Hunter Water Corporation A.B.N. 46 228 513 446

Standard Technical Specification for:

POTABLE WATER RESERVOIRS
STS 409

This Standard Technical Specification was developed by Hunter Water Corporation to be used for the design, construction/installation and/or maintenance of facilities that are, or are to become, the property of Hunter Water Corporation. It is intended that this Standard Technical Specification be used in conjunction with various other standard and project specific drawings and design requirements as defined by Hunter Water Corporation for each particular project.

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Standard – STS 409 – Potable Water Reservoirs

1 Purpose

This Standard Technical Specification (STS) describes the general requirements of Hunter Water for the design, construction, supply, installation or modification of potable water reservoirs that are, or are to become, the property of Hunter Water.

This STS 409 does not include:

- chemical storage applications. See STS 670 for chemical storage
- water retaining structures within treatment plants.

2 Interpretation

For the purposes of interpretation of this STS 409, except where the context requires otherwise:

- 'Drawings' means the drawings detailing the work involved in a particular project in hand
- ‘Include’ means including but not limited to, and is used to provide clarification or examples of the type and nature of items intended
- 'Specification' means a specification detailing the work involved in a particular project
- 'Standard Drawings' means Hunter Water Corporation Limited drawings (referenced in Appendix A:)
- ‘Standards’ means applicable industry standards (referenced in Appendix B:) which include:
    - Australian Standards (AS);
    - Australian / New Zealand Standards (AS/NZS);
    - American National Standards Institute (ANSI); and
    - International Standards Organisation Standards (ISO)
- 'Standard Technical Specification' (STS) references any of Hunter Water’s Standard Technical Specifications, as implied by the text.

Headings are for the convenience of the reader and shall not be used in the interpretation of this Standard Technical Specification.

Unless the stated otherwise any expression such as "give notice", "submit", "approval", or "directed" means give notice to, submit to, approval by, or directed by the person nominated by the Hunter Water.

Approval does not imply acceptance of responsibility by Hunter Water for compliance with this technical specification. Unless approval has been issued in writing, approval has not been granted.

Failure to comply with the requirements of this STS or any referred documentation may result in rejection. Where equipment and / or manufacture is rejected, notice will be given by Hunter Water in writing. All associated rectification work shall be completed by the contractor at their cost.

2.1 Order of Precedence

All work shall meet all stated requirements in this STS in addition to project specification or standards specified.

Any deviation from this Standard Technical Specification shall be approved in writing on a case by cases basis by Hunter Water’s Document Owner.

The order of document precedence is:

- legislative requirements
- content in this STS
- Australian Standards
- WSAA standards.

3 Roles and Responsibilities

3.1 Document Owner

The Document Owner of this Hunter Water Standard Technical Specification of STS 409 Potable Water Reservoirs is Hunter Water's Manager Planning and Engineering.

3.2 Responsibilities

The Document Owner shall approve in writing the issue of any updated version of this Standard Technical Specification.

Any concession to any requirement in this STS 409 is valid only when authorised in writing by the Document Owner.

4 Definitions

Where the following term, abbreviation or expression occurs in this STS, it is defined as follows, unless the context implies otherwise:-

Term / Abbreviation / Expression	Definition
AIV	Automatic Inlet Valve
AS	Australian Standards
BWL	Bottom water level - lowest level of supply from within the tank. That is a minimum 100 mm above the tank floor at the location of the outlet pipework.
CFD	Computational Fluid Dynamics computer modelling
DFT	Dry film thickness
OEM	Original Equipment Manufacturer
EWP	Elevated work platform
FCR	Free Chlorine Residual
FRP	Fibre reinforced plastic
GPO	General purpose 240V electrical outlet
GRI	Geosynthetic Research Institute
Hunter Water	Hunter Water Corporation
HMI	Human Machine Interface
ITP	Inspection and Test Plan
Jetter Truck	High pressure cleaner mounted on a truck
LCC	Life cycle cost. Means the full cost of the asset over its lifecycle, from design, construction, operation to decommissioning
NCC	National Construction Code
Overflow level	Minimum 200 mm above top water level
PFD	Process flow diagram
PLC	Programmable logic control
Potable water	Water treated for human consumption.
Receiving water bodies	An ocean, natural lake, wetlands or natural creek line
Reservoir	Where the word ‘reservoir’ is used in this document, it should also be read as applicable to potable water tank, and high level tank
RL	Relative Level
RTU	Remote/radio telemetry unit
SAA	Standards Association of Australia
SCADA	Supervisory Control and Data Acquisition
SIPS	Smart Integrated Pump Scheduling
Strake	Longitudinal wall plate/panel
STS	Standard Technical Specification
Sump invert	Base of the sump
Tank invert	Lowest point of the floor
TCR	Total Chlorine Residual

Term / Abbreviation / Expression	Definition
TWL	Top water level – maximum operating level of the reservoir
Ventilator	Air vents to release air from the cavity below the reservoir roof
Vermin	Mammals, reptiles, birds, amphibians (Includes: bats, birds, frogs, lizards, mice, possums, rats, snakes)
WSAA	Water Services Association Australia

5 Compliance

These compliance requirements apply to all reservoirs supplied to Hunter Water.

5.1 Legislation and Standards

All reservoirs supplied to Hunter Water must comply with the applicable legislative, regulatory, Codes of Practice and/or Standards in force at the time of commissioning of the reservoir and its associated equipment.

5.1.1 Legislative Requirements

The relevant Commonwealth and New South Wales legislation and Local Council Requirements apply to all reservoirs and associated equipment supplied to Hunter Water. The following are key aspects of these legislative requirements.

5.1.1.1 Work Health and Safety Legislation

The Work Health and Safety (WHS) Act, NSW, 2011 (WHS Act), Work Health and Safety Regulation, NSW, 2011 (WHS Regulation) and NSW WorkCover Codes of Practice have specific requirements, including:

- requirements in relation to the design, manufacture, import, supply, installation, construction and/or commissioning of equipment. Whether these are directly applicable to the Contractor, OEM or indirectly to Hunter Water, these provisions shall be met and a Contractor shall provide all equipment, services and documentation within its scope of supply to meet these requirements
- the application of the relevant Codes of Practice.

5.1.2 Codes of Practice

5.1.2.1 NSW WorkCover Authority

The NSW WorkCover retained, approved and endorsed Codes of Practice apply, including:

- How to Manage Work Health and Safety Risks Code of Practice
- Managing Work Environment Facilities Code of Practice
- Technical Guidance Code of Practice
- WHS Consultation, Co-operation, Coordination Code of Practice
- Managing the Risk of Plant in the Workplace Code of Practice.
- Managing risks of falls at workplaces

5.1.2.2 Safe Work Australia

Safe Work Australia Model Codes of Practice that have not yet been approved by NSW WorkCover should be used as guides.

5.1.2.3 Australian Building Codes Board

Any building work associated with the installation of reservoir equipment or systems at Hunter Water must comply with the Australian Building Codes Board National Construction Code.

5.1.3 Standards

Any Standards relevant to reservoirs or associated equipment supplied to and operated by Hunter Water apply, including specific Standards or suites of applicable Standards referenced in STS409.

5.1.4 Quality Accreditation

Any reservoirs or associated equipment should be designed, manufactured, and where practicable installed and commissioned by an organisation with a quality management system accredited as compliant with ISO 9001:2008 Quality management systems — Requirements.

6 Life Cycle Cost

Where requirements nominated in this document allow a choice in the type of reservoir, arrangement or materials of construction, the final choice will be determined by the lowest life cycle cost. Lifecycle costs to be included (as a minimum) are:

- cost of reservoir structure and associated infrastructure
- access and maintenance costs
- maintainable items and equipment, including
    - life and replacement cost of coatings
    - roof and including ancillary items such as ventilation equipment
    - electrical and mechanical equipment, including switchgear, telemetry, valves etc
- electricity supply:
    - network mains supply, with or without onsite electricity generation, or
    - stand-alone on-site generation and storage
- zero greenhouse gas emissions with lowest cost energy

7 Prior to Concept Design

7.1 Reservoir Life Cost Considerations

This section applies to the planning phase of potable water reservoirs lifecycle, including investigations prior to the concept design of a reservoir. In the planning phase the following issues must be considered and addressed:

- functionality:
    - receive, store and discharge water to meet Australian Drinking Water Guidelines
    - achieve Hunter Water's chlorine residual target range
    - incorporate remote monitoring, control and telemetry alarms
    - have minimal visual impact, through consideration of reservoir placement and landscaping
    - support Hunter Waters energy efficiency programs (SIPS)
- operability and maintainability:
    - comply with the requirements outlined in the Hunter Water WSA 03 - Water Supply Code of Australia - Version 2.1
    - provide safe working conditions for operation and maintenance personnel
    - seek to minimise operator attendance and be low maintenance
    - be maintained using Hunter Waters standard maintenance practices
    - utilise components from the Hunter Water approved products list
    - operate reliably, effectively and automatically without the need for operator's intervention
    - incorporate security measures in accordance with standard drawing RES-113 and STS 105 Security at Hunter Water Corporation Assets
- community impact:
    - undertake early community engagement, prior to final site selection
    - draft a communication plan, including identification of stakeholders
- environmental impact
    - identify environmental requirements and constraints.

7.2 WSAA standards; Reservoir Size

Reservoirs must be sized in accordance with WSA 03 - Water Supply Code of Australia (Hunter Water Edition).

The sizing of the reservoir needs to be a documented process accounting for, as a minimum:

- water network security
- detention times
- water quality
- zone pressures (height/elevation).

7.3 Location Factors

Potable water reservoirs must be above ground.

A potable water reservoir site must have these features:

- land owned by Hunter Water, or an easement dedicated to Hunter Water
- all weather heavy vehicle access to the reservoir from existing public road
- access to the Hunter Water Radio network access
- asset security, including bushfire protection zone, vandalism
- area for a second reservoir at the site of equal capacity, RL and wall height, for future replacement or increase storage capacity, in respect of the ultimate development
- the site and access road must be above a 1% AEP flood event.

In addition to the above, the following factors must be considered and documented during the site selection process:

- provision of a buffer from houses, built-up areas and future development
- proximity to pipelines and the requirements for hydraulic design (refer Clause 12)
- environmental exposure impacts on design life
- site slope and ground conditions
- space for flowmeter / valve pits
- space for chlorination facility if required
- proximity to electricity network, for supply to site
- stormwater management and drainage from the site including access roads so flooding of the facility is avoided
- an overflow path to a waterway that doesn't impact other landholders
- potential for release for chlorinated potable water to receiving water bodies
- landscaping to minimise visual impact.

7.4 Land Selection

The reservoir site land ownership must be, in order of preference:

1. Land provided within the development by the person or business that is developing the land or their agent. (Hunter Water is to be given title or easement rights)
2. Hunter Water owned land (if Hunter Water is the developer)
3. Council land (Community land/Operational land)
4. Vacant Crown land
5. Serviced private property
6. Vacant private property
7. Established Crown land

8. Road reserve

7.5 Easements

The reservoir site must have easement rights or freehold title (vested in Hunter Water) for:

- reservoir sites
- access roads to reservoirs and
- services to and from the reservoir.

The reservoir must be contained within an easement if wholly within a public reserve or a designated lot if not within a public reserve. The easement or lot or combination of both is to encompass:

- batters
- embankments
- retaining walls
- access road;
- pipework to and from the reservoir
- stormwater drainage
- power supply
- services and all other components of the reservoir.

7.6 Community Engagement

The community engagement must be done in accordance with the Hunter Water Asset Creation Framework. Early engagement must be undertaken with:

- Hunter Water's community engagement team
- the community to identify any issues with the preferred sites. A community reference group or alternative suitable community engagement process may be required to identify all issues with the potential sites.

8 Site Investigations

8.1 Site Survey

The reservoir site and services surveying must be done in accordance with Hunter Water STS 911. The reservoir site and associated pipes routes must be surveyed by a registered surveyor to identify the boundaries, surface contours and existing services, the survey will be used in:

- siting the reservoir
- determining operating levels
- designing and constructing:
    - pipework routes (inlet, outlet, scour, overflow, bypass)
    - flowmeters
    - water service
    - power supply
    - site drainage
    - access road and turning areas.

8.2 Geotechnical

The reservoir site requires geotechnical investigation to determine the ground conditions and all associated parameters required for the design and construction of the reservoir and any associated works. The geotechnical investigation must address (but not be limited to) the following:

- characteristics of the in-situ soil in accordance with AS 1289.3.8.1:2017
    - including dispersive soils and contaminated soils
- recommended foundation preparation
- design of site fill to achieve acceptable bearing pressures
- corrosiveness of the soil in relation to corrosion of the reservoir floor material
- local geology and the possibility of rock pinnacles and sink holes
- consolidation, settlement, and differential settlement of the tank foundation
- slope stability (local & global)
- surface drainage requirements, including surface water courses, tank overflows and scouring, and rainfall storm runoff
- sub-surface drainage requirements, including groundwater and tank leakage collection
- risk of foundation damage (e.g. dissolution, softening, piping etc.) by leakage or other water flows.

A factual and interpretive report detailing the investigation and findings must be included in the project documentation.

9 Design for Water Quality

The reservoir design and configuration contributes to water quality outcomes in the water distribution network. To achieve water quality outcomes the reservoir design must ensure:

- all downstream connections receive a free chlorine residual greater than 0.2 mg/L, which may require the inclusion of a re-chlorination facility
- water within the reservoir is well-mixed
- protection of the stored water from external contamination.

Hunter Water's performance target for all customers is to receive water with a chlorine residual of greater than 0.2 mg/L. Reservoirs must be designed to meet this performance target. This may require a re-chlorination facility to be installed at the reservoir site.

9.1 Chlorine Residual Target

Water leaving a reservoir must have a FCR residual:

- up to a target of 3 mg/L with a control tolerance of +/- 0.2 mg/L
- never exceeding 4.5 mg/L
- minimum FCR of 0.2mg/L at water service connections of end users.

9.2 Chlorine Modelling

Chlorine residual must be modelled for the reservoir and the reservoirs reticulation network. The modelling must identify:

- chlorine residual range coming into the reservoir based on sampling data
- chlorine residual range at the outlet of the reservoir, taking into account retention time and mixing within the reservoir
- expected chlorine residual at a minimum of 6 reticulation sample locations in the downstream supply zone, including:
    - most disadvantaged customer (i.e. lowest residual)
    - customer closest to the reservoir (i.e. highest residual)
    - all licence monitoring points

9.3 Chlorine addition

The preferred location for chlorine addition is into the reservoir in front of the inlet pipe. The method for chlorine addition must be selected using the following guideline.

Chlorine type	*Form*	*Apply when?*	*Notes*
Sodium Hypochorite	Liquid solution	Heavy vehicle access available. Low to mid-range chlorine. demand. Chemical storage less than 15,000L. Close to development.	Liquid solution has a higher risk of spillage/leakage than other options. Requires truck delivery bund to contain potential spills during delivery.
Chlorine Gas (920kg bottles)	Gas	Buffer zone exists around site. High chlorine usage (ie >~70 kg per week). Heavy vehicle access available. Chlorine gas is preferred and site.	No delivery bund required
Chlorine Gas (70kg bottles)	Gas	Buffer zone exists around site. Light vehicle access available. Chlorine usage is low (ie ~<70 kg per week, equal to one drum change per week).	No delivery bund required
Chlorine generated on site from Sodium Chloride	Dry	No heavy vehicle access to deliver sodium hypochlorite solution or gas bottles. No or poor buffer zone to development. Waste disposal can be accommodated (brine).	High energy usage. No hazardous chemicals involved.
Calcium Hypochlorite	Dry tablets	Dosing required for less than 3 years. Intermittent dosing, e.g. 3 months of the year only	Manual chlorine tablet dosing is not an acceptable long term option.

9.4 Mixing of Reservoirs

The reservoir design must integrate mixing to achieve water homogeneity, minimising dead zones, stratification and short circuiting. The reservoir design must:

- achieve chlorine residual target +/- 0.2mg/L FCR across the reservoir
- include a seasonal flow design curve
- minimise dead zones, stratification and short circuiting
    - include mechanical mixing when 100% turnover is not achieved in 72 hours in all operating scenarios including low demand conditions (E.g. Average day demand under drought water restrictions)

- review the design and modelling results using the WA Water Corporation's reservoir assessment tool
- include forced mixing if chlorine is dosed on the inlet to the reservoir or into the reservoir.

9.5 Reservoir retention time assessment

A mass balance assessment of water flow in/out of the reservoir and retention time must be performed to identify scenarios where turnover is more than 72 hours for 100% water turn over.

This assessment must consider the demand scenarios over the life of the reservoir, and any changeable reservoir control/configuration. The results of the analysis are to be provided to Hunter Water in a short report, along with the relevant modelling files.

9.6 Computational fluid dynamics modelling

For reservoirs >2 ML, CFD analysis is required to determine how water homogeneity and chlorine residual of +/- 0.2mg/L across the reservoir will be achieved.

The CFD modelling must:

- be undertaken for:
    - any interim arrangements, e.g. where one reservoir is constructed on a site where two are ultimately proposed
    - final site configuration
- take into account variables including:
    - daily diurnal pattern
    - season demand curve
    - flow range into reservoir
    - Demand on the reservoir from any downstream pump station and/or cycling of any downstream reservoirs.
    - hours filling per day and number of fill events
- inform the design to maximise passive mixing (non-mechanised)
- identify additional mechanised mixing requirements to achieve water quality homogeneity within the reservoir;
    - additional mechanised mixing equipment must be located outside the reservoir (E.g. pump and nozzle arrangements)

The CFD model must be used to determine mechanical mixing requirements.

9.7 Inlet nozzles and passive mixing

The reservoir must be designed to maximise passive mixing (non-mechanised). The reservoir inlet pipe must have a mixing-enhancing nozzle. The mixing nozzle must be manually adjustable, to enable site-specific set-up to optimise mixing.

9.8 Mechanical mixers

Mechanical mixing equipment must be provided to achieve water quality homogeneity. Mechanical mixers must be installed if:

- chlorination dosing is occurring at the reservoir
- full turnover of the reservoir is more than 72 hours in low demand conditions
- identified in the CFD modelling.

Mixing equipment must be accessible for maintenance without entry to the reservoir.

9.9 Ventilation

The reservoir must incorporate natural air ventilation. The objectives of the ventilation are to limit condensation, corrosion and minimise temperature rise. The ventilation must:

- be designed for a chimney effect, with air drafting from the perimeter of the roof to the high points of the roof
- maintain temperature rise of air cavity inside the reservoir to no more than 15°C above ambient air temperature
- allow for air to enter and be discharged during reservoir operation
- be sized for six air changes per hour based on the air volume above TWL.

Ventilation can be achieved by a combination of inlet ventilation openings provided at the top of the reservoir wall together with ventilators located at the centre of the roof structure or designed in accordance with drawing RES-105. Ventilators must be selected based on the wind loading at the reservoir site.

9.9.1 Vents

Vents must:

- be vermin proof
- not allow rainwater runoff to enter the reservoir
- be installed on flat surfaces, avoiding corners and joints
- avoid introducing ledges or protrusions to discourage birds roosting
- have mesh fastened, not adhered in place
- have a minimum 200mm clearance from surrounding surfaces
- roof mounted vents must be inspectable and maintainable from the roof

Examples of vents that meet this requirement include:

Vent type	Indicative Representation
Gooseneck or J type vent	

Mushroom type vents	

9.10 Vermin Proofing

The reservoir must be designed and constructed to be vermin proof, as contamination of potable water in reservoirs by vermin is a public health risk. All gaps must be screened in the form of covering by two screen layers, a corrosion resistant security screen underlain by a stainless-steel insect mesh. The insect mesh must have maximum apertures greater than 1mm and equal to or less than 1.8mm and strands of diameter between 0.7mm and 2mm, and be installed to create a full seal that stops insect access. Vermin proofing materials to be as specified in Table 10.2 and 10.3 below.

10 Materials selection and Design for Durability

Reservoirs with bolted panel walls can be used for reservoirs with volume less than 5 ML or design life less than 15 years.

10.1 Reservoir Foundations

Reservoirs foundations must:

- be designed to meet the settlement of the reservoir site
- be designed to meet the differential settlement of the reservoir site

Reservoir foundation design must consider reservoir:

- top water level
- wall material
- settlement tolerance of reservoir design
- site geotechnical information.

10.2 Design Life

The reservoirs design life requirements for components are listed in Table 10.1, these design life values assume all maintenance is performed.

Table 10.1 Asset Component Design Life

Component	Minimum Design Life
Reinforced Concrete Reservoir	100 years min
Post Tensioned Reservoir	75 years
Steel Reservoir	75 years
Bolted steel reservoir	15 years
Steel Coating System	15 years coastal 25 years inland
Reservoir Liner	25 years
Rafters and Columns	75 years, 25 years to first maintenance of protective coatings. 100 years for FRP structural members.
Tendons	75 years
Purlins	25 years
Roof Sheeting	25 year, 25 years to first maintenance
Safe access including platform, staircases	100 years, 25 years to first maintenance
Above Ground Pipework	50 years
Below Ground Pipework	100 years
Mechanical Equipment	20 years
Electrical Equipment	15 years
Cathodic Protection System	25 years for impressed current system
Ventilators (whirly birds or static)	20 years

10.3 Preferred Product and Equipment List

The current Approved Products and Manufacturers List is available on the Hunter Water website, www.hunterwater.com.au

Where products not included on the Approved Products list are proposed their use as or in relation to potable water reservoirs must comply with AS/NZS 4020 (Testing of Products for use in Contact with Drinking Water) prior to seeking Hunter Water's approval.

10.4 Material Selection

Reservoirs must be design and constructed from the materials in Table 10.2 and

Table 10.3. The material selection must:

- Reservoir coatings systems (both internal and external) must to be in accordance with WSA 201
- be certified to AS 4020
- meet the design life
- minimise the need for ongoing maintenance
- minimise/eliminate material degradation
- be compatible with a free chlorine residual of up to 6 mg/L
- be suitable for ambient temperatures up to 50°C.

Reservoir materials must be selected for compatibility with the following water quality properties of the water entering the reservoir:

- alkalinity
- pH
- fluid temperature
- chloride levels
- LSI (min and max)
- total hardness
- free chlorine residuals.

Table 10.2 Coastal Tank Material Minimum Requirements (<5 km from coast)

Element	Steel Reservoir	Concrete Reservoir
Walls	250 MPa Mild Steel Plate	Concrete 40 MPa (min)
Floor	250 MPa Mild Steel Plate	Concrete 40 MPa (min)
Rafters	Galvanised Mild Steel	Galvanised Mild Steel, or Extruded Marine Grade Aluminium Alloy (Z beams)
Purlins	Seasoned Hardwood Timber, or Roll Formed Marine Grade Aluminium (C-Profile)	Seasoned Hardwood Timber, or Roll Formed Marine Grade Aluminium (C-Profile)

Roof Sheeting	Aluminium, Alloy 5251 (Min 0.9 mm)	Aluminium, Alloy 5251 (Min 0.9 mm)
Roof Access Platform	Marine Grade Aluminium	Marine Grade Aluminium
Roof Access Covers	Marine Grade Aluminium	Marine Grade Aluminium
Internal Stairs	Not required where wall hatches fitted at ground level	316 Stainless Steel / FRP / GRP
External Stairs	Marine Grade Aluminium, or Hot dip galvanised steel, or Stainless Steel	Marine Grade Aluminium, or Hot dip galvanised steel, or Stainless Steel
Columns	Mild Steel CHS, or FRP	316 Stainless Steel, or Reinforced Concrete, or FRP
Handrails	Marine Grade Aluminium, or Stainless steel, or Galvanised steel	Marine Grade Aluminium, or Stainless steel, or Galvanised steel
Pipework	Refer approved products. No PVC above ground.	Refer approved products. No PVC above ground.
Vermin mesh (fly screen)	Stainless steel (min 2 mm), Locker Group 316 stainless steel plain weave Mesh 10 Gauge 26 (0.457 mm strand, 2.08 mm opening, and open area of 67%) or approved equivalent	Stainless steel (min 2 mm), Locker Group 316 stainless steel plain weave Mesh 10 Gauge 26 (0.457 mm strand, 2.08 mm opening, and open area of 67%) or approved equivalent
Security screen	Locker Group hot dip galvanised Louvre LV10G (strand 4.8 mm wide by 1.0 mm thick and open area of 88%) or approved equivalent	Locker Group hot dip galvanised Louvre LV10G (strand 4.8 mm wide by 1.0 mm thick and open area of 88%) or approved equivalent

Table 10.3 Inland Tank Material Requirements (>5 km from coast)

Element	**Steel Reservoir**	**Concrete Reservoir**
Walls	250 MPa Mild Steel Plate	Concrete 40 MPa (min)
Floor	250 MPa Mild Steel Plate	Concrete 40 MPa (min)
Rafters	Galvanised Mild Steel	Galvanised Mild Steel, or Extruded Marine Grade Aluminium Alloy (Z beams)
Purlins	Seasoned Hardwood Timber, or Roll Formed Marine Grade Aluminium (C-Profile)	Seasoned Hardwood Timber, or Roll Formed Marine Grade Aluminium (C-Profile)
Roof Sheeting	Aluminium Alloy 5251 (Min 0.9 mm)	Aluminium Alloy 5251 (Min 0.9 mm)
Roof Access Platform	Marine Grade Aluminium	Marine Grade Aluminium
Roof Access Covers	Marine Grade Aluminium	Marine Grade Aluminium
Internal Stairs	N/A	316 Stainless Steel / FRP / GRP
External Stairs	Galvanised Mild Steel	Galvanised Mild Steel
Columns	Mild Steel CHS, or FRP	316 Stainless Steel, or Reinforced Concrete or FRP

Handrails	Galvanised Mild Steel	Galvanised Mild Steel
Pipework	Refer approved products. No PVC above ground.	Refer approved products. No PVC above ground.
Vermin mesh (fly screen)	Stainless steel (min 2 mm), Locker Group 316 stainless steel plain weave Mesh 10 Gauge 26 (0.457 mm strand, 2.08 mm opening, and open area of 67%) or approved equivalent	Stainless steel (min 2 mm), Locker Group 316 stainless steel plain weave Mesh 10 Gauge 26 (0.457 mm strand, 2.08 mm opening, and open area of 67%) or approved equivalent
Security screen	Locker Group hot dip galvanised Louvre LV10G (strand 4.8 mm wide by 1.0 mm thick and open area of 88%) or approved equivalent	Locker Group hot dip galvanised Louvre LV10G (strand 4.8 mm wide by 1.0 mm thick and open area of 88%) or approved equivalent

10.5 Internal Reservoirs Liners

Where a reservoir liner is required to meet the design life requirements, the internal liner must be:

- suitable for use in chlorinated drinking water (free chlorine residual maximum of 6 mg/L) and be compliant with WSA 201 and AS/NZS 4020
- of material to meet the performance requirements detailed in GRI specifications GM-13, GM-17, GM-18, GM-25 or GM-28
- impermeable to water for temperatures between 2 and 35°C
- stable at ambient temperatures between -5 and 50°C
- watertight around all penetrations
- compatible with the reservoir materials
- capable of supporting, without damage, foot traffic and light duty rubber tyred equipment for maintenance
- installed in accordance with the approved design details and the membrane Manufacturer's recommended instructions
- plastic welded by qualified welders. The plastic welders must be Certified Welding Technicians as qualified by the International Association of Geosynthetic Installers (IAGI).

The liner material manufacturer must provide evidence of:

- performance in disinfected water applications
- details of the batch number
- inspection test plans
- seaming procedures
- seam mapping.

10.6 Coating Systems for Steel Reservoirs

Reservoir coatings systems (both internal and external) must to be in accordance with WSA 201.

Note: Concrete wall reservoirs storing water of low alkalinity may require coating to achieve asset life.

10.6.1 Coating Materials

All coating material containers must have recorded and provided to Hunter Water:

- manufacturer's name
- product name and batch number.

10.6.2 Reservoir Internal Surfaces

Steel reservoirs internal surfaces must have:

- two (2) coats of a high build solvent-less epoxy
- each coat consisting of a minimum DFT of 250 microns
- each coat is to be a different colour
- the finish coat colour of white
- each coat applied to the whole reservoir in one continuous coating before starting the next coat
- the tank is to be completely washed out prior to application of finish coats where a holder primer is needed
- supporting inspection test plans.

The coating must be applied to all internal surfaces including:

- walls
- floor
- exposed pipes
- accesses
- roof support columns.

Coatings thicknesses to achieve equivalent functionality must be nominated for approval.

10.6.3 External Surfaces

Reservoir external surface coatings must be:

- for coastal tanks <5 km to the coast:
    - zinc epoxy to manufacturer’s requirements with a solvent borne acrylic as the topcoat also to manufacturer’s requirements
    - external colour is ‘Colorbond’ mist green, final selection to be confirmed by the Hunter Water
- for inland tanks >5 km to the coast:
    - two (2) coats of an inorganic zinc silicate to a minimum dry film thickness of 75 microns per coat
    - external colour is ‘Colorbond’ mist green solvent borne acrylic topcoat to manufactures requirements
- for underside of floors:
    - be coated with 75 microns DFT of inorganic zinc primer when annular or floor plates are in contact with the ground
- applied in accordance with the manufacturers ITP.

11 Structural Design

The reservoirs design must meet the following standards:

- Hunter Water STS 404
- roof and associated columns and supports to AS 4100
- wind load to AS 1170.2
- earthquake load design to Class 4 importance level as per AS 1170.4
- AS 1170.0-2002 Structure design actions
- AS 1170.1-2002 Structure design actions Part 1 Permanent, imposed and other actions
- AS 1657-1992 Fixed platform, walkway and ladder loads
- AS 5100.5 Non-water retaining concrete elements.

The reservoir design must:

- account for thermal expansion and contraction
- be structurally designed for a water level at the top of the reservoir wall.

11.1 Stormwater Management

The reservoir site design must manage stormwater drainage. Stormwater from the roof must be captured in a spoon drain around the reservoir and directed to the neighbouring stormwater systems. The reservoir site stormwater drainage must:

- direct water away from the reservoir foundations and be designed to avoid perched water under the tank
- underfloor drainage to keep underside of reservoir dry
- provide protection to the access road, reservoir and surrounds
- manage stormwater runoff using a network of drainage pits, pipes and swales
- dissipate the energy of the stormwater, with no erosion resulting from the stormwater leaving the reservoir site
- comply with the site Environmental Approval
- comply with local Council or other authorities requirements.

11.2 Reservoir under floor drainage

Reservoirs of floor are greater than 100m2 must have underfloor drainage to prevent hydraulic pressure under the floor from:

- reservoir leakage
- pipework leakage
- groundwater.

The underfloor drainage must be designed to collect leakage and groundwater at a collection drainage pit which is operator accessible for regular inspection.

The underfloor drainage must be slotted HDPE pipe or similar with a corrugated profile, uniform slot spacing and filter sock, in accordance with AS 2439, Part 1.

11.3 Fabricated Mild Steel

Reservoirs fabricated from mild steel must be designed to the following:

- AWWA D100-05 Section 14 using API 650 variable point design method
- mild steel plate for reservoir shell and floor to AS 3678 (Grade 250 only)
- mild steel sections for roof structure, supports, and platforms to AS 3679 (Grade 300)
- mild Steel columns to AS 1163 (Grade 350).

Reservoir wall and floor plate design must include:

- an additional minimum 2 mm thickness for all plate as allowance for thickness loss from corrosion
- design limiting stress for base bending up to 0.5 x Yield Stress
- a maximum additional horizontal deflection due to filling must be the lesser of 'wall height' divided by 250 (height /250), or 20 mm
- handling methodologies / procedures to minimise plate buckling / deformation
- welding requirements must be nominated on the design drawings.

11.3.1 Steel Floor Plates

Reservoir floors made from steel must:

- use annular plates for wall / floor connection stresses.

11.4 Reinforced Concrete Reservoirs (Cast In-Situ & Pre-Cast)

Reservoirs constructed from concrete must be designed to the following:

- AS 3735 Concrete Structures for Retaining Liquids
- AS 3600 Concrete Structures for structures up to 50 years, otherwise AS 5100.5;
- other relevant standards include AS 1012.3, AS 1012.4.1, AS 1012.4.2, AS 1012.4.3, AS 1012.3, AS 1141.5, AS 1141.6.1, AS 1141.6.2, AS 1302, AS 1303, AS 1304, AS 1478, AS 3582, AS 3972, AS 1379, AS 2758.1 and AS 3610.

In addition to these Australian standards include:

- water bar type seal
- minimum steel reinforcing for crack control to meet crack widths limited to:
    - 0.1 mm water retaining concrete, and
    - 0.2 mm for non-water retaining concrete
- minimum wall thickness of 230 mm wide, with double reinforcing steel. (Single reinforced concrete structural elements are not permitted)
- the reservoir floor must have a 1 in 100 fall to a sump
- the sump in the reservoir floor must be:

- located at the wall, 3 to 6 m from the access hatch, unless alternate location indicated by PFD
- of dimensions 600 mm x 600 mm x 600 mm deep
- with a scour from the sump.

11.4.1 Cast In-Situ Reservoirs

Concrete reservoirs cast in situ must have witness points for the concrete installation. Refer to STS 404 for detail requirements of ITPs.

11.4.2 Concrete Requirements

Reservoir concrete must comply with Hunter Water STS 404. In addition to STS 404 the design and construction must include:

- cover to the ground face of:
  - 50 mm against a polyethylene membrane or blinding concrete
  - 65 mm directly in contact with the ground.
- supply of a certificate that the joint sealing product is suitable for potable water installations (AS 4020)
- compliance with drawing RES-115 for floor to wall joint standard arrangement
- detailed drawings of interfaces between pre-cast sections or between pre-cast and cast in-situ sections.

Where joint sealing is to include a primary and secondary seal, watertightness test is to be completed and passed prior installation of secondary seal (Refer drawing RES-115).

11.5 Columns

Reservoir internal roof support columns must:

- be kept to a minimum (preference is for a single central reservoir roof support column)
- be solid or open sections, E.g. “H” section (avoid hollow sections for columns and roof members)
- not be located on joints of steel plate floors (Align plates so columns are located in areas free of joints).
- If required in a concrete reservoir, the column must be Stainless Steel or Aluminium

11.6 Roof

Reservoir roofs must:

- have a pitch between 3% and 5%. If pitch is above 3%, handrails and access walkways must be provided to access maintainable equipment
- have straight joints between roof sheeting and platform, hatches and any roof penetrations, to maximise integrity and longevity of joint seals
- have gaps less than 5 mm, to prevent vermin access

- use sheeting from the centre to the perimeter, with laps of roof sheeting in accordance with the manufacturer's recommendations, but seeking to minimise number of laps
- have roof flashing to prevent the entry of stormwater and debris into the tank, including hatches
- use purlin with down-turned bottom lips (to prevent accumulation of moisture)
- direct all rainwater flow off the roof to a spoon drain incorporated into the hardstand area below (gutters must not be used)
- allow for thermal expansion and contraction of sheeting, incorporating sliding joints or similar
- be designed for the mounting and maintenance of solar panels, where solar panels are specified in the project scope
- not have a combination of dissimilar metal components.

12 Hydraulic Design

12.1 Pipework

Reservoir inlet, outlet, scour drain and overflow pipework must be in accordance the following sections. A reservoir site conceptual flow diagram is included in Appendix D:. A bypass between the inlet and outlet pipework must in included for when the reservoir is out of service.

Pipework thrust restraint must be considered in all pipework design.

Pipes under the reservoir floor must be concrete encased, with a minimum 300 mm concrete encasement.

12.1.1 Inlet Pipework

Reservoir inlet pipe must:

- be separate to the outlet pipework, with no common sections of pipe (i.e. no bidirectional flow in a pipe)
- be sized for peak instantaneous flows, based on ultimate site master planning
- have isolation valves a minimum of 2 m from the reservoir wall to allow 360-degree rotation of a valve handle
- be arranged to maximise mixing, and minimise short-circuiting and dead zones/legs
- include dismantling joints on the depressurised side of isolation valves (between the valve and the reservoirs).
- include double isolation of the reservoir:
    - where a site has two reservoirs each must be able to be double isolated, for cleaning and inspection, while the other reservoir remains online
    - a spring top hydrant between double isolation valves to prove valve sealing
- enter the reservoir through the floor or low in the wall, as determined by CFD modelling
- include a 50 mm tapping for chemical addition, located between the double isolation valves for operational purposes
- have provision for addition of chlorine solution on the inlet pipe
- include a free chlorine residual measurement sampling point.

12.1.2 Outlet Pipework

Reservoir outlet pipework must be:

- separate to inlet pipe, with no common sections of pipe (i.e. no bidirectional flow in a pipe)
- sized for peak instantaneous flows, based on ultimate site master planning
- nominally located close to the centre of the reservoir and penetrate the floor (i.e. not side entry)
- fitted with a bell-mouth. The bell-mouth must be covered by a guard of aperture 100x100mm (the purpose of the guard is to stop a diver being able to enter the pipe). The guard must be:

  - taken into account in hydraulic modelling and discharge flow rate estimates
  - stainless steel grade 316 or FRP
  - bolted to the floor using stainless steel anchor bolts
  - Vortex plates are required to ensure air entrainment is minimised
- positioned with the outlet at a height 100 mm to 200 mm above the reservoir floor to:
  - minimise the risk of any accumulated sediment within the reservoir being disturbed and being discharged during reservoir operation
- outlet valves must be a minimum of 2 m from the reservoir wall to allow 360-degree rotation of a valve handle
- arranged to maximise mixing, and minimise short-circuiting and dead zones.

The outlet pipework must have:

- double isolation of the reservoir:
  - where a site has two reservoirs each must be able to be double isolated, for cleaning and inspection, while the other reservoir remains online
  - a spring top hydrant between double isolation valves to prove valve sealing
- free chlorine residual measurement sampling point for automated and manual sampling.

12.1.2.1 Chlorine residual monitoring

The chlorine residual monitoring instrument must:

- draw sample water from the outlet pipe of the reservoir
- sample line nominally less than 20 m from sample point to analyser
- be supplied with flow rate 10 to 15 L/hr and pressure 20 to 400 Kpa (to match requirements of Hunter Water approved chlorine analyser)
- be housed in a cabinet or structure to achieve its operating temperature range
- be accessible for weekly calibration
- have a calibration workbench, minimum 500 mm deep x 1000 mm long x 1100 mm high, adjacent to the instrument and within the length of the probe cable
- return analysed water to the reservoir, via a closed system, not open to atmosphere (with the analyser stream piped directly to the reservoir).

12.1.3 Reservoir Overflow Pipework

Reservoir overflow pipework must be:

- a vertical pipe located outside the reservoir (where possible) with an overflow inlet of:
  - A bell-mouth on the internal section of the overflow pipe (an elbow must be after the bell-mouth for the overflow to then pass to the outside of the reservoir) or
  - A weir in the wall, feeding to an external pipe
- sized for peak instantaneous flows, based on ultimate site master planning
- always operational
- have no valves on the overflow pipework

- vermin proofed by vermin screening at the overflow inlet or a “duck bill” at the outlet. The head loss from the vermin proofing must be considered.

The overflow inlet must be:

  - situated a minimum 200 mm above TWL
  - sized using a weir calculation. There must be a minimum 300 mm free board between top of bell-mouth or weir and the lowest point of roof structure or associated brackets/mountings
  - free of obstruction from roof members.

For fabricated steel reservoirs the connection through the wall plates must be mild steel welded and the overflow pipework components must be protected using internal solvent- less epoxy coating system.

The overflow pipework must have:

- a visual overflow level marker at the main entry hatch
- an air gap prior to connecting to any stormwater pipework.

12.2 Automatic Inlet Valves (AIV)

The reservoir inlet pipe must be fitted with an automatic AIV, when the reservoir is gravity fed. The reservoir does not need an AIV when the reservoir is filled by a pumping system, but will require the ability to have one retrofitted if the system expands.

Hunter Water to advise where use of fail-safe condition of valve is required.

12.3 Sampling Arrangement

The reservoir must incorporate sampling point arrangement as shown on drawing RES-110.

12.4 Cleaning and Maintenance Hydrant

The reservoir must have a hydrant connection for manual cleaning of the reservoir, the hydrant must:

- be located at ground level within 3 m of the access stairway:
  - externally for reservoirs with doors in the wall, or
  - internally for reservoirs with roof access only
- be supplied via a DN100 pipeline connected to the upstream side of the inlet pipeline isolation valves in a section of pressurised pipework
- include a 100 x 100 tee, for connection of a booster pump or jetter truck.

12.5 Scour / Washout Bulkhead

The reservoir must have a scour pipe complying with drawing RES-108. The scour must:

- be 100mm in diameter larger than the reservoir inlet pipe
- connect through a valved connection to the overflow line as per standard drawing RES-101
- include an external connection pit to allow sludge to be trapped and pumped out located as per standard drawings RES-101

- connect to sewer system where the sewer system is within 300 m of the property boundary.

For steel reservoirs the scour bulkhead must be installed in the wall adjacent to the overflow pipe as per standard drawing RES-108. The pipe penetration must be at the bottom of the wall.

For concrete reservoirs the scour point must be located from the sump.

12.6 Site Discharge Structure

The reservoir site discharge structure must manage reservoir overflow and scoured flow. The discharge structure must:

- comply with standard drawing RES-112
- dissipate energy and ensure that no erosion occurs prior to the receiving water body. This function of the design must include:
    - Energy dissipation measures to match the reservoir top water level and discharge pipe diameter
    - Requirements outside the reservoir site boundary
    - a pit for collection of sediment and sludge
- provide travel time for dissipation of residual chlorine. Including:
    - compliance with Hunter Water's Procedure - EP0112 – De-chlorination of discharge water
    - a sampling location at the point in the discharge structure, where de-chlorination is achieved.

Assess the impacts of reservoir discharge to both upstream and downstream receiving water bodies including flooding and contamination due to both controlled and uncontrolled discharges.

12.7 Reservoir Bypass Pipework

The reservoir site must incorporate pipes to bypass each individual reservoir where the ultimate development indicates two reservoirs are needed, or where the reservoir is in series. The bypass pipework must:

- provide operationally flexibility
- allow isolation of individual reservoirs where the site has multiple reservoirs
- co-ordinate with the suppling water pump station operating mode "Reservoir off line control mode".

13 Electrical Design

The reservoir electrical components must comply with the design requirements of Hunter Water's STS500 and Approved Product List.

A reservoir site must include the following electrical components, as a minimum:

- incoming power supply
- switchboard containing metering, main distribution section, PLC and telemetry equipment
- instruments for reservoir level etc.
- telemetry antenna
- lightning protection system
- cathodic protection system (where required)
- area lighting
- security system.

13.1 Power Supply

The reservoir site power supply must be three phase 50Hz supply from;

- network mains supply, with or without onsite electricity generation, or
- stand-alone on-site generation and storage (E.g. solar photo-voltaic and battery)

(Hunter Water has a zero greenhouse gas emissions with lowest cost energy strategic objective.)

All reservoir sites must:

- have a generator change over switch and connection point for reservoir main switchboards
- avoid underground power supply crossing other services.

Where solar photo-voltaic onsite electricity generation is preferred it must comply with Hunter Water's STS 501. For reservoir sites solar panels can be mounted:

- on ground, or
- on roof.

13.2 Switchboard

The reservoir switchboard must be designed and constructed in accordance with Hunter Water's STS500.

13.3 Metering of Incoming Power Supply

The reservoir site incoming power supply cabinet must have a separate external door fitted to this compartment to provide access to the Supply Authority Meter readers, without providing access to other controls. This door must be locked with an "OPS 3" lock.

13.4 Site 230v GPOs

The reservoir 230V general purpose outlets (GPOs, must be provided in the following locations:

- one on the internal escutcheon door of the Distribution section of the main switchboard

- one inside the PLC/Telemetry/Instrumentation Panel for the technician's use.

13.5 PLC Telemetry and Instrumentation

The reservoirs' PLC, software, SCADA, Telemetry equipment, control power supplies, GPO for technician's use and field wiring terminals, must comply with Hunter Water's STS 500 and STS 550.

A HMI must be installed on the escutcheon inside the Instrumentation Cubicle internal door, the HMI must display all monitored items at the reservoir.

13.6 Level Instruments

A reservoir must include the following level monitoring equipment:

- radar level transmitter
- high level alarm float switch.

An outdoor metal enclosure must be provided on the reservoir roof to house the:

- surge protection
- field terminals for level instrument and float switches
- field terminals for security switches on roof access hatches.

13.7 Radio Path Survey

When the reservoir Concept Design is complete a radio path survey must be completed. Hunter Water must be engaged to perform the radio path survey, the radio path survey must nominate:

- a base station
- transmit and receive frequencies
- antenna direction/bearing to base
- antenna mounting height
- antenna size.

Note: Developer funded reservoir designers must pay HWC to perform the radio path survey.

13.8 Telemetry Antennae

An antenna must be installed at the reservoir site for the Hunter Water radio network. The antennae must be positioned to meet the following requirements:

- point outwards from the reservoir (not across the top of the reservoir)
- 3m above the reservoir roof (to avoid exposure to radiation generated by the antennae)
- located from the base of the lightening protection, according to AS 1768
- lower than the lightening protection, according to AS 1768
- to minimise the length of cable to the electrical cabinet
- mounted on a dedicated bracket (not mounted to handrail or handrail posts)
- connected to the site telemetry radio.

13.9 Lightning Protection

The reservoir must have Lightning Protection in accordance with the requirements of STS 500 and AS 1768.

13.10 Cathodic Protection (steel reservoirs and columns)

Steel reservoirs must have Impressed Current Cathodic Protection System designed by a cathodic protection specialist and comply with the requirements of STS 500.

Cathodic protection anodes suspended from the roof, must be accessible from the roof for removal, to avoid entanglement by divers or robotic cleaners.

13.11 Area Lighting

Reservoirs must have lighting as per AS 1680 for after-hours maintenance on:

- reservoir access stairway and platforms
- reservoir security compound area including main electrical switchboard.

External lighting must be operated by a switch on the Distribution section of the site switchboard. External lights must not have movement sensors or similar automatic activation systems.

Lighting levels must be in accordance with the requirements of STS 500.

13.12 Security System

The site security system must comply with STS105.

14 Control

Reservoir monitoring will include as a minimum fixed level sensor, chlorine residual analyser and site security, which will be telemetered and shown on the Head Office SCADA system. A site specific ACMM must be produced if mechanical mixing, chlorine dosing, actuated valve or and position monitored valve are installed.

15 Design for Access and Maintenance

Reservoir access must be designed for:

- reservoir site access
- reservoir internal and external maintenance.

Intent of reservoir access is that access is by:

- diver
- robotic machines
- side wall hatches
- confined space entry methods
- not by internal ladders or stairs

15.1 Access Road

Reservoir access roads must be design and construct in accordance with STS 412 – Roadworks and the requirements in

Table 15.1.

Retaining walls required for the associated with access roads and earthworks design must be detailed in the design documentation.

The access road must provide access to:

- the external stair
- the crane pad. The crane pad must be located adjacent to the reservoir roof hatches
- specific site requirements

Table 15.1 Specific access road requirements

Parameter	Value
Extent	All weather access from the closest public road to the reservoir site and extend around the circumference of the reservoir.
Parking and turning adjacent to reservoir	Road must accommodate turning at the reservoir of a truck (minimum dimensions 12.5 m long x 2.5 m wide x 4.3 m tall) or crane, where the crane is suited to the size of the reservoir and its roof. Parking for two 7.5 tonne trucks adjacent to the reservoir in at least one location.
Materials	Flexible pavement with asphalt seal for a 30-tonne vehicle Concrete pavement where areas are subject to repeated vehicle turning.
Minimum pavement width	3.5 m to provide single lane access for a 30-tonne vehicle.
Desirable maximum grade	12.5%
Absolute maximum grade	15% (>15% may be acceptable where concrete pavements are used)
Preferred cross fall	3%
Maximum cross fall	5%

Flood Rating	Access road to have same flood immunity as as connecting road network
Land ownership	Where the reservoir doesn't front a public road, the access road must be on land defined for transfer to Hunter Water

15.2 Access for External Maintenance

The reservoir must have maintenance access around the reservoir. The access must be a level surface 5m around the reservoir for setting up EWP or scaffold around the reservoir circumference for external maintenance of the reservoir.

15.3 Reservoir and Roof Access

Reservoirs must have means of access into a reservoir, these must include:

- a minimum of one cleaning access hatch
- a minimum of one chemical dosing hatch
- a roof maintenance access panel designed for removal of roof sheet.

Reservoirs with steel walls must have:

- two doors in the wall, with one door a minimum of 1.1m wide x 1.8m tall.

15.4 Internal Reservoir Access

Reservoir internal access by personnel must be by maintenance access hatch using a crane and man box, as above.

Where permanent internal reservoir access is a project specific requirement, stairs must be used. Internal ladders are not permitted. The stairs must comply with AS 1657 and STS 600.

Steel walled reservoirs must have the access doors in the base of the wall.

15.4.1 Reservoir Worker Access Hatch

Where personnel access hatches are fitted to the roof, they must be:

- A minimum of 900 x 900 mm
- be surrounded by walk way on all 4 sides, walk way must be 1.2 m wide
- be hinged or sliding
- be lockable when cover is at an open or closed position
- have a mechanical means of opening, hand operated winch or similar for hinged hatch covers weighing more than 20 kg
- have grating under the hatch, to prevent fall from height:
    - Grating to be aperture approximately 50 x 50 mm

15.4.2 Cleaning Access Hatch

Reservoirs must have a cleaning access hatch in the roof. The access hatch must:

- be minimum dimensions 1200 x 1200 mm in accordance with RES-105
- be surrounded by walk way on all 4 sides, walk way must be 1.2 m wide
    - The walkway must be able to support the feet of a confined space entry tripod

- be only for lowering equipment into the reservoir. Not used for cable entry or other purposes
- be hinged or sliding
- be lockable when cover is at an open or closed position
- have a mechanical means of opening, hand operated winch or similar for hinged hatch covers weighing more than 20 kg
- have grating under the hatch, to prevent fall from height:
    - Grating to be aperture approximately 50 x 50 mm
- be separate to any man access hatches.

15.4.3 Chemical dosing hatch

The chemical dosing hatch is used for inserting chlorine tablet canisters into the reservoir. The chemical dosing hatch must:

- be accessible from the reservoir roof platform
- 300 mm diameter
- lockable.

15.4.4 Maintenance Access Panel

An area of roof sheeting is to be designed to be removed for maintenance access into the reservoir. The maintenance access panel must be:

- a minimum 2 m x 3 m
- clear of structural members or have removable purlins (so that when sheeting is removed, there is a clear opening to lower large objects into the reservoir)
- of contrasting sheeting colour (to identify the removable sheets)
- be located adjacent to the crane pad and up to 10 m from the access platform
- 2 eyebolts, as per the eyebolts clause.

15.4.5 Roof Access Stairs

The reservoir must have external free-standing fabricated stairs and platform structure complying with standard drawings RES-102 and RES-103, for accessing the reservoir roof platform and roof hatch/s.

15.4.6 Roof Platform

For reservoirs, the roof access platform must:

- be directly over the traffic accessible area (to enable the maintenance operator to use the davit to pick up equipment from a vehicle below (refer drawing RES-109 for davit details))
- have a minimum unobstructed flat area of 1,500 mm x 3,000 mm
- not be obstructed by the open hatch/s
- have a handrail on the perimeter of the access platform with a gate in the handrail to give access to the peak of the roof:
    - the gate will be used for personnel to access the roof

- a lanyard attachment cable must be installed from inside the gate to the peak of the roof, for a person to attach to – while the person is protected from falling off the roof by the handrails around the roof platform. (Refer drawing RES-102 and RES-105).

15.4.7 Steel Wall Reservoir Wall Access

Steel reservoirs must have a minimum of two wall personnel hatches. The hatches must be:

- one hatch must be a minimum dimensions 1100 mm wide by 1800 mm high (to allow both personnel access and access for a small excavator “Dingo” or equivalent. (Refer drawing RES-106)); This hatch must be located near the vehicle access road
- a second man access hatch of 600 mm wide by 1800 mm high, located opposite the other hatch.

15.5 Handrailing and Access on Roof

Reservoirs must have handrails around the perimeter of the roof, complying with AS 1657 and STS 600. All handrailing must incorporate kick rail. Where the roof pitch is > 3%, provide roof sheet mounted walkway and handrails to roof mounted components such as vents, sensors where maintenance is required.

15.6 Anchor Points

The reservoir must have two (2) eyebolts for each opening in the roof in accordance with STS 600 and STS 640. Eyebolts are to be secured on a central post to enable maintenance personnel to attach Lanyards (Life Lines) and to work around the reservoir roof and wall (refer drawing RES-102 and RES-105).

Anchor points must be able to be inspected from on top of the reservoir roof.

15.7 Reservoir Perimeter Access

An access path must be installed around the base of the reservoir and a vehicle road around the outside of the access path. The perimeter access path must:

- extend from the base of the reservoir wall
- be a minimum of 1500 mm wide
- be reinforced concrete or AC
- have a spoon drain to contain rain water from the reservoir roof and direct the rain water to the site stormwater system
- the perimeter access path must extend around all structures and pits, where these restrict the continuity of the path.

The vehicle access path must:

- adjoin the concrete perimeter access path
- be 3.5 m wide
- be crushed rock or gravel or asphalt
- provide vehicle access all the way around the reservoir.

15.8 Signage

The reservoir must have signage:

- complying with drawing RES-111
- confined space sign fitted at all access points.

16 Site Security

16.1 Fencing

The reservoir must include a security fence around the perimeter of the stair access and switchboard (refer drawing RES -114). Reservoir sites boundaries must be fenced for below ground or partially buried reservoirs, for other reservoir sites, the need for fencing must be identified during the concept design phase. A reservoir site boundary fence must:

- extend around the whole of the easement or lot as per the site survey (refer Clause 6.4) meeting the requirements of standard drawing RES-113
- include a lockable 4m wide vehicle access gate
- include a personnel access gate as per standard drawing RES-113.

16.2 Security System

Reservoir sites must include a security system in accordance with STS 105. In additional to STS 105, at the top of the reservoir access hatch stairs install a 24V integrated infra-red motion sensor and speaker, this motion sensor/speaker must:

- detect intruders on the reservoir platform, at the top of the stairs
- have a recorded message “Stop, you have entered a restricted area, the police have been notified”
- generate a SCADA alarm to notify despatch of the intruder.

Any additional site security requirements must be identify during the concept design phase by risk assessment.

16.3 Security Mesh

Reservoir security screen must be securely fixed to all edges of the opening or vent using a fixing strip and exposure Class 4 corrosion resistance fasteners at maximum 200 mm spacing, in accordance with AS 3566 and installed with EPDM washers.

17 Landscaping

The reservoir design drawings must include a landscape plan. The plan must:

- maintain the aesthetics of the area
- blend the site into the local area
- aim to minimise visual impact on neighbouring properties
- be determined on lowest cost for ongoing maintenance
- choose native flora suitable to the area
- show planting in annulus bands from the reservoir as:
    - 0 – 5 m from the reservoir, avoid plant, needed for maintenance access
    - 5 - 10 m no trees within 10 m of the reservoir
    - 10 – 20 m plants that have an expected height of 3 m less than the height of the reservoir
    - >20 m no restrictions
- avoid planting over services or under services
- incorporate bushfire asset protection zone requirements.

Hunter Water guidelines for planting can be found in Hunter Water Corporation's website:

If the reservoir is within a public reserve or crown land then the local Council must be consulted to identify appropriate types of planting and any other specified requirements.

18 Reservoir Testing and Commissioning

18.1 General

The reservoir must be tested in accordance with an approved detailed testing procedure. This procedure must be submitted to Hunter Water for approval 10 working days prior to testing. The reservoir testing procedure must include:

- disinfection and flushing of the inlet and outlet pipe, and any other operational pipework used to serve customers that forms part of the reservoir
- flushing of the inlet pipework until a free chlorine residual is obtained
- cleaning of reservoir internal surfaces to remove construction debris
- washing of reservoir internal surfaces to remove dirt and dust
- disinfection of reservoir internal surfaces with a solution of minimum 5mg/L of chlorine
- disposal of washdown and disinfection water through the scour pipework, following de-chlorination procedure
- maintain free chlorine residual of 3mg/L during reservoir filling and testing
- mixing of the reservoir during testing and commissioning for complete disinfection
- allow testing water to be removed quickly and safely from the reservoir if required.

At the completion of testing, the test water disposal method must be:

- approved by Hunter Water prior to:
    - emptying the tank to drain to the scour line, or
    - returning it to supply/putting it into service.

The reservoir testing procedure must include:

- filling the reservoir at a uniform rate, not exceeding 2 m wall height per day, and a rate of less than 200 mm wall height per hour
- filling to the design top water level and allow to stand for a minimum of 7 days. During which time the water level must be monitored daily. If the reservoir must be drained or the water level drops more than 300 mm below top water level for longer than 24hrs, the stabilisation period must recommence
- a water tightness test of 7 days. To pass this test the reservoir the water level must no drop more than 10 mm over the 7-day period
- monitoring of settlement of foundation by survey compared to baseline survey prior to filling
- survey by an independent registered surveyor
- method for maintaining water quality in the reservoir up to handover of the reservoir to Hunter Water.

Hunter Water will provide the water for the first round of testing, if any tests are aborted or need repeating the contractor is responsible for purchase of the water from Hunter Water at the current residential rate.

The reservoir testing procedure must include:

- testing of final water quality to demonstrate the water is safe to send to customers (valid for up to 3 days)
- demonstration of equal chlorine residual distribution throughout the reservoir.

The following requirements must be incorporated into the detailed testing procedures as appropriate. An example ITP is included in Appendix C.

18.2 Concrete Tanks

Reservoirs constructed of concrete must be tested in accordance with requirements of STS 404.

18.3 Mild Steel Fabricated Tanks

18.3.1 Floor Testing

Reservoirs with a steel floor must be tested for leaks either by:

- vacuum testing using a vacuum box and a pressure of 650 mbar absolute (i.e. 350 mbar of vacuum)
- 100% magnetic particle examination to AS 1554.1, with no cracking or porosity permitted.

18.3.2 Wall Testing

Reservoirs with steel walls must be:

- continuously inspected during the water testing, for the presence of leakage from the full exterior including all mountings.:
    - If leakage is detected, filling must cease immediately and an approved method of repair must be completed prior to recommencement of the testing. The water level must be lowered to an approved "safe" level prior to carrying out any repair work. This "safe" level must be at least 600 mm below the area of repair
- monitored (top water surface) for the holding period of 48 hours:
    - If the water level fails during this period, then the water level must be held for a further 48 hours. If a further drop in water level is detected, an approved procedure for leakage detection and repair must be immediately instigated.

18.4 Foundations

The reservoir foundations load / settlement behaviour must be monitored during the water testing phase by accurate survey compared to baseline survey prior to filling. If the total settlement at any control point exceeds 10 mm or the differential settlement between any two adjacent control points on the perimeter exceeds 5 mm, then filling must be immediately terminated and the testing procedure must be modified or abandoned.

During reservoir commissioning, accurate survey must be undertaken and compared to baseline survey prior to filling to record any settlement. All survey work associated with testing must be carried out by an independent registered surveyor, with a report summary of results presented to Hunter Water on completion.

18.5 Roof

The reservoir roof must be tested in accordance with AS 3735.

18.6 Liners

Reservoirs with internal liners must have factory sampling and testing of liner materials conforming with ASTM D 4354 (Standard Practice for Sampling of Geosynthetics for Testing). The membrane manufacturer must prepare factory testing reports, which includes results of all sampling and testing defined by the GRI specifications.

The testing identified in the GRI specifications or Manufacturer's Quality Assurance / Quality Control Plan is required for each batch of base resin and for each batch of manufactured product and will be used for the purposes of compliance testing.

Fusion welded joints of the geomembrane material must be carried out and tested in accordance with modified ASTM D1693 using fusion welded sections of the manufactured geomembrane material and exposed to a solution of 1% sodium hypochlorite or 1% chloramine solution at 50oC for a minimum exposure period of 4800 hours. The test specimens must be orientated such that all sections of the weld and heat affected areas are subjected to the bending stresses. The weld and heat affected areas of the geomembrane must exhibit no surface cracking when viewed at 10x magnification after 4800 hours of exposure.

18.7 Overflow / Scour

The reservoir overflow and scour systems operation must comply with Hunter Water's Procedure - EP0112 - Dechlorination of discharge water.

19 Design Documentation and Drawings

19.1 Design report

The reservoir designer must prepare a report detailing the logic behind the final design. It must cover all requirements included in strategies, preliminary design reports and concept design reports.

The design report must include as a minimum (but not limited) to the method of calculation of the:

- steel shell
- hoop stress in the walls
- bending stress in the floor to wall joint, and
- wall deflections.

For pre-cast post tensioned reservoirs detail design and construction documentation must include (but not limited to) specific details of the:

- precast panel design
- joint interfaces
- tensioning
- stitch panel.

The design report must be accompanied by the following:

- detailed drawings, calculations and specifications as required for the various components of the system
- ventilation design report
- CFD modelling report
- radio path survey report
- where applicable approvals or letters of agreement from stakeholders/regulatory bodies (e.g. Government Agencies, RMS, Subsidence Advisory, etc.)
- agreement to easement rights
- permit to enter land external to development.

Prepare all design drawings in accordance with STS 911.

Construction report must include:

- tensioning methods. Including cable type and size, sheath type and size, concrete strength at transfer, number of jacks required, cable stressing method (on end or both ends), cable stressing order, stressing load, allowable draw in, and calculated cable extensions should a post tensioned reservoir be required
- full details of the grouting procedure, including materials, bleed control additive, mixing equipment, pumping equipment and grouting procedures.

19.2 Electrical Design

The reservoir site electrical design must comply with the requirements of STS 500 and include (but not be limited to) the following drawings:

- incoming supply and PLC I/O
- general arrangement of switchboards
- power and Control schematics for all equipment
- PLC I/O Schematics for all equipment
- telemetry
- instrument loops
- installation wiring diagrams for each item and instrument type
- equipment and cabling layouts
- light and small power layouts
- PLC layout.

On site power generations (where applicable) standard electric drawings may be obtained from Hunter Water in electronic format. These must be used as the basis for the design of the specific reservoir project drawing set.

All electrical design drawings must comply with the requirements of STS 904.

19.3 Operating and Maintenance

Operation and Maintenance Manual to be in accordance with STS 906 provided as part of the project documentation.

20 Related Documents

In addition to STS 409, all work shall comply with relevant current Standards and regulations inclusive of all amendments. In particular:

- Workplace Health and Safety Regulations
- WorkCover NSW Codes of Practice
- Safe Work Australia Model Codes of Practice
- Hunter Water's Design Manuals
- Hunter Water's Standard Technical Specifications
- Hunter Water's Standard Drawings

Appendix B: Standards is a list of Standards referenced in this specification and other Standards relevant to the scope.

21 Document Control

Document Owner: Manager Civil Engineering

Document Approver: Group Manager Planning and Engineering

Version	Date	Author	Details of Change	Approval Date	Approved By	Next Scheduled Review
1.0	21/01/2022	G Moore	Complete review of Hunter Water Design Manual 7.	APRIL 2022	STUART HORVATH	2024

Appendix A: Standard Drawings

Drawings to be added in future versions, including reservoir PID with chlorine monitoring & dosing points.

Appendix B: Standards

Works must comply with the requirements of the following current Standards to the extent that they are relevant and not overridden by this Specification.

The following standards are referenced in this specification.

Reference Number	Title
AS 1012.3	Methods of testing concrete - Determination of properties related to the consistency of concrete
AS 1012.4.1	Methods of testing concrete - Determination of air content of freshly mixed concrete - Measuring reduction in concrete volume with increased air pressure
AS 1012.4.2	Methods of testing concrete - Determination of air content of freshly mixed concrete - Measuring reduction in air pressure in chamber above concrete
AS 1012.4.3	Methods of testing concrete - Determination of air content of freshly mixed concrete - Measuring air volume when concrete is dispersed in water
AS 1141.5	Methods for sampling and testing aggregates - Particle density and water absorption of fine aggregate
AS 1141.6.1	Methods for sampling and testing aggregates - Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.6.2	Methods for sampling and testing of aggregates - Particle density and water absorption of coarse aggregate - Pycnometer method
AS 1163	Cold-formed structural steel hollow sections
AS 1170.0-2002	Structural design actions - General principles
AS 1170.1-2002	Structure design actions Part 1 Permanent, imposed and other actions
AS 1170.2	Structural design actions - Wind actions
AS 1170.4	Structural design actions - Earthquake actions in Australia
AS 1289.3.8.1:2017	Methods of testing soils for engineering purposes, Method 3.8.1: Soil classification tests - Dispersion - Determination of Emerson class number of a soil
AS 1302	Geometrical product specifications (GPS) - Indication of surface texture in technical product documentation
AS 1303	Steel reinforcing wire for concrete
AS 1304	Welded wire reinforcing fabric for concrete
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout - Admixtures for concrete
AS 1554.1	Structural steel welding - Welding of steel structures
AS 1657	Fixed platform, walkway and ladder loads
AS 1680	Interior lighting - Safe movement
AS 1768	Lightning protection
AS 2758.1	Aggregates and rock for engineering purposes - Concrete aggregates
AS 3582	Supplementary cementitious materials - Fly ash
AS 3600	Concrete structures
AS 3610	Formwork for concrete (Supplement to AS 3610-1990)
AS 3678	Structural steel - Hot-rolled plates, floorplates and slabs
AS 3679	Structural steel - Hot-rolled bars and sections

AS 3735	Concrete structures retaining liquids
AS 3972	General purpose and blended cements
AS 4020	Testing of Products for use in Contact with Drinking Water
AS 4100	Steel structures
AS 5100.5	Bridge design - Concrete
STS 104	Concrete Supply and Construction (General) Specification
STS 105	Security at Hunter Water Corporation Assets
STS 404	Concrete Supply and Construction Water Retaining Structures v3 0
STS 500	General Requirements for Electrical Installations
STS 550	General Requirements for SCADA and Automation Systems
STS 600	General Mechanical Requirements
STS 640	Lifting Equipment
STS 903	Work As Constructed WAC Information
STS 904	Preparation of Electrical Engineering Drawings
STS 906	Operations and Maintenance Manual Requirements Template(
STS 911	Preparation of Civil Structural and Mechanical Engineering Drawings

Appendix C: Example ITP

ITP to be added – use version from Cameron Park Reservoir as basis.

Appendix D: Two Reservoir Conceptual Process Flow Diagram

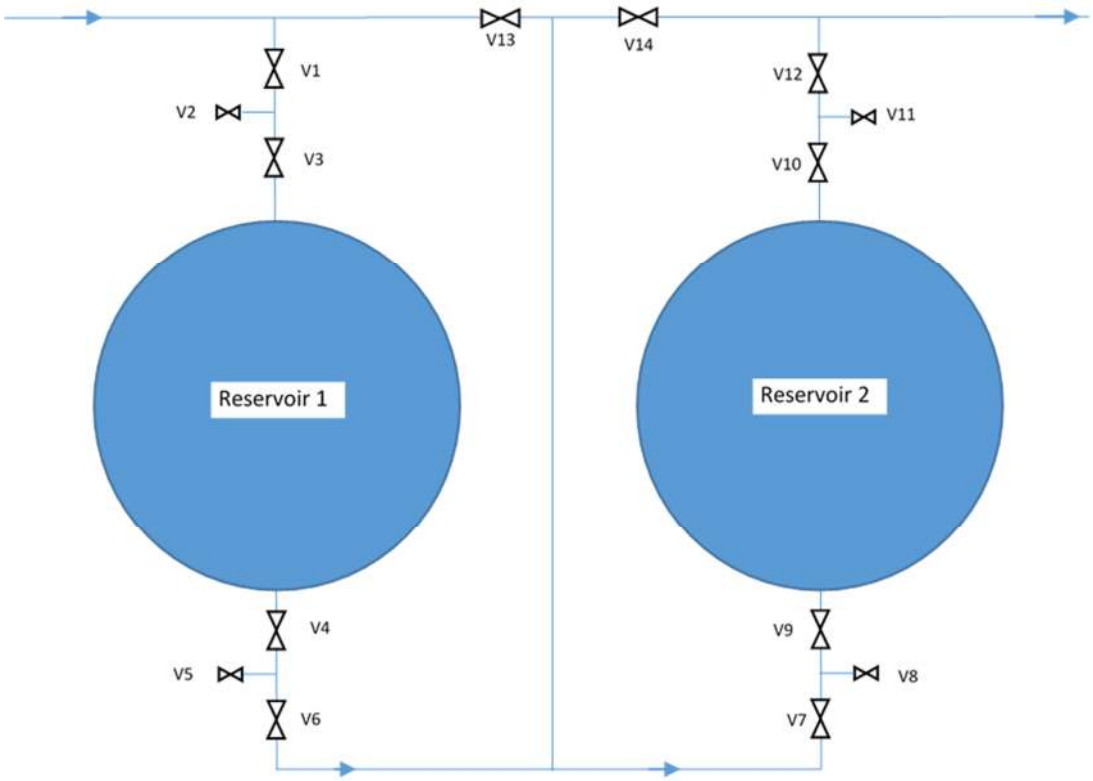

Figure 1 Conceptual Process Flow Diagram

Note 1: Not intended as preferred site configuration

Table D.1 Typical Reservoir Isolation Configuration

Scenario	1	2	3	4
Description	**Res 1 online**	**Both res online**	**Res 2 online**	**Both res off-line**
Reservoir 1	On line	On Line	Off Line	Off Line
Reservoir 2	Off Line	On Line	On Line	Off Line
V1	Open	Open	Closed	Closed
V2 (hydrant)	Closed	Closed	Open	Open
V3	Open	Open	Closed	Closed
V4	Open	Open	Closed	Closed
V5 (hydrant)	Closed	Closed	Open	Open
V6	Open	Open	Closed	Closed
V7	Closed	Open	Open	Closed
V8 (hydrant)	Open	Closed	Closed	Open
V9	Closed	Open	Open	Closed
V10	Closed	Open	Open	Closed
V11 (hydrant)	Open	Closed	Closed	Open
V12	Closed	Open	Open	Closed
V13	Closed	Closed	Open	Open
V14	Open	Closed	Closed	Open