



PROCESS, INSTRUMENTATION AND CONTROLS

GENERAL PLANT LAYOUT AND EQUIPMENT SELECTION PRINCIPLES

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Summary of Changes

Version	Section	Description of revision
2	2.1	Updated list of applicable referenced standards
	2.8	Added reference to the building code for fire safety design
	2.13	Added endorsed registration classes
	2.18	Updated sections on pumps meters regarding identification and placement in chambers respectively.
	4.1.1	Updated table to include foul air.
	5.2	Updated section on importance level to include additional information on asset types, examples and applicable standard references.
	6.1	Updated to include reference to the Health and Safety at Work (Hazardous Substances) Regulations
	6.3	Updated to include reference to the Health and Safety at Work (Hazardous Substances) Regulations
	Appendix A	New appendix included – Importance Level determination flow chart

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Definitions

Treatment Plant	Water treatment plant (WTP) - treats raw water by mechanical or chemical processes to meet the Drinking water Standards for New Zealand, or Wastewater treatment plant (WWTP) - receives wastewater from Wastewater transmission (ref. “Transmission”) to remove contaminants through mechanical, chemical, and biological processes.
Assets	Infrastructure owned and/or operated by Watercare.
Competent person	A person who is qualified because of a specific knowledge, training and applicable experience that is familiar with the Health and Safety at Work Act and conversant in identifying and taking corrective action to potential dangers in the workplace.
Controlling authority	Person(s) in a position of responsibility that is authorised to make a decision on changes, provide access and provide direction.
ESF	Watercare’s engineering standards framework is the single point of access for current standards that allows engineering work to comply with the requirements under the Watercare Bylaw.
Hazard	Potential source of harm.
Infrastructure	Facilities in an operational capacity that is managed by a controlling authority.
Risk	Combination of the probability of the harm caused by a hazard and the impact or severity that may result.

Acronyms

ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
CAD	Computer aided design
CSE	Confined Space Entry
dbA	Decibels with weighing “A” for human perceived loudness
DN	Nominal diameter
°C	Degrees Celsius
HVAC	Heating, ventilation, and air conditioning
ID	Internal diameter
IL	Importance level
kg	kilogram
kPa	Kilo Pascal
L	Litre
LED	Light emitting diode
m	Metre
m^2	Square metre (area)
m^3	Cubic metre (volume)
MCC	Motor control centre
mm	Millimetre
m/s	Metres per second (velocity)
NB	Nominal bore
O&M	Operations and Maintenance
PE	Polyethylene
PVC	Polyvinyl chloride
SCADA	Supervisory control and data acquisition system (networked control system)

Sec	Seconds
SDS	Safety data sheet
VSD	Variable speed drive

1. Scope and general

1.1 Purpose and scope

This document describes good design practices for operability and safety at Watercare facilities and general considerations for process plant layout and material selection. These practices are intended to guide designers in the layout and features and the relationship of elements within facilities.

1.2 Applicability

Where the verbs must, shall and will (or its past tense forms) are used they describe a requirement for compliance with the statement in which it is used.

'Shall' and 'must' expresses a mandatory condition or action. 'Will' is used to prescribe a performance outcome or intent.

1.3 Standard documents overview

1.3.1 Relationship of Watercare standards

Watercare standards comprise of codes of practices, design standards, standard design drawings, construction standards, and asset and material standards.

The Watercare standards are requirements additional to nominated national standards, international standards and industry best practice to meet, and in some cases exceed legislative requirements, to accomplish long term operability and good asset management practices to benefit our customers. The interface of these standards with each other and the project specifications are as follows:

1.3.1.1 Design Standards

The design standard sets a level of design for particular types of infrastructure based on operational area and associated risk. The design standards provide the minimum criteria for:

- Establishing standard design drawings
- Interface design between standard drawings and specific design
- Establishing the correct sizing of components to meet the baseline parameters of the standard drawings.
- The basis for developing tailored designs.

1.3.1.2 Design drawings

The standard design drawings support the requirements of the design standard. Minimum and maximum criteria are set, and specific standard details are shown.

1.3.1.3 Asset and material standards

The asset standards describe the requirements for asset creation, asset numbering, asset capture, production of manuals and operational documentation. Material standards describe the minimum compliance requirements of materials supplied for asset acceptance. Often selected materials will have limitations of use and requirements specific to the operating environment and infrastructure classification.

1.3.1.4 Construction standards

Construction standards prescribe the methods and requirements for workmanship to be employed when constructing works in accordance with the design requirements, standard drawings, and bespoke designs. To achieve the best outcome the construction requirements, focus on proven methods and best practice to ensure quality is maintained to achieve the design life of infrastructure and that maintainability, health and safety and environmental requirements are met. Where construction standards are used or referred to in contracts they form part of the specification of the contract.

1.3.1.5 Project specific specification (particular specifications)

These specifications identify site/project specific requirements that are not covered by the normative construction standards or standard design drawings identified during specific design.

1.3.1.6 Design build projects

Design build projects shall follow the minimum requirements set out in the standard documents for design and construction.

1.4 Quality control and quality assurance

1.4.1 Dispensations affecting quality

Any departure from the standards for the works shall not compromise quality, safety, and regulatory requirements. Any proposed departure shall be evaluated by completing an Application for Dispensation against the applicable standard and by demonstrating that the departure complies with the requirements and applicable certification by providing proof of quality documentation.

1.5 Materials

1.5.1 Material standards

Materials shall include all equipment, machinery, components, or products used to complete the works.

All materials necessary for the work shall be supplied in accordance with Watercare’s Material Supply Standard. Materials shall be new and suitable for their intended purpose and performance requirements.

Machinery and equipment shall be in a good, maintained condition and safe.

1.5.2 Recycled and reused materials

Recycled material and material reuse shall not be accepted unless specifically approved by Watercare.

1.6 Asset information

Asset information shall be progressively captured and supplied in accordance with the requirements of Watercare's Asset Recording standards. These standards shall be followed for new, upgraded or decommissioned assets.

1.7 Design requirement exemptions

The following projects are typically excluded from design work:

a) Installation or replacements of like-for-like valves, fittings and meter assemblies with componentry that are fully compliant with the Watercare Material Supply standard.
b) Repair of a system component or replacing it with a similar Watercare approved component of the same operational capacity as described in the original design.
c) Maintaining corrosion protection on facilities unless a new corrosion protection system is proposed.

To qualify for the design exemption the works must be reviewed by Watercare's engineering plant controller.

Where materials or equipment deviates from Watercare's Materials Supply Standard, an Application for Dispensation shall be prepared and assessed by Watercare's technical governance group.

2. Plant layout design

2.1 Referenced Standards

This standard must be read in conjunction with the Watercare, national and international standards listed below. Where conflict or ambiguity exists, this standard shall take precedence. Where there is conflict between referenced standards, the higher level of standard shall take precedence.

2.1.1 Watercare standards

- DP – 09 Electrical design
- DP – 12 Architectural design guidelines
- ME - General mechanical construction standard
- MS - Material supply standard
- 7363 - Standard for producing CAD and geospatial drawings
- AI - Data and Asset Information standard
- ESF-500-STD-406 – Organisational Physical Security Standard
- HSW-010-HLP-006.1 – Health, Safety and Wellbeing Toolkit Document – Asset Lifecycle Safety

2.1.2 National and International standards

- Water Services (Drinking Water Standards for New Zealand) Regulations 2022
- NZS 1170 Structural design actions
    - Part 5 Earthquake actions – New Zealand
    - Part 5 Supp 1 Earthquake actions – New Zealand – Commentary
- NZS 3106 Code of Practice for concrete structures for the storage of liquids
- NZS 4219 Seismic performance of engineering systems in buildings
- AS 1345 Identification of the contents of pipes, conduits, and ducts
- AS 1657 Fixed platforms, walkways, stairways, and ladders. Design, construction and installation.
- AS 3780 The storage and handling of corrosive substances
- NZS 4541 Automatic fire sprinkler systems
- AS/NZS 4024.1601 Design of controls, interlocks and guarding - Guards - General requirements for the design and construction of fixed and movable guards.
- NZS 6801 Acoustics - Measurement of environmental sound
- AS/NZS 60079 – Series of standards that set out the requirements for the design, selection and installation of electrical equipment in hazardous areas.
- AS/NZS 5601.1:2013 Gas Installations
- AS 1418 Cranes, Hoists and Winches
- AS 4343 Pressure Equipment – Hazard Levels
- AS 4991 Lifting Devices
- ASME B31.3: Process Piping
- ASME B31.4: Pipeline transportation systems for liquids and slurries
- AS/NZS 2885.1: Pipelines – Gas and liquid petroleum – Part 1: Design and construction
- AS 2885.3: Pipelines – Gas and liquid petroleum – Part 3: Operation and maintenance
- API 570: Piping inspection code: In-service inspection, rating, repair, and alteration of piping systems.

2.1.3 Regulations

- Health and Safety at Work Act 2015
- The Hazardous Substances and New Organisms Act 1996 (HSNO)
- Health and Safety at Work (Hazardous substances) Regulation 2017
- Resource Management Act 1991
- Building Act 2004
- Electricity Act 1992 and Electricity (Safety) Regulations 2010
- Gas Act 1992 and Gas (Safety and Measurement) Regulations 2010
- Fire and Emergency New Zealand Act 2017
- Fire and Emergency New Zealand (Fire Safety, Evacuation Procedures and Evacuation schemes) Regulations 2018
- Health and Safety at Work (Major Hazard Facilities) Regulations 2016

2.1.4 Other publications

- Seismic Design of Storage Tanks 2009 (New Zealand Society for Earthquake Engineering).
- API 650 Appendix E 13th Edition, American Petroleum Institute.
- Engineering NZ practice note 19 “Seismic resistance of pressure equipment and its supports”
- Hazardous Substances (Labelling) Notice 2017
- Approved Code of Practice for Cranes 3rd Edition (Department of Labour)
- WorkSafe’s Hazardous substance signage guide

2.2 Site plan

Every facility must have a site plan available in electronic format and a printed hardcopy displayed for staff to view. The site plan shall show the location of:

- Buildings
- Tanks
- Storage areas for hazardous substances
- Storage areas and fill points for flammable substances (e.g. gas and fuel)
- Hazardous areas where potential hazards need to be highlighted.
- Firefighting equipment
- Emergency equipment (first aid kit)
- Evacuation areas

The site plan shall be to scale such that distances can be determined off the drawing.

2.3 Universal design

Site design and layout should incorporate the principles of universal design.

- Equitable use,
- Flexibility in use,
- Simple and intuitive use,
- Perceptible information,
- Tolerance for error (fail safe controls),

- Low physical effort,
- Size and space for approach and use.

2.4 Minimising rooms and maximising sightlines

Increasing the number of rooms within a process facility has significant capital cost implications dependent on:

- Room-based access and egress for complying with standards including the building code.
- Separate systems for HVAC, electrics and lighting.
- Increased footprint to accommodate pathways blocked by walls.

There are compelling reasons to house certain equipment in their own room, such as security, electrical safety and noise. However, many process functions can be housed in a single larger room so long as noise, fumes, and safety are controlled. Larger rooms are inherently safer due to better visual sightlines and lower in cost due to shared services.
The objective is to reduce walls and door access by addressing the objectives noted previously to create larger, light filled spaces which are easier to manoeuvre within during construction and operation.

2.5 Illumination

As process plant technologies have evolved, the staffing levels of process areas have been declining. Modern SCADA systems allow process control and monitoring from remote locations such that occupancy levels are steadily reducing. Equipment maintenance has become more predictable so that both minor and major maintenance can be scheduled in advance, and usually can be carried out in daylight hours. This provides opportunities to reduce the expenditure on lighting:

- The use of natural lighting can often provide sufficient lighting levels for safe access during daylight hours. This can allow supplementary access lights to be controlled by photocell, and task lighting to be activated either manually/timer or by motion sensors.
- Lighting levels in rarely used enclosed areas (such as an emergency exit corridor) is often provided at office-type lumen levels. Energy efficient bulbs should be used to reduce operating cost while still providing the required lighting levels.
- Office area illumination levels were developed in the era of paper and pencils on tables. The transition to flat panels, projectors, and whiteboards, renders direct overhead lighting somewhat inappropriate. Lighting in these areas should assessed and selected according to the function of the workspace, e.g. diffused lighting and have adjustable intensities to suit usage.

2.6 Signage

Safety signs and labels shall be in a visible location on all approach angles to the equipment. All written signs shall be in English.

2.6.1 Restricted areas or areas requiring special permits or training

Signage is required to indicate areas where there is excessive noise or chemicals are stored. These areas may be separated from general areas by soundproof doors or other permanent barrier. Special permits or equipment/training may be required for entry into these areas.

Additionally, access may be controlled through security systems requiring keypad codes, swipe or proximity cards.

2.6.2 Pipework

Labelling and identification of pipework, conduits or ducts shall be in accordance with AS 1345. Refer to Section 3.1.

2.6.3 Equipment

All equipment shall be provided with permanently fixed nameplates or labels. The equipment weight shall be indicated on the nameplate for major equipment items.

2.7 Design of vehicles access ways and manoeuvring areas

Facilities requiring truck access shall have adequate access areas for vehicles entering and leaving the site. This may include turn-around space and building access appropriate for the facility i.e. where pumps are periodically overhauled off-site there will be access right up to appropriately sized doors with consideration to lifting equipment used. Fencing and bollards may be used to limit these areas or avoid unintended access (reversing into walls, installed equipment, or driving off retaining walls).

2.7.1 Protection barriers

Protection barriers shall be installed where moving equipment and vehicles are in regular operation. Barriers include:

- Bollards around building corners and entrances
- Fencing and chains to restrict operators, other vehicles or equipment entering the operation area.
- Light beams
- Pressure pads.
- Speed humps.
- Cargo restraints and barriers

Where barriers or bollards are installed, they shall be designed to meet the appropriate loading requirements in AS/NZS 1170.1 and shall be based on the expected service vehicles entering the facility or area. Bollards shall have a minimum height of 900mm above ground level.

2.8 Fire safety

Fire safety design requirements are covered in the Building Code (Clauses C1 to C6) and is specific to the layout and contents of a building. The Building Act dictates the extent to which compliance with the Building Code is required.

A qualified fire safety engineer shall be engaged to assess and design for fire safety, meeting compliance with legislation.

Fire safety design considerations include:

- Access and egress routes.
- Illuminated signage.
- Maximum fire cell area.
- Need for sprinkler/inert gas in switch-rooms.
- Smoke detection and manual call point system.
- Fire alarm panel location.

Managing fire alarms at Watercare facilities:

- Buildings as defined by the Building Act must be equipped with an acceptable early warning system.
- Facilities not classed as buildings under the Building Act will be assessed based on operational and financial risk.
- Small sites that are of low risk and not housed in a building or significant structure – typically just a standalone control panel, will not be specifically monitored for fire. It is considered that loss of SCADA transmission will trigger a call-out in any event.

2.9 Security and premises access control

For physical security requirements, refer to Watercare's Organisational Physical Security standard.

2.10 Ventilation

Design guides for ventilation rates are often intended to control fume levels by dilution (with fresh air) and dispersion (to the outside) environment. Modern technologies have developed lower volatility chemistry, superior odour containment and simple fume extraction systems. In addition, analytical equipment to detect fumes and trigger ventilation systems have become much more advanced in recent years. It is recommended that ventilation systems be modulated based on hazard and occupancy and be capable of operating at low flow rates regardless of stipulated minimums in design guides and practices.

2.11 Welfare facilities

Welfare facilities should include:

- Toilet and washroom facilities which are typically required for larger pump stations and treatment plants.
- Decontamination facilities such as a shower for personnel and equipment.
- Water supplies at facilities are required to have backflow preventers which are certified annually.
- In areas with process water or recycled water supplies these shall be marked as non-potable.
- Where chemicals are stored and handled a safety shower and eyewash station is required.
- In some cases, a lunchroom, laboratory or office may be required.

2.11.1 Toilets and washroom facilities

Depending on the facility type, the hours personnel spend at the facility and the operational practices or activities undertaken at the site, the following items should be considered:

- Lockers or storage areas for storing personal items.
- Gender appropriate toilet facilities.
- Shower facilities that allow personnel to clean and not distribute potential contaminants.
- Soap or wash solutions with cleaning cloths and towels for drying.
- Labelling of facilities.
- Bins or containers to dispose of waste material such as paper hand towels.

The tables below list the minimum number of toilets and washbasins that's required based on occupancy.

Table 2.1: Number of toilets and washbasins for mixed use (or woman only)

No. of people at work or facility	No. of toilets	No. of washbasins
1 – 5	1	1
6 – 25	2	2
26 – 50	3	3
51 – 75	4	4
76 – 100	5	5

Table 2.2: Number of toilets and washbasins for men

No. of people at work or facility	No. of toilets	No. of washbasins
1 – 15	1	1
16 – 30	2	1
31 – 45	2	2
46 – 60	3	2
61 – 175	3	3
76 – 90	4	3
91 – 100	4	4

2.11.2 Decontamination facilities

Decontamination protects workers from hazardous substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, tools, vehicles, and other equipment used on site; it protects all site personnel by minimizing the transfer of harmful materials into clean areas; it helps prevent mixing of incompatible chemicals; and it protects the community by preventing uncontrolled transportation of contaminants from the site.

Decontamination facilities (e.g. shower) should be provided in areas between the contaminated area and the clean area.

Decontamination measures include but are not limited to:

a) Prevention – appropriate clothing, encasement, protection monitoring, air scrubbing and work practices.
b) Removal – appropriate containment and removal stations setup that may include clothing disposal, decontamination solutions, scrubbing implements, breathing equipment, washing and rinsing facilities, towels and replacement garments.
c) Testing – Reliability test on decontamination methods should be performed periodically to ensure effectiveness. These tests may include visual observation, sampling and laboratory analysis.

2.11.3 Water supplies

Water supplies should be to Watercare's connection standards to provide clean and safe water for consumption and cleaning. Process water must be kept separate from drinking or personnel washing facilities.

2.11.4 Safety showers

Safety showers should have an appropriate design to meet AS 4775 and of materials suitable to the installation environment to prevent corrosion or function deterioration.
The layout should consider:

- That showers are sited in suitable and accessible locations, and within 10 seconds walking time from a location storing hazardous substances.
- Safety showers shall provide a minimum flow rate of 60 litres per minute and a minimum of 15 minutes operation.
- Staff awareness of equipment location and with appropriate signage.
- Adequate drainage shall be provided at all safety showers.

2.11.5 Personnel spaces and support zones

The location of personnel spaces such as lunchrooms, break rooms and control rooms must consider but not limited to:

- Air quality and temperature.
- Exposure to sun and weather.
- Wind direction and the potential direction of gasses.
- Distance and location from chemical storage.
- Lightning.
- Noise and vibration levels.
- Prevention from direct entry from exclusion zones without passing through the decontamination zone.
- Should be separate from publicly accessible areas.

The area layouts must be optimised for the particular purpose such as to provide for, but not limited to:

- Suitable seating areas and work platforms.
- Storage and change facilities.
- Areas for food preparation/heating with wash-up facilities.
- Hand wash facility

2.12 Chemical management and storage

2.12.1 General

The design must produce chemical storage and handling solutions that meets the current legislative requirements under the HSNO and Health and safety at work (Hazardous substances) regulations.

2.12.2 Treatment chemicals

2.12.2.1 Hazardous substances classes

Table 2.3: Hazardous substances classification

Substance classification	Description
Class 1	Substance of explosive nature
Class 2	Flammable gas
Class 3	Flammable liquid
Class 4	Flammable solid
Class 5	Substance with ability to oxidise (to accelerate a fire)
Class 6	Acute or chronic toxicity – toxic to humans
Class 8	Corrosiveness
Class 9	Eco-toxicity with or without bioaccumulation (directly or indirectly toxic to the environment)

2.12.2.2 Chemical contact and chemical fumes

The traditional approach has been to equip workers with protective clothing when performing maintenance on chemical feed equipment. To manage fume hazards by dilution through ventilation, and/or by exhausting the fumes to the exterior away from personnel. There are several concerns with this approach:

- Protective equipment (such as for strong acids) is bulky and movement-restrictive. This makes maintenance less efficient.
- Dilution is no longer considered as a preferred approach to treatment of chemical fumes. In part due to the lack of understanding of low exposures on humans and the environment, and in part due to the increased energy consumption.

Where chemicals are used, consideration must be given to the handling, storage use (mixing or dosing) and disposal (packaging, containers and residues) of the chemicals, as well as safety facilities such as emergency showers, eye wash stations and safety data sheet (SDS) information. The objective is to contain fumes within the chemical storage system, and to scrub any fumes prior to discharge to the environment. Where chemical metering equipment is to be taken out of service for maintenance, a purging system should be provided to flush the chemical out of the equipment prior to maintenance.

2.12.2.3 Storage

a) The design shall comply with the Health and Safety at Work (Hazardous substances) Regulations 2017.
b) Access to class 6 and 8 storage areas must be secured from access by unauthorised persons.
c) The storage area must have appropriate ventilation.
d) Where goods are being transported and delivered to storage locations (including generator refuelling), parking provision shall be made for standing vehicles so that general site traffic is not disrupted or stalled.
e) The storage area must be designed with appropriate spillage retention measures where tanks or pipe work may fail, or where chemicals are transferred or decanted.
f) Bund protection from rain whilst allowing air flow or retention as required for the substance (such as louvered walls to prevent rain but still facilitate air flow.
g) Incompatible substances or substances that may react dangerously must not be stored in the same area.

h) Onsite storage volumes should be considered to minimise the impact of hazards and need to be in compliance with the regulations.
i) Larger chemical volumes require to be stored away from public spaces as defined by the regulations.
j) The storage area must be prepared for any health-related emergency or spillage that can occur from the stored substance.
k) Above ground tanks that require to be earthed and bonded shall be designed to AS/NZS1020:1995 and lightning protected in accordance with AS/NZS1768:2007 as appropriate for the related classification.
l) Class 2 (flammable gases) tanks may not be stacked above one another.
m) Class 3 (flammable liquids) tanks may not be located end-to-end unless determined by risk assessment that failure of a tank end will not impact other tanks.
n) Where chemical containment cabinets are installed, adequate provision shall be made for ventilation to prevent the build-up of chemical vapours within the unit.

2.12.2.4 Labelling and signage

Containers, pipework and storage items must be appropriate for the substance, i.e. inert and not prone to corrosion when storing the substance and marked accordingly. Also refer to Section 4.

a) Containers should be marked accordingly with labels and signage, such as not to be mistaken for food or beverage i.e. do not use containers that can be mistaken for such.
b) Labelling shall be in accordance with the Hazardous Substances (Labelling) Notice 2017
c) Hazardous substance tanks must be marked with the design approval number.
d) "Danger" signage should be visibly displayed to alert personnel of potential hazards at the storage area.

2.12.2.5 Secondary containment

Secondary containment must be designed for stationary storage containers of pooling substances including:

- Flammable or organic peroxides
- Explosive substances
- Corrosive or toxic substances; or
- Where substances retained in a stationary container which needs to be protected from contamination

Secondary containment shall be in accordance with the Health and Safety at Work (Hazardous Substances) Regulations 2017.

2.12.2.6 Waste management

The plant layout design should consider the practicalities of waste management for the site such as:

a) Emptying of bunds:
    - Discharge to waste of naturalised substances into the environment.
    - Removing content off-site for disposal
    - Bund cleaning practice

b) Storage of out-of-date substances for collection, its labelling and segregation from other parts of the plant.

2.12.2.7 Record keeping

a) Hazardous substances register (inventory records) shall be kept up to date – refer to WorkSafe's New rules for hazardous substances.
b) Hazardous substance's location plan must be developed and kept up to date.
c) Safety data sheets (SDS) available and linked to inventory.
d) Hazardous substances management plan (HSMP) and training material must be prepared to include methodologies for:
   i. Storage
   ii. Handling
   iii. Transport
   iv. Disposal
e) Emergency response plan (ERP) is a living operational document that must be reviewed and updated at least every 12 months. This should cover:
   i. Reasonably foreseeable emergencies
   ii. How to obtain information about the hazardous properties of the substances involved
   iii. Any training required to deal with emergencies involving each substance.
   iv. The list of hazardous substances present at the site
   v. Personnel / emergency services involved in the response, in the event of an emergency.
   vi. Describe location of emergency equipment
   vii. Records for inducting staff to the ERP and testing the ERP every 12 months (or within 3 months if there is a change to the plan)
   For a template of an ERP please consult with Watercare's Health and Safety team.
f) Audit methods and frequency must be established.

2.13 Hazardous areas

a) A hazardous area is an area where an ignitable or explosive gas atmosphere is, or may be expected to be, present in such quantities as to require special precautions to prevent the risk of ignition or explosion. This includes where explosive vapours may be present around a place where flammable substances, such as petrol and kerosene, are used or stored.
b) Any approved safety barriers must be designed for installation to the equipment supplier's instructions without modification.
c) All equipment installations within these areas shall employ protection techniques appropriate for the area of classification as defined by AS/NZS 60079.
d) All equipment including cable and glands, shall be certified by a suitably certified testing authority.
e) A hazardous area verification dossier (HAVD) shall be developed in accordance with AS/NZS 60079 demonstrating compliance. AS/NZS 60079.17 details the required information to be included in the dossier – examples of the information required include:
   i) Scope and purpose (hazardous area classification, equipment selection, installation details, ongoing maintenance)
   ii) General information (project / facility name, locations, identification of hazardous area)

iii) Hazardous area classification (detailed hazardous area classification report)
iv) Equipment selection and installation details (comprehensive overview of equipment installed in hazardous area including certification, temperature ratings, type of protection, IP ratings etc.)
v) Inspection and testing records (records of inspection and testing during verification, e.g. visual, insulation testing etc. The test records should also list any non-conformances and how this was remediated)
vi) Verification report and certificates issued by an independent person carrying out inspections and reviewing tests.
vii) Maintenance plan for existing equipment
viii) Electrical certificate of conformity (CoC)
ix) Competency records of person(s) involved in installation, verifying testing and inspections (National Electrical Equipment in Hazardous Area Competency Standard AS/NZS 4761 details the competencies required.)
x) Hazardous area management plan (HAMP)

f) Hazardous areas shall have appropriate signage identifying the area and substances as hazardous. The Hazardous Substances Toolbox (https://hazardoussubstances.govt.nz/) provides guidance on when and what type of signage is required.

Figure 2.1: Examples of signage identifying hazardous areas

Note: The Electricity (Prescribed Classes of Registration for Electrical Workers) Notice 2023, published in the *New Zealand Gazette* on 1 September 2023, defines endorsed registration classes including Electrician (Endorsed Hazardous Areas), Electrical Service Technician (Endorsed Hazardous Areas), Electrical Engineer (Endorsed Hazardous Areas), Electrical Inspector (Endorsed Hazardous Areas), and Electrical Installer (Endorsed Hazardous Areas). Everyone must meet all requirements of the new framework Electrical Workers Registration Board

2.14 Cross-connection control

Table 2.4: Recommended cross-connection protection at equipment

Description of equipment / installation	Recommended minimum protection
Liquid chemical tanks	i) Provide air gap on dilution water supply ii) Air gap to overflow and drain iii) Provide day-tanks
Dry chemical feeder tanks	i) Provide air gap on fill supply ii) Air gap to overflow and drain
Chemical feed pumps	i) Discharge at point of positive pressure ii) Provide vacuum relief or similar anti-siphon device iii) No pump priming

Description of equipment / installation	Recommended minimum protection
Chemical carrier lines	Provide a reduced pressure zone (RPZ) backflow device at the supply
Chemical injection point to carrier line	Provide a reduced pressure zone (RPZ)
Chemical injection line in common with potable water / non-potable water	Provide a reduced pressure zone (RPZ), eliminate cross-connection (separate injectors for raw or filtered water)
Surface washers	i) Atmospheric vacuum break ii) Pressure vacuum breakers assembly iii) Double check valve assembly
Filter backwash	Provide air gap to overflow and drain
Filter-to-waste	Provide air gap to overflow and drain, or air gap to process stream ahead of filters
Membrane cleaning (in-place)	Physical disconnect
Sample lines to monitoring equipment	i) Air gap ii) Atmospheric vacuum breaker
Monitoring equipment for raw and potable water	i) Air gap ii) Physical disconnect

2.15 Process and potable water in plant piping

a) Potable water for consumption shall be completely separated from process water supplies. Due to the complexity of process water reticulation system layouts the probability of interconnection of process water piping is high.

b) Best practice is to take process water from discreet points for individual processes.

Potable water for process uses in the facility shall be from no more than two discrete points with backflow prevention at the supply point.

c) A reduced pressure zone (RPZ) backflow device shall be installed at these take-off points. Backflow devices shall be installed outside of buildings to prevent flooding during malfunction or blockages. Where backflow devices cannot be installed outside of buildings and needs to be within a building, appropriate drainage shall be provided to account for any discharge from the configuration.

d) Refer to Section 3.4 for piping layout and Section 4 of this part for colour coding of pipework.

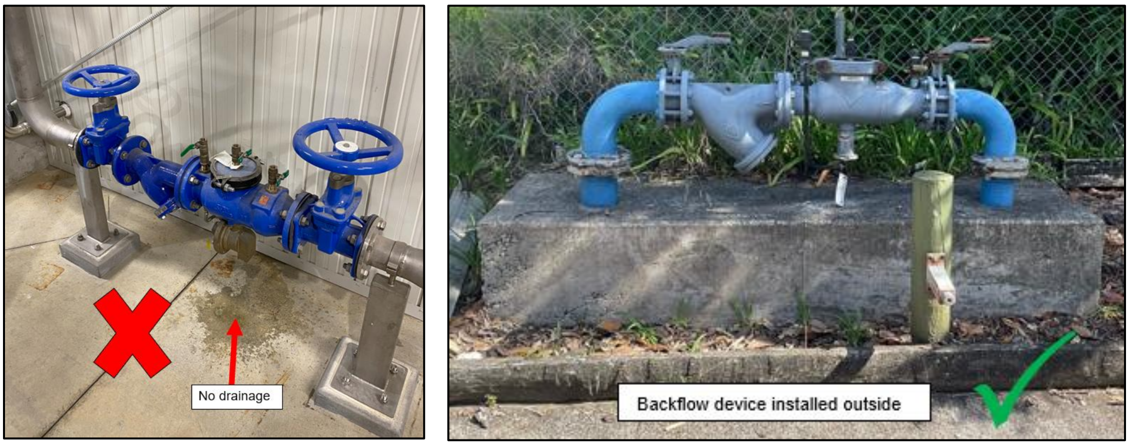


Figure 2.2: Example of a backflow device installed inside a building with no drainage, creating a flooding risk.

2.16 Common wall construction

The design shall consider cross contamination that may occur because of shared or common walls between water being treated and finished water. Either double walls with an adequate separation to allow inspection or monitoring of the wall integrity, or basins should be arranged to be well separated for prevention.

2.17 Confined spaces

All confined spaces shall be designed in accordance with AS 2865 – Confined Spaces.

Consideration shall be given to locating equipment or operating systems for equipment outside of confined spaces without needing to enter – e.g. valve with spindle extension where it can be operated aboveground. Any confined space shall consider emergency response and extraction methods for all personnel. The design shall ensure that confined spaces are eliminated during the design phase wherever practical. If a confined space cannot be designer out, safe access and suitable ventilation shall be provided by active or passive means to achieve the required air change.

2.17.1 Safe access

Wherever practical, a fixed method of entry and egress shall be designed. This includes installation of stairways, platforms; and ladders and fixed or removable davit arms with certified fall-prevention anchor points. Where fixed access is not practicable, appropriate space and orientation shall be allowed for a portable tripod system.
When accessing a confined space, regardless of the intent or duration, the following is required:

- All workers shall have up-to-date confined space entry (CSE) training certified by a third party.
- A certified extraction team with appropriate equipment support needs to attend the entry.
- A plan for each entry, including a hazard assessment and contingency planning, needs to be prepared, submitted, and reviewed prior to the CSE being approved.

2.17.2 Ventilation

A confined space risk assessment shall be carried out during the design to determine the most appropriate method of ventilation. Confined spaces must be adequately ventilated enabling the space to be purged with fresh air.

Note: Where dry wells are adjacent to wet wells, the separating wall shall be sealed to prevent any transfer of airborne contaminants.

2.18 Equipment operability and general positioning

When planning the layout of a facility, equipment should be positioned at a common level where practicable to:

- Minimise varying levels and access requirements (platforms)
- Avoid ladders for routine activities.

- Undertake operational activities with good posture and the necessary mechanical leverage (e.g. opening and closing valves)

Deign should be in a sequential and logical manner that avoids unnecessary crossing movements between equipment where practicable.
Safe pedestrian access should also be provided for operational staff traversing between equipment and service vehicles for maintenance activities.
This section must be read in conjunction with Section 3. Mechanical Design.

Table 2.5: Equipment positioning considerations.

Equipment	Positioning
Valves	Size >50mm positioned 600mm to 1000mm from the operator platform to the top of the operating mechanism. This includes any valve of any size that is required to be disabled for regular maintenance such as check valves. Size <50mm positioned not higher than 1500mm from the operator platform (excludes regularly maintainable valves)
Pumps	Mounted on a pump skid with surface level minimum 200mm above the ground level. (excludes submersible pumps) Horizontal clearance of minimum 1000mm Vertical space above pumps over 15kg shall be clear and provided with access for lifting equipment which shall be properly aligned over the equipment that requires lifting. **Note**: All pumps shall be labelled with numbers and be in sequence starting from left to right for pump stations and in sequence for plants where practicable.
Process (dosing) pumps	Mounted on a dosing skid positioned at a height of 600mm clear from pipework that could leak onto the pump and positioned to allow clearances for maintenance of pump components
Sensors	In reach of platforms and other access means and removable such that equipment or parts cannot be dropped into process containers
Meters	Meters shall be positioned inside buildings or accessible chambers. Water supply meters which include testable reduced pressure zone (RPZ) backflow devices shall be installed outside buildings and aboveground to prevent flooding (should a failure occur). Clearances and pipe runs must be observed as described by the manufacturer's installation requirements
Monitoring stations	Suitable for human interaction not requiring leaning over other equipment and at a height from standing surface of 1.2m to 1.5m
Cable runs	Short as possible, either mounted above 2000mm overhead on cable trays or in cable ducts. Ducting should not be in areas that can flood or have poor ventilation and prone to high temperatures.

2.18.1 Ergonomic design of pipework

Valve hand-wheels and valve spindles shall be positioned so that they can be operated (manually or with actuator) without potential for injury. Positioning of lifting points shall consider use of appropriate craneage.

2.18.2 Manhole covers and lids

Where covers and lids are not hinged consideration shall be given to the maximum weight (20kg) for manual lifting or tools required for removal. Assessment of the need for manhole safety grilles shall be undertaken. Some larger hatch covers will require the provision of barriers with four-sided protection when open (e.g. McBerns or Austral style lids). Standard Watercare design for hatches include securable struts to hold the cover open.

2.18.3 Flooring systems

The need for non-slip floor coatings and stair treads shall be considered at each site. Gaps in platform gratings shall be avoided, and gratings must be secured with proprietary fixings as per the manufacturer's specification.

2.18.4 Vertical removal of heavy equipment

In process areas, it is preferable that equipment weighing more than 15kg should be located such that it can be installed/removed vertically. Overhead lifting devices, such as bridge cranes or monorails should be able to transfer equipment to a loading dock or truck. Where floor-based devices such as trolley hoists would be used, the facility should have a simple pathway to move the removed component to a loading dock or truck bed. This approach to facility design will improve both the constructability as well as maintenance. Valves (and other moving process equipment) heavier than 15kg should only be installed along horizontal piping.

Where craneage and anchor points are provided consideration must be given to how they are certified/ inspected periodically.

2.18.5 Reliable and maintainable lighting

Every light fixture should be accessible (for bulb replacement, cleaning, and aiming) by a maintenance worker using a standard 2.5m stepladder, resting on a solid floor. Ceiling lights should be limited to skylights. Where a travelling bridge crane is installed over a large process equipment area, the motorised hoist trolley should be equipped with an LED spotlight to illuminate the area below the hoist whenever the crane hoist is powered. LED-type bulbs should be used in all fixtures where available.

2.18.6 Working at height

Consider elimination (i.e. hinged poles for lowering radio aerial) or safe means of access. Examples include replacement of lighting elements, ventilation ducting and cable tray, monorail trolleys and gantry cranes, radio and lightning conductors, roof repairs and maintenance.

2.19 Power management

In sites where high voltage transformers are installed signage and locked gates will restrict access to authorised personnel. Where switch gear with high voltage bus bars are installed then signage and fixed panels will limit access. Appropriate spacing around switchboards and MCCs for future maintenance shall be provided.

Provision of emergency stops at local control centres shall be provided.

Energised equipment (electric, pneumatic, hydraulic) needs to be provided with means of de-energising and/or isolation.

Radiation sources (UV, microwave and laser) needs to be isolated from frequently accessed areas. The wide availability of thyristor-type variable speed drives has led to their increased use. It is not uncommon to see multiple-pump facilities with every pump being controlled by a VSD. Even in cases where minimum flow rates are always greater than that of a single pump and head variations are minimal. Under these conditions, fixed speed pumps offer at least a 5% improvement in wire-to-water efficiency. In addition, fixed speed units are lower in cost, have longer life expectancies, and the electrics do not require air-conditioned environments. Where there are multiple operating pumps or blowers in a facility, attempts should be made to minimise the use of VSD's.

3. Mechanical Design

3.1 Safety interlocks

All mechanical equipment must have lockable devices installed (i.e. switches, valve locks) which allow for physical locking of the equipment where stored energy may cause harm. Mechanical safety interlock devices shall be installed and tested in accordance with the product supplier's requirements.

3.2 Guards

Wherever practicable, maintenance access should be achieved by external access points without the need to remove guards.

a) All rotating, moving, or oscillating items shall be fully guarded to comply with the relevant standards and WorkSafe requirements.
b) All drive mechanism, rotating and reciprocating parts and drive belts shall be securely shrouded to provide protection and safety for both maintenance and operating personnel.
c) All such guards shall be of adequate material and coverage but shall also be readily removable for gaining access to the plant without the need for first removing or displacing any major item of plant.
d) Guard design shall allow inspection ports or with expanded metal sections to allow inspection without having to remove the guards in compliance with AS/NZS4024.1601.
e) All guards shall be designed and fitted with location pins or other suitable devices to ensure the correct positioning of the guard and provide positive fixing.
f) Guards shall require the use of engineering tools for removal and shall not be able to be simply lifted on and off.
g) Grilles, bars or mesh shall be provided behind inspection ports where moving equipment may be reached. Interlocks shall be provided to stop equipment if covers are opened.

3.3 Maximum equipment noise levels

a) Facilities shall be designed and assessed by a competent acoustic specialist to ensure that operators are not exposed to noise levels that are:
   - Equivalent to 85dbA averaged over 8 hours, or
   - A peak noise level of 140dbA.
b) Where noise levels cannot be eliminated, the designer shall consider:
   Separating noisy machinery from communal workspaces or areas frequently traversed by operators using barriers to block noise or the use of noise dampers or enclosures.

Ambient noise levels above 85dbA require signage advising the entrant to wear hearing protection. When properly worn, this reduces the risk of damage to hearing. However, hearing protection by its nature inhibits communications between workers. This increases the time, cost, and safety risk of on-site maintenance personnel. Without good verbal communications, safety alerts are compromised.

The objective is to procure equipment with a maximum noise level below 80dbA. This will keep ambient noise levels below the specified limits without intensive acoustic treatment of the area or room. Noise enclosures are not preferred as they inhibit maintenance and inspection.

3.4 Piping layouts

a) Detailed design shall include:
- Detailed layout and co-ordination, including all necessary bends and offsets.
- Support and anchorage.
- Flexibility and dismantling
- Expansion and contraction (including nozzle loading where this is expected)
- Prevention of water hammer

b) All pipe supports shall be seismically rated to suit the site conditions. Pipes shall not be supported:
- By existing structures not specifically designed for pipe static and dynamic loadings
- From roof girts, rafters of purlins.

c) Components within the pipe systems such as meters valves and strainers shall be independently supported to facilitate dismantling and not pass stress onto the connecting pipework.

d) Thrust support shall be designed for at equipment such as pumps and nozzles.

e) The drawings shall indicate the size of pipes, their material selection, and the exact arrangement.

f) The pipe arrangement shall provide for ease of installation and future dismantling with consideration to suitable clearances around supports, saddles, slings, fixing bolts and foundation bolts.

g) Pipes laid horizontally shall have a gradual fall towards drain or scour points as appropriate.

h) High points shall be vented, and low points shall have suitable drainage devices appropriate to the media.

i) Dismantling joints or dismantling options through flange and pipe arrangement (such as at bends) shall be made available:
- Maximum 10m apart on all pipe carrying solids, sludge, etc.; and
- At pipe material or diameter changes
- At key changes in height, structures (access areas) and change in direction.
- To allow dismantling without interfering with adjacent pipe runs

j) Hangers and supports shall be designed with adequate spacing for the material type so as not to cause any spacing or stresses in the pipe and designed to NZS 4219 for seismic resilience. In general, the following considerations shall be followed for hangers or supports:
- Installed at directional changes.
- Adjacent to connections for valves, pumps, and large instrumentation
- Manufactured from a material that is suitable to the installation environment.
- Provided with appropriate insulation to prevent galvanic reaction.
- Allow for adjustment, dismantling and replacement.
- For fire sprinklers refer to NZS 4541

k) Unless required for sealing against ventilation or liquid, all pipework passing through structures shall be run through a sleeve.

l) Pipework carrying thick media requiring regular cleaning (e.g. solids, sludge, scum, centrate) shall be provided with regular clean-out ports, typically at directional changes with suitable containment to catch run-off during the cleanout procedure.
m) Pipework running above surface carrying harmful chemicals should be double sleeved through a carrier duct along walkways and crossings with suitable drain, indication and inspection points.
n) Components within the pipe systems such as meters valves and strainers shall be independently supported to facilitate dismantling and not pass stress onto the connecting pipework.
   Bends shall as far as practicable be long radius. Short radius elbows shall be avoided.
o) Pipe layouts shall have clean lines, neat and with true alignment and grade, without unsightly offsets, minimising cross-overs and be arranged to be accessible and readily replaceable.
p) Pipe layouts shall allow for expansion and contraction.
q) Offsets where required shall use 45° bends.
r) For process pipework up to 50mm diameter, a minimum 100mm clear space shall be provided between the pipe (or pipe flange), to adjacent structures, pipes and equipment. For larger pipe the clearance shall be twice the external diameter.
s) Pipework shall be labelled in accordance with AS 1345 and show the pipe content and flow direction. Labels shall be placed to ensure that the pipeline is identified as soon as possible after a person passes through a doorway, around a corner, or any other obstruction that breaks the continuous line of sight. Refer to Section 4 for pipe labelling and coating.

3.5 Sampling points

a) Sampling points shall be located outside of confined spaces.
b) Sampling points shall have safe access.
c) Sampling points shall have appropriate taps (3-piece ball valves) and be labelled.
d) Dip sampling points shall have accessible floor level hatches or other appropriate access that allow for safe collection of samples. Wherever practicable samples should not be obtained through safety rails or over obstructions.

3.6 Frames and mountings

a) All supports, holding down details and fixings for plant and equipment shall be detailed by the design, ensuring that all plant and equipment can withstand seismic loading (refer Section 5) with the necessary support fixings and anchors.
b) Baseplates for motor driven plant shall hold both the driver and driven units. Sub baseplates shall be welded to the main baseplate.
c) Fixing systems provided with base plates shall be designed for taking up adjustment for necessary alignment and to compensate for wear during normal service.
d) Baseplates shall be designed to be without distortion or deflection that could permanently damage the equipment or baseplate.
e) Eye bolts or holes shall be provided for lifting the complete assembly on the base plate in addition to lifting facilities on the individual components.
f) The underside faces of baseplates that contact foundations shall be rough machined to ASME B46.1 machinery surface.
g) Provision shall be made for all baseplates to be filled with grout during installation.

h) All baseplates, pipe supports, and other items fixed to the concrete foundation shall have straight smooth sides.
i) All holes as necessary shall be machined and not flame cut.
j) All bolt holes in steelwork shall be minimum 1.5 x hole-diameter from the nearest metal edge.
k) Flexibly mounted equipment shall be provided with suitable dampeners with resilient surfaces to limit seismic movement.
l) Frame members, if constructed from hollow sections, shall have the ends closed off and be fully sealed against ingress of moisture. Galvanised hollow frame members shall have vent holes fully sealed with lead plugs after being galvanised.
m) Separation/galvanic isolation of the two dissimilar metals shall is required to prevent possible galvanic action.

3.7 Acoustic louvres

a) The louver shall be of weatherproof design suitable for and proven for use in the specific application.
b) For air intake louvers where the velocity through the effective pressure area exceeds 4m/s, or the pressure drop exceeds 30 Pa, provide side draining louvers.
c) Where clear wall height above louver ≥ 2m, provide gutter across top of louver to divert rain water to sides of louver face.

3.8 Material and equipment handling

a) Equipment shall be designed and installed to provide sufficient access and clearance to allow for the safe and efficient carrying out of routine inspections, operations and maintenance activities.
b) All equipment shall be readily accessible for removal and be fitted with appropriate and clearly identified lifting points.
c) Equipment shall be installed to the requirements of the manufacturer.

3.9 Platforms and access structures

All platforms and access structures shall be designed in accordance with AS 1657.

a) The design of platforms and access structures shall take into consideration the structural steelwork requirements and access structures and platforms section of Watercare's Mechanical Construction Standard.
b) Walkways and platforms shall be provided for maintenance access and inspections. Platforms should be extended such as to prevent reaching over handrails and at a suitable height for equipment handling.
c) Allow for site specific spill conditions and corrosion protection.
d) Stairways are preferred over ladders. Where ladders are provided it shall be extendable to a minimum of 1000mm through the chamber lid above ground level.
e) Platform system shall be complete with grating, kick-plates, stairs, handrails, ladders and all associated accessories.
f) Platform system material selection must be appropriate for the environment to prevent or reduce corrosion.
g) The design shall in general comply with AS 1657 with the following considerations:
   i. Walkways shall be provided for maintenance access and operational inspection.
   ii. Comply with Ministry of Business Innovation and Employment requirements.

iii. Access platforms shall be provided at all equipment drives at a suitable height for maintenance.
iv. Extend walkways to prevent the need to reach over railings for equipment access.
v. Apply additional specific or calculated loads for equipment or pipework. This could include loads related to lifting equipment mounted to platforms/walkways and loads for equipment laydown and removal via trolley. Additional loading capacity shall be allowed as required for lifting equipment into mounting areas or where platforms may be used to transport equipment, or for laydown areas.

h) The walkway systems shall be suitable for installation outdoors, for exposure to continuous 90% relative humidity conditions, for ambient air temperature from 5° C to 35° C and for exposure to intermittent water or sludge splash, spill conditions and a marine coastal environment.

3.10 Gantries and cranes

Lifting devices shall be painted safety yellow (BS5252 – 08 E53 or RAL 1007) and the load capacity clearly visible and readable from the nearest normal working platform or floor. All lifting equipment shall be certified.

a) Consideration should be given to use of temporary gantries and cranes to be retained as part of the permanent installation thereby reducing the need for mobile plant and ensuring the installation is adequate for equipment handling of the site.
b) Where gantries and cranes become permanent installations, they must be serviced after completion of the works before being handed over into Watercare's service.
c) Permanent gantry cranes shall have safe and adequate access for inspection and maintenance purposes in accordance with the Department of Labour's approved Code of Practice for Cranes.
d) Fixed cranes can be considered where frequent equipment movement in a localised area is necessary or where the equipment is of a type that requires a specific handling method.
e) Gantry rails provide flexibility in the movement of equipment across distance, reducing downtime and increasing productivity, but is more expensive in initial design and setup.
f) Total cost option analysis that includes operational value must be completed for selecting the most appropriate crane system.

3.11 Loading materials, hoppers and conveyors for handling

Docking and loading, and materials handling plans must be prepared.

3.11.1 Loading access

a) Truck and vehicle movement should consider a one-direction access road for vehicle movement to reduce the necessity for manoeuvring areas to offloading areas and site road width, and pedestrian separation.
b) The road surface around the site shall be level and rated to HN-HO-72 traffic loading requirements.
c) Suitable drainage for surface water must be provided.
d) Loading docks and road approach surface must not exceed 10% angle difference to prevent truck to platform misalignment, cargo topple and traction problems. Build-out blocks must be designed to make up the hypotenuse angle to prevent impact of the top of trucks with the facilities or structures.

e) Depressed docking or elevated platforms are recommended over downloading to road surface. Where forklifts or scissor platforms are used suitable clearances and bump protection must be provided for manoeuvring of this equipment.
f) Bumpers must be positioned to prevent vehicles damaging loading structures in line with the expected manoeuvrings for delivery and docking.
g) Some deliveries and material handling may require to be kept dry. The docking or offloading areas must then be suitably covered and protected from the elements.

3.11.2 Hoppers and conveyors

This section shall be read in conjunction with WorkSafe's Best Practice Guidelines for Safe Use of Machinery and the AS/NZS 4024 series of standards to conveyors.

a) Hoppers and conveyors for loading product into processes must be positioned such as to limit the distance from the material offload area.
b) Conveyors carrying screening solids that may cause blockages shall be accessible along the length of the machine.
c) Stop / start (including emergency stop) control switches must be in reach of the operator.
d) Areas that pose a risk (nip points, chain drives and belt drives) shall be identified and guarded to prevent entanglement of loose items.
e) Lifting of product to hoppers by gantry is preferred over the use of a forklift. Gantries must be suitably rated, refer to Section 3.10.
f) Hoppers should be positioned at low or recessed levels and product transferred to elevation by a conveyor or alternatively a vacuum system for fine powdered product.

4. Pipe labelling and coating of equipment

4.1 Pipe labelling

Both networks and plant facilities include pipes conveying fluids / gases and shall be identifiable by attaching a label with an appropriate naming and colour combination. All pipes shall be labelled in accordance with AS 1345: Identification of the contents of pipes, conduits and ducts.

4.1.1 Pipe label colours

Table 4.1: Pipe label colours based on contents.

AS 1345	Colour (AS 2700)	AS 1345 Description	Additional Watercare Descriptions
Water	Green G21- Jade	• Drinking water **(to include dark blue band for potable use)** • Waste water (excludes sewage and other dangerously polluted water) • Cooling water, including seawater • Heating water • Storm water • Hydraulic power supply • Recycled water	• Raw water • Back pulse water • Ultrafiltration (UF) water • Backwash / Upwash water • Biologically activated carbon (BAC) filtered water • UV dose water • Pond water
Steam	Silver-grey	• Live steam • Process steam • Exhaust steam • Space heating steam	
Oils, flammable and combustible liquids	Brown X53 – Golden Tan	• Fuel and lubricating oils • Animal and vegetable oils for food • processing • Petrol, diesel, and other light fraction • fuels • Other flammable or combustible liquid • substances	
Gases	Yellow-ochre Y44 – Sand	• Fuel gases • Process gases • Liquefied gases under pressure • Pneumatic transport of particulate solids • Exhaust gases and fumes • Medical gases	• Hydrogen (H_2) gas • Carbon dioxide (CO_2) gas • Chlorine gas • Natural gas • LPG gas • Biogas
Acids and Alkalis	Violet P23 – Lilac	• All corrosive liquids and gases	• Sodium hypochlorite (Hypo) • Carbon dioxide (CO_2) solution • Lime • Hydrfluosilicic acid (HCA) • Polyaluminium chloride (PACl) • Acetic acid • Aluminium sulphate • Soda ash • Sulphuric acid • Ferric chloride • Polymer
Air	Light Blue B25 – Aqua	• Compressed air • Instrument air	• Process air

AS 1345	Colour (AS 2700)	AS 1345 Description	Additional Watercare Descriptions
		• Vacuum • Ventilation • Pneumatic conveyor	
Electrical conduit and ducting	Orange X 15 – Orange	• Electricity supply circuits	
Other liquids / foul air	Black	• Chemical mixtures in water or organic • solvent • Liquid foodstuffs (see Note 2) • Sewage, organic waste • Chemical and process wastes	• De-gritted supernatant • Thickener Supernatant • Thickened sludge • Centrifuge centrate • Washwater / filter to waste • Membrane overflow • Washwater / filter to waste • Wastewater / foul air to odour treatment
Fire Services	Red R13 – Signal Red	• Dedicated water, foam, other fire • extinguishing supply lines	• Safety shower

Note: The "Addition Watercare Descriptions" listed in the table above is not an exhaustive list- and adequate description should be used based on the specific process.

4.1.2 Pipe label placement

Pipe labels should be positioned so that they are clearly visible from a standing position on the ground. If the pipe is elevated above the sightline of an operator, the label should be positioned below the spring line of the pipe. Similarly, if the pipe is located below the sightline, the label should be positioned above the spring line. Pipe labels should be located at the following positions:

- Every 8m along straight pipe runs.
- Adjacent to fittings or junction boxes
- Within 1m of every valve
- Where pipes pass through walls, doors, or floors (either side if accessible)
- Bulkheads
- Service appliances.

4.1.3 Pipe label size

The label size is determined by the diameter of the pipe carrying the substance as shown in the table below:

Table 4.2: Label dimensions required based on pipe size.

Outside Diameter of Pipe	Minimum Height of Label	Minimum Height of Text
< 40mm	Continuous band around pipe	4mm
40 – 75mm	25mm	12mm
> 75mm	50mm	24mm

Note: <u>All text should be in upper-case</u>

The length of a label should **not be less than 375mm** – longer lengths may be required depending on the description of the substance.

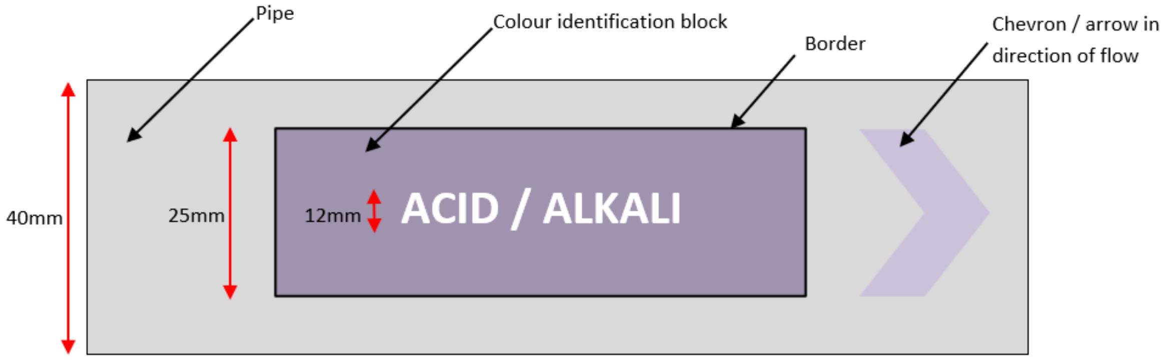


Figure 4.1: Typical Pipe Marker for pipe size 40 – 75mm, as per AS 1345:1995

4.1.4 Pipes with consumable contents

Pipes that carry substances for human consumption e.g., potable water should be identified with an additional dark blue colour (e.g., AS 2700: B21) band or patch-marker (for very large pipes). This helps plant operators differentiate between potable and mildly contaminated substances grouped in the “Water” category.

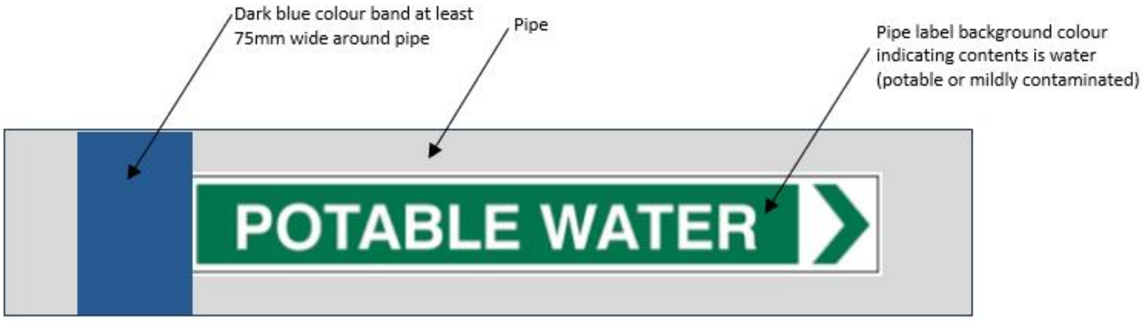


Figure 4.2: Example of a dark blue band around a potable water / service water pipe.

4.1.5 Special hazards

Pipes presenting special hazards to operators shall have additional identification which includes a yellow and black band or patch marker as shown in the table 4.3 below.

Table 4.3: Special hazard categories

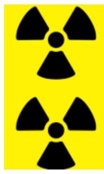
Hazardous Services	*Biological Hazard*	*Ionizing Radiation*
		

Figure 4.3: Example of an alternating diagonal yellow and black band (smaller diameter pipes)

4.2 Pipe and equipment coating

4.2.1 Pipe coating

Where pipelines require additional coating to provide corrosion protection, the coating shall be painted Pipeline Grey – N43 (AS 2700) or Ironside Grey – 10 A09 (BS5252) after which the appropriate labelling colour and placement needs to be applied. The appropriate coating system shall be determined in consultation with Altex and confirming the site-specific macro and micro-environments.

For corrosion resistant pipe materials (e.g., stainless steel) no protective coating system is required.

4.2.2 Equipment and machinery coating

The appropriate coating system shall be determined in consultation with Altex and confirming the site-specific macro and micro-environments. Also see Section 6 for specific corrosion protection considerations. The designer must complete the project schedule in the Material Supply standard and provide it to the coating supplier to support the coating selection.

Table 4.4: Equipment and machinery coating colours

Equipment	BS 5252 Colour	RAL	Colour
Centrifuges	10 A 01 Sea fog	RAL 9003 Signal white	
Blowers	20 E 53 Fan blue	RAL 5015: Sky blue	
Blowers panels	00 A 03 Silver sand	RAL 7035 Light grey	
Blowers	20 E 56 Bondi blue	RAL 5002 Ultramarine blue	
Inter-stage pumps	20 D 44 St Tropaz	RAL 5010 Gentian blue or NCS 1950: 5040-R 90 B (Mid-blue)	
Other major pumps	00 A 13 Baltic sea	RAL 8022 Black brown or NCS 1950: S 9000 N	

Equipment	BS 5252 Colour	RAL	Colour
Sludge tanks	06 A 03 Cloud	RAL 080 80 05 Micaceous light grey	
Clarifier mechanism	00 A 09 Scarpa flow	RAL 7024 Graphite grey	
DAF Mechanism	00 A 09 Scarpa flow	RAL 7024 Graphite grey	
Gantry cranes/monorails	08 E 53 Lightning yellow	RAL 1007 Daffodil yellow	
Transformers	08 C 33 Calico	RAL 1001 Beige	
11kV Switchgear	08 C 33 Calico	RAL 1001 Beige	
415V MCCs	04 B 15 Dawn pink	RAL 070 90 05 Off-white	
Variable speed drives	08 C 33 Calico	RAL 1001 Beige	
Distribution boards	04 B 15 Dawn pink	RAL 070 90 05 Off-white	
Battery chargers	04 B 15 Dawn pink	RAL 070 90 05 Off-white	
DCS Panels	04 B 15 Dawn pink	RAL 070 90 05 Off-white	

Equipment	BS 5252 Colour	RAL	Colour
Polymer tanks	10 B 15 Solitaire	RAL 1015 Light ivory	
Sludge feed tanks	10 B 15 Solitaire	RAL 1015 Light ivory	
Blended sludge tanks	18 B 15 Catskill white	RAL 9016 Traffic white	
Digester feed tanks	18 B 15 Catskill white	RAL 9016 Traffic white	
Progressive cavity pumps	20 E 53 Fan blue	RAL 5015: Sky blue	
Recirculation pumps	14 E 56 Fun green	RAL 6032 Signal green	
Plug valves	20 E 56 Bondi blue	RAL 260 30 35 Royal blue	
Blended sludge polymer tanks	10 A 01 Sea fog	RAL 9003 Signal white	
Odour fans	White to match ducting		
Electric motors	Same colour as connected rotating equipment		
Conveyors	TBC, site specific		
Sludge/Polymer Pumps	TBC, site specific		
Gravity belt thickeners	Stainless Steel Epoxy		

5. Seismic design of equipment, equipment supports and tanks

5.1 General

a) This part covers the requirements for seismic resistance of tanks, equipment and equipment supports and provide additional relevant information to assist designers. It does not override any statutory requirements.
b) All structural aspects of design shall be verified by a New Zealand Chartered Professional Engineer experienced in the seismic design of industrial structures and tanks.
c) All equipment and equipment support shall comply with the applicable requirements of the NZ Building Act, the New Zealand Building Code and the applicable approved documents including the New Zealand Loadings code AS/NZS 1170 (Structural design actions) and the appropriate materials codes. Equipment inside buildings shall be designed to the appropriate risk level and as prescribed by NZS 4219 (see section 5 below).
d) Pressure vessels shall, in addition, comply with the specific seismic requirements of the New Zealand Ministry of Transport, Marine Division.
e) Alternative design methods must be approved by the relevant Territorial Authority (to be sought by the designer) and accepted by Watercare.
f) The seismic design should consider the structural system comprising both the equipment and its supporting system.
g) The Supplier/Contractor shall submit with his design the following information:
    i. Weight and geometry of the equipment including positions of the centre of gravity and support points for maximum weight and normal operating weight.
    ii. Ductility capability.
    iii. Structural type and methods of achieving ductility (if applicable)
    iv. The equipment horizontal design action co-efficient.
    v. Displacements of equipment for the serviceability and ultimate limit states.
    vi. Foundation loadings (dead, basic live, earthquake and wind load, where applicable)

5.2 Importance levels

5.2.1 General

Importance Level (IL) is a categorisation system, defined in the New Zealand Building Code by how significant the asset is to life safety, functionality and the potential consequences (social, economic and environmental) of its failure. The categories range from 1 to 5, with 1 being the lowest Importance Level, and 5 being the highest.

From a design compliance perspective, the IL primarily influences the magnitude of seismic, snow and wind loading requirements on a given asset (for ULS design) and the factors of safety applied in the design of an asset (for working-stress design).

It also influences the requirements for functionality after a natural disaster event (via Serviceability Limit State (SLS)) requirements, as outlined in AS/NZS 1170.0. Importance Level 2-4 assets have an SLS1 requirement, where structural and non-structural components do not require repair and IL4 structures also have an SLS2 requirement where the structure is to maintain operational continuity (following a SLS1 and SLS2 event respectively).

The selected IL shall determine the applicable return periods for the Ultimate Limit State and Serviceability Limit State(s).
The IL should be selected based on a risk assessment and consequence of failure that considers:

- Specific risks to the operation of the plant.
- Performance requirements of the equipment and facility, and whether operational continuity is required during and immediately after a major earthquake.
- System redundancy.
- Hazardous materials at the plant which has the potential to cause hazardous conditions that extends beyond the plant in the event of a seismic event.
- Insurance risk.

The IL shall be determined early on in the design phase in conjunction with the plant manager and operator(s).

AS 1210 Pressure Vessels also provides guidance on the relationship between vessel hazard levels (AS 4343) and IL of pressure vessels, defined as "*interconnected parts and components, valves, gauges and other fittings up to the first point of connection to piping*".

Engineering New Zealand's Practice Note 19: Seismic Resistance of Pressure Equipment and its Supports draws a comparison of applicable standards, structure classification and descriptions. These descriptions shall be read in conjunction with Tables 3.1 and 3.2 of AS/NZS 1170.0 when assessing a facility.

Note: Given the relative complexity, interdependence and interconnectivity of the assets within Watercare's network, the system as a whole is required to be considered when assigning Importance Levels to assets, rather than reviewing in isolation.

5.2.2 Asset types and design standards

Due to the wide range of Watercare assets, there are a number of standards designers are required to comply with, giving reference to design Importance Levels.

The primary infrastructure assets managed by Watercare, along with the relevant design standards and guidelines that give reference to Importance Levels, are summarised in Table 5.1 below. These assets can be grouped into three types, structural (buildings), structural (non-buildings) and non-structural.

Table 5.1: Asset types and relevant design standards / guidelines.

Asset Type	Asset Examples	Codes/Standards/Guidelines
Structural – Buildings Enclosed structure intended for occupation by people or infrastructure assets and services.	• Water pumping Station Building (Network/Transmission) • Wastewater Pumping Station Building (Network/Transmission) • Water Treatment Plant Buildings • Wastewater Treatment Plant Buildings • Headworks Buildings • Offices/Administration/Controls Buildings • Sheds, portacoms and enclosures	• New Zealand Building Code Clause A3 • AS/NZS 1170.0-5: Structural Design Actions
Structural – **Non-Buildings** Load bearing structures with the following primary functions: - Storage water or wastewater - Transportation of provision of access for people, vehicles and/or water assets - Enclosure or stabilisation on of property/land	• Storage tanks, reservoirs, clarifiers, digesters, odour control biofilters (concrete). • Bridges – Access and pipe bridge structures • Tunnels • Shafts, wells and chambers (below ground/partially buried) • Dams • Fences • Retaining Walls • Fixed Platforms, Walkways, Stairways, Ladders • Gantry cranes and davit cranes	• NZS 3106:2009 Design of Concrete Structures for the Storage of Liquids • NZSEE Seismic Design of Storage Tanks 2009 • WSL DP-14 – Standard for Transmission Water Pump Stations • Waka Kotahi Bridge Manual SP/M/022 – Third Edition, Amendment • NZSOLD Assessment of Dam Failure Consequence and Potential Impact Classification • WSL DP-02:2012 Guidelines on Dams and Water Retaining Embankments • AS/NZS 1170.0-5: Structural Design Actions • New Zealand Building Code Clause A3

Asset Type	Asset Examples	Codes/Standards/Guidelines

Non-Structural	• Water and wastewater pipeline systems
	• Water and Wastewater Treatment*:
	  ○ Rotating equipment and mixers
	  ○ Vessels & heat exchangers
	  ○ Screens and strainers
	  ○ Membrane filters, ultrafilters
	  ○ Separators, presses and decanters
	  ○ Boilers and calorifiers
	  ○ Biogas flares, treatment equipment and engines
	  ○ Conveyors and screw feeders
	  ○ Odour control biofilters (vessels)
	• Pumps*
	• Valves and penstocks*
	• Generators*
	• Transformers, Electrical Supply & Control Equipment*
	• Monitoring Equipment & Instrumentation*
	
	*Refer to Section **Error! Reference source not found.**. Importance Level is applicable to the building, foundation or structure that houses/supports the item.
		• AS4343:2014 – Pressure Equipment – Hazard Levels
		• Engineering New Zealand Practice Note 19: Seismic resistance of pressure equipment and its supports
		• AS1210:2010 Pressure Vessels
		• ESF-500-106 (water) – Design principles for pipelines over 250mm diameter
		• ESF-500-206 (wastewater) – Design principles for pipelines over 300mm diameter
		• ESF-500-STD-401: General Plant Layout and Equipment Selection Principals (this document)
		• NZS 4219:2009 - Seismic Performance of Engineering Systems in Buildings

Importance Levels applied to the seismic assessment of existing assets should be evaluated with caution as the original design intent may not have considered seismic risk to the same degree as the recommendations for new assets. Seismic assessment of buildings should refer to the latest building assessment guidelines with appropriate understanding of the consequential outcomes on the associated assets and potential disruption or environmental impact.

5.2.3 Factors influencing importance levels

5.2.3.1 For structures

Buildings/General Structures:

Tables 3.1 and 3.2 of AS/NZS 1170.0 defines the attributes of a structure that influence Importance Level and provides examples of facility types. Factors that influence Importance Level classification include:

- Size of structure
- Occupancy rates/risk to human life
- Contents within structure and function i.e. social or environmental consequences of damage/failure to this building
- Post-disaster requirements

Bridges:

Table 2.1 of the Waka Kotahi Bridge manual references AS/NZS1170.0 and notes the attributes of a bridge structure that influence Importance Level. Factors that influence Importance Level classification include:

- Size and location
- Transportation function
- Accessibility it is providing
- Occupancy rates/risk to human life
- Post-disaster requirements (redundancy of the system/network)

Storage Tanks/Reservoirs (above ground):

Above ground storage tanks in Watercare's possession are typically for treated water. The following factors influence Importance Level selection for these assets:

- Size of tank (consequence of failure)
- Proximity of tank/facility to adjacent property and consequence of failure
- Number of properties serviced by a reservoir
- Redundancy in the event of failure/being out of service for an extended period of time during which repairs may be required

Storage Tanks/Chambers (below ground):

Importance Levels for bespoke below ground chambers, wells and tanks are typically classified in accordance with the requirements of AS/NZS 1170, with the selection of the Importance Level being influenced by the size, function and redundancy of the system, as well as the ability to mitigate spilling into adjacent property (for wastewater systems).

Tunnels:

Importance Levels for tunnels are typically classified in accordance with the requirements of AS/NZS 1170, with the selection of the Importance Level being influenced by post disaster requirements, redundancy of the network, accessibility it is providing and the function of the tunnel (i.e. what it is being used to transport).

Dams:

Due to the relatively limited number of dams and them being complex/unique in shape/configuration, there is limited definition in the design standards (noted above) on Importance Levels for these assets. Generally, these are designed or assessed on a case-by-case basis with a site-specific hazard assessment and therefore should be considered as IL5.

A site-specific hazard assessment is typically designated to higher importance structures with unique configurations and/or a high-risk potential to be damaged by natural hazards (generally Importance Level 5 and Importance Level 4 assets with a 100-year design working life). This type of assessment often requires more rigorous design and assessment processes than more conventional code-based approaches and is undertaken by qualified professionals with specialised knowledge of the hazards.

Table 5.2: Asset examples for structural assets.

Description	Importance Level	Structural Criteria	Watercare Asset Examples
Low risk associated with human life, social, financial and environmental consequences	IL1	**Buildings/General Structures:** Small buildings/Structures not usually occupied and <30m^2 in floor area. Stand-alone fences and walls. Building not housing equipment of facilities that have higher Importance Levels.	Portacoms. Sheds, enclosures, isolated buildings. Stand-alone fences and signs. Retaining walls not directly supporting Watercare assets or utilities (with a higher IL designation).
		Tanks (Above Ground): Small, proprietary treated water tanks of low risk to adjacent property or the public in the event of failure.	Small, isolated proprietary treated water tanks where >24 hours loss of service can be accommodated.
		Bridges: Bridges where failure would not be likely to endanger human life and the loss of which would not be detrimental to post-disaster recover activities for an extended period.	Isolated bridges rarely used, not transporting utilities and/or providing access to critical infrastructure.
Medium risk associated with human life, social, financial and environmental consequences	**IL2**	Structures not included in Importance Levels 1, 3 or 4 Isolated buildings housing pumps or power supply serving a small population with redundancy in the system. Proprietary treated water tanks/reservoirs of moderate risk to adjacent property or public in the event of failure. Footbridges, Bridges with low volume/use and bridges not transporting utilities.	Regular buildings not housing utilities/services and/or not subject to crowding/congregation. Isolated buildings housing pump stations and/or electrical buildings serving <1,000 people and have redundancy to the system. Proprietary treated water tanks serving water to <1000 people and is repaired between 12-24 hours.

Description	Importance Level	Structural Criteria	Watercare Asset Examples
High risk associated with human life, social, financial and environmental consequences	**IL3**	**Buildings:** Facilities which house utilities not designated as post-disaster. Common facilities containing hazardous materials, capable of causing hazardous conditions that do not extend beyond the property boundaries. Facilities where more than 300 people can congregate in one area.	Buildings with open spaces where people can congregate (300 or more). Buildings housing treated water or wastewater utilities (tanks/ chambers/wastewater and water treatment plants/mechanical and electrical equipment) that are of IL3 designation and not required for post disaster functionality.
		Treated water Tanks/Reservoirs (above ground): Treated water tanks/reservoirs of serious risk to adjacent property or public in the event of failure.	Treated water tanks/reservoirs serving between 1000-10,000 people and requires repair within 8 hours.
		Tanks, chambers, wells (below ground)	Treated water tanks/chambers/wells with redundancy to the network/system. I.e. the system/network can remain functional with an alternative system if it fails in a major seismic event (or other natural disaster). Wastewater tanks/chambers/wells that have prevention measures in place to prevent spilling into neighbouring properties.
		Bridges	Bridges transporting utilities that aren't required for post disaster functionality i.e. where there is redundancy, allowing the broader network/system to remain functional with an alternative system if it fails in a major seismic event (or other natural disaster).

Description	Importance Level	Structural Criteria	Watercare Asset Examples
		Tunnels	Tunnels which transport utilities, rail and/or vehicle traffic where there is redundancy in the network. i.e. there is the possibility of redirecting utilities/transport/traffic if it becomes damaged following a seismic or other natural disaster event.
Very High risk associated with human life, social, financial and environmental consequences	IL4	**Buildings:** Buildings and facilities designated as 'essential facilities'. Buildings and facilities with essential post-disaster functions. Facilities which house hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries.	Buildings housing treated water or wastewater utilities (tanks/chambers/water and wastewater treatment plants mechanical and electrical equipment) that are of IL4 designation (Refer to **Error! Reference source not found.**). Facilities housing water supply and/or wastewater utilities that ensure the functionality essential services and where there is no redundancy (backup) in the network:
		Tanks/Reservoirs (above ground): Treated water tanks/reservoirs of extreme risk to adjacent property or public in the event of failure.	Treated water tanks/reservoirs serving >10,000 people and must remain fully operational post disaster event i.e. has no redundancy.
		Tanks, chambers, wells (below ground): Tanks/chambers/wells which are required to be functional after an earthquake.	Tanks, chambers, wells that house utilities with no redundancy to the network/system. i.e. the system/network cannot function with an alternative system if it fails in a major seismic event (or other natural disaster). Wastewater tanks/chambers/wells that have no prevention measures in place to prevent spilling into neighbouring properties.

Description	Importance Level	Structural Criteria	Watercare Asset Examples
		Bridges: Bridges of high importance to post disaster recovery.	Bridges housing water utilities and other critical infrastructure of IL4 designation. Bridges providing access to facilities of IL4 designation. Bridges transporting utilities that have no redundancy in the network. i.e. no alternative methods to enable the wider network/system to remain operational if they were to be damaged following a major seismic event (other natural disaster).
		Tunnels: Tunnels which are required to be functional after an earthquake.	Tunnels which transport utilities, trains and/or vehicles that have no redundancy in the network. i.e. no alternative routes to re-direct these following a major seismic event (or other natural disaster).
Catastrophic risk associated with human life, social, financial and environmental consequences	**IL5**	Structures that have special functions Structures whose failure poses catastrophic risk to a large area (>100km^2) or a large number of people (>100,000).	Major Dams Extreme Hazard Facilities

5.2.3.2 For non-structural

Water and Wastewater Pipeline Systems:

- Extent of economic significance the pipeline is servicing (local network vs transmission)
- Post event repair times and cost:
  - Downtime costs
  - Procurement of materials
  - Lead time for equipment/materials
  - Site accessibility
- Number of customers the pipeline is servicing
- Post disaster requirements
- Life Safety: water supply is essential for life (treated water) or serves a sanitation function (wastewater). Watercare have a register of households with dialysis users which can

factor into the resilience of local networks and may flow through to Importance Level decisions.

It is to be noted that water and wastewater pipeline systems have a pipe function classification scoring system, refer to ESF-500-STD-106 and ESF-500-STD-206 which covers Pipe Function Class 1 (Low Risk) to 4 (Essential Lifeline). This scoring system closely aligns with the Importance Level (1-4) scoring system regarding risk and will be referenced interchangeably.

Water Treatment Plant and Assets:

- Water treatment plants vary in size and output. Some of the smaller treatment plants can be offline for extended periods without significantly impacting Watercare's ability to supply their customers. The following factors should be considered:
- Number of customers impacted by failure
- Alternative methods of supply during failure
- Downstream storage
- The larger water treatment plants provide an essential function for life and are required to operate post disaster. Generally, any asset associated with the principal function of the plant, producing treated water with an essential post disaster function will be IL4, and for treatment plants serving smaller populations and/or where supply could be augmented from other sources after an earthquake, an IL3 classification may be sufficient.
- Some secondary functions within a water treatment plant, such as sludge dewatering can justify a lower Importance Level due to the ability to bypass the process or allowance for accumulation of secondary streams.
- Some vessels and pressure piping have an Importance Level impacted by the contents, pressures and volumes contained. Generally, Watercare doesn't have high hazard level pressure equipment. Chlorine gas for disinfection is classed as a very harmful gas which drives the Importance Level of associated equipment up.

Wastewater Treatment Plant and Assets:

- Wastewater treatment plants provide a vital function of sanitation for the communities they serve, but there can be allowance for emergency storage or short-term disruption in the upstream network. The allowance provided will dictate whether it is designated as IL3 or IL4.
- Disruption can have an environmental impact that should be considered e.g. sewer discharges to sea via the connected stormwater system.
- Some secondary functions within a wastewater treatment plant, such as biogas treatment and odour control, will have a lower Importance Level due to the ability to bypass the process, or due to having minimal impacts on the environment.
- As with water treatment plants, it is necessary to consider the contents, pressures and volumes of chemical vessels and pressure piping, but generally, the hazard level classifications will be low. The Importance Level is more likely driven by the process function.

Water Pump Stations:

- Pumps associated with network transfer of water are used to boost pressure and lift water from low elevations to higher elevations.
- Failure of some water pumps can lead to customers and parts of the network losing water supply.
- Failure of water pumps has a different impact on the network depending on their function.
- Local network booster pumps increase pressure to a contained area. Failure of these pumps can lead to either low pressure at customers or water outage, depending on the lift provided.
  - Pumps providing 15m or less lift will likely result in low pressures on failure
  - Pumps providing greater than 15m lift will likely result in customers going out of water on failure
- Transmission pumps act to move flow around the transmission network. Some are required to operate continuously to keep large parts of the city supplied. Others are designed to operate when the normal network operation cannot provide the flow required.
- Other factors that should be considered are:
  - Impact on the network of a failure
  - Back-up power
  - Availability of spares/replacement assets
  - Downstream storage

Wastewater Pump Stations:

- Pumps associated with the transfer of wastewater throughout the network. Wastewater pumps are split into two categories Local and Transmission.
- Failure of wastewater pumps will have less impact on customers than water pumps but will lead to spills of wastewater into the environment. Some customers adjacent to the wastewater pump station may be impacted by the failure.
- Transmission pumps typically pump flows greater than 78l/s (equivalent to approximately 7,500 people).
- Transmission pump station servicing over 10,000 people (equivalent 105l/s of flow) are considered significant (IL3 and 4).
- Some transmission pump stations are considered essential lifelines.
- Local network pump station generally supplies less than 7,500 people
- Other factors that should be considered are resilience:
  - Local storage
  - Back-up power
  - Availability of spares/replacement assets

Other Non-Structural Items within Watercare Assets

- These items are designed to codes and standards, or designed by manufacturer's proven techniques, where Importance Levels are not applicable to the design of the item. However, the function of the item within the process or plant may be what derives the Importance Level of the building, foundation or structure that houses the item.
- The Importance Level of the structural components within the connected system may also be driven by considerations such as resilience and consequence of failure of the item(s) or system.
- Examples of these items within Watercare's portfolio of assets includes:
  - Pumps
  - Valves and Penstocks
  - Generators
  - Transformers, Electrical Supply & Control Equipment
  - Monitoring Equipment & Instrumentation

Table 5.3: Asset examples for non-structural assets.

Description	Importance Level	Criteria	Watercare Asset Examples
Low risk associated with human life, social, financial and environmental consequences	**IL1** (Pipe Function Class 1 for Pipelines) (Hazard Level D, E for Pressure Vessels/Equipment where IL is <u>not</u> elevated by other factors)	**Local Water Pipeline Systems:** Pipework in local network area that service areas of negligible economic impact. Post event repairs can be extended for a significant time.	Pipeline in local network where the consequence of failure is a reduction in supplied pressure, but water can still be supplied.
		Local Wastewater Pipeline Systems: Pipework in the local network where failure will have negligible environmental impact or impact to people. Post event repairs can be extended for a significant time.	
		Water Pump Station Structural Elements: Pump station where the failure will cause low pressure to fewer than 50 residential properties.	Local network booster not essential to maintain water supply to customers.

Description	Importance Level	Criteria	Watercare Asset Examples
		Wastewater Pump Station Structural Elements: That have upstream catchments fewer than 50 residential properties.	Small local booster where the failure causes minimal impact to the local environment.
		Structural Elements Associated with, Valves or Pressure Equipment	Foundation or building for valves within a Watercare facility that is non-process critical.
		Structural Equipment Associated with Electrical Power Supply, Lighting and Control Equipment: Structural support or building housing utility switchboards. Light supports and structures supporting utility cable trays or conduits.	Utility power feed to non-essential asset e.g. structural supports for cable tray. Light pole for flood light.
Medium risk associated with human life, social, financial and environmental consequences	**IL2** (Pipe Function Class 2 for Pipelines) (Hazard Level C for Pressure Vessels/Equipment where IL is not elevated by other factors)	**Local Water Pipeline Systems:** Local Network mains larger than 150mm internal diameter, that if lost would result in unsatisfactory service disruption for 12 to 24 hours causing moderate economic impact.	Waterpipe serving a local network where a failure results in short term low pressures to fewer than 1,000 residential properties. Waterpipe serving a single reservoir and community of population fewer than 10,000.
		Local Wastewater Pipeline Systems: Local network mains larger than 225mm internal diameter network where failure will have negligible environmental impact or impact to people. Post event repairs can be extended for a significant time.	Wastewater line at the start of a transmission network serving a community of fewer than 10,000 properties.

Description	Importance Level	Criteria	Watercare Asset Examples
		Water Pump Station Structural Elements: Pump station where the failure will cause low pressure to fewer than 1,000 residential properties, or no water to 50 properties or fewer.	A local booster that serves a large area or is needed to keep a small number of properties supplied.
		Wastewater Pump Station Structural Elements: Local network wastewater pump station servicing 1,000 properties or fewer that will not impact an environmentally sensitive area on failure.	A local wastewater pump station servicing a small catchment.
		Water Treatment Plant Structural Elements and Principal Assets within: For Water treatment plants that aren't essential to supply the local area and be out for extended periods without impacting supply.	Water treatment plants where the area they supply can by supplied by another source if they fail. E.g. Pukekohe.
		Structural Elements Associated with, Valves or Pressure Equipment: Valves on a secondary process not essential to the main function.	Air valve chamber after a network pump station. Foundation or platform for sludge pump delivering from water treatment sludge tank to filter press.
		Structural Equipment Associated with Electrical Power Supply, Lighting and Control Equipment: Where monitoring equipment is not essential to the main function of the plant.	A jetty used to access and mount a turbidity probe on the final storage dam of a wastewater treatment plant. Used for monitoring resource consent compliance but will not stop the main process if it fails.

Description	Importance Level	Criteria	Watercare Asset Examples
High risk associated with human life, social, financial and environmental consequences	**IL3** (Pipe Function Class 3 for Pipelines) (Hazard Level B for Pressure Vessels/Equipment where IL is not elevated by other factors)	**Water Pipeline Systems (Transmission Network):** Transmission network pipelines servicing larger numbers of customers (>10,000 people) that if lost causes significant economic impact or substantial hazard to human life, the natural environment and properties.	Rising main from raw water pump station, which is part of a collection of sources, where the consequence of failure doesn't result in disruption for the Water Treatment Plant. Part of the Transmission Network with sufficient redundancy to maintain supply in the event of a failure.
		Wastewater Pipeline Systems (Transmission Network): Transmission network pipelines servicing larger numbers of customers (>10,000 people) that if lost causes significant economic impact or substantial hazard to human life, the natural environment and properties.	Wastewater transmission main serving a population of 10,000 or fewer properties, where failure will not have a large impact on the environment or flood neighbouring customers.
		Water Pump Station Structural Elements: Transmission pump stations that aren't used under normal operation of the transmission network.	Transmission boosters that are used to bolster supply during peak demand, like Triangle Road to the Albany to Pine Hill booster station.
		Wastewater Pump Station Structural Elements: A transmission pump station that has adequate emergency storage or where overflows will flood neighbouring properties or adversely impact the local environment.	A transmission wastewater pump station near residential properties or an environmentally sensitive area.
		Structural Elements Supporting a Wastewater Treatment Plant: Process-critical asset at a facility that can tolerate short term disruption.	A biological nutrient removal decanter structure at a large wastewater facility where there is some emergency storage upstream, redundancy within BNR tanks, or accumulation available in a storage dam.

Description	Importance Level	Criteria	Watercare Asset Examples
		Water Treatment Plant Structural Elements and Principal Assets within: Treatment plants or plant assets that can be out for short periods without impacting supply to customers.	A treatment plant where the area supplied can be supplied from another source temporary while repairs the plant are carried out.
		Pressure Equipment Support Elements and Chemical Piping: Chemical dosing piping and support structures or clean-in-place chemical piping for membrane filters.	A sulfuric acid CIP line (very harmful liquid) operating at design pressure of 12.5 Bar in a DN50 pipe is situated at a WWTP membrane filtration facility for final stage water polishing. Pipe is Hazard Level E → IL1. The final IL of the pipe and its supporting elements are elevated due to the function of the CIP pipe – ensuring membrane filtration operation in an IL3 plant. Also, loss of containment could result in harm to personnel or the environment.
		Structural Elements Supporting Pumps and Valves	Buildings, wells and foundations supporting pumps and valves associated with a transmission pipeline that is classed as IL3.
		Structural Elements for Standby Generator	Foundations for a standby generator at an IL3 pump station or treatment plant that mitigates power disruption after an earthquake.
		Structural Elements for Monitoring Equipment:	A flow meter chamber at the final stage of a water treatment plant that controls a main pump or has a critical function in the dosing of chlorine or fluoride.

Description	Importance Level	Criteria	Watercare Asset Examples
Very High risk associated with human life, social, financial and environmental consequences	**IL4** (Pipe Function Class 4 for Pipelines) (Hazard Level A for Pressure Vessels/Equipment)	**Wastewater Pipeline Systems (Transmission):** Transmission and local network pipelines that are essential to maintain service post natural disaster and are intended to remain in service.	Large wastewater pipes where failures will lead to large amounts of wastewater flooding residential properties or being dumped into environmentally sensitive areas. Large wastewater rising mains running near to or under public properties or critical customers.
		Water Pipeline Systems (Transmission and Local)	Water treatment plant transmission piping where the consequence of failure could result in lack of drinking water for over 10,000 properties for an extended period. Local water pipelines and any upstream critical path transmission pipelines feeding these that service: • Fire stations • Police stations • Emergency vehicle garages and shelters. • Hospitals and other healthcare facilities with surgery or emergency treatment functions. • National defence facilities. • Aviation control towers, air traffic control centres, emergency aircraft hangars. • Emergency backup facilities
		Water Pump Station Structural Elements: Transmission pump stations that are critical to supply large areas numbers of customers where failure could mean large number of customers running out of water.	Transmission pump stations that are critical to provide water to large areas of Auckland, such as the New Lynn Pump Station.

Description	Importance Level	Criteria	Watercare Asset Examples
		Wastewater Pump Station Structural Elements: Transmission pump stations where there is inadequate storage or overflowing will flood neighbouring properties or environmentally sensitive areas, or critical infrastructure.	Transmission pump stations where failure will lead to large quantities of wastewater overflowing into the environment, such as PS 64. A pump station adjacent to a: • Fire station • Police station • Emergency vehicle garage and shelter. • Hospitals and other healthcare facilities with surgery or emergency treatment function. • National defence facilities. • Aviation control towers, air traffic control centres, emergency aircraft hangars. • Emergency backup facilities
		Water Treatment Plant Structural Elements and Principal Assets within: Major treatment plant serving large community that is essential to maintain service post disaster event (single point of failure). IL is defined for structural elements supporting essential process equipment within plant.	Structural elements supporting equipment within Treatment plants, where the plant would have a major impact on sanitation or potable water supply post natural disaster, and services some of the facilities listed above.

Description	Importance Level	Criteria	Watercare Asset Examples
		Structural Elements Supporting Pressure Equipment and Chemical Piping: Large Vessels or Power Boilers vessels with critical functions for the process or for storing very dangerous liquids or gases. Chemical dosing piping or clean-in-place chemical piping for membrane filters, essential to the function of the plant.	10 m^3 Chlorine pressure vessel (very harmful gas) at 10 Bar is Hazard Level B → IL3. The final IL is elevated due to the function of the dosing system – ensuring water quality in IL4 plant. The IL is applied to the vessel shell design and structure supporting the shell. An HFA dosing line (very harmful liquid) operating at design pressure of 12.5 Bar in a DN50 pipe is Hazard Level E → IL1. The final IL is elevated due to the function of the dosing pipe – ensuring water quality in IL4 plant. The IL is applied to the pipe occasional loading design and pipe support structures.
		Structural Elements, Valves and Penstocks	Valves and penstocks that are part of the main process system if an IL4 facility. The IL is applied to foundations, supports and structure mounting the items.
		Structural Elements for Back-up Generator	Back-up generator serving an IL4 facility. The IL is applied to foundations and building housing the generator.
		Structural Elements for Transformers, Electrical Supply and Control Equipment	A transformer or electrical supply / control components that are process critical for an IL4 facility. The IL is applied to transformer foundations, switch room and MCC buildings, and support frames for electrical conduits and cable trays.

5.2.4 Hazard levels of assets

AS4343 applies to pressure equipment such as pressure vessels and piping under pressures greater than 50kPa.

Because Watercare's dangerous chemicals are mostly stored in tanks (covered by Hazardous Substances Regulations), AS4343 would typically be applied to pressurised chemical dosing or clean-in-place pipe systems. These pipelines are usually of small diameters (less than 100NB) and relatively low pressure (less than 10Bar), so the hazard level is typically E.

All Watercare's water and wastewater pipe systems will also be hazard level E.
In general, the Importance Level of pressure equipment will be driven by the function rather than the hazard level.

5.3 Tanks outside buildings

a) Refer to Section 5.7 below for pressure vessels.
b) Seismic design of tanks should comply with either:
- Seismic Design of Storage Tanks (New Zealand Society for Earthquake Engineering), or
- API 650 - Appendix E; except that:

The earthquake loading coefficients should be derived from the seismic loading spectra specified in NZS 1170.5 with corrections for damping levels appropriate to storage tanks as follows:

$$\boldsymbol{C_d(T_i) = C_h(T_i,\mu).Z.R.N(T_i,D).S_p..DF/k_\mu}$$

Where:

	$C_d(T_i)$	=	horizontal design action co-efficient for response mode i
	$C_h(T_i,\mu)$..	=	spectral shape factor for structural period T_i
	Z	=	hazard factor
	R	=	return period factor (either R_s of R_u for the appropriate limit state under consideration. See below)
	$N(T_i,D)$	=	Near fault factor (assume = 1)
	T_i,	=	period of vibration for response mode i
	S_p	=	structural performance factor (assume = 1)
	k_μ	=	inelastic spectrum scaling factor
	μ	=	displacement ductility factor (assume = 2)
	DF	=	Damping Correction Factor (see below)

c) **Risk factor R**. When selecting which state applies to individual parts, consider equipment/tanks designated as post disaster or essential for operational continuity:
Serviceability Limit State SLS1: $R_s = 0.25$
Serviceability Limit State SLS2:
i. Equipment/tanks essential to operational continuity after SLS2 earthquake: $R_s = 0.75$
ii. Other equipment: SLS2 not required to be considered.

Ultimate Limit State:

i. Equipment/tanks designated as post disaster: R_u = 1.8
ii. Equipment/tanks containing hazardous materials capable of hazardous conditions beyond the boundary: R_u = 1.8
iii. Equipment/tanks part of the treatment process: R_u = 1.3
iv. Other equipment/tanks: R_u = 1.0

d) **Damping Correction Factor DF.** The NZS 1170.5 spectra are based on 5% viscous damping. For other damping values, the following correction factors in Table 5.1 shall be used.

Table 5.1: Dampening correction factors outside the NZS 1170.5 spectra range of 5%

% Critical Viscous Damping	Correction Factor DF
0.5%	1.75
2%	1.33
5%	1.00
10%	0.80
15%	0.71
20%	0.67

For the convective mode, the appropriate value of damping is 0.5%. For the impulsive mode, refer to Seismic Design of Storage Tanks (New Zealand Society for Earthquake Engineering), or API 650 - Appendix E.

e) Tank materials shall satisfy to provisions of the appropriate material supply standard, except where these conflict with the requirements above.

5.3.1 Specific earthquake analysis

a) For all structures exceeding 10m in height, or T1 > 0.4sec or, T1 > 2sec and regular in accordance with NZS 1170.5, a dynamic analysis shall be carried out to determine the following:
- The degree of ductility demand on the yielding elements.
- The acceleration of equipment attached to the vessel.
- The structural separations required for connection bridges and appurtenances.

5.4 Seismic loading coefficient

Seismic loading shall be determined using NZS 1170.5. The relevant loading spectrum for the site subsoil shall be confirmed.

5.5 Equipment supported by building structures

a) In general, equipment seismic loadings will be larger the higher in the building the equipment is located, because earthquake induced accelerations in a structure increase with height.

b) Equipment fixed to the building structures with connections generally have little or no ductility capability and shall be designed to NZS 4219 “Seismic Performance of Engineering Systems in Buildings”. The design shall be dependent on:
- Basic seismic coefficient for the structure.
- Height of the centre of mass of the structure relative to the equipment.

- Whether the structure has been designed to be ductile.

c) When the equipment mounting is ductile, the seismic coefficient shall be modified in accordance with NSZ 1170.5 and NZS 4219.

5.6 Free standing equipment

a) Most items will have no provision for ductility. These shall be designed to remain elastic under the earthquake loading and will have seismic coefficients depending on the natural period of vibration.

b) Items with ductility capability may be designed with the lower seismic forces with consequent saving in structure and foundations.

5.7 Pressure vessels

The design seismic coefficient for pressure vessels shall be determined in accordance with Engineering NZ practice note 19 “Seismic resistance of pressure equipment and its supports”.

6. Specific materials considerations for processes

6.1 Introduction

a) This section shall be read in conjunction with the relevant sections of the Health and Safety at Work (Hazardous Substances) Regulations 2017 (e.g. Part 17, Subpart 13 – Pipework)
b) This part shall be read with the Watercare Material Supply Standard (ESF-500-STD-601) and shall take precedence where in discrepancy with MS as to convey the specific requirements for process plants.
c) Materials and equipment must be specified to meet performance, construction, quality, space, and structural loading requirements.
d) Pressure rating selection is in accordance with the design needs, but consideration should be given to common stock-keeping of spare parts to provide maintenance flexibility through common selection.
e) Materials must be compatible with other materials and equipment and must be corrosion resistant.
f) All material components must be specified except for incidentals that may be reasonably expected to be supplied as part of the installation. However, these must be verified to be of industrial standard and fit for purpose in the installation environment.

6.2 Materials that may not be used

The following materials may not be used in any part of equipment or design:

- Cadmium or cadmium plating
- Chromium plating
- Untreated exposed copper or copper-based alloys (the exception of copper busbars and cabling exposed ends which shall be tin plated)
- Electroplated zinc coated carbon steel.
- Asbestos
- Cupronickel
- PCBs or other similar hazardous materials

6.3 Piping systems

a) Refer to the Health and Safety at Work (Hazardous Substances) Regulations 2017, Part 17: Subpart 13 – Pipework)
b) Pipe materials for process works shall in general comply with ASME B31.3, ASME B31.4, or AS 2885.1.

6.3.1 Mild Steel (MS)

a) Mild steel pipe shall comply with AS 1579 (NZS 4442).
b) Steel tube or tubulars shall comply with BS EN 10255 Non-alloy steel tubes suitable for welding and threading, in medium weight, or heavier if service conditions require.
c) Galvanised pipework shall be steel tube or tubulars and shall comply with BS EN 10255 in medium weight, or heavier if service conditions require.
d) Galvanised pipes shall not be used for pipework with a diameter greater than 100 mm.

6.3.2 Stainless Steel

a) Grade 316L or Grade 316 stainless steel pipe and fittings.
b) Stainless steel pipe shall comply with ASTM A312M-13b.
c) Spiral wound tubing shall not be used.
d) Line pipe shall be minimum schedule 10.

6.3.3 Ductile Iron

a) Ductile iron pipework shall comply with AS/NZS 2280 (Pressure pipe), BS EN 598:2007 +AS1, BS EN 545 and BS EN 969.
b) Pipework shall be light cement mortar lined, unless specified otherwise.
c) All pipework shall be Class K9 except for flanged pipework which shall be Class K12, unless otherwise specified.

6.3.4 Polyvinyl Chloride (PVC)

a) Pipe shall be manufactured to AS/NZS 1477 (Pressure pipe), AS/NZS 1260 or AS/NZS 1254 (Drain pipe) as appropriate for the service and duty.
b) PVC must not be used on pressure systems (only gravity lines) except for chemical dosing systems or as otherwise approved.
c) Thermal expansion using expansion loops, or another proprietary device as required must be considered.

Note: PVC pipe must be either covered or protected with a coating system from direct sunlight.

6.3.5 Acrylonitrile Butadiene Styrene

a) ABS: Acrylonitrile Butadiene Styrene pipework shall comply with AS/NZS 3518.
b) ABS pipework shall be suitably rated for the design service, but as a minimum Class 9 shall be used.
c) The pipework shall be installed in accordance with AS IEC 60300.2.
d) Thermal expansion using expansion loops, or another proprietary device as required must be considered.

Note: ABS pipework must not be used for pressure systems or sludge applications.

6.3.6 Polyethylene

Note: PE pipe must be either covered or protected with a coating system from direct sunlight. UV protection is limited to short term resistance only.

As per the Material Supply Standard

a) Thermal expansion using expansion loops, or another proprietary device as required must be considered.

6.3.7 Fibre Reinforced Plastic

a) Fibre reinforced plastic pipes shall comply with AWWA C950, AWWA M45 and PD ISO/TR10465-2 as appropriate.

Note: Fibre reinforced plastic pipes must not to be used for pressure applications.

6.3.8 Hose

a) Hose for process pipework shall be textile reinforced rubber, Dunlop D214 or equal.
b) Hose material shall be suitable for the operating pressure.
c) Hose for wash down purposes shall be GEM type or equal.
d) Reels for hose storage shall be fabricated from stainless steel and be supplied with 10 metres of 32 mm diameter hose (PVC).
e) Gate valves are preferred for flow control of hoses.
f) Flow shall be controlled at the downstream end by use of a proprietary nozzle allowing adjustment from jet through spray to stop.

6.3.9 Subsoil Drainage

Subsoil drainage pipes shall be class D PVC-U to Transit New Zealand F2 (PN12) or heavy wall (SDR 17) polyethylene. This is equivalent to SN16 rating.

6.4 Pipe fittings

6.4.1 General

Unless otherwise specified, the fitting materials and ratings shall be the same as the adjacent pipe material and the related standard.

6.4.2 Stainless steel and mild steel

a) Fittings may be fabricated from the same grade of steel as the adjacent pipe with the same coating and lining material. Refer to the mechanical construction standard for the appropriate welding practices.
b) Mild steel wrought pipe fittings for steel tube (including galvanised) shall comply with BS EN 1024 heavy weight.
c) Stainless steel wrought pipe fittings for tube shall comply with ASTM A403M – 19a.

6.4.3 Polyvinyl chloride (PVC) and acrylonitrile butadiene styrene (ABS)

a) PVC fittings should be injection moulded.
b) Fittings must have the same pressure rating than the adjacent pipe.
c) Special manufactured pieces should be avoided and must be approved on a case-by-case basis.
d) Fittings shall be double socket.
e) All isolating valves 50 mm and smaller shall be double union ball valves with PVC body and ball and with PTFE ball seats and seals, or as appropriate for the fluid and duty. Check valves shall be of a similar specification. Valves greater than 50 mm shall be flanged unless noted otherwise.
f) Enough additional union couplings shall be provided in the pipeline to facilitate removal for maintenance or replacement.

6.4.4 Concrete

a) Prefabricated RC pipe fittings shall be factory fabricated by the pipe manufacturer.

6.4.5 Vitrified clay

a) Moulded VC fittings shall comply with BS EN 295-1 and shall be as manufactured by the manufacturer of the adjacent pipe.

6.5 Jointing selection

6.5.1 General

a) The method of jointing of pipes, valves and fittings shall be specified by the designer.
b) All connections over 50mm shall be flanged or welded.
c) The number of joints must be minimised but keeping in mind to facilitate the removal for maintenance or replacement of sections and key fittings.

6.5.2 Steel welding

Steel welding must follow the Mechanical Construction Standard and may include:

- Arc welding
- Oxy acetylene welding

6.5.3 High Density Polyethylene (HDPE)

a) Refer to the material supply and general civil construction standards for typical jointing methods.
b) Butt-weld shall take precedence over electrofusion welding or other mechanical means of jointing.

6.5.4 PVC

a) Below ground installations should be ring jointed and mechanically coupled. For below ground installations refer to the general civil construction standard.
b) Above ground installations may be solvent welded, and union coupled.
c) Solvent weld joints shall:
    - Be made with pressure grade solvent cement (and associated primer and cleaners) to the manufacturer's method.
    - Have the socket pushed over the spigot and rotated a quarter to a half turn to ensure the full depth is reached. Witness marks should be made.
    - Excess cement must be removed from both internal and external surfaces.
    - Not be disturbed for a minimum of 5 minutes after being made.

6.5.5 Flanges

Note: On existing sites, the flanges should be selected to the same standard of most existing flanges, e.g. if the site has mostly ASME flanges, then the appropriate rated ASME flanges should be selected for the new installation.

a) Flanges should typically be selected as per the flange patterns nominated in the material supply standard and assembled in accordance with the general mechanical construction standard.
b) All galvanised surfaces in contact with stainless steel shall be isolated and coated or painted to provide protection against galvanic corrosion.

c) Machined flange faces shall be coated with a suitable soluble lacquer for corrosion protection during storage only and must be cleaned on assembly.
d) Flange jointing sets shall include all bolts, nuts, washers and flange gaskets or insertions necessary for jointing together the flanges of the specific diameter and pressure rating.
e) Flanged joints shall be made with bolt sets, bolt studs with nuts on each end, or studs with nuts where the flange is tapped.
f) The gasket material must be selected suitable to contact with the conveyed media and operational duty.

6.5.6 Flexible couplings

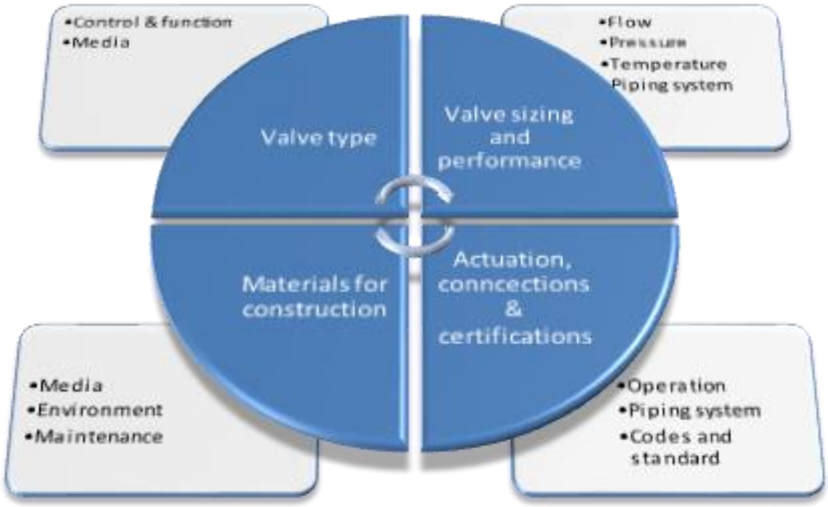
a) Rubber ring joints shall be of suitable material for the contact with the media being conveyed and the operational duty. Rubber rings may not be reused.
b) Victaulic fittings may be considered in process plants where the joints are visible, not be buried, and must be of suitable material selection to not cause galvanic action and be suitable for the conveyed media. The following shall apply for the use of Victaulic fittings:
    - Fittings shall only be installed with prior agreement from operations and plant managers.
    - Fittings must be installed to the supplier's methodology using the brand specific grooving tools where applicable.
    - When preparing the pipe for grooving, ensure that no ferrous contamination occurs between the grooving equipment and pipe. The grooving equipment needs to be clean and appropriate for the pipe material specified.
    - The coupling seal must be suitable for contact with the conveyed media and operational duty.

6.5.7 Pressed-fit couplings

a) Pressed couplings must be installed to the supplier's methodology using brand specific proprietary pressing tools.
b) The rubber seal ring must be selected suitable for contact with the conveyed media and operational duty.

6.6 Valve selection

a) Valve type selection – (graph: application (grey) and attributes(blue)):



b) Waterworks valves with ductile iron body material as described in the materials supply standard are suitable for mainstream water application throughout the processes but may not be suitable for some chemical process systems.

c) For mainstream valves carrying slurries the abrasiveness of the media must be evaluated to ensure correct sealing mechanisms and any additional lining methods are specified.

d) When selecting waterworks valves for mainstream purposes consideration must be given to the micro location of the valve to ensure suitable external coating selection above what is standard provision from the manufacturer. Considerations may include solvents, volatile organic compounds, or inert gasses. The additional coating specification must be specified following the direction provided in the material supply standard for corrosion protection.

e) Industrial valve standards apply as follows as may be appropriate for the media:

Standard	Standard description
ASTM B61	Standard specification for steam or valve bronze castings
ASME B16.33	Manually operated metallic gas valves for use in gas piping systems up to 125 psi
ASTM F1794	Standard specification for hand-operated, globe-style valves for gas (except oxygen gas) and Hydraulic systems
ISO 9393-2	Thermoplastics valves for industrial applications
ISO 7508	Un-plasticized Polyvinyl Chloride (PVC-U) valves for pipes under pressure
ISO 19240	Industrial valves – Lines metal quarter turn and check valves for chemical process and related industries
BS EN 1984	Industrial valves Steel gate valves
EN 593	Industrial valves Metallic butterfly valves for general purposes
BS EN 12288	Industrial valves. Copper alloy gate valves
BS EN 1983	Industrial valves. Steel ball valves

f) Depending on the media transported through the valve, the valve lining must be specified appropriate to the application and may include but is not limited to:

Material	Property considerations
Soft natural rubber	Good in either wet or dry abrasive services, water, and some acids and alkalis. Soft natural rubber has one of the best abrasion resistances when strong chemicals are not present. Temperature -30 to 80°C
Hard rubber	Hard rubber is a good general chemical resistant lining that can be used in slightly higher temperatures than its soft counterpart. Temperature -30 to 90°C
GRAPHITE BASED HARD RUBBER	Graphite hard rubber has a good chemical resistance and at higher temperatures than the normal hard and soft natural rubbers. Maximum temperature 120°C
EPDM: (Ethylene Propylene Diene Monomer)	General purpose material. Excellent chemical resistance to a wide variety of corrosive elements including acids, caustics and hot water. It is abrasion resistant and good for high temperature services. EPDM has poor oil resistance. It is also satisfactory for intermittent steam sterilization. Temperature range -30 to 150°C
Neoprene	Widely used in wastewater applications. A good choice for general purpose chemical resistance where the media contains entrained oils. It also resists aldehydes, certain alcohols, fertilizers, explosives, petroleum, air, acids alkalis, and is abrasive resistant. In most cases it is interchangeable with Buna-N (Nitrile) Rubber. Temperature range -30 to 90°C
BUNA--N: (Nitrile Butadiene Rubber)	A general-purpose oil resistant polymer known as nitrile rubber. It is a copolymer of butadiene and acrylonitrile. Buna-N has a good solvent, oil, water, and hydraulic fluid resistance. It displays good compression set, abrasion resistance, and tensile strength. Nitrile should not be used in highly polar solvents such as acetone and methyl ethyl ketone, nor should it be used in chlorinated hydrocarbons, ozone, or nitro hydrocarbons. In most cases it is interchangeable with Neoprene. Maximum temperature 135°C
Butyl	A good choice for gases because it has a very low vapor and gas permeability. Also good for many acids and alkalis. Good for applications involving steam sterilization. Temperature -28 to 120°C
Chlorobutyl	Chlorobutyl has excellent abrasion and corrosion resistant properties. The maximum recommended temperature for Chlorobutyl is 80°C
Polypropylene	A general-purpose lining with good chemical and temperature resistance. Utilized for water treatment, chemical processing, most plating fluids, and steel mill pickling lines, foodstuff, and drinking water. Temp: -20 to 90°C
ECTFE (HALAR): (Ethylene Chlorotrifluoroethylene)	Excellent wear and abrasion qualities, excellent corrosion resistance, low coefficient of friction, and excellent electrical properties. Maximum use temperature 175°C
ETFE (TEFZEL): (Ethylene Tetrafluoroethylene)	Outstanding resistance to chemicals and strong acids. Also has high abrasion resistance for tough services. Below 175°C has no known solvent.
PTFE (XYLAN): (Polytetrafluoroethylene)	Good wear resistance, low coefficient of friction, and fair corrosion resistance. Use Temperature 230 - 260°C
PFA: (Perfluoroalkoxy)	Good wear and abrasion qualities, excellent corrosion resistance, low coefficient of friction, and excellent release capabilities. Max use temperature 270°C
PVDF (KYNAR): (Polyvinylidene Fluoride)	Offers very low permeability. A strong, tough abrasion resistant fluorocarbon material resistant to most acids, bases, and organic solvents. It is ideally suited to handling wet or dry chlorine, bromine, and other halogens. Temperature -20 to 135°C.
FEP: (Fluorinated Ethylene Propylene)	Good wear and abrasion qualities, excellent corrosion resistance, low coefficient of friction, and excellent release characteristics. Max use temperature 200°C
Viton	Offers exceptional resistance to oils, most chemicals and many solvents at elevated temperatures. It can be used in most applications involving mineral acids, salt solutions and chlorinated hydrocarbons. Viton is not recommended for ammonia, its derivatives or polar solvents, e.g. Acetone. -28 to 150°C

Material	Property considerations
Blue glass (CHEM)	Intended for viscous chemical applications such as wastewaters where a smooth lining is necessary to prevent process media from sticking to the walls of the valve.
Green glass (NON-CHEM)	Intended for non-chemical applications such as wastewaters where a smooth lining is necessary to prevent viscous fluids from sticking to the walls.
Polyurethane	Polyurethane has excellent abrasion resistance (-30 to 65°C)
FDA epoxy	Good wear and abrasion qualities, good corrosion resistance. Max use temperature 100°C.
PVC	PVC has resistance to a variety of chemicals including oxidizing acids and provides excellent abrasion resistance. Max use temperature 70°C.

6.7 Fixings and brackets

- Fixings and restraints shall ensure that the equipment withstands seismic loading without excessive stress or displacement, in accordance with the NZ Building Code and NZS 4219.
- Electrical equipment and instrumentation must not be fixed to handrails or pipework.
- Sensor lines should allow for vibration (e.g. coiled pipe) or additional slack for movement.
- Also see section 9 on corrosion control. Care must be taken when selecting dissimilar materials to prevent galvanic action.

6.8 Dose pumps

a) Chemical dosing pumps shall be a positive displacement type.
b) Minimum turndown of 100:1.
c) Power supply shall be single phase.
d) The pumps shall be capable of providing a flow rate as defined in the data sheets that must be provided during design.
e) Dosing pumps shall have an analogue input for pump speed control, a stop/start input and a fault signal.
f) Dosing pumps shall be standardised throughout the site where practicable.
g) The pumps shall provide accurate and controllable dosing of each chemical.
h) All wetted materials shall be appropriate for contact with the chemical being pumped.
i) Dosing pumps shall be able to pump degassing liquids such as sodium hypochlorite. Auto degassing features may be permissible if suitable for the application.
j) Appropriate connection joints from the dosing pump to the suction and discharge pipework shall be included.

6.9 Corrosion control

a) When selecting corrosion control measures, consideration must be given to the micro location of the assets to ensure suitable external coating selection above what is standard provision from the manufacturer.
b) Considerations may include solvents, volatile organic compounds, or inert gasses from adjacent processes that may impact on the corrosion of the assets in another area.
c) Internal corrosion protection for specific media must be considered.

The coating specification of any additional corrosion protection measures must be specified following the direction provided in the material supply standard for corrosion protection.

Appendix A: IL determination flow chart

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