Sydney WATER

Water Reservoir General Technical Specification

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Revision details

Version No.	Clause	Description of revision
1.0		Final issue for use

Introduction

This Specification is for the design, supply and construction for Water Reservoirs for Sydney Water assets.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification shall be sufficient to ensure safe systems or work or operation.

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Abbreviations and Terms

Term	Definition
AICV	Automatic Inlet Control Valve
AMS	Asset Management System
ASCV	Automated Shut-off Control Valve
CGD	City Growth and Development Team – in Sydney Water
DC	Delivery Contractor
DE	Digital Engineering
DM	Delivery Management
ECC	Engineering and Construction Contract
EDMS	Engineering Drawing Management System
EICV	Emergency Inlet Control Valve (also referred to as Inlet Emergency Control Valve)
FDS	Functional Design Specification
FIFM	Flow Isolation Flow Management
FMECA	Failure Mode, Effects and Criticality Analysis
GIS	Geographical information system
HIDRA	Hazard Identification and Risk Assessment
HIPO	High Incident Potential Occurrence
HSEQ	Health, Safety, Environmental, Quality and Community
ICAM	Incident Cause Analysis Method
IECV	See EICV above
IFC	Issued for Construction
IMP	Incident Management Plan
IMTE	Inspection, Measuring and Testing Equipment
KPI	Key Performance Indicator
LTI	Lost Time Injury
NABC	Needs Approval Business Case
OABC	Options Approval Business Case
OHS	Occupation Health and Safety
OTS	Operational Technology Services
P&ID	Process & Instrumentation Diagram
PCBU	Person Conducting a Business or Undertaking
PIRMP	Pollution Incident Response Management Plans (Client provided)
PM	Project Manager
PMP	Project Management Plan
PRV	Pressure Reducing Valve
POEO	Act Protection of the Environment Operations Act 1997
PSC	Professional Service Contract
PSV	Pressure Sustaining Valve

Term	Definition
QMP	Quality Management Plan
QMS	Quality Management System
RA	Report Actions
REF	Review of Environmental Factors
RDC	Regional Delivery Consortium
RFI	Request for Information
SoW	Scope of Work
SWC	Sydney Water Corporation
WBS	Work Breakdown Structure
WMS	Work Method Statements
WPO	Work Package Order
WTP	Works to Proceed

1. Scope

1.1 Introduction

This specification sets out the general design and documentation principles and methodology that Sydney Water Corporation (SWC) requires to be fulfilled by designers and constructors in relation to new surface and elevated reservoirs and their associated site facilities. The criteria shall also be used for retrofitting and renewing components to existing reservoirs where possible.

For the design of refurbishment work for existing reservoirs, the intent of this document shall be complied with as far as it is economically justifiable, particularly with respect to roof replacement work.

This specification for new reservoirs does not necessarily reflect the need to upgrade existing older reservoirs. However, some upgrade may be opportune at the time of major works, such as reservoir relining, where items such as wall access hatches, davits, cathodic protection and internal ladders, may be considered for upgrade. Other items, such as access security, gauge boards, chamber covers, and sample points are to be assessed on a site by site basis or as a total water system upgrade to meet new policy.

This specification is generally developed for surface and above ground reservoirs with a steel or concrete wall and floor and with steel or aluminium roof. Where other reservoir designs are proposed the general concepts and intent of this document shall apply.

Innovation and new ideas are actively encouraged and may be acceptable to SWC if they deliver an operable and maintainable solution and should comply with the intent of this specification.

Where there is a conflict between another Sydney Water document and this document in relation to reservoir design or construction, this document shall take precedence.

1.2 Scope Covered

The principal items of work to which this document applies are:

- Concept design for reservoir including survey and geotechnical investigation.
- Documentation including detailed design calculations, design drawings, workshop and fabrication drawings.
- Operations and maintenance manual and “Work-as-Executed” drawings.
- The rehabilitation works at the site as detailed in the respective clause of the Site Specific Technical Specification.

2. General Requirements

The design life of the structural components of the reservoir and any components, which are not accessible for maintenance, must be at least 100 years. The reservoir shall be designed in accordance with this design criteria in this document, SW Technical Specification- Civil, available standard drawings and the relevant consent conditions from regulatory departments.

The reservoir designers shall investigate appropriate shapes, surface area to effective storage volume ratio, materials, reservoir access and egress, inlet/outlet orientation and configuration, reservoir baffles and mixing devices to determine the combination which will maximize the mixing zone and that will best result in minimising the reservoirs mixing and detention time.

Designers shall locate the reservoir to minimise excavation while limiting the visual impact of the reservoir on the surrounding neighbourhood.

The designers shall be responsible for undertaking a geotechnical investigation (including phreatic information) and determining the most suitable founding level for the reservoir.

The design and construction of the reservoirs must also adhere to the requirements of the latest version of the following Sydney Water Specification:

- Technical Specification - Civil (CPDMS0023).
- Technical Specification - Mechanical (BMIS0209).
- Technical Specification - Electrical (CPDMS0022).
- Instrument and Control Standards TOG_TS01 and TOG_TS02.

3. Site Preparation

3.1 Safety

The design of the reservoir shall take into account all relevant safety codes, regulations and how their design will affect the health and safety of those who will interact with the asset throughout its life.

In particular, the requirements of the management specification as per part 3 and 7 and SWC Safety in Design procedure must be followed.

The design and construction of the reservoir and associated infrastructure shall consider the practicability of future operational and maintenance requirements, in particular OH&S needs. It shall focus on attempting to eliminate problems at the design stage rather than creating future weaknesses, which result in the need to redesign, implement special safety precautions, special procedures or administrative controls.

As part of applying safety hierarchy of control to eliminate or reduce safety risks, considering shall be given at reservoir functions such as secondary disinfection and how this can be catered for such as on ground access.

3.2 Heritage

Some Sydney Water reservoirs are a listed heritage item and appear on Sydney Water's Heritage Register and the State Heritage Inventory.

If the reservoir being refurbished is a listed heritage item and/or the site contains some other heritage listed item(s), the design of the reservoir must take into account all relevant requirements including Heritage ACT 1977 and Heritage Compliance Procedure – SWEMS0031.

3.3 Environmental

The design of the reservoir shall take into account all relevant environmental regulations and SWC guidelines and protocols. In particular the following are to be considered:

- Schedule of Environmental Requirements – SWEMS0015.04.
- The project Review of Environmental Factors (REF).
- SWC water discharge protocols especially considering the particular receiving waters.
- Specific council environmental requirements.
- Sydney Water's Lead Management Guidelines and AS 4361.1 Guide to Hazardous Paint Management.
- Application of circular economy principles in relation to construction, ongoing maintenance, material selection, products used to reduce environmental impacts.

3.4 Earthwork and Excavation

All excavation, earthworks for the foundation design and construction must be undertaken in accordance with Sydney Water Technical Specification - Civil.

3.5 Erosion and Sediment Control

The design of the reservoir shall take into account all relevant regulations and SWC guidelines and protocols to minimize the erosion. In particular the following are to be considered;

- Schedule of Environmental Requirements – SWEMS0015
- Technical Specification Civil – Part 2.

3.6 Reservoir Isolation

Reservoir isolation must be undertaken in accordance with Sydney Water's Flow Isolation Flow Management (FIFM) process. Unless otherwise specified in the Site Specific Technical Specification, the reservoir must be emptied for the construction of refurbishment work.

The Delivery Contractor must be aware that double isolation of the inlet and outlet main(s) to reservoir may not be possible.

Unless otherwise detailed, a blank flange on the inlet(s) and outlet(s) of the reservoir must be installed to provide additional isolation. All blank flanges must have a suitable tapping point to ensure there is no pressure build-up behind the flange. The flange shall be in accordance with AS 2129 Table D.

If the pipe is not flanged, a flange must be installed before internal rehabilitation work on the reservoir can commence. The size and welding requirement for the new flange shall be in accordance with the latest version of the Water Supply Code of Australia Sydney Water Edition.

In some reservoirs, the inlet and/or outlet valve may not completely seal. Any leaking water from these valves must be captured and directed it to the scour or elsewhere, such that it does not affect work within the reservoir or become a hazard.

During refurbishment work, the robustness and soundness of the isolations of water mains must be monitored. Any anomalies must be reported immediately to Sydney Water.

3.7 Site drainage

Reservoir, road, footpath and site drainage must be conveyed to the appropriate watercourse in suitable conduits to minimise erosion both on and off the reservoir site.

Drainage discharge and erosion control must be incorporated into the site drainage design. Energy dissipaters must be designed to prevent erosion from high velocity discharge from scours and overflows.

Where required by the local council or in areas of high residential density, site detention measures must be incorporated into stormwater discharge. This might include design of OSD tank in accordance to the relevant council requirements.

The stormwater collection and discharge system must be designed to avoid creating saturated or boggy ground both on the site and in adjoining properties.

Drains, particularly those around the perimeter footpath must be designed to minimise silting with no discharge is allowed on the batters or backfilled slopes.

Drainage must be provided from valve pits. Gravity type drainage is preferred. shall be designed to minimise erosion and subsequent silting of any drains collecting stormwater runoff. Where the reservoir is subject to ponding if the drain blocks, drain pipework should be oversized to minimise chance of blockage.

3.8 Survey

All site set-out and survey work, where survey work also includes the production of WAC records, must be conducted in accordance with technical specification civil part 1.

As a minimum for project related to reservoir construction or refurbishment, a licensed surveyor must carry out duties including:

1) Prior to construction commencing, establish site boundaries and easement boundaries and the location of the tank in accordance with the drawings and benchmarks.
2) During construction activities to check on;
   - the levels of inlet and outlet pipes
   - levels of overflow pipe
   - grading of the tank floor slab
   - verticality of the tank walls
   - height and consistency in the level of the rim of the tank
   - diameter of the tank and roundness of the tank (if circular)
   - straightness of walls and internal angles of tank (if not circular).

4. Condition Assessment of Existing Reservoirs

Pre-Construction condition assessment data must be gathered through direct inspection, observation and monitoring. The information must be analysed and interpreted to determine the structural condition and serviceability of the asset. The pre-condition inspection report must also be used for comparison with the post-construction condition assessment to determine if there has been any damage.

4.1 Inspection scope

- A level 1 inspection is limited to a visual assessment only. The extent of the visual inspection is divided into two parts: (1) the external inspection (including the area surrounding the reservoir) and (2) the internal inspection of the atmospheric and below water elements.
- The primary elements which must be assessed must be recorded in the inspection sheet. The reservoir must be inspected from accessible areas only.

4.2 Inspections levels and planning

Reservoirs are inspected in multiple stages. The first inspection stage (Level 1 inspection) is typically performed by operators/ diving contractors/ non-technical professionals (all are termed as 'Inspector'), as a cursory visual inspection which covers both the internal and external of the reservoir. This inspection is based on visual assessment only, and its purpose is to provide an understanding of the reservoirs condition and identify those reservoirs that are in need of detailed inspection (Level 2). Detailed conditional inspection is an in-depth inspection completed by a suitably qualified engineer and any special condition must be developed and agreed prior to undertaking the assessment.

4.3 Competency

Personnel with appropriate competencies must be engaged to carry out condition assessment. The engagement must review its engineering competency requirements as per D0000833 Engineering Competency Standard to facilitate in the selection of the appropriate resources for the Works.

The requirements of this standard apply to all persons involved in design of SWC's assets.

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4.4 Structural Appraisal

Structural members within the reservoir can suffer deterioration from a range of modes, generally either physical or chemical. If critical elements within the structure deteriorate, the structural integrity can be affected which can result in failure of those elements.

The purpose of this section is to identify key locations and elements within a reservoir which are susceptible to deterioration. The intention is for level 1 inspectors involved in the assessment of surface reservoirs to be able to readily identify if a structural element is exhibiting critical signs of deterioration.

Error! Reference source not found. Table 1 provides information on specific types of deterioration modes which are prevalent in reservoir elements and what a level 1 inspector should be looking for whilst undertaking an inspection.

Table 1 Key signs of deterioration on reservoir elements

Element	Key signs of deterioration
Steel elements	• Pitting corrosion on beams, purlins, tank columns and connections • Galvanic corrosion at connections, particularly on kick plates, cleats, hand rails, walkways and roof sheets • Cracking in any steel element, particularly at joints, beams, columns and purlins • Buckling or distortion of any steel member, particularly beams, purlins, columns and roof sheeting • Any loose or missing connections, particularly on kick plates, cleats, hand rails, walkways and roof sheets; and • Widespread coating breakdown on any coated steel element exposing bare metal • Welding cracks • Loss or missing bolts
Concrete elements	• Corrosion of reinforcement on any concrete element • Spalling of concrete elements which have exposed the reinforcement or prestressing strands • Scaling on concrete elements where aggregate has been exposed • Leaching through a crack where a large amount of efflorescence has built up • Porous concrete sections which appear to have become weakened • Any previous repair which has cracked or spalled • Cracks in concrete elements which are greater than 0.3 mm wide
Foundation/Footing	• Instability signs including cracks on the ground surface • Gaps or voids forming between footing and other elements • Cracks in other elements of the reservoir structure (i.e. walls) • Obvious deflection, instability or deformation • Settlement cracks or signs of ground movement in the vicinity of footings, on pavements or on other ground surfaces • Signs of slope instability around the reservoir footings

4.5 Defect identification

4.5.1 Concrete elements

Assessment of concrete elements in the reservoir must include deterioration modes including:

Corrosion of Reinforcement

Reinforcement bars within a concrete element are protected by the alkalinity of the concrete. The ingress of chloride ions, air, moisture and other elements above a particular threshold can cause the protective layer around the reinforcement to breakdown. Corrosion initiation can commence once the passivating layer around the reinforcement has broken down or chloride concentration at the reinforcement level has exceeded a threshold (pitting corrosion).

Corrosion of the reinforcement can appear on the concrete as rust stains, cracks, delamination and spalling.

Scaling

Scaling is related to the flaking of sections of concrete or mortar from the surface of the concrete. As the degree of scaling increase over time the coarse aggregates get exposed and can become loose or detach from the concrete.

The degree of scaling can be categorised into light, medium and severe:

- Light scaling – Loss of surface mortar only
- Medium scaling – Loss of mortar with exposed aggregates; and
- Severe scaling – Loss of mortar and coarse aggregate.

Leaching

Leaching appears on the concrete surface as a white deposit or efflorescence of either salt or lime powder. Leaching is caused when water flows through the cracks and pores in the concrete, dissolving minerals such as portlandite ($Ca(OH)_2$). When the water evaporates, the dissolved minerals are deposited on the surface as a white powder.

Failed Repairs

Failed repairs refer to previous repair or remediation works which have been undertaken within a concrete element. A previous repair is an indication that the element/structure has previously been damaged or sustained deterioration and should be evaluated during inspections. The repaired sections condition can be a reflection on whether the original issue has been resolved. Defects such as cracking, spalling and delamination are all indications that the repair has failed, and the original issue may still be present within the structure.

Honeycombing

Honeycombing is when there is voidage between the coarse aggregates within the concrete. It is caused by a lack of vibration or compaction in the concrete during placement. Honeycombing can result in the concrete being permeable and weak.

Spalling

Spalling is defined as when a fragment of concrete detaches from a larger mass. The main cause of concrete spalling is the deterioration of concrete through reinforcement corrosion which can lead to the accumulation of steel corrosion products at the interface between the reinforcement and the concrete. These corrosion products exert stresses on the concrete and can lead to spalling.

Cracking

Cracks can occur in a concrete element due to numerous mechanisms. Cracking in concrete can be an indication that the concrete is suffering some degree of deterioration. There are numerous types of cracks which can occur in concrete and as the significance of each crack differs, any cracks found to be greater than 0.3 mm wide should be identified to allow further analysis to be undertaken.

4.5.2 Steel Defect identification

Assessment of steel elements in the reservoir must include deterioration modes including:

Loose/Missing Connections

In steel members, loose or missing connections can lead to accelerated deterioration of the element. Common causes of loose or missing connections within steel members are incorrect installation, corrosion or vibration.

Cracking of Welds

All cracks in welds are considered to be severe and require further investigation. If a weld is found to have cracked (irrespective of size and location) the location and degree of cracking must be recorded.

Cracking

Cracking can occur in steel elements due to a number of reasons. Common causes of cracks in steel elements are loading, fatigue and stress. Cracking in structural members can cause serious issues. Due to this any cracking in steel elements must be recorded.

Galvanic Corrosion

Galvanic corrosion is corrosion associated with the current resulting from the electrical coupling of dissimilar metals in an electrolyte. Galvanically accelerated corrosion can also occur due the creation of anodic and cathodic regions on a metal surface by the formation of differential aeration cells or differential concentration cells. A typical example of galvanic corrosion in a reservoir is where a stainless steel bolt has been used to fasten a mild steel handrail to the reservoir.

General (Uniform) Corrosion

General corrosion is a type of deterioration which is roughly distributed uniformly over the surface of an element. Although a corroding metal surface comprises discrete anodic and cathodic sites, the distribution of anodic and cathodic sites will change with time in a uniform electrolyte and the metal loss may appear to be generally distributed as semi-protective corrosion product films develop.

Localised Corrosion

Localised corrosion is a localised corrosion activity caused by changes in the environment and/or the composition and microstructure of the metal, including the effects of galvanic cells and microbiological activity. Pitting is one form of localised corrosion. Crevice corrosion and flow enhanced corrosion, such as impingement attack and erosion corrosion, are other forms. Localised corrosion may also be caused by microbiological activity.

4.6 Protective coating testing

An internal and external coating inspection must be carried out to determine the existing condition and feasibility for repairs. The testing must be carried in accordance with WSA 201 clause 6.2.6.1 “Existing Coatings” and AS 2312 Table 8.2 “Assessment of Coating for Feasibility of Repair.”

Internal coating inspections may be limited to a visual inspection and dry film thickness testing of upper strakes whilst the reservoir is online. Remote Operated Vehicle (ROV) inspections can provide some useful information as to the coating condition below water level.

Reservoir internals which are bitumen lined must be fully removed and epoxy coated. Therefore, a condition assessment of the bitumen coating is not required.

The external coating assessment must also take into consideration the existing coating type (e.g. lead based primer), hence sensitive receptors such as proximity to houses, childcare centres, parks, and waterways may warrant a more risk adverse approach.

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5. Engineering Assurance

5.1 Personnel Competency

The complexity and level of detail required for complex or high-risk assets, and understanding the risks to Sydney Water assets, requires engineers with appropriate qualifications, in-depth knowledge, high levels of skills and experience. Closely coordinated analysis and reporting is required between the various engineering disciplines.

The engineering competency requirements must be reviewed considering all relevant regulations and SWC guidelines including:

- Management Specification – Part 4.
- SWC's Engineering Competency Standard.

5.2 Verification and Independent Verification

The Sydney Water Engineering Competency Standard sets out minimum requirements for competency of personnel undertaking various engineering tasks including design and independent verification.

The Design Management Plan documentation must include as a minimum :

- Discuss the records of design and development inputs.
- Provide certification from competent engineers.
- Discuss, threshold criteria, adopted site specific impact criteria, conformance with impact criteria, and any non-conforming results.
- Provide condition surveys and appraisal of the existing condition of the assets.
- Document corrective or asset protection measures to be undertaken, if required.

Sydney Water may review the submitted design and provide comment for consideration. Sydney Water does not verify the design process or calculations. Sydney Water review of the submitted documents including any supporting documentation does not relieve the author(s) of their responsibilities. Responsibility remains with the author(s).

5.3 Quality Control

The design documents must be prepared in accordance with a quality management system complying with ISO 9001. It must specifically address all Sydney Water assets at risk from the building works and must cover all aspects that may be of influence.

Where applicable, it is the expectation of SWC that the Contractor will eliminate, prevent, reduce or mitigate any quality impacts and assist SWC to fulfil its quality compliance obligations. The Contractor will ensure to continually improve on its quality performance in ways that are responsible and valued by SWC. The Contractor is expected to align itself with SWC's Management System section.

6. Documentation and Performance Requirements

6.1 General

The minimum information required in the title block of each drawing submitted is as follows:

- Name of the Contractor.
- Name of the reservoir.
- Reservoir number.
- Reservoir capacity in megalitres.
- Reservoir diameter and effective height.
- Title of the drawing.
- Drawing numbers to be obtained from Sydney Water Design Services.
- Name, address and contact details of the Contractor.
- The name of the designer, verifier and person approving the drawing.

The format shall be to SWC standards including the standard drawings title and in line with Management specification – section 4.

The status of the drawing shall also be indicated (preliminary, for review, final). Drawings submitted prior to final sign-off shall be issued with a draft number associated with the drawing number. Changes to final, signed drawings shall be issued with an issue letter.

6.2 Design Drawings

The principal items of work to which this document applies are:

- Concept design for reservoir including survey and geotechnical investigation.
- Documentation including detailed design calculations, design drawings and workshop drawings.
- Operations and maintenance manual and "Work-as-Executed" drawings.

The design for all new reservoirs must provide details for the relevant components at every stage of submission as pe the following.

Table 2 Stages of design Submission

Stage of submission	
Concept – **30% design stage**	• Site layout and indicative location on site • Tank main sizing and specification • Earthworks. • Structural systems for floor, walls and roofing (Concept only) including alternative systems worth considering • Foundations, earth retention and ground treatment. • Perimeter footpath and drainage. • Access roads within site. • Access hatches locations through the reservoir wall and roof.
Preliminary – **50% design stage**	• External stairs, internal rung ladders, safety cages, platforms, landings, including main access platform to enable access to the reservoir via its roof. • Roof access and ventilation hatches, including hatch locking devices, security alarm features, safety screens and working platforms with suitable handrails. The use of a removable roof panel at a convenient location to allow hoisting of machinery and equipment and to minimise the total number of hatches is preferred. • Inlet, outlet, overflow, diver vacuum outlet and scour pipework, complete with flanges, valves, support brackets, foot stools, anchor blocks, pipeline connectors and spigot bands as required. • Electrical installation relating to power for equipment operation, and instrumentation and control. • Site drainage and scour discharge arrangements. • Vermin proofing of the reservoir include roof/wall interface, overflow pipe, ventilation Roof chlorine dosing hatches (if required).
Detailed – 80% design stage	• Roofing and roof support structure sizes and connection details • Floor and walls of reservoir structure details • Foundations, earth retention and ground treatment details • Erosion and sediment control measures. • Drainage.

	• Outlet screen support rings and brackets. • Cathodic protection system (Vandal Proof). • Accessible water quality sampling tap (Vandal Proof). • Chlorine dosing tap. • Chlorine analyser. • Lightning and earthing system. • Painting and protective coatings in accordance with Sydney Water's Protective Coating Specifications. • Landscaping. • Boundary fencing (chain wire type). • All other works that may be necessary to construct and commission a fully functional reservoir.
IFC – 100%	• Finalising any outstanding details from earlier stages of the design process • Float switch brackets and conduits for installation of telemetric control by others. • Water level sensing devices and float switches and related telemetric transmitter and interfaces. • Overflow alarm switch and conduit brackets • Security fencing and gate around external stairway. • Restoration of site. • Switchgear and control gear kiosk.

6.3 Design data

The following data shall be identified for the reservoir at the commencement of design and shall also be shown on the Design Criteria Drawing, which shall be accepted by Sydney Water before proceeding. All levels shall be in Australian Height Datum (AHD).

- Type of reservoir construction for roof, walls, floor and foundations.
- Nominal internal diameter (m) or critical dimensions if not circular.
- Nominal capacity (ML).
- Operating storage (ML).
- Reserve storage (ML).
- Dead storage (ML), if any.

- Ground level at centre of reservoir (m).
- Height to full supply level (FSL) (m).
- Minimum operating level (Obvert of outlet pipework).
- Maximum delivery flow (ML/day).
- Overflow level (m).
- Inlet, outlet, overflow and scour diameters (including orientation & configuration).
- Water quality management devices (eg. mixer, baffles, HENs etc).
- Overflow capacity (l/s).
- Centre point of reservoir (Easting & Northing).
- Design wind loading (both internal and external).
- Design earthquake loading.
- The Design Criteria drawing shall also include a site plan; geotechnical bore hole details; reservoir plan and cross section showing the location of all pipework, access points, dosing and sampling points; and typical wall sections showing height and thickness of wall strakes.
- Any special maintenance requirements for new material/system

6.4 Technical Submissions

The Contractor is required to undertake consultation with SWC, external stakeholders and during the design process. Where it is required by the Contract Document or as requested by Sydney Water, a description of construction materials and/or methods to be used must be submitted in the form of a detailed Technical Submission(s).

The submission shall comprehensively detail the proposal, and include, but not necessarily be limited to, such information as material data, equipment to be utilised, timing, staging, safety procedures and precautionary measures. Technical data and sketches must accompany the submission where appropriate.

For all products, sealants, coatings, and other such products used, the Technical Submission must include:

- The name of the manufacturer
- The name of the approved applicator
- Product name of all materials used
- Technical data sheets with instructions for the use of each material
- Material Safety Data Sheets showing all hazards and first aid information
- Trial Application, Inspection and Testing plans (if requested); and,
- Approvals for use in potable water (if appropriate).

Where a specific product has been specified in the Contract Documents, an equivalent product may be proposed for approval by Sydney Water. In the Technical Submission, all such substitutions must be clearly detailed, and the appropriate technical data provided. Suitable documentation from the manufacturer certifying the suitability of the product for their intended use and the compatibility between the substituted product and any other products, must be included in the Technical Submission.

The submission must be sufficiently detailed to satisfy Sydney Water that the proposal is appropriate for the proposed application, can be carried out safely, and will not have any detrimental effects on the existing structure, or personnel working at the site, operation of the reservoir, or the surrounding environment.

Technical Submissions must be accepted by Sydney Water. The Contractor must allow a period of 10 working days for the review of submissions.

Sydney Water possesses the right to request to provide further information, such as sketches, technical data, or design calculations, to determine if the proposed work can be carried out safely, without detriment to the existing structure or operation of the reservoir. Where such assurances are unable to be provided, Sydney Water possesses the right to request changes to the proposal without additional cost to Sydney Water.

Acceptance of a technical submission must not relieve the the responsibilities of the contract in carrying out the work safely, protecting the existing structure, or meeting any other requirements of the Contract.

The Technical Submission, once reviewed by Sydney Water, must become part of the offer to undertake work under the Contract and shall not be modified or departed from without the written acceptance of Sydney Water.

6.5 Material

All materials must be durable and corrosion resistant for the required design life. .

All materials in direct contact with water or which are part of the roof structure must be suitable for contact with potable water and certified to the latest version of AS 4020 where applicable.

Hinges and pins on hatches, gates and doors must be heavy duty stainless steel.

Materials used in the manufacture and installation of pipes and fittings must comply with the Sydney Water edition of the WSA Water Code. Unless changed by this specification, written instructions or the detail drawings, the conditions and requirements of the Code apply.

The materials for the major elements (Floor, wall, roof, pipe works) of the reservoir must be identified for the reservoir at the commencement of design and must be reviewed by the Client & SWC at the concept design stage.

All material selection to comply with the following clauses.

6.5.1 Roof Steel Work

- Roof structure, including beams and purlins, must be constructed in accordance with this clause, drawings and specifications.
- Stainless steel shall be Grade 316 chromium nickel austenitic, not harden by heat treatment and not magnetic. All stainless steel must be finished to Grade 2B or HRAP.
- All stainless steel used within the reservoir must have a surface roughness (Ra) of less than 0.5 µm.

- In fixing the roof members of the steel shell bracket, allowance must be made to accommodate the rounding of the reservoir shell when the reservoir is filling, by checking on the degree of out-of-roundness of the reservoir before filling.

6.5.2 Roof Aluminium Work

- Aluminium extruded sections must be fabricated from Alloy 6061-T6 or 6082-T5 unless otherwise specified. Flat sheets for hatch frames and covers must be fabricated from Grade 5083-H321/116 unless the bend radius is less than 2.5 times the thickness of the sheet, then Grade 5052-H32 is permitted.
- Aluminium tread plates attached to roof sheeting must Grade 5052-O with raised angular pattern on the top face.
- Floor plates around hatches must be 6 mm thick aluminium fabricated from Grade 5052-O.

6.6 Design computation

A set of completed computations shall be provided to SWC by the designers to show that the requirements of this technical guideline and the material referenced within it have been adhered to. The computations shall be clear and legible. The computations shall include a design philosophy and contents page. Any analytical model developed as par of the design or assessment must be provided to SWC for review and archiving purposes.

The computation pages shall be numbered and clearly define each element being designed, the design outcome and code references. The Contractor must also ensure that failure mode effect and criticality analysis (FMECA) is consistently applied during design. The process for undertaking FMECA is detailed in D0001045 FMECA Procedure.

6.7 Digital Engineering

Analytical 3-D modelling must be included in the design process to evaluate the impact of alternative design options and operational factors to manage the complex hydrodynamic behaviour and rheologies that occurs in reservoirs. If deemed necessary, 3D modelling must be included as well, depending on size and shape of the reservoir as well as hydraulic complexity.

It is a requirement for each delivery team to provide a systems architecture/infrastructure diagram or table which defines the platforms and software it is using and relationships between them. The Project Digital Engineering Execution Plan (DEXP) must outline the specific versions of software being used to deliver and, as a minimum, will outline the following information:

- Content creation and collaboration tools.
- Information management systems used to manage project BIM, GIS (if applicable) and relevant reference data – including information relating to each systems role and use cases.
- System configuration details, including role-based permissions and workflows, rules, audit trails, administration and support.

- Model federation tools and methodology.
- Tools and methodology for reporting, communications and issue management.
- Overview of any integrations with project controls and any other systems.

6.8 Work as Executed Drawings

WAE drawings must capture all variations from approved Issue For Construction drawings, and should accompany a register to record the reason and approval process of each variation. These variations must be marked up on the drawings and must reference the SW RFI number.

WAE drawings must be produced and submitted in accordance with the latest version of Sydney Water's CAD Standards.

7. Civil and Structural Design

The following principles guide the delivery of design management:

- Ensure safe, reliable and sustainable designs and assets
- Design assets for lowest life cycle cost to achieve desired level of service and acceptable risk
- Comply with legislation, regulations, licences, policies and SWC's management systems
- Provide information to enable asset management
- Continuous improvement and innovation.

7.1 Geotechnical Investigation

The adequacy of all existing, available geotechnical investigation data must be investigated, and all necessary additional field and laboratory investigations required for the assessment must be undertaken.

When the foundation is near a slope crest then the location of the outside of the ring beam shall be at least four times its width from the intersection of the horizontal founding plane and the natural ground slope. When this cannot be achieved, a separate slope stability analysis shall be required.

Refer Sydney Water Technical Specification - Civil for minimum requirements and further information.

7.2 Structural investigation and design

The structural design criteria nominated In Appendix A must be treated as the minimum to be adopted, however, any additional codes or design considerations deemed to be appropriate may be incorporated provided no conflict with the nominated codes or criteria results and agreed with SWC prior to commencement of the structural analysis and design.

7.3 Construction loads

Any temporary load during construction shall be identified during design stage and documented.

The Contractor shall not impose additional loads on the reservoir structure during construction.

7.4 Tank Design

As essential parts of the water supply system it is important that water tanks have a long watertight and maintenance free life. All aspects including the structural design, material selection, joint design and construction techniques are required to be to a high standard. All the components inside the tank shall be suitable for use with potable water in accordance with AS/NZS 4020. All design work shall be in accordance with the relevant Australian Standards, AS3735 in particular, SWC Technical Standards and Guidelines.

The tank design shall be co-ordinated with the mechanical, hydraulic and electrical engineering design to ensure all necessary embedments and penetrations are properly designed and detailed.

The size of reinforcing should be chosen recognising that cracking can be better controlled by using a large number of smaller diameter bars rather than fewer large diameter bars.

Given SWC preference for reducing the number of joints in tanks and the high temperature differentials, the 25% reduction in minimum reinforcement ratio allowed under section 3.2.2 of AS3735 is not permitted to be used in design of the Water tanks.

7.4.1 Roof Systems & Sheeting

A roof shall be provided to completely cover the tank. The tank roof design shall be in accordance with the following;

- If a choice of orientation in positioning a roof member exists, the member must be positioned in such a way that water (due to condensation or other effects) can run off the member. Purlins made from channels must therefore always be positioned with the flange facing the eaves of the roof. Purlins which have a downturned lip on the bottom flange or no lip at all are preferred.
- Connections must be designed to eliminate or minimise the number of horizontal surfaces in contact where corrosion can develop.
- The roof and roof to tank joint shall not allow dust or vermin to enter the tank
- The number of columns supporting the roof shall be kept to a minimum
- Fixing of the roof shall allow for contraction and expansion thermal movements relative to its supporting members.
- Roof sheeting shall be installed in single lengths when possible.
- Concealed fix roof sheeting systems are not permitted.
- All tubes and other elements must be seal welded or, if impractical, shall be provided with drain holes at low points to prevent ponding and trapping of water.
- Cold-formed steel members must not be used regardless of whether they are galvanised.
- The underside of any rafter or beam support must be 200 mm minimum above FSL of the reservoir.

7.4.2 Standard Roof System

Surface Reservoirs

The standard roofing system must be aluminium sheeting (minimum BMT 0.9 mm) supported on a structural frame made from aluminium and/or hot-dip galvanised steel members. The roof cladding must be non-reflective and of a light colour.

Individual structural steel members must be made from steel plates, hot-rolled sections. The use of hollow sections in wet locations must be avoided. All reservoir columns form part of the standard roofing system.

The fasteners for roof sheets and tread plates must be types that ensure positive fixing or anchoring and address differential thermal movement.

Elevated Reservoirs

Elevated reservoirs must have a steel or aluminium roof. All the roof area is to be accessible and designed to be walked upon. For the roof access including on reservoir roof low maintenance strategies to be employed for access.

The roof must be as flat as is practical and made of traversable solid steel plate and must meet AS 1657 clause 2.1.2.1. The roof must have sufficient cross fall to prevent rainwater ponding.

Lap welds are to be arranged to eliminate the ponding of rainwater and subsequent corrosion. All welds are to fully seal the roof plate laps.

The entire roof must have a non-sip coating.

7.4.3 Alternative Roof System

Alternative roof systems and/or detailing of individual elements and/or connections may be acceptable. Such alternative proposals must be detailed for submission to Sydney Water and it will be dealt with individually or on a case-by-case basis. The proposal must demonstrate that the system is structurally adequate, has adequate durability and provides a safe system for access and maintenance.

The use of hidden fixings is not acceptable as it can result in unexpected failure due to difficulty of inspection and assessment. A "standard" roof with external access to the roof sheeting fixings using standard equipment and general roofing personnel must be the starting point. Alternate options must be submitted as an additional option to be considered.

7.5 Reinforced and Prestressed Concrete for wall and floor

All concrete works must be undertaken in accordance with Sydney Water Technical Specification – Civil.

Concrete tank walls may be precast only for temporary reservoir construction (less than 5yr life). It has however been the experience of SWC that the detailing and construction of joints at the wall to wall and wall to floor junctions has not been adequate in the past and required significant rework on site and input to resolve watertightness issues. Joint details shall ensure that adequate space is provided at in-situ stitching sections for reinforcement, waterstops and the concrete without the concrete becoming honeycombed.

7.6 Bolted Connection in refurbishment of existing reservoirs

Bolts subject to tensile loads, single bolts, and bolts subjected to severe vibration, including all bolts carrying crane or hoist loads, must be effectively locked in position using an approved method such as lock nuts.

Bolt diameters must match existing bolt sizes. Where existing holes in cleats have been enlarged due to the removal of corroded materials, bolt sizes must suit new hole diameters and must be forwarded to Sydney Water for acceptance prior to bolting.

Where bolted connections are exposed in the finished work, bolts must be inserted such that the heads are on the face most exposed to view, with nuts and cleats on the hidden face. Where equal exposure to view is evident, bolt heads must be on consistent faces and on the face of the main members being connected.

If a previously tightened high strength bolt is slackened off, the whole bolt assembly must be discarded and replaced with a new bolt assembly and tightened as specified.

All bolts must be fitted with appropriate washers. At least one washer but not more than two washers must be placed under the part being rotated during tightening.

Bolts must not be used to force fit the abutting material together and any lack of fit must be assessed and proposal submitted to Sydney Water for acceptance Bolts complying with bolting categories 4.6/S and 8.8/S must be tightened so that the joined parts must be firmly drawn together using a standard ring spanner, calibrated torque wrench or pneumatic impact wrench.

Bolts must not be overstressed, and the applied torque must not exceed that recommended by the bolt manufacturer. In no case the bolt tension must not exceed 65 per cent or be less than 50 per cent of the guaranteed yield load of the bolt.

Column Concrete Encasement in refurbishment of existing reservoirsn some reservoirs where the roof is being replaced, it may be required to weigh down the base of some columns to stop the floor of the reservoir being damaged due to uplift during strong winds when the reservoir is empty.

Unless otherwise accepted by Sydney Water or detailed in the drawings, the additional weight must comprise of a concrete column formed around the base of the existing columns as detailed in the Drawings.

A rebate must be formed around the top of the concrete encasement at the interface with the steel column. The material used to form the rebate must be removed before the column is painted. Once the concrete is cured and the painting of the column is complete, the rebate must be filled with an approved sealant.

If it is found that the concrete plinth supporting the base of the column is larger than the internal diameter of the pipe specified to be used as permanent formwork, the corners of the plinth must be cut back so that the base of the pipe fits flush with the floor.

If the base of the new concrete column will partly or fully cover any floor joint, details of the proposal must be submitted to Sydney Water for acceptance. The section of the column to be encased in concrete, including the columns base plate and fasteners must be cleaned and protected with an approved zinc rich primer before encasement.

8. Site Work

8.1 Road Works

The road must be designed in accordance with Technical specification - Civil.

The access road must have a minimum road width of 4m and be designed to accommodate 20,000 litre capacity articulated water tankers used during reservoir cleaning. Design vehicular movements shall be 20 cars per day and 1 water tanker per year. A tanker turning/loading area shall be provided at the reservoir with suitable turning circle. The designer must include a swept path analysis to confirm the water tanker can safely turn within the specific turning/loading area.

The road must provide access for maintenance to valves, positioning a truck near the davit, allowing a mobile crane to reach any point on the roof.

Alternative pavement types, such as brick paving which allows grass to grow, is preferred in lightly trafficked areas in existing reservoir sites where heritage aspects are deemed necessary to be compatible with the existing site.

8.2 Earthworks

All earthworks must follow the requirements of Technical Specification – Civil.

8.3 Footpath

A 2 m minimum width reinforced concrete footpath (not including width of kerb and gutter) must be provided around the full reservoir perimeter. A 150 mm minimum height kerb and gutter mustl be provided to the perimeter of the footpath and mut be graded to facilitate flow to a drainage pit. The pit must be drained to a suitable location with the reservoir scour and overflow discharge.

8.4 Landscaping

The proposed landscape plan must be accepted by Sydney Water, and Council where required, before commencement of the landscape works. The proposal must include information on proposed plant material (species, size, numbers and location), method of site preparation, installation and establishment procedures, details of any proposed hard landscaping, edging materials and maintenance programs.

The overall earthworks and landscape design must achieve ground surface levels and a general site character that blends as much as possible with the existing surrounding topography and landscape. Ultimately the landscaping must achieve vegetative screening of the reservoir from adjoining and distant residential viewpoints.

The entire site must be reinstated and landscaped on completion of the construction works with particular compliance to the Council Development Consent conditions. The preference for landscape design is using grass or species native to the area, with low maintenance requirements. All vegetation must be clear of areas utilised for reservoir operation and maintenance tasks. Consideration must be given to the mature size of the vegetation to ensure that there is no encroachment over the reservoir structure and debris is minimised.

The landscaping must be of a minimal maintenance type with native plantings.

Any bare areas of rock must be treated to disguise the freshly cut surfaces. Proposals must be submitted for acceptance by Sydney Water and to Council where required as part of the landscape proposal.

The landscaping contract must incorporate a minimum maintenance period of 12 months.

8.5 Waste Management in refurbishment of existing reservoirs

Sydney Water policy is to support waste reduction initiatives, and preference will be given to submissions which utilise recyclable iron or steel abrasive procedures.

l All site handling and storage of all wastes must be carried in accordance with the relevant parts of AS 4361.1.

All liquid wastes, generated from surface preparation, operation of site hygiene facilities or from any other sources must be collected and disposed of in full accordance with all requirements of the EPA and Sydney Water.

Testing of all waste generated must be carried out to determine their classification in accordance with the NSW EPA “Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes” (1999), and must take all necessary steps to allow Sydney Water to gain “Consent to Dispose of Hazardous Waste” required by the EPA for all hazardous wastes generated.

These steps include provision of all details to allow the waste to be classified, all quantities of wastes to be disposed of, all procedures to be used to treat or stabilise the waste (where appropriate) and the proposed method of disposal.

Only industrial or hazardous waste carriers and depots for the deposition or treatment of liquid, sludge or solid chemical waste that are licensed by the EPA might be used.

A guarantee must be submitted in writing that the procedure used by the Delivery Contractor for disposal will result in all waste being accepted by the landfill authority and/or waste treatment facility. Site Buildings or kiosks for valve control, cathodic protection, mixer controls and IICATS electrical equipment must be vandal resistant. All these controls must be in one building or kiosk where possible.

8.6 Fencing and Security

The extent of security arrangements at a site will be dependent upon the sites criticality or security risk level. High risk sites may need additional alarm systems while the low risk sites may only require a perimeter fence.

The security risk level for specific sites must be determined by SWC and to advise on what items, such as hatches, are to be fitted with an alarm. Usually all reservoirs must be fitted with an electronic alarm system.

Security fencing at a reservoir site must normally be a minimum of a double barrier type arrangement. This includes a primary barrier of a chain wire perimeter fence and a secondary barrier of a fenced external access stairway and locked hatches. The following areas must require particular attention:

- Securing access to the roof.
- Loss of grate / covers on pits and stormwater drains.
- Loss of walkway floor plates on the roof of reservoir.
- Loss of cathodic protection system components.
- Damage to communication and monitoring equipment.

- Damage to exposed valves, pipework and fittings.

The base of the stairs shall incorporate a secure fence and gate barrier to prevent unauthorised entry. The fencing shall conform to the following basic requirements:

- Steel fence panels and gate.
- Overall height minimum of 3.7 metres.
- Palings to be triple point spear at nominal 150 mm centres with cross bar supports not providing a climbing point.

or

- Perforated sheet steel of minimum 3 mm thickness with an outwardly semicircular rounded top with a 750 mm overhang.
- Posts to be fixed to concrete footings or welded to reservoir wall.
- Gate to be nominal 750 mm wide x 2100 mm high with triple point spear

or

- Perforated steel sheeting and fixed header panel above.
- The design must ensure that there are no hand or foot holds which would facilitate climbing past the fence barrier.
- The gate locking mechanism, suitable for a heavy duty padlock, shall be protected from vandalism by a steel cover.

The security installation for the reservoir must also meet the following requirements:

- All hatches large enough for a person to enter (>350 mm diameter) must have a heavy duty reed switch.
- All ladders and stairs must have a heavy duty reed switch installed at the entry door and an approved PIR installed towards the top of the ladder/stairs.
- Any existing PIR on the reservoir shall be replaced unless otherwise detailed in the site specific technical specification.
- For a stair tower, the PIR is installed at the second landing above the top of the mesh walls. Where this is not practicable, Sydney Water Security Unit should be contacted to determine the most appropriate location.
- If the existing external ladder/stairs are to be retained once the stair tower has been completed, the PIR on the existing ladder/stairs must retained.
- If the existing bracket for the PIR sensor is secured to the top of the stiffening ring, it must be moved so that it is secured to the vertical face of the stiffening ring. If the stiffening ring does not have a suitable vertical surface, then a new cleat shall be welded to the wall of the reservoir.
- The Security Delivery Contractor must complete all appropriate commissioning forms and update the electronics site file.

8.7 Noise assessment

Noise level tests shall be conducted on site for compliance with environmental and occupational noise levels upon completion of all reservoir works. Requirements of the Statement of Environmental Factors and the Sydney Water Noise Specifications shall be met.

The reservoir design shall consider the following and any other noise generating items and minimize the impact on site workers and neighbours.

- Inlet water flow
- Mechanical mixers.

9. Electrical Work

9.1 General

All design and electrical works to be undertaken as a minimum must comply to the Technical Specification Electrical, Instrumentation and Control Standards, and other standards and specifications where applicable.

Existing schematics of the site may not accurately reflect the wiring found onsite. The Delivery Contractor shall be responsible for independently verifying the electrical installation that may be impacted prior to any work.

Where there is more than one asset on a site, the various electrical systems for each asset needs to be designed so that each system can be completely renewed on each asset without impacting the operations of the other assets on the site for any extended period.

9.2 Lighting and general power

General power or lighting shall not be required for surface reservoirs except for ones located in the structure or electrical kiosk.

For elevated reservoirs the stem and dry riser shall be internally lit in accordance with the requirements of AS1680. The lighting fittings must be non-metallic and rated IP56.

9.3 Cabling and associated equipment

All cabling must be installed underground in a conduit and pit system. A pit must be installed at the base of the reservoir to permit the cables to transition from the underground conduit system to the reservoir mounted cable tray. Provision for one future power and one future ELV conduit must be provided when sizing the pit.

A cable tray must run from the base to the top of the reservoir and be mounted to the stair tower structure, The cable tray must be accessible from stairs to permit installation and removal of wiring without the need of additional access equipment. The cable tray must be vandal proof and enclosed/protected from all sides. Sizing of the cable tray must consider appropriate segregation of services and allow for 25% additional services.

Where metallic cable tray is used, dissimilar metals and galvanic corrosion must be considered. As a minimum, the cable tray must be the same material as the structure it is secured to.

9.4 Instrument junction boxes

A hinged padlockable weather proof 316 Stainless Steel enclosure fitted with terminals must be mounted on top of the reservoir for terminating fixed length instrument cables. It must be mounted securely to the reservoir structure so it will withstand wind and other environmental conditions. The bottom of the enclosure must be a minimum of 500mm above the reservoir roof. The top of the enclosure must not be higher than 1800mm above the reservoir roof. Refer to sample drawings for more detail (SSD132 Reservoir instrument junction box and SSD133 Reservoir buoyancy switch installation).

All other instrument junction boxes must comply with the Instrument and Control Standards.

9.5 Structures containing electrical equipment

A structure containing the electrical, instrumentation, control, and other ancillaries must be provided. The structure must comply to the switchroom requirements in the Technical Specification Electrical.

A double 240V 10A general purpose outlet and a 415 volt 5 pin 32 amp outlet must be installed inside the structure and made available for general use.

Where a kiosk is installed, the kiosk must be rated IP56, vandal and vermin proof. The kiosk will be constructed from stainless steel and comply to the requirements in the Technical Specification Electrical for low voltage switchboard and motor starter. The kiosk shall be provided with heaters (240v) to prevent moisture that may impact on electrical components.

The kiosk must have a double 240V 10A general purpose outlet and a 415 volt 5 pin 32 amp outlet. These are to be made accessible for general purpose use when the kiosk outer doors have been opened.

The Kiosk's overall dimensions shall suit the equipment and space requirements, and shall be as compact as practical, yet provide sufficient access to all equipment for maintenance purposes.

9.6 Lighting and surge protection

The lightning protection and surge protection system must comply to the Technical Specification Electrical, Instrumentation and Control Standards.

Surge protection must be provided for electrical, and instrumentation and control equipment. The design must ensure there are no discrimination issues that may result in additional damage/outage to equipment.

A traditional welded steel structure is generally self-protecting in regards to lightning. Earth electrodes may be used to intentionally earth the reservoir if the construction method creates a high electrical resistance to earth. The roof sheeting may also need to be connected to the lightning protection system if the roof is electrically isolated from the steel roof cross members and wall for corrosion reasons.

If glass-fused bolted panels are used for the wall and bolted together the panels may not be electrically connected together as in panel metal to metal contact or via the bolts making contact. When there is no electrical continuity between the wall panels and roof, roof down conductors and earth electrodes must be installed.

9.7 Earthing

Design of the earthing system needs to ensure there is appropriate separation between power, instrumentation, and cathodic protection earthing. The system installed must comply to the Technical Specification Electrical, Instrumentation and Control Standards.

9.8 Photovoltaic system

Design of the earthing system needs to ensure there is appropriate separation between power, instrumentation, and cathodic protection earthing. The system installed must comply to the Technical Specification Electrical, Instrumentation and Control Standards.

10. Pipe Work & Valves

10.1 General

All pipework must be steel, stainless steel or ductile iron and be cement lined (except for stainless steel).

The reservoir must be provided with a bypass with normally closed isolating valve, from the inlet to the outlet pipe, to facilitate supply arrangements while the reservoir is isolated.

A hydrant must be installed on the inlet main, upstream of the reservoir isolating valve, for the purpose of water supply to clean the reservoir and for use of a mobile chlorinator.

All pipework at greater than 3 m invert depth must be of concrete encased steel “maintenance free” design.

Isolating valves must be provided on the inlet, outlet, scour, diver vacuum outlet and perimeter footpath drain pipes.

Air valves must be provided at high points on the watermains.

The need for bypass valves and pipework around stop valves must be assessed in accordance with Sydney Water’s Edition of WSA 03 and Technical Specification - Mechanical.

10.2 Inlet/Outlet

The reservoir must have separate inlet and outlet pipes. Where multiple surface reservoirs with common FSL’s are to be co-located on the site the designer must ensure that the inlet and outlet pipework arrangement provides a balanced hydraulic solution for the turnover of reservoir water and that all reservoirs rise and fall in unison.

The invert of any pipe located through the wall of the reservoir must be a minimum of 300 mm clear above the floor of the reservoir to avoid the potential for ingress of sediment into the pipeline.

Common inlet and outlet mains must be avoided if possible. The outlet pipe must be located as far from the scour as possible to minimise the possibility of sediment being discharged through the outlet pipe.

The inlet main must be provided with a non-return valve to prevent reservoir depletion in the event of an inlet main pipe failure. The outlet must be installed with a bellmouth fitting.

All pipework penetrating the reservoir wall must be mild steel to facilitate welding. Appropriate compensation plates must be provided in the wall for the penetrations. The inlet and outlet pipework must project 600 mm from the inside face of the reservoir and a minimum of 600 mm on the outside face. The external side of the pipes at the wall penetrations must be flanged to AS 4087 PN16.

The reservoir pipework must be connected to external pipework via adequate rocker pipes to accommodate any movement and/or minor misalignments.

Maximum temperature differential for the elevated reservoir’s steel stem must be considered, but not less than 60 degrees, to determine the expansion in the steel stem. The information must be used to design the pipework expansion joint requirements.

As a minimum the following must apply:

- A less than 6 metres high stem must have one stainless steel flange and flange bellows type expansion joint near the connection to the bowl.
- A greater than 6 metres high stem must have one stainless steel flange and flange bellows type expansion joint, near the floor and a second expansion joint under the bowl.

Vertical pipework must be adequately braced and fixed to the stem and dry riser to minimize vibration and ensure structural integrity.

The outlet pipe, where it connects to the steel bowl, must be fitted with a taper to eliminate outlet hydraulic losses.

10.3 Overflow

The overflow must have a standard long radius bellmouth at the top of the reservoir and be adequately braced to the reservoir wall. A screen to prevent the entry of vermin must be positioned in the overflow line. This would typically be within the bellmouth of the reservoir but may be positioned further along the line.

The centre of the vertical length of pipe must be located 2.0 m from the wall of surface reservoirs or close to the dry riser with a minimum 100 mm clearance for elevated reservoirs.

A crank in the vertical leg of the overflow pipe may be acceptable if it is at a location where a straight vertical alignment is not possible.

The overflow pipe diameter must be determined based on maximum reservoir inflow rate with a minimum margin of 10% and must be no less than DN300 for surface reservoirs and DN200 for elevated reservoirs.

The top or weir level of the overflow must be 100 mm above the full storage level.

For surface reservoirs the horizontal length of pipe through the wall must be at an adequate height above the floor to facilitate maintenance, prevent silt build up and facilitate welding of compensation plates in the wall. The vertical length of pipe must be adequately supported with a footstool and a footing under the floor. A welding collar must be provided at the first joint inside the wall on the horizontal length of pipe.

No isolating valves must be installed in the overflow pipe. The overflow pipe discharge must be fitted with a flap valve to prevent siltation and small animal entry. Larger overflow pipes must also be fitted with means to prevent personnel entry, such as safety bars no more than 100 mm apart.

10.4 Screens

A screen must be provided over the outlet pipe within the reservoir. The screen must be designed to prevent foreign materials entering the outlet pipe. The screen must also be of sufficient strength to prevent a diver being drawn into the outlet pipe in the event of a high flow.

The screen must be preferably fabricated from a non-metallic material such as High Density Polyethylene (HDPE), fibre reinforced plastic (FRP) or similar. The outlet screen mesh size must also be able to stop smaller items such as flaking paint etc from going downstream. If synthetic materials are unavailable in the required mesh size, stainless steel must be used but it must be suitably isolated from contact with dissimilar metals including the reservoir wall, floor or ladder.

The screen must be fixed to the reservoir wall or floor by a suitable method which facilitates periodic removal of the screen and replacement if necessary. Grade 316 stainless steel fixing bolts must be used and require insulating bushes to ensure electrical isolation from the steel components they contact. Screens in elevated reservoirs must be fixed to the outlet pipe flange.

The centreline of the screen need not necessarily align with the centreline of the outlet, provided adequate clearance between the outlet bellmouth and the screen is provided to ensure divers are not sucked against the outlet.

The following issues must be considered in the design of the screen:

- The total area of openings in the screen must not be less than 2.5 times the outlet pipe cross sectional area.
- The number of dissimilar materials must be kept to a minimum.
- The weight of the screen must be kept to minimum.
- For large sized screens preference must be given to designs that allow for the installation of the screen in two halves that can be bolted together in-situ.
- The size of screen mesh or holes must be maximum 15 mm.
- The screen must be robust enough to withstand impact by divers working in the reservoir when full.
- The design must ensure that water outflow is not compromised.
- The surface of the screen must be no closer than 500 mm from the face of the outlet pipe

10.5 Scour

The scour pipe diameter must be determined from the discharge rate and time required to empty the reservoir and must be no less than DN300 for surface reservoirs and DN200 for elevated reservoirs.

The scour pipe outlet from the reservoir floor must be located at its lowest point and such that cleaning is simplified. The floor must be constructed in such a way as to facilitate the movement of silt towards the scour outlet.

A removable FRP or stainless steel safety grill with mesh sizes for safety purposes must be provided over the scour inlet.

The scour line must be fitted with a facility to enable the collection and tankering of silted water generated from the reservoir dewatering and cleaning process.

- The scour line must be provided with two isolation valves and a “Camlok” fitting or similar. This arrangement must be suitable for installing a flexible hose for tankering.
- For reservoirs greater than 1 ML the scour line must be provided with an interceptor pit to enable silt to be collected, removed and tankered for disposal. The pit must have facilities for controlling flow, such as a stainless steel stop board, to enable the collection of silt.

The scour line must be fitted with a facility to attach water de-chlorination equipment such as a liquid sodium ascorbate injection pump. A 25 mm tapping and ball valve are to be installed into the scour line near the reservoir. The tapping must be connected by 25 mm copper pipe to a gate valve and screwed fitting just below ground level with appropriate surface fitting cover.

The scour water release arrangement must comply with Sydney Waters Discharge Protocols. Alternative options for discharging must be provided for approval, provided the option complies with the intent of the above specification.

Alternative discharge options to private property must require consent approvals for the discharge of water to adjacent landowners. This must be obtained prior to submission of designs for approval. These options are generally not favoured due to land use changes over time.

Scour line silt arrestor facilities must be integrated with the needs of other reservoirs on the site to reduce the need for separate facilities.

For surface reservoir, a localised depression must be provided in the floor at the scour to improve the cleaning and silt collection process.

The scour pipe must pass underneath the reservoir ring beam and be concrete encased to prevent loads from the ring beam causing distress to the pipe.

10.6 Hydraulic Enhancement Nozzle (HENS)

HEN must be provided to assist in the hydraulic mixing of the water inside the reservoir using the kinetic energy (velocity) of the inlet flow. The directional placement must be made in consideration with the mechanical mixer placement. Refer to water quality section for further requirements of design and placement of the enhancement nozzles.

An observation and access point (i.e. hinge opening) to assist with cleaning and removal of upstream debris of the HENS must be provided.

10.7 Valves and Valve Chambers

All valves must comply with the requirements of Technical Specification - Mechanical.

All valves must be readily accessible for operation from ground level and by standard operating methods.

Valves with operating element positioned more than 1300 mm above ground level must be provided with an elevated operating platform with appropriate access in accordance with AS 1657.

10.7.1 Manual Valves

Isolation valves are generally to be of metal seated gate valves complying with Sydney Water Technical Specification - Mechanical.

Where butterfly valves are proposed advice shall be sought from Sydney Water on specific operating and maintenance requirements. Butterfly valves shall not be used where they function as the only flow isolators. However, they may be used in conjunction with gate valves to provide double isolation.

Gate valves are generally to be buried as per the Sydney Water's Edition of WSAA Water Supply Code WSA 03 and SWC Standard Drawings sW1-302, sW3-301,302 & 303, and complete with extension spindles, if required, and surface box.

Where valves are to be buried at an invert depth greater than 3m, advice is to be sought from Sydney Water on access requirements. A full size valve chamber may be required.

Butterfly valves, non-return valves and gate valve gearboxes must not be buried. The gate valve gearboxes may be installed in half-chambers as per Sydney Water's Edition of WSA 03.

Manually operated valves require a minimum clear access of 1m radius around the surface fitting and vehicular access for operation and maintenance.

Where permanent handwheel type valve operating mechanisms are proposed they shall be fitted with a locking device suitable for a padlock.

10.7.2 Actuated Control Valves

All actuated control valves shall be reviewed by Sydney Water.

Control valves are designed to control the flow and/or pressure in the pipework to achieve the required operational outcomes. The valves shall be IICATS controlled and/or monitored and have an on site manual method of operation.

Actuated control valves shall be provided with an isolating valve on either side and a thrust type dismantling joint to facilitate their removal for maintenance or repairs. A bypass pipework arrangement shall be provided around the control valves with isolating valves to facilitate supply arrangements when the control valve is out of service. The size of the bypass shall be determined by the Designer but generally should be not less that the size of the control valve.

A DN15 tapping with 'block-and-bleed' two-part stainless steel ball valves and pressure gauge shall be provided upstream of the actuated valve.

Actuated valve types are varied in their functionality and design. Hydraulically operated globe and electrically operated butterfly and gate valves are preferred to simplify maintenance and spare parts. Other types of actuated valves, such as plunger, eccentric plug, segmented ball etc. may also be considered in special cases where the preferred valves cannot meet the required duty. Valves must operate through simple hydraulic or electrical systems and designs are to be reviewed by Sydney Water at an early stage of design.

10.7.3 Type of Control Valves

AICV (automated inlet) and ASCV (automated shutoff) control valves

An AICV must be installed on each reservoir inlet pipe to control flow into the reservoir and to maintain the level of the reservoir within the desired upper and lower limits. For some special applications, dual purpose AICV may be utilised to act as an altitude (level) control during normal operation and as a PRV to maintain supply to the reservoir zone when the reservoir is taken off-line.

ASCVs are installed to divert water flow within the site for system purposes, e.g. to change from gravity mode to pumping mode or to change from one pumping destination to another.

AICV and ASCV control and monitoring requirements are similar.

EICV (emergency inlet control valve)

EICVs (also referred to as inlet emergency inlet control valves IECVs) must be installed in the reservoir inlet line when the reservoir overflow facilities are inadequate or where an overflow could lead to a dangerous situation or property damage. EICVs are also required where the reservoir is gravity fed from another reservoir via an AICV and not filled by a water pumping station. This valve is only monitored by IICATS system, but not controlled.

EICVs must shut off the incoming water supply in case the water pumping station pumping to the reservoir fails to stop or the reservoir AICV fails to close when the reservoir reaches its FSL.

EICVs shall be normally open. The IECV must be closed automatically by a hard wired EICV buoyancy switch installed in the reservoir. A highly reliable and fail-safe control system is necessary for the operation of the EICV.

EICVs must fitted with a stored energy system capable of closing the valve if necessary, during a power failure. This is usually a 230V AC electric actuator backed by an UPS (uninterrupted power supply) unit. Other systems may utilise a counterweight held in the open position by a latching solenoid. This type of EICVs must be provided with an oil hydraulic actuator to open the valve automatically and a hand pump to open the valve manually in the event of failure of the hydraulic actuator.

PRV (pressure reducing) and PSV (pressure sustain) valves

PRV must be used to reduce the downstream pressure or flow rate to desired lower values. Some PRVs are installed for reducing pressure into the zone when a reservoir is taken offline.

PSV must be used where it is required to maintain a pre-determined minimum upstream or inlet pressure regardless of the reservoir supply zone demand.

10.7.4 Valve Chambers

All below ground automated control valves, butterfly valves and non-return valves shall be installed in valve chambers. Valve chambers are classified as a wet area and may be subject to flooding. All equipment in chambers including cable entries shall be protected to IP68 rating at a minimum depth of 4 m for a minimum of 4 days. Valve chambers shall be fitted with a buoyancy type level switch to provide a ‘valve chamber flooded alarm’ input signal to the site RTU.

Conduits entering chambers shall be bell mouthed to eliminate damage to cables during cable pull. All gaps around the conduit entry to valve chamber shall be sealed with water proof non-setting compound. External conduits and above ground conduits subject to the possibility of damage shall be mechanically protected.

Valve chamber design must comply with the following:

- The valve chambers shall be designed having regard that frequent access will be required for valve maintenance and that they may be a “confined space”.
- The top of the chamber shall be a minimum of 100 mm above the surrounding ground level to prevent runoff entering the chamber. The surrounding ground is to be built up to prevent a trip hazard with less than 25 mm protruding. The exposed concrete edge of the valve chamber shall be chamfered at 25 mm/45˚.
- The chamber access hatches shall be of a lightweight design and fitted with Sydney Water’s padlocks.
- The chambers shall be protected from vehicles by suitable bollards or traffic barriers.
- All chambers are to be provided with inclined rung type access ladders which shall have retractable handposts. Fixed above ground handposts are acceptable where they are not a safety hazard or/and where the valve chamber is not deep enough for retractable handposts.
- Chambers shall be well drained, preferably by a gravity drain.

- All valve chambers and pits with instrumentation or electrical equipment must be monitored as per the Instrument and Control standard TOG_TS02. Refer to the Monitoring and Control section of this document for requirements.
- Chambers shall be provided with adequate external flood lights or with provision for portable lighting for maintenance tasks.
- Adequate space shall be provided each side of the pipeline and valve within the chamber for maintenance tasks.
- The chamber roof shall be removable in order to facilitate valve installation and replacement.
- Valve actuators must not be installed inside valve chamber. They must be maunted on adequate pedestals installed on the valve chamber cover.

10.8 Thrust & Anchor Block Design

All valves which can produce thrust forces when closed should be anchored designed in accordance with Technical Specification – Civil loading and design requirements.

Where the pipe work is laid in fill, its design must take into account the possibility of differential settlement within the length of the pipeline and between the pipe and the reservoir. Flexible joints/connections and/or 'rocker' pipes may need to be incorporated in the pipelines.

Concrete anchor blocks must be provided to all pipework at changes of direction, offtakes ('Tees') and tapers. Restrained joint spigot and socket type pipework or grip type flanges or couplings must not be used

11. Water Quality

11.1 General

The reservoir design and its associated pipework shall consider the impact on water quality across the full range of flows. Water quality concerns such as water age, mixing and short circuiting shall be assessed and addressed in detail in the design

11.2 Sources of Contaminations

The stored water shall be protected from external contamination by effective component design. Consideration is to be given to:

- Minimise the number of roof openings.
- Ensure all ventilation openings have a robust bird and vermin proof mesh covers.
- Seal all roof openings effectively with durable materials and lipped covers.
- Prevent rainwater spilling over lips of hatches.
- Seal the wall and aluminium roof edge interface with durable, well anchored and contoured foam or similar material.
- Ensure that roof rainwater does not locally pond on the roof. All external walkways and roof platforms shall be sloped at a minimum of 2%.
- All lap welded plates shall be arranged so as to eliminate local water ponding at the weld.
- All roof design details shall minimise the likelihood of leaf litter buildup.
- Design of roof air flow system must prevent contamination from birds roosting on exterior reservoir walls and vermin entering the reservoir.
- Installation of a screen on the top of the overflow pipe to prevent vermin ingress.
- Site vegetation/landscaping to be designed not to deposit leaves or other material on reservoir roof.

11.3 Water Mixing

The preference is for mechanical mixing as this is reliable and effective. This maybe supported by additional hydraulic design options for improved circulation (e.g. jets, baffles, HENs etc) however the best solution shall be selected not solely based on cost. Continuous mixing is required for any chlorine dosing whether tablet or RCP.

Water mixing and chlorine residual distribution within the reservoir are integral part of the reservoir and its pipework design. The method or need for mixing will be site specific and must be discussed with the client prior to starting the design. Some options for consideration include:

- Separate inlet and outlet pipes are mandatory and are to be orientated to maximise the mixing zone within the reservoir resulting from inflow and outflow rates. The optimum inlet/outlet orientation shall be determined from the 3-D mathematical modelling.
- A Hydraulic Enhancement Nozzle (HEN) is to be installed on the end of the inlet pipe to assist in utilising the inlet flow velocity or energy to mix water. The HEN is required on all reservoirs other than those of very large capacity, (i.e. greater than 20 ML), where it is likely to be ineffective. The optimum HEN configuration and orientation shall be determined from the 3-D mathematical modelling design phase including the location of the mechanical mixer.
- An electrically driven mechanical propeller type mixer or alternate mixer technologies, e.g. recirculation systems with an external pump, will be required especially on larger reservoirs. The optimum mixer configuration including size, position, horizontal alignment from centre of reservoir and upwards angle of attack shall be determined from the 3-D mathematical modelling (be verified by an independent party). Mixers shall have the capability for horizontal alignment to be easily adjusted. Mixers should be installed in consultation with the manufacturer. The mixer support mast must be designed to account for vibration and fatigue loads. It must not impart chafing to the reservoir's epoxy coating lining. Facilities are to be provided for maintaining the mixer such as adequate roof hatch size and lifting arrangements. The mixer design and type shall be discussed in detail with the Client.
- The HEN, in simple small volume surface reservoirs, is to be at the bottom of the reservoir and should point 30º inward from the reservoir wall tangent and upwards at 30º from horizontal. The HEN shall be flanged and bolted to the inlet pipe to facilitate rotation of its alignment. For elevated reservoirs the HEN shall point 30° outwards from the reservoir wall tangent and upwards at 60° from horizontal.
- The need for a tapered or full bore HEN shall be determined from the inflow velocity but generally a HEN water exit velocity of 2 m/s minimum is required.
- Fingerboard style inlet baffle arrangement shall be considered for reservoirs greater than 20 ML to assist in spreading the flow across the reservoir at the same time creating enough turbulence for extending the mixing zone. The optimum baffle configuration shall be determined from the 3-D mathematical modelling.
- Where a HEN, inlet baffle, mechanical mixer or other devices are proposed their design arrangement shall be complimentary in the water mixing process and assessed at the 3-D mathematical modelling stage.
- Electrically driven mixers shall be fitted with an electrical isolation switch. The isolation switch is to be lockable.
- The operation of the mixer shall be monitored and alarmed through IICATS.
- Special consideration and design shall be given to the mechanism and process for removing and maintaining a mechanical/electrical mixer.
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11.4 Dosing & Sampling

Facilities shall be provided for automatic or manual chlorine dosing to ensure the appropriate homogenous water quality is maintained within the reservoir and is delivered from the outlet main. Facilities shall also be provided to sample reservoir water to determine the chlorine residual and other water quality parameters.

Dosing options include liquid sodium hypochlorite (up to12.5% solution) and calcium hypochlorite tablets. The designer, in consultation with the Client, is to determine whether to install a permanent rechlorination plant, to use a mobile chlorinator or tablet dosing or a combination arrangement.

Liquid dosing is initiated from a delivery vehicle with a pump to inject the hypochlorite through the site dosing pipework. The pipework shall consist of the following components:

- The external connection point for dosing is to be a 20 mm stainless steel ball valve and male "Dunlop Camlok" polypropylene fitting. As per agreed wall dosing point design specification.
- For surface reservoirs the fitting is to be located in the reservoir wall 5 metres from the inlet main in the direction of flow or reservoir current and 1.5 m above the reservoir floor level.
- For elevated reservoirs the fitting shall be located in the inlet pipe at the base of the reservoir.
- For surface reservoirs the internal component of the dosing point is to be a 20 mm stainless steel diffuser pipe protruding 300 mm into the reservoir and rising vertically 250 mm. The pipe shall have diffuser holes of varying diameter (5 to 8 mm) along its vertical leg to promote even dosing. The diffused holes are to be orientated towards the reservoir centre.
- Additional chlorine dosing taps shall be provided on the reservoir wall if a single dosing point is insufficient for uniform dispersal of the chlorine into the full reservoir storage volume.
- For elevated reservoirs the dosing arrangement shall be a 20 mm stainless steel pipe protruding ¼ pipe diameter into the inlet pipe.
- All dosing taps are to be provided with a stainless steel vandal resistant cover with a padlock unless located within a secure building or structure.

A chlorine tablet dosing hatch might be provided within a surface reservoir roof ventilation hatch, or the monorail access roof hatch for elevated reservoirs, to facilitate manual tablet dosing tasks. Any new hatch has to be designed so that it is clear of the roof frame below and the required access walkways are designed to comply with the relevant structural codes.

Tablets are placed in a PVC container and lowered into the water through the hatch for slow release of the hypochlorite. The hatch shall be located near as practicable to the reservoir inlet to promote mixing. The dosing hatch shall accommodate a nominal 200 mm diameter PVC dosing container. For reservoirs larger than 10 ML capacity additional tablet dosing hatches are required to better distribute the chlorine.

Water sampling facilities are required for the monitoring of chlorine levels and other water quality parameters. The arrangement of the sampling point shall take into account that sampling is a one person task.

- One sampling tap shall be provided on the inlet main and one on the outlet main, within 5 m of the surface reservoir. For elevated reservoirs the sampling taps shall be in the inlet and outlet mains within the reservoir stem 1.2 m above ground level.
- The sampling tap arrangement, valves and pipework, shall be of 12 mm stainless steel. The sampling pipe shall protrude ¼ of a pipe diameter into the inlet or outlet pipe. The sampling pipework shall be kept as short as possible.
- An additional sample tap shall be provided for surface reservoirs through the reservoir wall 2 m from the outlet pipe and 1.2 m above reservoir floor level. A 12 mm stainless steel sample pipe shall internally protrude 300 mm through the reservoir wall.

- The tapping shall be connected to a chlorine analyser. The sampling pipe arrangement, where an analyser is connected, shall also be provided with a second sample tap for analyser calibration tasks or one off sampling. A second tapping point will be required for the return water from the analyser.
- The sampling taps shall be colour coded, using coloured plastic tags, to readily identify their function or water source. Red for inlet, Blue for outlet, White for inlet/outlet and White for reservoir depth sample.
- All sampling taps are to be provided with a stainless steel vandal and vermin resistant cover with padlock where not within a building or secure structure.
- All tap outlets are to be provided with a plastic cap or cover to prevent contamination into the sample pipe from insects and dust.

Dosing and sampling requirements are site specific and must be discussed with the Client prior to starting the design.

11.5 Vents and ventilators

Ventilators over stored water are required to reduce humidity and chlorine levels in the air above the stored water. The ventilators shall be suitable for a high humidity atmosphere, to be vermin proof and not allow ingress of rain or roof water.

Perimeter vents with mesh shall be provided in order that a cross flow ventilation is developed to minimise humidity. Venting of the water storage area shall exceed the requirements of AS 1940. Venting shall be sized to cater for the peak water inflow and outflow and the subsequent rise and fall of the water level. The vents are to be equally spaced around the perimeter. The total area of the perimeter vent mesh shall be a minimum of 2 m2 for reservoirs up to 10 ML capacity and 4 m2 for larger reservoirs.

Ventilation of an elevated reservoir access shaft and dry riser is required for OHS person entry purposes.

12. Access

12.1 General

Access and hatch arrangements must take account of all operation and maintenance activities associated with the reservoir.

The design must provide a safe means of access and egress and minimise the risk to persons working at height and inside the reservoir or on any associated structures.

The design must make adequate allowance for access by divers to clean, maintain and inspect the reservoir. The design must facilitate access when the reservoir is empty in conjunction with the reservoir wall hatch.

WorkCover, Australian Standard and OHS&R safety requirements must be met for all stairs, ladders, platforms and hatches, particularly with regard to entry within the reservoir under empty, full or partially full conditions.

12.2 Stairways, Ladders and Handrails

All external stairways, ladders and handrails shall comply with AS 1657 and must be, after fabrication, hot-dip galvanised to 500 g/m^3. Site welding must not be permitted.

External access to the roof must be via stairs. Stair flights must not be more than 6 m vertical projection and must as close to equal as possible. Vertical ladders are not permitted. Access arrangements must reflect the frequency of use and safety aspects especially where height is above 5 m.

A continuous safety hand railing must be constructed for all area with access platform or pathway. The handrail must consist of two rails and kick plate and must conform to AS 1657.

All brackets and fixtures to the body of the reservoir must be installed prior to painting. The hand railing must have one gap fitted with a self-closing gate. The gate must have bearing hinges and spring closing mechanisms and must be located adjacent to a lifting davit, to facilitate lifting material onto the roof.

A self-closing and latching gate must be provided at the internal ladder access hatch.

Provide “Monowills” or equivalent tubular handrails with a kick plate.

Where davits are installed, provide a self-closing gate in the perimeter handrail which closes inwards and has a self-locking mechanism. It must also be provided with a facility to fit a padlock.

12.3 Roof access and Steel Walkway

Roofs must be provided with walkways around all openings to provide access for opening and closing the hatch covers.

Anti-slip steel floorplate working areas must be provided around all perimeter access hatches.

Where walking access is required over the roof sheeting a walkway of 600 mm minimum width, anti-slip treadplate must be provided fastened to the ribs of the roof sheeting. Aluminium treadplate is generally preferred. However, in locations where there is a high risk of theft of the aluminium, galvanised steel or FRP are the preferred alternatives. The anti-slip surface must be fully bonded to the substrate and must be capable of withstanding foot traffic, materials dragged across the surface, UV radiation and bird pecking, etc.

The ridge walkway must commence from the internal ladder hatch working platform.

12.4 Access Hatches

Roof access hatches include:

- An equipment hatch with safety grille. Equipment hatch must be provided in the roof with a minimum clear opening size of 2000 x 2000mm or as required by the equipment within the reservoir.
- An instrument hatch with safety grille.
- Dosing hatch/es as required with situated close to the inlet, for the purpose of chlorine tablet dosing. (Also see Water Quality requirements clauses).

All hatches and other roof openings must be detailed to prevent rainwater and vermin from entering the reservoir by the use of rigid flashing and shields to deflect water.

All access hinges must be:

- Welded to their attachments or bolted with set screws or bolts incorporating lock nuts.
- All nuts must be inaccessible when the hatch is closed to minimise vandalism.
- Hinge pins must have swaged ends to minimise vandalism.

All hatches must be provided with locking mechanisms suitable for fitting a padlock. Sufficient locking mechanisms must be provided on each hatch to prevent forced twisting and partial opening of the hatch.

The hatches must be designed after carrying out a risk assessment so that their weight is suitable for manual handling by one person.

The hatches must be designed after carrying out a risk assessment so that their weight is suitable for manual handling. All hatches must be provided with hinged safety screens, which fit under the hatch covers, to prevent personnel from falling into the reservoir, when the hatch covers are open. The safety screens must consist of aluminium welded mesh fabricated from 10 mm (minimum) square bars on a 100 mm maximum pitch each way and adequate to support a person.

A self-latching locking device must be provided to hold all roof hatch covers open particularly against wind gusts.

Minimum clear opening on ladder hatch to be 900 mm wide x 1000 mm long.

12.5 Ground Level Access

Ground level access into the on ground reservoir when empty must be provided by the following:

- A single large maintenance access hatch must be provided in the reservoir wall near the loading bay or adjacent to an access point from the bay. The hatch must have a clear opening of 1600 mm high x 750 mm wide. The hatch door must be externally hinged and open inwards with external locking bolts.
- A second sealed maintenance access hatches must be provided in the reservoir wall on opposite side of the reservoir to the larger hatch. This hatch shall provide cross ventilation. The hatch shall be oval shaped

with a minimum size of 965 x 680 mm and be located approx. 1000 mm above the floor. The hatch shall be bolted closed and hinged to facilitate its use.

- Access into the stem at the base of elevated reservoirs must be by a door 1200 mm wide x 2100 mm high with access steps. Access through this door must comply with AS 1657.
- The door must be of steel material and lockable.
- The door must have a catch for retaining it in the fully open position.

12.6 Stair Towers

The stair tower must be designed as a set of mainly modular components to ensure that components can be reused at another site if required.

The tower must be designed to provide access to the roof including during construction. Scheduling the construction of the stair tower as one of the first tasks when they have access to the site.

Unless otherwise advised in writing from Sydney Water, the existing external ladder/stairs must remain operational while the reservoir is operational until the new stair tower is fully commissioned.

The cleats welded to the wall of the reservoir to secure the stair tower or to support the bridge leading from the stair tower shall be galvanised.

The security mesh around the base of the tower must be attached to the stair tower's frame so that it cannot be removed from the outside. The mesh must enclose the full perimeter of the tower, including the area beneath the entry gate.

Where there is not a full flight of stairs leading to the uppermost landing of the stair tower, the size of the landing below the top landing must be increased to account for the reduced number of steps. The size of the top landing must remain the size of a typical landing.

The Contractor must ensure that the stair tower's gate is manufactured such that shroud covering the locking mechanism passes over the handrails of the landing adjacent to the gate.

12.7 Work Platform for elevated reservoirs

A work platform at the top of the stem must be provided for access to the sealable hatch and as a working area when the reservoir is empty and maintenance task are being undertaken.

- The platform must cover all of the cross section of the stem, except for openings for the stairway, hoist shaft and pipe work.
- The platform must meet the requirements for AS 1657 - Fixed Platforms, Walkways, Stairways and Ladders - Design, construction, and installation, loading requirements as per Technical specification - Civil and AS 1170 Structural Design Actions.
- The operating platform must be supported from the sidewalls of the reservoir stem and the floor of the platform shall extend to these side walls.
- Provide a handrail around the central hoist shaft
- Provide a gate 1.2m wide in the handrail for lifted material. The gated to be fitted with a sprung closing device and latch. The gate to open away from the hoist shaft.

- If the work platform is made from open tread grid it must be fitted with a fine grid under it to prevent items falling through. The platform must be classified as a working platform and is to conform to Australian Standards.
- Provision must be made for hoisting material to this operating platform. The work hoist arrangement must have a minimum safe workload of 500 kg or 20 percent greater than the weight of the heaviest item that it must be required to lift including the flanged flexible pipe joints, whichever is greater. The hoist must lift from the floor of the base of the reservoir onto the work platform.
- Provide a sealable hatch for access from the Work Platform into the base of the water storage area for maintenance access when the storage is empty. A hatch support mechanism must be provided to support the hatch as it is unbolted and removed. The support and hatch sealing mechanism must be operable from the platform area. No works should need to be performed from the ladder.
- Provide a permanent fixed stepladder for the safe ingress and egress of personnel from the Work Platform through the access hatch into the water storage area and a landing to stand on when unbolting the sealed hatch. The landing must be a maximum of 1.8 metres from the highest bolt in the access hatch.

12.8 Observation Platform inside elevated reservoir

An observation platform must be provided above the stored water under the roof for the purpose of inspections, diver work area and attachment/maintenance of water level monitoring equipment.

- Provide a 1.2 metre minimum width observation platform that wraps around the majority of the dry riser over the stored water. It must be a minimum 300 mm above maximum top water level and must be made from a non-metallic non-corrosive material such as “Fibre Reinforced Plastic” and must meet Sydney Water’s requirements for materials in contact with potable water. All fastenings must be of the same material. Metallic fastenings are not acceptable.
- The break in the platform must be just sufficient for a short ladder to access a below water diver work platform.
- The platforms must have a 3 guard rails and a self-closing gate fitted.
- Install a spring operated self-closing gate with a 1.2 m clear opening complete with latch, in the handrail around the observation platform to facilitate the hoist arrangement to lift large items into the stored water area of the reservoir.
- Provide an access opening in the dry riser, between the spiral stairway observation platform. The opening must be a minimum of 1.2 metres wide and sufficiently high to accommodate a monorail & hoist. The opening forms part of the ventilation air flow path and shall not have a door.

12.9 Davit

No Davit installation is required unless it is specifically requested by operation.

12.10 Access over pipe penetration

Provide steps over inlet and outlet pipes which penetrate the reservoir wall to facilitate access around perimeter footpath at base of reservoir in accordance with Sydney Water Technical Specification – Civil.

Provide handrails or guardrails at the top of any steep embankments or retaining walls.

Provide a self-closing gate across the handrail opening at top of any ladder flight.

13. Protective Coating

The corrosion protection of the steel work of the reservoir including relining of the reservoir shall be in accordance with Water Services Association of Australia (WSAA) “WSA 201 Manual for Selection and Application of Protective Coatings” as well as Clause under “Protective Coating” in Sydney Water Technical Specification – Civil

For the radial roofing system in the refurbishment of reservoirs, new spiders shall be fully galvanized Exposed galvanising on the central column must only extend down to FSL. Any new section of the central column below this level must be painted.

Unless otherwise directed by Sydney Water, where an existing spider is to be replaced, the centre column must be cut such that any painting platform below the spider is also removed.

Galvanized surfaces shall be protected from any damage or degradation, e.g. ricochet from abrasive blasting works, grinding, or welding works.

Reservoirs with concrete floors, an electrical connection must be maintained between the columns and the wall . To maintain the electric continuity for a reservoir with galvanised steel rafters, the area around two holes on the underside of each column cap plate must be “masked off” before painting. Once the bolts securing the rafters have been installed and tightened, the exposed parts of the masked off area, including the bolts providing electrical connectivity between the column and rafters, shall be protected in accordance with this clause. Similarly, 25% of all bolts connecting the rafters to the reservoir wall shall be treated in the same manner. For reservoirs with an all-aluminium roof design, details on “bond-in” of the columns and the roof will be provided in the drawings., details on “bond-in” of the columns and the roof will be provided in the drawings. Continuity testing must be undertaken to ensure the various steel elements and stainless-steel elements below TWL of the structure are connected. Results of these tests must be provided to Sydney Water.

13.1 Cathodic protection

An impressed current cathodic protection system must be installed in the reservoir to protect the internal steelwork of the reservoir from corrosion.

The cathodic protection system must meet the minimum requirements of this specification. The contractor must submit details of the anode and reference layout to Sydney Water for approval before installation.

On all steel walled reservoirs, including those that do not currently have Cathodic Protection installed, there must be electricity connectivity between all steel columns and the walls. Where rafters are installed on a concrete floor reservoir, the rafters must be the method of providing an electricity circuit between the column and the reservoir wall. On steel floor tanks, the floor must be used as the connection.

Due to the high consequence of vandalism, the design of the cathodic protection system must be located to minimise the risk of damage to the system.

A recognised cathodic protection consultant must be engaged to provide specialist design, installation and testing of the cathodic protection system. The consultant must be recognised by Sydney Water and be able to demonstrate relevant experience on similar reservoir protection projects.

The requirements for the cathodic protection system are specified in Appendix C.

13.2 Painting

All steelwork which is not galvanised, including wall and floor plates, shell stiffeners, internal columns shall be painted to WSA 201.

All exposed or immersed pipework, valves and fittings must be painted with EHB-SF coating system in accordance with WSA 201 unless approved otherwise.

For reservoirs with a high graffiti occurrence the bottom two strakes of the reservoir wall must be coated with either a polyurethane or polysiloxane based coating system as per WSA 201.

The external wall of the reservoir and exposed pipework must be painted “Environmental Green”, AS 2700 colour code G66. Other paint colours may be required as nominated by Sydney Water for reasons agreed with the local community, council or other authorities.

All painted steelwork and pipework within reservoir must be White (N14) in colour to assist in inspections and cleaning operations.

All refurbishment work within 500 mm of the top of walls, columns and remaining roof members, including all grinding, welding and drilling, must be completed before the area can undergo final cleaning or any coating. New members must not be attached to the walls, columns or remaining roof members until painting is completed and complies with specification.

All damage to existing external coatings from construction works shall be repaired. This includes but is not limited to Heat Affected Zones (HAZ) caused by internal hot works (e.g. any welding to wall or top ring). This damage is not always seen immediately, hence all external areas must be repaired back to bare metal where internal hot works has been carried out. A mud map of welding and oxy cut areas must

be carried out to help locate all external damaged areas to be repaired.

13.3 Hazardous Paint Management in existing reservoirs

The existing coating in certain steel elements including the internal and external tank shell and the top of the stiffening may contain hazardous materials, e.g. lead and bitumen. The removal and handling of the lead must be in accordance with AS 4361.1 Guide to Hazardous Paint Management, Sydney Water Lead Management Policy, Lead Management Guidelines and the site specific REF.

All hazardous coatings must be removed such that it is not released into the environment. An approved EMP (Environmental Management Plan) and HPCP (Hazardous Paint Compliance Plan) must be in place, before commencing work that could disturb the lead. Hazardous coating disturbance works includes but is not limited to welding, grinding, drilling, sanding, abrasive blasting cleaning, water blasting.

PCCP Class 5 and 6 certification is a must to carry out these this works.

13.4 Relining

All coating works must be inspected and tested in accordance with WSA 201. ITP for the coating works must be submitted and approved by Sydney Water before any works can commence.

Where the existing lining needs to be partial or fully replaced, a full proposal must detail all the proposed sequence of steps involved in the relining process, including removing the existing lining and application of new lining, as part of their Technical Submission and AS/NZS 4020 requirements. This sequence must detail when other repairs to the reservoir will be undertaken. Products used must comply to AS/NZS 4020.

It must be ensured the surface is free of all metal defects (e.g. heavily pitted areas, sharp edges, welds, etc.) prior to preparing the surface to the specified degree of cleanliness and profile as per WSA 201. A P3 (3 mm radius) preparation grade must be achieved.

All coating defects must be clearly marked and repaired. The marked area must be visually evident after repairs to assist in reinspection of area. Sydney Water may request any spot repairs to be holiday tested again to ensure they are defect free.

A plan must also be documented how already coated areas must be repainted, e.g. mud mapping for each coat.

13.5 Weld inspection

The fabrication designer shall specify non-destructive weld testing to be carried out, either by an independent Inspection Authority or by the Contractor, and to be witnessed by an independent Inspection Authority. Inspection test reports shall be NATA endorsed.

The following minimum non-destructive testing requirements or their equivalent shall be specified:

- All welds in the reservoir floor shall be tested by vacuum box test for the detection of leaks in the welded seams. This test shall be performed using a "Suction Box/Soap Suds" method, and a partial vacuum of at least 14 kPa.
- Horizontal butt joints of the bottom strake/floor plate fillet weld shall be examined for a minimum of 10% of their length
- Acceptance requirements shall be as detailed in AS 1554, Part 1 or Part 4 or Part 6 and AS 2207 as appropriate for Category SP welds.

- An Inspection and Test report shall be provided which includes certificates, specifications and reports for materials, weld procedure, welder qualification, weld maps of all NDT locations and furnace charts for any PWHT operations.

Weld in the reservoir walls must be testing as per the following requirements. Any deviation form the following testing requirements must be reviewed and approved by SWC.

Table 3 - Weld Inspection Frequency

Reservoir size	Testing location - wall Strakes	Spacing/Frequency	Min. aggregate test length of total	Test type
<10m Dia	Horizontal joints	500mm length at 3m spacing,	As per spacing req's	ultrasonically or radiographically
		Visual Assessment	100%	
	Vertical Joints	500mm length at 3m spacing	As per spacing req's	Radiographically
		Visual Assessment	100%	
>=10m Dia.	Horizontal joints	5x 500mm @ 3m spacing, thereafter increased to 10m spacing when no defect detected - See note 1	10%	ultrasonically or radiographically
		Visual Assessment	100%	
	Vertical Joints	500mm length at 3m spacing	15%	Radiographically
		Visual Assessment	100%	

Notes:

1- The increase in spacing between tests for Horizontal joints is allowed only when no defect is identified. When any defect identified testing needs to revert back to 3 metres spacing starting from the first increased length.

2- All T joints must be tested 75mm vertically and 100mm Horizontally (50mm each side of the centreline).

3- When no defect identified the maximum testing of all welds to be limited to 1/3 of total weld length.

14. Fiberglass (FRP & GRP)

The requirements and properties of such products must be in accordance with Sydney Water's "Specification for FRP platforms, walkways, stairways and ladders". Manufacturer's data required in this Specification's Schedule of Technical Data must be submitted.

All FRP products must have a proven service life of 35 years minimum.

All FRP ladders must be a proven system such as "Nextep Miyama" or equivalent, including the stiles, rungs, and wall brackets.

15. Monitoring and Control

All instrumentation, monitoring and control equipment must comply with Sydney Water Instrumentation and Control Standards. This includes any reference to IICATS connected equipment identified in other sections of this document.

Full requirements are provided in Sydney Water:

- Instrumentation and Control Standards (General) TOG_TS01,
- Water Distribution Related Instrumentation and Control Standards TOG_TS02, and
- Flow Monitoring Standards – Flowmeters TOG_TS05.

The typical monitoring and control requirements for a reservoir are:

- Control panel,
- Water quality monitoring,
- Chemical dosing system control,
- Power failure monitoring,
- The IICATS RTU and modem,
- Site 24V dc power supplies,
- Site access monitoring,
- Reservoir level monitoring and control,
- Flow monitoring where required on the site,
- Mixer and cathodic protection monitoring, where required on the site,
- Valve and valve pit monitoring and control,
- Cable, and conduit installation on the site,
- An I/O list for the RTU, with allocation of analogue and digital alarm and controls.

Additional items may be required depending on site specific design.

A Plain English Functional Description (PEFD), developed in conjunction with the asset owner, must be provided. Sydney Water Operational Technology (OT) will develop the Functional Design Specification (FDS) and the control and monitoring sequences for the assets being controlled by the IICATS RTU in-coordination with the asset owner.

The final I/O list for a site will be issued by Sydney Water OT group. Standard Input/Output (I/O) lists are available in the Instrument and Control Standards as a guide.

All digital and analogue devices applicable to the site are to be installed and calibrated as specified in the Instrument and Control Standards.

On-site commissioning, or re-commissioning, of Instrument and Control equipment must only be completed by Sydney Water, OT, IACS team.

15.1 Telemetry

All cabling, conduits, pits and any other materials necessary to enable connection to the Telstra network for telemetry must be installed. This includes breaking into the nearest telecom pit or pillar located outside the site boundary, with Telstra approval.

15.2 Level monitoring and alarms

Level monitoring and alarms for a standard site includes, but is not limited to level gauge pressure transmitter/s, overflow impending buoyancy level switch, low level buoyancy level switch, trip IECV to close buoyancy level switch (if required), mixer healthy (if required), and cathodic protection healthy (if required).

The primary device for water level monitoring must be a gauge pressure transmitter located near ground level for above ground reservoirs. A dedicated minimum 20mm tapping into the reservoir with rodding point, or through a reservoir wall, must be provided. The tapping must be less than 300mm above the floor level and below the MOL. It must be positioned below the outlet pipe bell mouth, or obvert, to prevent air entering the transmitter. Refer to the Instrument and Control standards for detailed location and sizing requirements.

The primary device for water level monitoring for underground reservoir when there is no a suitable location for a pressure tapping point, must be a radar level transmitter, located in a radar instrument hatch. A clear line of sight to the bottom of the reservoir must be provided from the top of the radar instrument hatch.

For refurbished reservoirs new float switches must be provided.

15.3 Valve monitoring and control

Control valves (AICV, ASCV and IECV) must be connected to IICATS.

All valve chambers and pits with instrumentation or electrical equipment must be monitored as per the Instrument and Control standards.

15.4 Flowmeters

A flowmeter must be installed in the outlet main for new reservoirs. A flowmeter may be required in inlet main for new reservoirs. This requirement must be defined in the scope after consulting the asset owner.

The flowmeter and installation type must be approved by a Sydney Water IACS representative during the design phase.

Flowmeters must be connected to IICATS. Specific items to note include:

- Adequate straight pipe sections either side of the flowmeter with no tapings or offtakes.
- The flowmeter should be installed in a pit. The installation type must be assessed as part of the design process for each installation (e.g. pit, half-pit, direct buried).

- The Designer must specify the flow range required of the flowmeter. The type, accuracy and quality of the flowmeter shall be sought from Sydney Water IACS.

At sites with cathodic protection the flowmeter earthing design must consider the interaction between the cathodic protection and flowmeter earthing. The manufacturers recommendations must be followed to ensure both systems operate effectively.

15.5 Pressure boards

A standard reservoir pressure board, with site specific calibrated mechanical gauge to show the reservoir level, must be installed.
Refer to the Instrument and Control standards for details on pressure gauge display and calibration (TOG_TS01 and SSD130), standard reservoir pressure board design (TOG_TS02 and SSD81), and reservoir pressure board positioning (TOG_TS02 and SSD85).

15.6 Inlet and Overflow level indication

An indication of the reservoir overflow level (OFL) must be provided:

- at the instrument hatch, and
- fitted on the outside of the reservoir. It must be visible from the ground.

An indication of the level of the outlet bell mouth, typically 0% full, must also be provided on the outside of the reservoir.

15.7 Water Quality monitoring

All new reservoirs require online monitoring for water quality parameters including chlorine as a minimum. Water quality analysers will be installed as per current Sydney Water specifications.

Water quality analysers must be monitored by IICATS.

15.8 Chemical Dosing

If a chemical dosing system is installed, or is already installed, it must be monitored and controlled by IICATS and built to Sydney Water standard designs.

16. Signage and Identification

16.1 Reservoir identification

Provision should be made to show the reservoir name “XXXXXXX Reservoir“ and reservoir number “WSXXXX” at a suitable location on the outside of the structure visible from the access road.

Provision shall be made for signage on the fences and gates to show SWC security signs. These are usually wired to the chain wire fence.

All signage should be in accordance with SDIMS0026 Customer Delivery Facility Signage Specification.

To assist in auditing and cleaning of the reservoir, the numbers of a clock-face shall be stencilled both on the inside and outside on the reservoir wall. Numbering should be located 500mm off the floor. (internally and externally), and above the high water mark (internally) with corresponding numbers. The internal ladder hatch provides the datum point and is nominated as 6 o’clock.

Columns shall be numbered with the centre post as No.1 rotating out in a clock-wise direction. Column numbered No.2 shall be nearest the 6 o’clock position (i.e. nearest the internal ladder hatch).

17. Completion and Commissioning

17.1 Commissioning

The reservoir must be hydrostatically tested by the contractor in accordance with quality commissioning SOP and Sydney Water specification D0001440 Commissioning - transitioning assets into operation.

For the purpose of hydrostatic testing, the reservoir shall be filled with water to the top water level and shall be kept full for a period not less than forty-eight hours or such longer period as is required by the superintendent.

Any leaks including visible wet patches or defects which may cause leakage, shall be remedied to the satisfaction of the principle. The reservoir shall be re-tested until it is completely watertight.

No limits are set on the rate of filling of a steel reservoir except that the rate of emptying, if the reservoir is emptied through the scour, shall be such that no flooding or environmental damage is caused by the discharging water.

The contractor shall, if so directed by the principle to conduct vacuum tests on the weld joints in the floor. Vacuum testing shall be carried out generally in accordance with the relevant requirements of AWWA D100. Other testing methods such as magnetic particle method might be acceptable as an equivalent subject to principle review and approval.

17.2 Restoration

Restoration shall be carried out to such a standard that the finished Works shall be as near as practicable to standard of the Site prior to commencement of Works.

The Contractor shall be responsible for all restoration works including, but not restricted to fences, footpath and pavement repairs to a condition equivalent to that prior to the commencement of work.

17.3 Contractors Submissions

The contractor shall submit all relevant documentation in accordance with quality commissioning SOP and Sydney Water specification D0001440 Commissioning - transitioning assets into operation prior to commissioning.

17.4 Cleaning upon completion

Facilities shall be provided to enable the cleaning of the water storage area by either a dewatering and hosing process or by divers with vacuum equipment.

A hydrant shall be located in the inlet main, upstream of the reservoir's isolation stop valve, to supply cleaning water.

Surface Reservoirs

- A DN80 mm diver vacuum equipment outlet penetration shall be located 1m above the floor. The location of the outlet shall correspond with the tanker loading bay.

Elevated Reservoirs

- Provide a 65mm water service from the base of the reservoir to the platform at the top of the central access shaft. Provision of two 25mm taps around the handrail of the platform. At the bottom of the reservoir provide a 50mm male Kamlock coupling for the connection of a portable pump.

- A DN80 diver vacuum outlet at the bottom of the reservoir. The 80mm pipe shall penetrate the bottom of the vessel extending down the inside of the stem (fixed inside the stem as required) and terminating 1.5 metres above the floor at the base of the stem just inside the access door.

The Diver Vacuum fitting shall be flanged on the internal end and provided with a stop valve and blank flange at the external end. The external part of the fitting shall be provided with a vandal resistant hinged steel box with padlock welded to the reservoir wall where not within a building or secure structure.

17.5 Removal of redundant equipment

The Contractor shall be responsible for removal of all redundant equipment including, but not restricted to mixer, walkways, balustrade, fences, roofing.

17.6 Future asset operation & maintenance

Operations, maintenance manuals and inspection requirements shall be provided to allow Sydney Water to properly operate and maintain the reservoir and associated equipment and works. The manuals shall be supplied in both hard and soft copy format.

The target groups for the manuals shall be as follows:

- Asset Management
- Strategic Operations – Water Systems & Security
- Asset Solutions
  - Contractor Management
  - Capital Works project management
- Water Services
- Civil Maintenance
- Mechanical / Electrical Maintenance
- Group Property
- Grounds Maintenance

Operation and maintenance issues to consider include, but are not limited to:

- Free and full access to all operational and maintenance fittings and structures such as stop valves and maintenance holes must be maintained.
- Where future external access to an asset will be prevented by building works the asset will need to be made maintenance free.
- Clearances between the structure and asset to allow safe, timely, effective asset operation and maintenance. Minimum clearances or exclusion zones are specified in the Technical Guidelines – BOA. However, subject to site specific assessment, additional clearances may be required.
- Risk of adverse impacts such as ground instability or damage to adjacent structures due to SW asset failure or operation and maintenance activities (e.g. excavation for repair works). Design of the adjacent structure must assume material within the zone of influence of the Sydney Water asset (for example

area within 45 degrees from the underside of the asset) shall not be relied upon by the adjacent structure for support.

- Safety including operations and maintenance staff, and the general public.

17.7 Work Method Statement

A Work Method Statement (WMS) specifically for the purpose of asset protection must be prepared. The WMS must be concise and focus on describing the hazards and risks to Sydney Water assets on the construction site and the control measures to be put in place. The WMS must contain the following.

Tasks involved:

- Identify the risks / hazards during execution
- Specify the control measures (including asset protection) implemented
- Describe the construction methodology with the sequence of work and impacts on Sydney Water assets
- Implementation of monitoring requirements
- Implementation of Contingency plan

17.8 3D scanning

A 3D scan of the inside of the reservoir will be performed by Sydney Water IACS group. This must be scheduled in the commissioning plan at completion of works before any water is introduced to fill the reservoir. The standard two-weeks notice must be provided of when this can be completed.

18. Reference

Document type	Title	Document Reference (Section, clause)
Policies and specifications	Sydney Water Technical Specification - Civil	Sydney Water Technical Specification Civil
	Sydney Water Technical Specification - Mechanical	Sydney Water Technical Specification - Mechanical
	Sydney Water Technical Specification - Electrical	Sydney Water Technical Specification - Electrical
	Building over or adjacent to Sydney Water assets	Sydney Water policy – Building over or adjacent to Sydney Water assets
	Manual for selection and application of protective coatings	WSA 201
	Guide to hazardous paint management	AS 43461.1
	Lining for Circular Non-Man Entry Pipes	SS 201
	Geotechnical site investigations	AS 1726
	Structural vibration Part 3: Effects of vibration on structures	DIN 4150-3
	Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration	BS 5228-2
	Evaluation and measurement for vibration in buildings	BS 7385-2
	Explosives-Storage and use Part 2: Use of explosives	AS 2187.2
	New South Wales Guide to standards and tolerances	NSW Government
	Concrete structures	AS 3600
	Concrete structures for retaining liquids	AS 3735
	Use of products in contact with drinking water	AS/NZS 4020 (current)
	Heritage Compliance Procedure	SWEMS0031
	Management Specification	1041412

Ownership

Role	Title
Group	Asset Lifecycle
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Change history

Version No.	Date	Approved by	Brief description of change and consultation
1	2/11/2021	Dinesh Dineshharan, Specialist Engineering Manager	New Document

Appendices

Attachment	Title
A	Structural Design Criteria
B	Cathodic Protection

Appendix A Structural Design Criteria

A1 APPLICABLE CODES AND STANDARDS

The reservoir must be designed in compliance with this specification and y with relevant Australian Standards . All aspects of design such as loading, ultimate factors, ultimate strengths and allowable stress, deflections and other serviceability requirements, must be based on appropriate Australian Standards.

Reinforced and pre-stressed concrete reservoirs must comply with AS 3735 - Concrete Structures for Retaining Liquids and Sydney Water Technical Specification – Civil.

Steel reservoirs must comply with AWWA D-100 – Welded Steel Tanks for Water Storage.

A2 FOUNDATIONS

The foundation must be designed in such way as to minimise differential settlements. The settlements, particularly those caused by the varying foundations (cut and fill) must be calculated as accurately as possible using the most advanced methods. A thorough assessment of the maximum differential settlement must be made.

Suitable elastic material such as bitumen shall be placed over the concrete ring beam to absorb relative movements between the floor plate and wall. For on ground reservoirs, a sand/bitumen layer shall be placed between the compacted sub-base and the underside of the steel floor to provide an even and flexible support for the floor.

A3 DESIGN LOADS

A3.1 Dead Loads

Weight of structural and fitting elements only.

A3.2 Live Loads

In accordance with AS 1170.1 or the following loads in the absence of any specific loadings in the above code:

- Walkways 2.5 kPa (min.).
- Platforms 4KPa.
- Non-trafficable roofs 0.5 kPa (min.).
- Safety grill under hatches – 2.5 KPa or140 kg static load with additional 50 % for impact load on a footprint of 250 mm x 150 mm

A3.3 Wind Loads

- In accordance with AS 1170.2, must correspond to a minimum a return period of 2500 years for the for the reservoir wall and 1000 years for the roof.
- The internal wind coefficient for the reservoir l must be more severe than – 0.5 (suction).

A3.4 Seismic Loads

- In accordance with AS 1170.4, must correspond to a minimum return period of 2500 years Seismic loads must be either based on the entire weight of liquid retaining structures and their contents or must take account of the separate effects of the liquid content, using internationally recognised methods. A recommended code for the above is NZS 3106–Concrete Structures for the Storage of Liquids.

A3.5 Hydrostatic Pressures

Liquid retaining structures shall be designed for hydrostatic pressures including those during testing according to the levels shown on the drawings.

A3.6 Other Loads

Other loads, which must need to be considered in the design, are those arising from but not necessarily limited to the following:

- Differential settlement of foundation material.
- Shrinkage and swelling of soil.
- Temperature variations and gradients.
- Thrusts from anchored components of hydraulic conveyances.

The proposed reservoir structure and individual elements must be carefully assessed in terms of their susceptibility to differential settlements, particularly in respect of the increased stresses caused by the settlements.

Concrete reservoirs shall be designed to take account of the effects of temperature gradients for both ‘Full’ and ‘Empty’ conditions in accordance with the temperature gradients in AS 3735.

A4 MATERIALS AND STRUCTURE TYPES

Steel reservoirs must comply with the following requirements:

Material	Mild steel plate to AS 3678
	Bars and structural sections to AS 3679
	Hollow sections to AS 1163

Permanent design tensile stress for wall and floor plate: 137 MPafor Grade 250 steel and 163 MPa for Grade 350 steel in accordance with AWWA D100

A5 ROOF AND SUPPORT COLUMNS MUST BE DESIGN TO RELEVANT AUSTRALIAN STANDARD (REFER TO SYDNEY WATER TECHNICAL SPECIFICATION – CIVIL)DURABILITY AND CONSTRUCTION REQUIREMENTS FOR STEEL RESERVOIR

A5.1 General

Regardless of the protection system used for steel connections and members inside the reservoir, the following minimum requirements shall be satisfied to allow for long term corrosion of steelwork in both the submerged and air spaces of the tank.

Structural steel reservoirs must satisfy the following requirements:

- Fabrication must be fully welded.
- The tank details must be designed to eliminate wherever possible:

- Un-welded joints that will promote corrosion.
- Pockets that will accumulate rainwater on the surface.
- Attachments to the steel that result in excessive localised stresses due to welding or imposed loads.

- All welds joining shell plates must be complete joint penetration butt-welded with a backing run.
- The use of low-hydrogen electrodes is mandatory for manual welding of shell plates, permanent attachments to the shell plates, fittings and for welds joining the shell plate to the bottom plates.
- All shell plates must be rolled, regardless of material thickness.
- Corrosion allowances must be specified on the Drawings.
- Joint efficiency allowance must be based on the weld inspection procedure.

A5.2 Cleats, Connections and Protuberances from the reservoir

- Minimum thickness of 12 mm including 2 mm corrosion allowance per face
- All sharp edges shall be rounded off to a 3 mm radius.

A5.3 Roofing members including 1mm corrosion allowance per face

- Minimum 10 mm flange thickness on channels, I sections, T sections Minimum 6 mm web thickness on channels, I sections, T sections Minimum 10 mm leg thickness on angles
- Minimum 6 mm wall thickness on tubes and hollow sections

A5.4 Fillet Welds

- Minimum 6 mm continuous fillet welding must be used for all connections, including seal welds. Intermittent welding must not be allowed.

A5.5 Cold formed steel sections

Cold formed steel sections are not permitted inside reservoir.

- Plates for wall and floor including 2 mm corrosion on inside face and 1 mm under floor plate FWall 8 mm minimum thickness.
- Floor 12 mm minimum sketch plate and 10 mm minimum floor plate.

A5.6 Wall and floor plate welding

Full penetration butt welds on wall plates and continuous fillet welds on floor plates Joint efficiency 100%

- **Creep Control brackets for on ground steel reservoir**

The designer shall ensure that adequate provision is made to prevent steel reservoirs from gradually creeping sideways when empty (and particularly before pipework is connected) due to uneven thermal effects, etc.

A6 DURABILITY AND CONSTRUCTION REQUIREMENTS FOR REINFORCED AND PRESTRESSED CONCRETE RESERVOIRS

Reinforced concrete and prestressed concrete reservoirs shall satisfy the following requirements:

The concrete strength, cover to reinforcement, design and construction must be in accordance with AS 3735, and Sydney Water Technical Specification – Civil. Vertical construction joints must not be permitted in circular tanks. Prestressing must be achieved by post tensioning tendons that are placed within the structural element. On completion of post tensioning, the ducts must be fully filled with grout as soon as practicable. Unbonded tendons that are protected by sheathing, grease and prestressing achieved by wire winding methods and subsequently protected by shotcrete must not be permitted

Appendix B Cathodic Protection

B1. GENERAL

An impressed current cathodic protection system shall be installed in the reservoir to protect the internal steelwork of the reservoir from corrosion.

The cathodic protection system shall meet the minimum requirements of this specification. The contractor is to submit details of the anode and reference layout to Sydney Water for approval before installation.

The contractor shall engage a recognised cathodic protection consultant to provide specialist design, installation and testing of the cathodic protection system.

At sites with cathodic protection the design must consider the interaction of the cathodic protection and flowmeter earthing. The manufacturers recommendations, for both systems, must be followed to ensure both systems operate effectively.

B2. PROTECTION CRITERIA

The reservoir shall be protected to a minimum polarised 'off' potential of 850 mV to a Cu_2SO_4 half cell at any points in the lining. The steelwork is not to be over protected at any time as lining damage could result.

B3. CATHODIC PROTECTION POWER UNIT

The cathodic protection power unit shall comply with Sydney Water's Standard Specification WB INT5A 40V. The location of the unit is within the new outdoor SCA.

B4. PLATINISED TITANIUM ANODES

Platinised titanium anodes shall be installed in the reservoir. The anodes are to consist of 3.0 mm diameter titanium wire substrate with 2.5 microns coating of platinum. The design life of the anodes shall be a minimum of 25 years before replacement is necessary. Anodes shall be located such that protection potentials on the internal steelwork are even throughout the reservoir. Anodes are not to be placed within 10.0 metres of outlets or agitators.

Anode locations:

- Anodes should be installed a minimum of 2.0 metres from the reservoir floor and a minimum of 2.0 metres from internal columns or reservoir wall. Anodes to be suitably weighted, to ensure movement of anodes within the reservoir is minimal. The number and length of anodes installed are to be sufficient to keep the initial operating voltage of the system to less than 10.0 V.
- The anode to anode cable connection must be crimped and suitable heat shrink sleeving applied to support the anode and weight for the designed 25 years life of the anode.

B5. ZINC REFERENCE

A zinc reference is to be permanently installed in the reservoir. The reference is to be installed approximately 1.0 metre from the side of the reservoir and 2.0 metres from the bottom.

Reference is to be at least 10.0 metres from an internal ladder and 10.0 metres from an outlet or inlet. It must be determined at the time of commissioning that the location of the zinc will give a protection potential typical of the protection level within the reservoir.

B6. PRECAUTIONS AND SAFETY

Locks shall be placed on all reservoir and roof hatches and entry gates to prevent access and tampering with the installation.

Safety signs (No Swimming and Danger) shall be attached to the hatch over the internal ladder and to the entry gate at the bottom of the external access stairway. All signs to be made to the relevant Australian Standards.

B7. CONDUIT, CABLE, JUNCTION BOXES, CONNECTIONS

The main anode cable, zinc reference cable and negative reservoir cable shall be terminated at the cathodic protection power unit.

All cables associated with the anode rings are to be double insulated either by double insulated cable in metal conduit or single insulated cable in non-metallic conduit.

Anode ring roof conduit shall be installed in straight runs parallel to roof concentric rafters.

Cable requirements:

- Anode cable ring on top of reservoirs – 4 mm^2 red single insulated in 20 mm non-metallic conduit.
- Cable connecting anodes to anode ring – 6 mm^2 red double insulated cable.
- Cable connecting zinc reference to cathodic protection unit – 1 mm^2 core flex in 20 mm conduit (brown, blue insulation).
- Cable from anode ring to cathodic protection power unit – 4 mm^2 red double insulated.
- Negative tank connection to cathodic protection unit – 4 mm^2 black single insulated in 20 mm conduit.
- The main anode ring is to be 4 mm^2 continuous cable. Anode cable connections to anode ring to be made in junction boxes above each anode. The junction boxes are to house the anode support. The anodes must be capable of being withdrawn from the reservoir by taking off the junction box lid. The weight at the end of the anode is also required to be withdrawn at this location. A 50 mm hole in the bottom of the junction box has been found to be adequate. The hole is to be drilled through the bottom of the junction box and through the aluminium roof of the reservoir. This is also an access point for lowering a Cu_2SO_4 reference electrode into the reservoir for test purposes. Conduit is to be installed from the junction box through the roof hole to minimise damage to the anodes. Any penetrations through the aluminium roof sheeting shall be fully sealed with compatible materials and in no case shall the penetration be made through the lapping of the roof sheets and fixing point to a support member.
- Anode connections to the cable ring are to be capable of disconnection within the junction box to allow testing of individual anode currents.
- All roof conduit to be saddled at 300 mm intervals. Cables run down the side of the reservoir to be installed in minimum 20 mm metallic conduit. All roof saddles to be riveted with aluminium self-sealing rivets.
- Junction box size to be approximately 170 mm L x 120 mm W x 100 mm H. All junction boxes to be drilled with a 6 mm drainage hole at the lower end. All anode junction boxes to be numbered. All conduit and junction boxes to be UV stabilised.
- Roof conduit is to be installed so that it does not present a trip hazard on designated walkways. Roof conduit is to be installed under walkways where possible. Low profile conduit protection plates may be used where necessary.

- The products listed below are considered adequate although alternative products may be used but must meet the minimum specifications of those products listed.
- Roof conduit – 20 mm Corrlock nylon flexible non-metallic conduit and fittings temp - 40°C + 105°C Type CL.
- Epoxy Epirez 8837 High Impact Coating EP for manufacture of anode weights.
- Zinc Rich Epoxy – See WSA 201 approved coating P1.

B8. STANDARDS AND DRAWINGS

All work is to be done in a tradesman like manner. The cathodic protection systems shall be installed in accordance with AS 3000 and AS 2832.3.

All materials used within the reservoir must be approved by Sydney Water or approved tested under AS 4020 for use in potable water reservoir.

B9. COMMISSIONING

At the time of commissioning or handover to Sydney Water the following shall be provided:

- All relevant drawings and specifications.
- Final settings of the cathodic protection power unit and past operating values of volts, current and zinc potential at 4 weekly intervals.
- Certificate of compliance from the anode manufacturer stating thickness of platinum.
- Calibrated zinc valve to Cu_2SO_4.
- A maintenance manual for the cathodic protection power unit.

B10. ATTACHMENTS

Reference should be made to Appendices for Cathodic Protection DC power supply units and danger signs.

CP-01.11

Cathodic Protection dc Power Unit Specification

(Referred to as WB INT/5A 40V Internal Unit)

B11. AC INPUT

- The input power supply shall be 240 V, 50 Hz single phase AC.
- Glanded cable entries shall be provided on the bottom of the cubicle.
- AC input to be protected by an appropriately sized circuit breaker that has a trip toggle position.

B12. CONTROL

- The control unit is to be capable of providing constant voltage or constant current or auto control. The auto control is to maintain the input reference voltage within plus/minus 5% of set point.
- Ref. suspended zinc in reservoir.

B13. DC OUTPUT

- The rated DC output shall be 5 Amps, 40 Volts capable of continuous operation at 40°C ambient.
- One positive, one negative output with bottom/rear/side cable entry provided. The output terminals shall each be capable of taking 16 mm^2 cable.
- The power unit shall be capable of continuous open circuit operation. The power unit shall be capable of withstanding a short circuit across the output terminals without damage to any device other than the protection fuses.
- The output current and voltage is to be continuously variable over the range of the meters. When set at constant current or voltage the selected value shall be maintained within plus/minus 5% of the set point.
- The unit is to be provided with output voltage and current limiters with indicating LEDS (red) to show when the voltage and current limits have been met. Voltage and current limiters are to operate immediately the voltage or current meets the set value.
- The current limit is to be able to be set over the range of 50 mA to 5 A.
- The voltage limit is to be able to be set over the range of 2.0 V to 40.0 V.
- The DC circuit is to be fitted with a fuse capable of carrying a 5 Amp HRC fuse and a second series fuse capable of holding a 3AG fuse.
- The unit shall be able to withstand cyclic "on/off" switching for the taking of "instant off" potentials.

B14. CABINET

The cabinet will be suitably corrosion protected for mounting inside the new outdoor SCA and will be provided with a lockable front cover to prevent unauthorised access to controls. The cabinet is required to meet minimum classification IP 53 (BS5490). The front cover shall have a clear perspex window to allow reading of front panel equipment.

The transformer is not to go 40°C above ambient temperature at full load.

B15. INSTRUMENTS

The transformer rectifier will be fitted with ammeter, voltmeter, plus a high impedance digital voltmeter with a minimum scale range of +1.0 volt to -2.0 volt (to measure input reference voltage). The input impedance of the reference circuit shall be a minimum of 20 megaohms. Front panel terminals shall be provided for measurement of DC output current (from a shunt), reference voltage and driving voltage. The ammeter full-scale deflection to be 5 A, the voltmeter full-scale deflection to be 40 V.

B16. CABLING

- All major cabling to be wire marked. All earth wires to be terminated at a common earth bar. Earth wires to be fitted with crimp lugs. No more than two power wires connected at any one point. Cables to be colour coded.
- Earthing of components via mounting fixings will not be accepted.
- The earthing connections shall be arranged so that removal of one component shall not affect continuity of the earthing conductor associated with any other component. Earthing conductor insulation shall be coloured green/yellow.

- All electrical connections shall be capable of being made and broken from the front, and all equipment and wiring shall be so attached that each can be removed and replaced separately from the front without disturbing the rest.
- All wiring shall fully comply with the S.A.A. Wiring Rules and the Service and Installation Rules of the local Supply Authority.
- All control wiring shall be carried out in 7/0.50 (1.5 mm^2) minimum copper conductor, 0.6/1 kV PVC insulated, V75 grade cable to AS 3147. Where flexibility is required the stranding shall be 32/0.20 (1.0 mm^2) minimum copper conductor.
- Each conductor shall be identified at both ends, by means of full circle, interlocking type cable markers, similar to Critchley interlocking 'Z' type.

B17. TERMINALS

Incoming main cabling terminals shall be shrouded.

All electrical connections shall be capable of being made and broken from the front, and all equipment and wiring shall be attached that each can be removed and replaced separately from the front without disturbing the rest.

No more than two wires shall be connected to any one terminal.

The clamping screws of the terminals shall not cut or damage the wires. Terminal blocks incorporating grub screws will not be accepted.

B18. RIPPLE

Less than 5 per cent RMS voltage at full load.

B19. LIGHTNING PROTECTION

Voltage surge diverters having a minimum rating of 10 kA to be fitted to all incoming and outgoing lines. All diverters common terminals must be terminated at a common earth stud. Combinations of Metal Oxide Varistors and Gas Discharge Arrestors shall be used on all lines.

Attachment 1 – Submissions for verification

Substitution of Materials

After submission of evidence that substitution of any materials will not affect the quality of the final product and at least five (5) working days prior to fabrication.

Shop Drawings

After receipt of “For Construction” drawings from Sydney Water and at least five (5) working days prior to fabrication.

Erected Steelwork

After submission of details of compliance of erected steelwork and within seven (7) days after completion.

Welder Qualification and Welding Qualification Procedure

After submission of test certificates and test results for welders and welding procedures, and at least four (4) days prior to fabrication.

Non-Destructive Weld Testing

After submission of test results on non-destructive weld testing and at least four (4) days prior to corrosion protection of the steelwork.

Fabricated Steelwork

After submission of details of compliance of fabricated steelwork and at least two (2) days prior to corrosion protection of the steelwork.

Site Welding

After submission of details of any proposed site welding additional to those shown on reviewed shop drawings and at least five (5) working days prior to the commencement of such site welding.

Qualifications of Coating Contractor

Only contractor with relevant contractor accreditation can perform works:. eg PCCP (Painting Contractor Certification Program) Class 5 for Hazardous Coatings (heavy metal), Class 6 Respirable Dust.