the coating of the substrate in its entirety.

The panel shall be preserved until all work of its type is completed.

12.4.10.10.2 Material

The decorative coating shall be as per Icon Water's *Approved Products List (STD-SPE-G-006)*.

All materials comprising the coating system shall be delivered to the site with all containers, seals and product identification intact. They shall be fully protected against frost and damp during transport and while on site.

The coating system shall consist of a 6 mm average thickness, an acrylic modified cement render, followed by one coat of sealer primer, an acrylic PVA primer, which shall be followed by an application of 1 mm average thickness of an acrylic heavy duty coating. The binder shall comprise acrylic emulsions, titanium dioxide, concentrated anti-fungicides and highly durable pigments and fillers. The texture-building ingredients shall comprise quality graded fillers and aggregates, with the pigment of selected colour throughout the coating and having a satin finish.

12.4.10.10.3 Workmanship

All work shall be carried out by a specialist firm approved by the manufacturer of the decorative coating and designated by the manufacturer as an "approved applicator" and approved by the Icon Water Representative. All work shall be carried out in strict accordance with the manufacturer's recommended application procedures.

The Contractor shall ensure that the applicator of the decorative coating is satisfied with the standard of the substrate to enable the finish of the decorative coating to match that of the applied sample. For off the form, fair faced concrete, the minimum standard of the substrate shall be as described in AS 3610 Table 3.3.1 as Class 2 concrete.

For masonry, the minimum standard of the substrate shall be as described in AS 3700. As the natural joint pattern is not to appear, blockwork shall be fair faced and flush jointed.

All masonry shall be rubbed down with a piece of concrete masonry prior to the application of the decorative coating.

All substrate shall be free of dirt, grease, paint, scaling and laitance, efflorescence, mould, fungi, infection, stains, rust, form oil, mastic compound and any other foreign matter. It shall not be subjected to continual wetting or hydrostatic pressure.

The Contractor shall make good any substrate which is not in accordance with these standards. Adequate protection shall be provided to all surfaces adjacent to the surfaces onto which the decorative coating is to be applied and shall be removed on completion of the application.

Application should not be carried out at below 5 degrees Celsius nor above 36 degrees Celsius. In particularly dry and/or windy conditions, the allowable coating working temperature range will be reduced further by the Icon Water Representative at their discretion.

Any day work joints of the coating shall be approved by the Icon Water Representative.

Internal and external angles shall be true and square. The Contractor shall cut-in against other materials to provide a true joint as directed.

All expansion joints shall be sealed or filled after the coating has been applied. Care shall be taken when joints are sealed or filled so as not to stain or interfere with the final coating.

All work shall be finished even, hard and true, free from stains or other imperfections. Any drummy work shall be cut out and made good.

The finished coating shall match the approved applied sample in colour, texture and uniformity.

All finished work shall be properly protected against damage from the sun, freezing, rain, workmen on site or any other cause. The work shall be provided with protection from freezing not less than 48 hours after application, from abrasive contact for a period of not less than 7 days after application and with protection against direct impingement of water or other liquids not less than 24 hours after application.

The Contractor shall refer to the project drawings or the Schedule of Finishes for the extent of the decorative coatings externally. All concrete surfaces and blockwork externally shall have the decorative coating applied.

The Contractor shall generally make good after all other trades. The Contractor shall undertake all pointing and stopping necessary and leave the finish of all walls and all other surfaces in a neat and tidy condition, ready for painting or handing over.

12.4.11 Tiling

12.4.11.1 Preparation of surfaces

The Contractor shall prepare concrete surfaces to receive applied finishes and remove all laitance.

If necessary the Contractor shall use a special approved plasticised epoxy bonding agent where toppings are applied to concrete surfaces.

12.4.11.2 Workmanship

All work shall be carried out by skilled tradesmen in a first class workmanlike manner. All tools, screeds and grounds shall be kept clean.

Surfaces shall be checked to ensure correct finished alignments and levels. The Contractor shall ensure that built-in elements, anchors and grounds are fixed prior to commencing and protect adjoining or abutting surfaces against damage through any cause.

Permanent and temporary grounds shall be fixed where and as necessary to ensure straight even surfaces and accurate lines.

The Contractor shall keep surfaces even, true, free from blisters, dropping, trowel marks or other defects and shall screed at all angles, corners and elsewhere as necessary.

All external openings shall be covered to prevent too quick drying and ensure that freshly completed work can neither dry out nor sweat out to the detriment of the surfaces.

The Contractor shall dispose of compo mixed with cement longer than one and a half hours. Retempering shall NOT be allowed after this time.

Where necessary, brass angles 3 mm thick, shall be provided at doorways to build up tiled areas above the general floor level.

12.4.11.3 Protection

The finished work shall be protected from damage by the weather and building operations and keep covered and moist for a minimum of 7 days.

12.4.11.4 Cleaning

On completion the Contractor shall clean down surfaces to remove all dirt, stains, etc. and buff polish all tiled surfaces to give a smooth, even appearance.

12.4.11.5 Ceramic floor tiles

Ceramic floor tiles shall be an approved Australian brand tile 50 mm x 50 mm x 6 mm fully vitrified tile of the colour shown on the drawings or specified in the project specification or schedule of finishes.

Floor tiles shall be laid on 1:1/2:4 cement, lime and sand bedding of 20 mm minimum thickness throughout. The back of tiles shall be coated with 1.5 mm thick neat skim coat and shall be bedded well down into position, to an even fall to floor waste and to a level line around all walls.

Tiles shall be cut with an abrasive saw, or nipped and ground to profile. Work shall be set out to full tiles wherever practical.

Tiles shall be set out with 2.5 mm joints and filled with grout.

Tiles shall finish to true, even surfaces, regular lines, evenly graded to outlets and free from defects.

12.4.11.6 Quarry floor tiles

Quarry tiles shall be an approved Australian brand tile 150 mm x 150 mm x 12 mm with non-slip surface, the colour shall be as shown on the drawings or as specified in the Job specification or Schedule of Finishes.

12.4.11.7 Ceramic wall tiles

Wall tiles shall be an approved Australian brand fully glazed tile 150 mm x 150 mm x 6 mm cushion edged of colour and glaze as shown on the drawings or specified in the project specification or Schedule of Finishes.

Tiles shall be fixed with a two-part water proof adhesive to fibrous cement or rendered masonry walls. Where necessary, fibrous cement walls shall be rendered to achieve the tolerance provided.

Tiles shall be laid with joint lines levels and plumb and accurately set out. Cutting of tiles shall be at internal angles as necessary. Edges and external corners shall finish with glazed edge tiles. Tiles shall be stack bonded.

The Contractor shall build in all accessories and other elements as required. Where necessary, the Contractor shall drill for fixing of other attachments and cut tiles close up around plumbing fixtures and other brackets and fittings.

12.4.11.8 Grouting

After tiles have been fixed for a minimum of 24 hours, the Contractor shall grout up with white cement, well worked into joints and rake back exposed edges of tiles and point and grout as for face of tiles.

Junction of tiles with joinery and door frames shall be cut 5 mm wide for the full depth of tile and bedding and be pointed up with one part polysulphide sealant, of approved brand, applied in accordance with manufacturer's directions.

All surfaces which are tiled shall finish to true lines or planes within a tolerance of 3 mm in 1.5 metres.

12.4.12 Painting

12.4.12.1 Materials

All paints shall be ready mixed, of an approved brand and type and shall be in accordance with WSA 201 and Icon Water's supplement to WSA 201 (*STD-SPE-G-005*).

All materials shall comply with the ACT Government regulations regarding the use of non-poisonous paints. Paint shall be brought on site in its original sealed containers. The use of bulk materials other than the best quality shall not be permitted.

Thinners, stainers, primers and undercoats shall be of the type supplied by the manufacturers for use with the various types of paint.

Putty shall be approved linseed oil - whiting putty stained as necessary to match adjoining work. Plaster based patching powder compound shall be used for porous and fibrous cement surfaces.

12.4.12.2 Workmanship

All paints shall be thoroughly mixed and stirred before use.

Primed or undercoated work shall not be left in an exposed unsuitable situation for an undue period of time before applying subsequent coats.

An adhesive tape test shall be applied to plastered walls before painting commences. Painting shall not commence until surfaces are in an approved finished condition to receive paint.

12.4.12.3 Preparatory work

12.4.12.3.1 Timber

All knots and gum veins shall be treated with patent knotting. All nail holes, open joints and cracks shall be filled. All woodwork shall be rubbed down with sandpaper and all roughness removed. All work specified to be clear finished shall be filled with approved patent filler and sanded down to smooth surface. All exposed corners shall be provided with a uniform arris by hand planing.

12.4.12.3.2 Metal

All metal surfaces shall be clean, smooth and dry, free from mill scale, grease, rust, tar, oil and other foreign matter. Surfaces shall be properly sanded and brushed down.

Metal work shall be degreased with mineral turpentine prior to applications of priming coat, etch primer, or red oxide primer as appropriate. All galvanised surfaces shall be etch primed. Shop primed metalwork shall be spot primed on site with matching primer.

Cast/ductile iron pipes shall be filled and sealed with an approved industrial coating compatible with the finish coats nominated in the project specification or schedule of finishes.

12.4.12.3.3 Masonry Surfaces

All nibs shall be removed and all minor cracks and imperfections filled and sanded down.

Where acrylic paint is specified, the Contractor shall dampen masonry surfaces as recommended by the manufacturer, prior to application of paint.

Where satin and flat enamel finishes are specified, masonry surfaces shall age for at least 6 weeks and gypsum plaster and fibrous cement surfaces for at least 30 days, before painting.

12.4.12.3.4 Rubbing Down

All timber and joinery work shall be lightly rubbed down between coats with fine sandpaper and brushed clean.

12.4.12.4 Application

All materials shall be used strictly in accordance with manufacturer's written instructions. Paint shall not be spread beyond its covering capacity.

All coats of paint shall be evenly and smoothly applied with full cover to all parts, finished free from blotches, brush marks, runs, sags, and other defects. Each coat of paint shall vary in tint from the preceding coat.

Each coat of paint shall be allowed to harden in accordance with the manufacturer's instructions before the next is applied.

Painting shall not be carried out in adverse weather conditions. No clear finishes shall be applied in wet or foggy weather.

Painting shall be left till such time in the work program to ensure that other trades have completed work in painted areas thereby minimising damage and patchwork to the finished surface.

The Contractor shall comply with all necessary safety precautions as recommended by the manufacturer and any relevant authority when handling and applying paint coatings. This shall include the use of protective clothing, skin creams and breathing masks as appropriate. Adequate ventilation and lighting shall be maintained at all times during the application and drying of paints.

The Contractor shall finish one colour against another to a true straight line and cut in against glass, metal frames and other junctions similarly.

The Contractor shall adequately protect all floors, fittings and other surfaces during painting, with drop sheets and masking as necessary.

All door hardware, switch plates and similar items shall be removed before adjoining surfaces are painted and replaced accurately on completion.

12.4.12.5 Clean up

All paint spots shall be removed from floors, tiles, light fittings, switch plates, hardware, stainless steel, aluminium, chrome plate, glass and all similar surfaces.

Glass and metalwork shall be cleaned and polished and the work of this trade shall be left in first class condition.

After completion of painting work, the job shall be thoroughly cleaned and tidied. The Contractor shall be fully responsible for any damage by his staff, suppliers and sub-Contractors and shall make all repairs as deemed necessary.

Appendix A – Technical Specification Update History

A.1 Update History

Issue C (04/11/16): Initial issue for use by Stantec (formerly MWH) for works at LMWQCC only.

Issue 1 (20/04/18): Updated and re-issued for works across all Icon Water asset areas.

Issue 2 (03/09/21): Updated and re-issued with minor amendments.

A.2 Issue 2 Updates (03/09/21)

Section	Update(Note 1)	
Definitions	Chartered Engineer:	Wording added as follows “A Registered Professional Engineer or Professionals Australia (RPEng) is considered equivalent to CPEng”.
Definitions	Developer:	Typo correction – “STD-SPE-G-019” now amended to “STD-SPE-G-019”
Definitions	Qualified Surveyor:	Added definition.
5.2.2	Table 5.2.2.1 Item 1.7 Project Specification:	Wording added as follows “Icon Water does not allow the use of NATSPEC (National Building Specification) as the basis for any civil or structural specification unless approved in writing by Icon Water’s Principal Civil Engineer”.
5.4	Survey:	“Registered Surveyor” updated to “Qualified Surveyor”.
8.4.1.4 and 8.4.1.5	Concrete delivery temperature:	Minimum concrete temperature at time of discharge changed to 5 °C (was 10 °C). Maximum concrete temperature at time of discharge changed to 35 °C (was 32 °C).
8.4.5	Cold weather concreting:	Wording added as follows “by implementing measures such as heating the water or aggregates”.
10.4.7.2	Galvanising:	Wording added as follows “Specifically, in the case of guardrails, guardrails shall be tack welded on site, removed and then fully welded. Galvanising shall only be applied after fabrication has been completed”.

Notes:

1. The updates in the table above refer to additional product approval in Issue 2 (compared to Issue 1) unless shown otherwise.

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Talk to us

E talktous@iconwater.com.au
T 02 6248 3111
@iconwater

GPO Box 366,
Canberra ACT 2601

iconwater.com.au