Standard for

Transmission Water Pump Stations

DP-14

Ver. 0.1

Date: 22 June 2018

Revision	Description	Released by	Date
0.1	Working draft for comment	J de Villiers	22/06/2018

Reviewed by:

Table of contents

GLOSSARY: TERMS AND ABBREVIATIONS 5

PART A – PRELIMINARY AND GENERAL REQUIREMENTS 6

1. INTRODUCTION 7

2. REFERENCED STANDARDS 7

2.1 WATERCARE STANDARDS 7
2.2 NATIONAL AND INTERNATIONAL STANDARDS 7
2.3 OTHER PUBLICATIONS 8

3. DESIGN DELIVERABLES 8

4. CRITICALITY AND INFRASTRUCTURE FLEXIBILITY PRINCIPLES 9

4.1 DESIGN LIFE 9
4.2 FUNCTION CLASSES AND CRITICALITY 9
4.3 RESILIENCE AND REDUNDANCY 9
4.3.1 Resilience measurements {Table based on the IIMM, 2015 example table 3.2.8} 9
4.3.2 Scoring 10

5. RISK 10

6. SAFETY AND HAZARD MITIGATION 11

6.1 SAFETY IN DESIGN GUIDELINES 11
6.2 SAFETY IN FACILITIES DESIGN GUIDELINES 11

7. DESIGN PROCESS FOR TRANSMISSION PUMPING STATIONS 12

8. PUMP STATION PLANNING CONSIDERATIONS 14

9. DESIGN OUTPUT FORMAT 14

10. PUMPING STATION SITE 15

10.1 SITE GROUND CONDITIONS 15

11. GENERAL DESIGN CONSIDERATIONS 17

12. DESIGN REVIEW 17

13. CONSTRUCTION 18

14. PUMPING STATION ASSET DATA 18

15. TESTING AND HANDOVER 18

15.1 COMMISSIONING 18
15.2 REJECTION OF MATERIALS OR PRODUCTS 19
15.3 HANDOVER DOCUMENTS 19

PART B – PUMP STATION LAYOUT AND SPECIFIC DESIGN REQUIREMENTS 20

1. GENERAL CONFIGURATION 21

2. MATERIAL SELECTION 22

2.1 PIPEWORK 22
2.2 INLET STRAINERS 22
2.3 VALVES 22
2.3.1 Isolation valves 22
2.3.2 Non-return valves 22
2.3.3 Pump bypass valves 22
2.3.4 Air release valves 22

3. PUMPING SYSTEM 23

3.1 HYDRAULIC DESIGN 23
3.2 PUMP SELECTION 23

4. PUMP STATION OUTLET 24

5. RISING MAINS 24

5.1.1 General 24
5.1.2 Hydraulic design 24
5.1.3 Pipe Material 25
5.1.4 Rising main levels 25
5.1.5 Combined rising mains 25
5.2 RISING MAIN SCOUR AND ISOLATION POINTS 25

PART C – ELECTRICAL, CONTROL AND TELEMETRY 26

1. ELECTRICAL, CONTROL AND TELEMETRY 27

1.1 ELECTRICAL 27
1.2 CONTROL SYSTEM AND TELEMETRY 27

PART D – INFRASTRUCTURE AND SUPPORT SYSTEMS 29

1. WATER SUPPLY 30

2. LIGHTING 30

3. SITE DRAINAGE 30

4. NOISE CONTROL AND VIBRATION 30

5. LIFTING EQUIPMENT 30

6. VENTILATION 31

7. SECURITY AND ACCESS LIDS 31

8. SIGNAGE 31

9. SITE ACCESS ROAD 31

Glossary: Terms and abbreviations

Accept(ance)	a sign-off by Watercare that it is in general agreement with a proposal. This sign-off does not transfer the designer's liability to Watercare.
BEP	Best efficiency point, typically at about 85% of the pump shut-off head. This is the pump design point.
DN	Nominal metric diameter designation conforming to the International Standards Organization.
ΣDDT	Trichloride-2,2-bis(*p*-chlorophenyl)ethane, synthetic organic compound used as an insecticide.
FD	Functional description completed to Watercare's template
Head	Measure of liquid surface elevation.
H&S	Health and Safety.
kPa	Kilo-Pascal.
LIM	Land Information Memorandum.
l/s	Litres per second.
NES	National Environmental Standard.
PS	Pumping Station.
CS1, CS2, CS3, CS4	Watercare engineering compliance statements for design and construction.
PN	Nominal internal pressure that a component can safely withstand.
P&ID	Piping and instrumentation diagram.
Rising main	Pressurised water pipe through which water is elevated to a point of supply.
SCS	Soil contaminant standard.
VOC	Volatile organic compound.
WGS84	World geodetic system. WGS84 is the latest reference coordinate system used by global positioning systems (GPS).

Part A – Preliminary and general requirements

1. Introduction

Design and construction of pumping stations need to be completed by competent persons to the minimum requirements as set out in this standard.

This standard covers the planning, design and construction requirements for water pump stations to transfer water from storage to another storage location or to boost system pressure.

The electrical standards and control templates are available separately and shall be read in conjunction with this standard. Watercare's telemetry requirements are location based and require input from Watercare to identify the applicable standards and/or site requirement at the pump station site.

2. 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 Watercare standards

- DP-07 Design principles for transmission water and wastewater pipeline design
- DP–10 Safety in Design guide
- DP-11 Watercare, 2017. Health and Safety in Facility Design
- DP-12 Architectural design guidelines
- 7363 – Watercare CAD manual
- AI - Data and Asset Information standard[1]
- MS – Material supply standard
- DP-09 Electrical design standard
- DW18 - Pump station electrical drawing set
- DW04 – Water pump station drawings for networks
- DW06 – Access structure drawings for water infrastructure
- CG – General civil construction standard
- ME – General mechanical construction standard
- EC - General electrical construction standards
- COP-03 Code of Practice for commissioning

2.2 National and international standards

NZS 1170 Structural design actions

Part 5 Earthquake actions – New Zealand

Part 5 Supp 1 earthquake actions – New Zealand - Commentary

NZS 3101 Concrete structures

AS 3996 access covers and grates

[1] At the time of publication, the referenced standard is still under review and will take affect once published.

AS/NZS1657 Fixed platforms, walkways, stairways and ladders. Design, construction and installation AS 1418

AS 1418 Cranes, hoists and winches

AS 4991 Lifting devices

AS/NZS 3000 Wiring rules

2.3 Other publications

Roberts, R, New Zealand Geotechnical Society, 2017, New Zealand Ground investigation specification, Volume 0, 1, 2 and 3

Worksafe NZ, Approved Code of Practice for cranes

3. Design deliverables

Design work shall be completed by Chartered Professional Engineers or a suitably qualified engineer who have their work reviewed by a Chartered Professional Engineer in accordance with the Watercare compliance statement policy. Any design produced may be subjected to review by a Chartered Professional Engineer.

The designer must consider the design under the full operational requirements and apply good engineering practice that reflects:

- Compliance with New Zealand legislation, the most recent national standards, regulations and local conditions
- Watercare standards as included and referenced in this standard
- Historical information that may impact on the design
- Community and customer expectations
- Other information or specific conditions as provided by Watercare

The design shall not imitate or amend a current approved Watercare standardised design. Specific design drawings shall cross-reference the standard Watercare design and constructions standards.

The following comprehensive documents shall be provided to Watercare for evaluation of the design:

a) Geotechnical reporting on the suitability of the land for the life of the asset
b) Basis of design report describing options and selection of design
c) Risk analysis
d) Design report
e) Material schedules
f) Project execution plan
g) Site specific specification for construction
h) Nominated minimum levels of construction supervision
i) Drawings showing location, detailed long sections, pipe grades and sectional details
j) Functional descriptions (FD) of the transmission system function in network
k) O&M manual draft
l) Standard operating procedure (SoP) draft
m) New assets register in accordance with Watercare's data and asset information standards
n) Design compliance statement – See Watercare compliance statement policy

4. Criticality and infrastructure flexibility principles

4.1 Design life

The design life for pumping stations system and associated structures is to provide 100 years' service life within an acceptable level of service (quality and capacity of service) offset against an acceptable cost of maintenance of the service at this level. Some components may require maintenance or intervention before the 100 year service life, such as instrumentation or pump replacements, and must be included in the overall lifecycle cost of the pump station.

Note: *Further information on life cycle cost and optimal point of replacement can be found in the International Infrastructure Maintenance Manual (IIMM, 2015)*

4.2 Function classes and criticality

Transmission pump stations and the associated infrastructure within the pumping station site shall have a minimum function class of 3.

Note: *Refer to the New Zealand Ground investigation specification for the level of geotechnical information to be applied*

Function class		Description	Design Safety Factors				Seismic return period factor (NZS1170) R_u
			Peak ground acceleration	Liquefaction /subsidence	Landslide/ lateral movement	Surface loading	
3	Critical	Pump stations servicing large numbers of customers (>10,000 people) failure could cause significant economic impact or substantial hazard to human life, the natural environment and properties.	1.8	1.35	1.6	1.5	1.8
4	Essential lifeline	Pump stations that are essential to maintain service post natural disaster or man-made mishap and are intended to remain in service.	2.3	1.5	2.6	2	1.8

4.3 Resilience and redundancy

Resilience of pumping stations include site specific flexibility as well as the wider system that the pumping station is functioning within to sustain a level of service and absorb or adapt to changing conditions when there is a failure at the pumping station.

4.3.1 Resilience measurements {Table based on the IIMM, 2015 example table 3.2.8}

Dimension	Principle	Indicators	Assessment method
Technical – vulnerability	Robustness	Maintenance regime i.e. preventative or run-to-failure	Audit against best practice
		Asset renewal strategy is up to date	Audit against standards

Dimension	Principle	Indicators	Assessment method
		Design standards are followed and reviewed	Audit against best practice
		Spare capacity in the network system	Audit / system modelling
		Condition rating of exiting asset/system	Audit
	Redundancy	Supply of backup equipment/components are identified and suppliers hold stock	Supplier audit
		System diversion plans are in place, kept up to date with new assets/system changes	System modelling and audit of plan
		Capacity from alternative source	System modelling
	Modularity / flexibility	Modular systems, interchangeability	Standard design / best practice
		Future allowance for upgrade, improvements and strengthening	Audit against best practice
Organisational vulnerability	Variation readiness	Qualifications of staff are appropriate to roles and responsibilities	Audit
		Staff quantity and resources are adequate to deal with reactive changes	Audit
		Continual development of staff	Survey / audit
		Communication is clear with protocols in place	Survey
		Information on systems and assets such as drawings and operational manuals are readily availability	Survey / audit
		Readiness/response planning are in place and practiced	Audit
		Funding availability to effect operational variance	Audit
		Insurance are up to date and with appropriate risk cover	Audit
	Leadership / culture	Decisive decision making	Survey
		Situational awareness	Survey
		System knowledge	Survey
		Innovative thinking	Survey
	External partners	Ability to leverage on external knowledge	Survey
		Partnerships, design and service delivery arrangements	Audit
		Behavioural/communication barriers that could restrict productive solutions	Survey

4.3.2 Scoring

Scores are assigned based on the assessment outcome for the individual fields listed under section 5.3.1 and collated up under the principle categories and rolled up as averages for technical and organisational averages.

Score	Description
1	Poor, not adaptive, complete loss of level of service
2	Marginal, adaptive but with system constraints or reduced level of service
3	Good, adaptive
4	Excellent, very adaptive/diverse with multiple redundancy options

5. Risk

Risk shall be assessed in accordance with the current Watercare Risk Management Framework.

6. Safety and hazard mitigation

6.1 Safety in Design guidelines

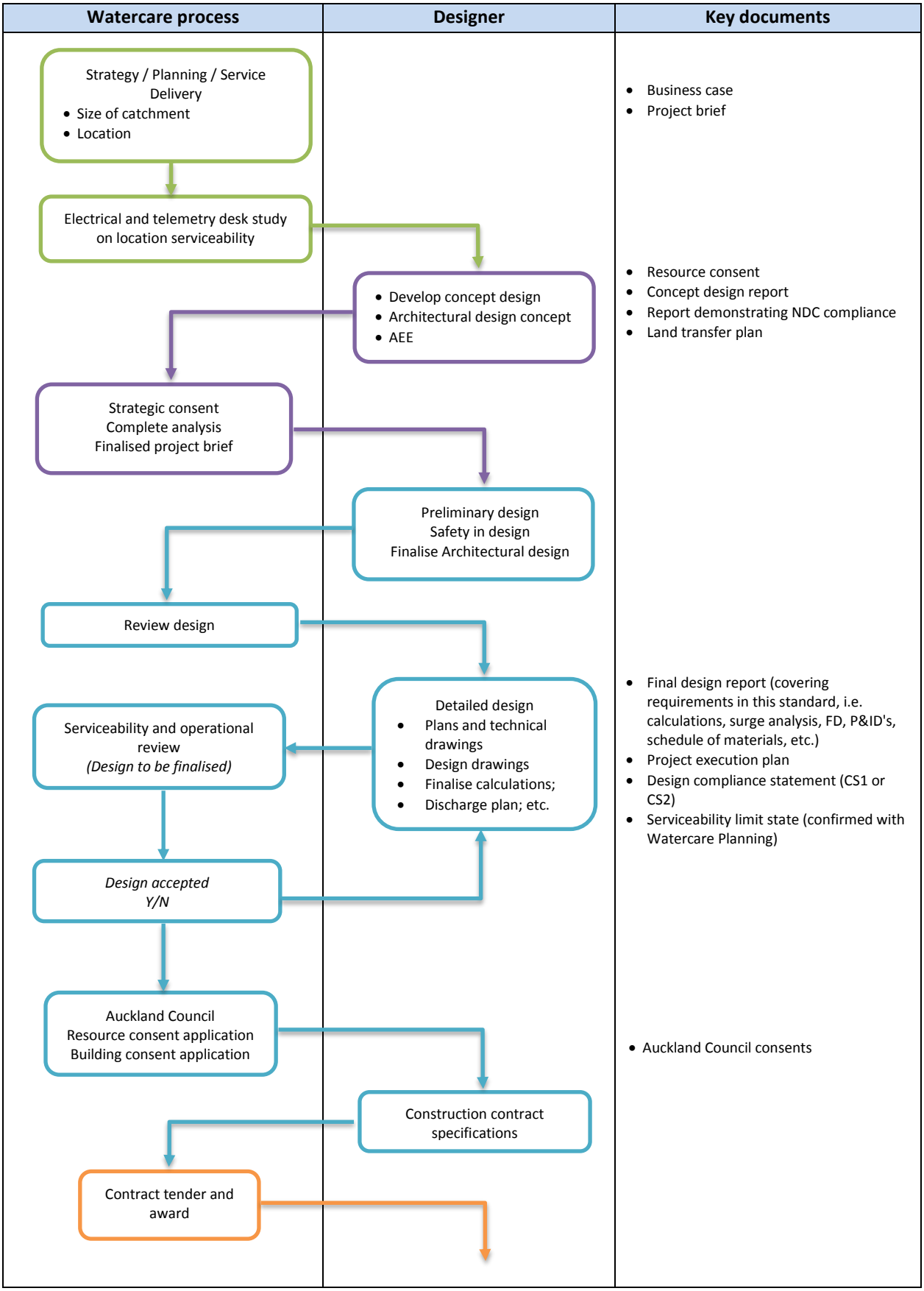
Refer to the Watercare Safety in Design standard for output requirements and to complete HAZOP analysis.

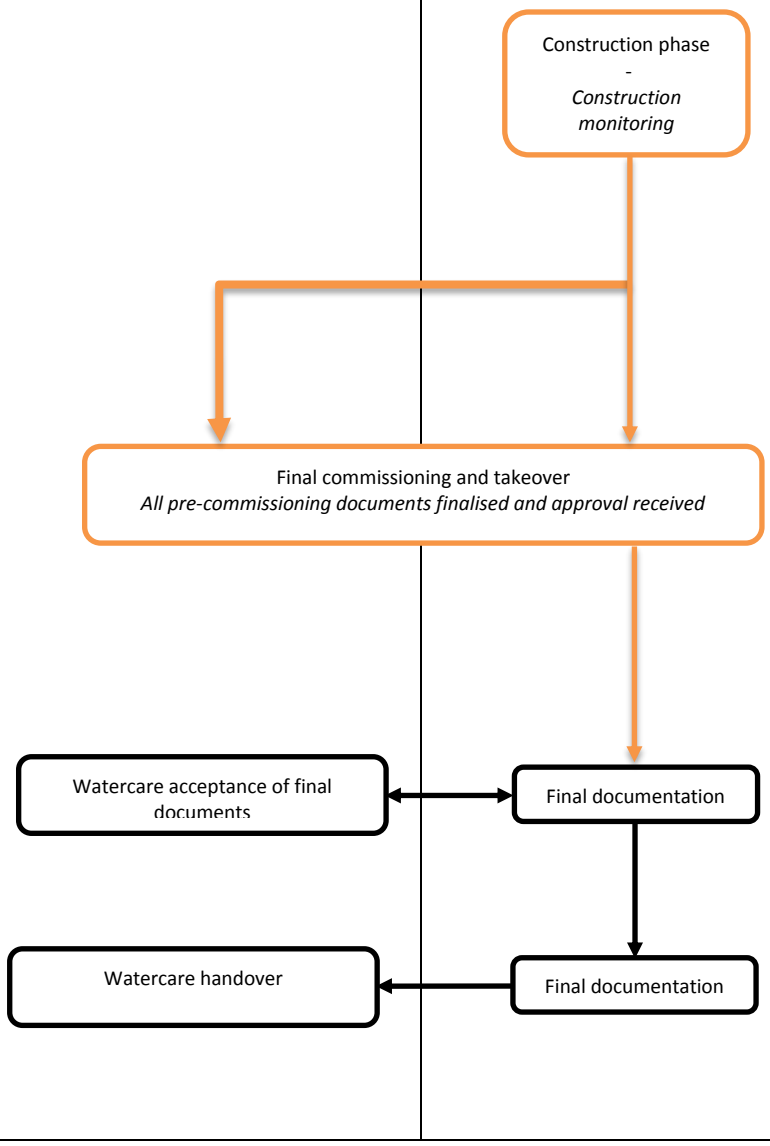
6.2 Safety in Facilities Design guidelines

Refer to Watercare Health and Safety in Facilities guidelines, 2017 for the functional safety outputs required at pumping stations.

7. Design process for transmission pumping stations

The following flow chart is a guideline on the expected stages for developing the pump station design:



Watercare process	Designer	Key documents
		• Prelim as-built drawings • Electrical certificate of compliance (CoC) • Signed-off pre-commissioning test results of structures and pipework. • Draft Operations and Maintenance Manual. • Factory acceptance testing (FAT). • Commissioning plan • Construction QA/QC sign-off (CS3 and CS4 with supporting documentation) • Commissioning plan • Approval to connect • Post-construction residual risks register • Operations and Maintenance Manual • Final Functional Description (FD) supplied separately to the O&M manual. • Electrical Certificate of Compliance • Design drawing sets, as-built drawings and survey data • Asset certificate • Engineering compliance statements • Agreed to transfer of liability

8. Pump station planning considerations

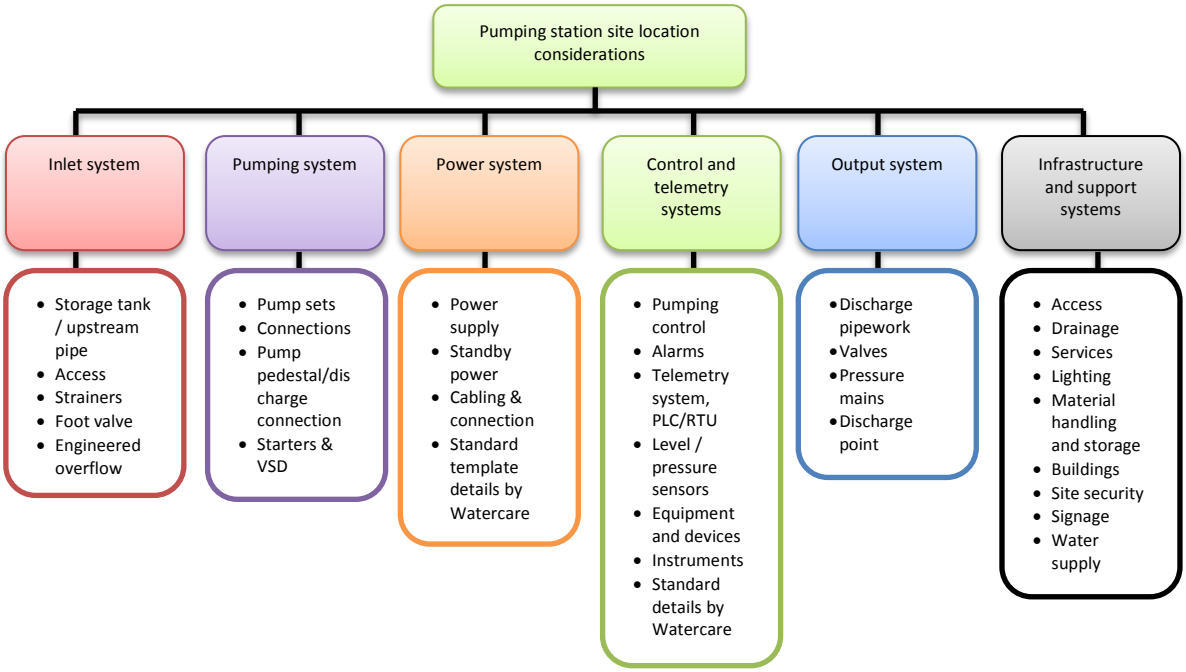
The feasibility study shall have considered technical, environmental and financial criteria over the entire design life of the system.

When planning and designing for a pumping station; consideration shall be given to pumping station placement including:

- Future expansion / upgrades that will allow the existing infrastructure to accommodate overall increase in the capacity of the pumping station and other staged infrastructure
- Running costs, life-cycle and ongoing maintenance costs
- Impact on existing pumping stations will require a full system integrated design
- Environmental and health and safety risks
- Dry-weather storage capacity
- Pumping station structures shall allow for the following minimum design life:
    i. Storage tanks 100 years
    ii. Pipework 100 years
    iii. Valves and meters 30 years
    iv. Electrical equipment 25 years
    v. SCADA and control 15 years

9. Design output format

The design considerations for review by Watercare shall follow the following output format:



10. Pumping station site

Pump stations shall be sited on public land or a dedicated lot for the exclusive purpose of housing the station and all related structures and equipment. The site must provide adequate space for service vehicle movements and future expansion as may be predicted.

The pumping station general site layout shall have:

a) A level aspect within the boundaries of the pumping station.

b) 24hr all-weather vehicle access, adequate parking and adequate manoeuvrability and hard stand areas to access all components for maintenance and replacement.

c) Dedicated underground mains power supply.

d) A dedicated control room / cabinet to house electrical equipment as specified in the Watercare electrical and control standards.

e) Building doors, switchboards, control cabinets and chamber cover-plates are to be provided with adequate clearances for maintenance access.

f) Electrical connection facilities for the provision of a temporary generator.

g) Dedicated utility service ducting.

h) Associated valves and metering.

i) Landscaping and planting as required by consent conditions or as otherwise specified by Watercare during the design review. Refer to Watercare architectural design guidelines.

10.1 Site ground conditions

Ground investigations shall be completed in accordance with the New Zealand Ground investigation specification, 2017 (http://www.nzgs.org/library/nz-ground-investigation-specification).

All data collected shall be uploaded to the Auckland Geotechnical Database in AGS4 format at:
https://agd.projectorbit.com

Contaminated sites should be avoided. Where a contaminated site has been confirmed, written approval to proceed shall be obtained from the Auckland Council and Watercare. The following issues shall be addressed in the request for approval:

- The nature of the contamination;
- Compliance with statutory requirements;
- Options to de-contaminate the area;
- Selection of pipeline materials to achieve the required life expectancy of the wastewater main;
- Safety of construction and maintenance personnel; and

Any contaminants in the soil, including topsoil on the site, shall be at the lesser levels of the health-based or environmental related protection values as described below:

- Health based protection values:

  NES Soil contaminant standards (SCS) for residential land use (no produce, if applicable) as derived in accordance with Ministry for the Environment Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (Chapter 7). In the absence of a derived NES Soil SCS, then a standard following the hierarchy outlined in the Ministry for the Environment, Contaminated Land Management Guidelines No 2 shall be adopted.

- Environmental related protection values:

Auckland Council Air Land and Water (ALW) Plan criteria for discharges as described in Rules 5.5.41.

- No asbestos containing material or volatile organic compounds in site soils.

No free (or separate) phase liquid contaminants and groundwater contaminant concentrations, with the exception of volatile organic compounds, which must be below the Australian and New Zealand Guidelines for Fresh and Marine Water Quality at the level of protection for 80% of freshwater species. Concentrations of volatile organic compounds shall be below typical laboratory screening detection limits (0.5 mg/L or lower).

The following table sets out the acceptance criteria for contaminant free sites:

Contaminant	Acceptance level (mg/kg)
Arsenic	<24
Cadmium	<7.5
Chromium	<400
Copper	<325
Lead	<250
Mercury	<0.75
Nickel	<105 [1]
Zinc	<200 [1]
Benzo(a)pyrene equivalent	<2.15
Pyrene	<1
ΣDDT	<0.7
VOCs	Below laboratory detection limit

[1] Can use upper limit background concentration in Auckland region (i.e. 320 for Nickel and 1160 for Zinc) if the soil is volcanic source

A site investigation including soil sampling and testing must be undertaken and a report submitted to Watercare in accordance with the requirements of the Ministry for the Environment, 2011, Contaminated Land Management Guidelines No. 1 - Reporting on Contaminated Sites in New Zealand. Testing shall be conducted by a NATA/IANZ accredited laboratory.

Soil testing data is required at the position for the proposed pumping station. Depending on the size of the proposed site additional soil testing at more than one location may be required if a single sample is not considered representative of the site.

11. General design considerations

The design shall be carried out in conjunction with the standard drawings, showing the typical layout that is expected for a pumping station. It is expected that the core requirements shall remain unchanged with design outcomes establishing the pipe sizes, fall/grade changes, pump and discharge sizes and any other dimensions.

The general design considerations include:

a) The general principles for pipe layout and structural design shall be reflected in accordance with the requirements of DP-07 Design principles for transmission water and wastewater pipeline design, Part C and D.

b) A designation schedule of essential infrastructure for post-disaster operational continuity shall be determined in consultation with Watercare and to determine the appropriate serviceability limit state.

c) Determine the station lifting height requirements, flow losses through pipework and fittings to calculate the total head.

d) Determine the operating philosophy and associated SCADA and telemetry requirements.

e) Develop the system curve that considers:

- The flow velocity initial flow and ultimate state and any staging.
- Static and friction losses.
- Total lifting head.

f) Complete geotechnical investigation for the purpose of structural design, construction considerations and land contamination report.

g) Structural design of infrastructure.

12. Design review

Once the design has been completed the designer shall undertake a review to ensure compliance with the requirements set out in this standard. The design shall be signed-off by a suitably qualified Chartered Professional Engineer. Compliance checks shall cover the following minimum criteria before submittal for evaluation by Watercare:

- Health and safety considerations identified during the design that includes for construction, normal operation, maintenance and emergency operation
- Community and environmental impact assessment
- System components, layout and configuration meet this standard and are in accordance with the typical pumping station standard details in the standard drawings
- Pump selection
- Plans indicating layout covering pipe size, grade, material types, transfer points and long sections
- Details of air release/vacuum and scour points
- Route selection meets concept/planning design
- Easements as appropriate
- Geotechnical data and considerations are taken into account during design
- Provisions made for future extension as appropriate, including upgrade staging and triggers
- Life cycle cost
- Compliance with referenced standards

13. Construction

Each section of the pump system shall be constructed but not connected until individually tested, unless suitable isolation is available to complete individual tests before testing and commissioning the system as a whole (refer to section 15 on commissioning).

Construction practices for components shall comply with the following Watercare standards:

a) General civil construction standard

b) General mechanical construction standard

c) General electrical construction standard

d) Material supply standard

14. Pumping station asset data

Pumping station data shall be captured in accordance with Watercare's Data and Asset Information standard.

Note: *As a minimum, redline mark-ups will be accepted for commissioning in anticipation of the final CAD versions being provided at handover.*

15. Testing and Handover

15.1 Commissioning

This section shall be read with Watercare's Code of Practice for Commissioning.

All pre-testing and quality assurance checks shall be completed before commencing with commissioning.

Once the individual sections have been tested, the final connections are made ready for commissioning of the pumps. A suitably qualified Watercare representative for the respective engineering disciplines shall witness the commissioning in conjunction with the third party professional(s) that is responsible for the commissioning works.

Commissioning work shall not progress unless the following documentation has been provided and has been accepted to proceed:

- Preliminary as-built drawings
- Electrical certificate of compliance (CoC)
- Signed-off pre-commissioning test results of structures and pipework
- Draft Functional Description
- Process and instrumentation diagrams (P&ID)
- Draft Operations and Maintenance (O&M) Manual
- Factory acceptance testing (FAT) completed, see Watercare Code of Practice for Commissioning (COP-03)
- Redline mark-up drawings
- Commissioning plan
- Applicable construction quality control signed off

The commissioning plan shall include, but is not limited to:

- HAZOP study

- Testing of all control system inputs and outputs (I/O's), see Watercare Code of Practice for Commissioning (COP-03)
- Pressure and level sensor adjustment
- Alarm status
- Pump control units
- Remote control and data transmission (RTU and PLC checks)
- Data logging and analysis
- Pump flow rates and rising/pressure main performance
- Noise and vibration level conforming during operation

Any non-conformance with this standard shall be corrected and re-tested.

15.2 Rejection of materials or products

All materials specified shall be accepted or standardised equipment as appropriate. Where products are required to be sourced that is not listed on any of these materials lists, prior approval by Watercare is required.

Materials supplied shall comply with the nominated standards and the minimum certification criteria provided as part of the handover process. Where substitutions of any materials or products are deemed necessary during the construction of the pumping station, approval in writing from both Watercare and the pump station designer is required.

Materials not accepted by Watercare shall be replaced at no additional cost to Watercare.

15.3 Handover documents

Watercare shall take over the pumping station when all of the below documentation are finalised and supplied:

a) Post-construction residual risks register.

b) Signed construction quality control sheets.

c) Operations and Maintenance Manual, see Watercare's Data and Asset Information standard.

d) Final Functional Description (FD) (supplied electronically and separate to the O&M manual), see Watercare's Data and Asset Information standard.

e) Electrical Certificate of Compliance.

f) Design drawing sets, as-built drawings and survey data.

g) New assets register including for associated linear assets in accordance with Watercare's Data and Asset Information standard.

h) Engineering compliance statements for design, construction and construction monitoring.

Where materials have not been supplied by Waterdcare, all product and material warranties and guarantees shall be transferred to Watercare.

Part B – Pump station layout and specific design requirements

1. General configuration

a) Two methods are used for providing water to the pump; positive suction head such as with an elevated tank or pressure main (see part C for booster pumps), and suction lift conditions where the pump must draw water from a lower level, requiring the inlet pipeline to be filled for priming the pump.

b) The pump station shall be installed at a minimum of 500mm above the 100 year flood level.

c) Isolation valves shall be accessible for operation without the need for confined space access.

d) The inlet shall be configured to minimise incoming flow turbulence.

e) The pump intake pipe from a reservoir or tank shall be formed with a long radius bend and facing downwards. The suction pipe must always be on a rise to permit air movement.

f) The inlet pipework shall be the same size as the pump inlet. The diameter may be slightly increased to reduce friction losses in which case an eccentric taper must be used. Concentric tapers should not be used.

g) The centre-to-centre clearance between pump intakes shall be a minimum of 1.5 times the external pipe diameter, or as otherwise required by the pump supplier to prevent vortices, air entrapment and pre-swirl.

h) The side clearance from the centre of the pump intakes to the walls of the pump station shall be minimum 750mm, or 0.8 times the external pipe diameter, whichever is greater.

i) Where the pump manufacturer requires minimum clearances for maintenance access an additional 250mm shall be provided.

j) Booster pump stations shall be installed above ground in an architectural designed building housing all the associated equipment.

k) The building or enclosure shall have a minimum internal operator standing height clearance of 2150mm

l) Structural design shall be to the selected function class.

m) Suitable drainage must be included to maintain the pump house in a dry condition from any seepage or surface flooding. The floor must be graded to a sump location with sump pump that discharges above the flood level.

n) Clearances around equipment shall be as specified in Watercare Design principles for transmission water and wastewater pipelines and:

- Pipework and pumps shall be at a height of minimum 400mm from the base of the building.
- Minimum (1.5 x diameter) lateral spacing between valves and pumps.
- Minimum 600 mm spacing between the wall and piping.
- 600mm clear space from the end of control and electrical cabinet doors when opened.
- Control cabinets shall be mounted at operator standing height.
- Valves and pumps must all be installed on a horizontal plane – equipment shall not be required to be removed on a lateral plane for replacement or servicing.
- Pipe protrusions through walls shall have a minimum clearance of 500mm before the first flange
- Adequate space for future replacement with larger diameter pipework and components.

o) Footings or supports shall be provided underneath larger valves, pumps and manifolds that are in excess of 35kg for the individual component.

p) Pipe support shall be provided to withstand structural and dynamic forces, and to provide the required height from the base of the building.

q) The pump station building shall be isolated against noise, refer Part D, section 4.

r) Service doors shall be sized to accommodate handling and removal of the pump station components to the largest removable component as a whole. Doors shall be sliding type or hinge open outwards.

s) Access to the pump station building shall be unhindered with adequate clearance for service trucks and any equipment required to maintain components.

2. Material selection

2.1 Pipework

a) Above ground pipework, or pipe transitioning from below ground to the surface shall be selected from Stainless steel, epoxy lined mild steel, or ductile iron.

b) Pipe fitting connections shall be flanged. Threaded, socketed, vitaulic or compression couplings are not acceptable.

c) Strategically located restrained dismantling joints are acceptable. Un-restrained joints are not acceptable.

d) Welded pipe connections shall be fabricated in removable sections, and shall be flange jointed as per above.

e) The minimum pipe pressure rating shall be PN16 (unless otherwise stated), and any other component, valve, or fitting shall have a minimum pressure rating of PN16.

2.2 Inlet strainers

a) In areas where screening or strainers are required, the device shall be incorporation into the inlet pipework, upstream of the pump.

b) Resilient seated valves shall be installed upstream of screens to enable individual isolation for cleaning.

2.3 Valves

2.3.1 Isolation valves

a) Main inlet and outlet isolation of the pump system shall be by resilient seated gate valve. Geared butterfly valves may be approved on a case-by-case application.

b) Individual pump train isolation may with ball valve type up to 50mm diameter or butterfly valves over 50mm diameter.

2.3.2 Non-return valves

a) Non-return valves shall be swing check type with a rubberised steel disc and as accepted by Watercare.

2.3.3 Pump bypass valves

a) Pump bypass valves used for pump performance control shall either be a controlled needle valve type a diaphragm release valve type. Modulated butterfly valves shall not be used for this purpose.

2.3.4 Air release valves

a) Air release valves where installed on the rising main shall be double acting and as accepted by Watercare.

3. Pumping system

3.1 Hydraulic design

a) Demand estimation shall be based on the requirements of the Watercare Design principles for transmission water and wastewater pipelines.

b) Pump performance control shall be by speed control. Outlet valve throttle control is not acceptable.

c) The maximum flow velocity shall not exceed 3m/s.

d) The maximum discharge pressure at the top of the hydraulic line shall not exceed 800kPa. The maximum operating pressure shall be less than the maximum cyclic pressure range (MCPR) for the selected outlet pipework. Refer to section 4.

The hydraulic design shall also consider:

e) Surge pressure shall be anticipated at minimum 200kPa regardless if calculated to be less.

f) Suction head. Net positive suction head (NPSH) shall have a minimum safety factor of 500mm.

g) Pumping station capacity (initial and ultimate capacity).

h) Internal diameter, length, route and materials of the rising main, including surge and fatigue analysis.

i) Levels and profile of the rising main and discharge point.

j) High points - to account for possible characteristics controlled by intermediate highpoints along the rising main.

3.2 Pump selection

a) Booster pump stations are designed as open systems with variable demand that depends on customer usage with a potential zero night-time flow. To meet this demand variability the pumping system is designed for constant pressure control. Pumps are arranged in parallel for demand fluctuation, raising pressure and redundancy purposes; and arranged in series for high pressure applications.

a) The minimum overall pump efficiency shall not be less than 80%. Lower efficiency may be considered in the following exceptional circumstances:

   i. The pump curve is very flat thereby consuming less power at intermediate flows, or

   ii. The anticipation of excessive impeller clogging and the associated maintenance outweighs the energy saving costs of selecting a more efficient impeller type.

b) Pump head curves with very flat head flow characteristics can make the pump difficult to control. Small changes in system resistance can create large changes in flow rate or cause ‘hunting'. The use of variable speed drives (VSD) in these scenarios shall require prior approval from Watercare.

c) Consideration to pump wear over the pump maintenance cycle to achieve flow design criteria.

d) The number of pumps depends on the pump station flow range, volume and power rating. Standby capacity shall be sufficient to maintain the pump station operation in the event of a pump failure or maintenance. Where a single pump provides duty an equal capacity pump shall be provided for standby. Where three pumps of equal capacity is provided, a fourth of the same capacity shall be provided as standby. For large or critical pump stations two or more standby pumps shall be used.

e) For wide varying flow ranges different pump sizes should be considered to minimize power costs. The number and size of standby pumps should be assessed base on the ultimate flow.

f) Phased pump installations should be considered for growth projections by selecting impeller size, variable speed drives and adequate space for additional pumps or larger replacements.

g) Pump stop/start shall not to exceed more than 6 cycles per hour (design flow). Pump duty standby to rotate on each successive pumping cycle.

h) The pump shall comply with the standards as listed in Watercare’s material supply standard.

4. Pump station outlet

a) All pump stations shall have a meter installed on the pump station discharge pipework.

b) The inlet and outlet pipework shall be interconnected with a non-return valve and an isolation valve installed (normally closed), regardless of whether bypass control is used for pump control inside the pump station pipework. This bypass is to allow the pump station to be bypassed under emergency.

c) For booster pump stations requiring firefighting capability a firefighting booster connection point shall be installed on the outlet.

d) The pump discharge pipe material design shall consider pipe and fittings to be pressure de-rated based on the material maximum cyclic pressure range (MCPR). The maximum operating pressure shall be less than the MCPR.

5. Rising mains

5.1.1 General

a) The rising main structural design and location shall be to Watercare's Design principles for transmission water and wastewater pipeline design. Rising mains shall not be situated in private properties.

5.1.2 Hydraulic design

The rising main pipe shall be designed in combination with the pumping system (see section 3 above) and include:

a) Length of the main, static and dynamic head losses.

b) Head loss shall be calculated using the Darcy-Weisbach equation with frictional coefficients determined using the Colebrook-White equation. A Colebrook-White friction coefficient of **0.3** shall be used.

c) Head losses through fittings shall be determined using the component manufacturer's value with a 10% inaccuracy factor. Where no data is available refer to Watercare's design principles for transmission pipeline systems on manufactured fitting friction losses.

d) Maximum allowed number of pump starts and the impact of cyclic fatigue on the selected rising main material.

e) Withstand surge pressures not less than 200kPa. Pressure surges shall be within the amplitude of the acceptable limits throughout the system. The surge analysis shall take into account the material fatigue of the selected pipe material and the derived maximum allowable operating pressure. The design shall identify solutions for Watercare's approval to mitigate the surge effects.

   Pressure surge solutions may include:

   - VSD drives for even start-up.
   - Slow-closing non-return valves.
   - Pressure relief valve and quick-closing non-return valve.
   - Automatic stepped main shut-off. Initial quick closing, thereafter slow-closing simultaneously with the pump shutdown.

f) Withstand a transient pressure of at least 80kPa below atmospheric pressure. Negative pressures can be prevented by:

   - Pump inertia/flywheel to continue pump rotation for a short period after power failure.
   - Surge tank.
   - Double acting air relief valves.
   - Air vessel.

g) A minimum flow velocity is 0.9m/s. The minimum flow velocity shall be calculated at the expected start of the service life. The design shall be carried out on the basis of full bore flow

h) The maximum rising main flow velocity shall not be more than 3m/s at ultimate service.

5.1.3 Pipe Material

a) Pipe material shall be supplied as complying with the applicable Watercare material standard.

b) The minimum pipe pressure rating shall be PN16 and any other component valve or fitting shall have a minimum pressure rating of PN16.

c) The maximum pressure design shall consider pipe and fittings to be pressure de-rated based on the material maximum cyclic pressure range (MCPR).

d) The maximum operating pressure shall be less than the MCPR.

5.1.4 Rising main levels

a) The main shall, wherever possible, rise continuously from the pumping station and terminate at its upper end into the receiving structure or system.

b) The minimum rising or falling grade shall be 0.5%.

Where a continuously rising main is not achievable the following shall be provided for:

c) Peaks and low points shall be minimised.

d) Peaks shall be constructed with a double acting air release valve structure.

e) Scour valve and air release valve chamber access shall where practicable be located in the back berm of the road corridor (the first 1m width of the road berm adjacent to the road carriageway is defined as the front berm).

5.1.5 Combined rising mains

a) Under exceptional circumstances, parallel pumping may be considered. For existing systems where the design basis is for a completely new parallel system or where the existing systems are redesigned and replaced specific approval and design philosophy must be developed.

b) The parallel system shall be both as duty mains. Standby mains is not typically acceptable due to water quality with stagnating water, corrosion and operational challenges with mains standing empty.

c) The operating points for parallel pumping stations shall be considered for the full system to set individual pumping points based on the pumping head for each pumping station or pump set on the common rising main. The combined output shall be graphically determined using the individual geodetic heads; head loss components for each pumping station to the discharge point and then combined onto a single graph.

d) Where the common rising main is a complex rising main the graphical determination shall be supported by modelling software. Watercare prefers that the modelling information is provided in *InfoWorks*.

5.2 Rising main scour and isolation points

a) The number of scour locations and isolation points shall be decided based on the length of the rising main at adequate intervals to reduce drain down time for repair and maintenance.

b) The scour shall be located with a hard-stand area that is accessible by truck.

c) Scours and mains isolation shall be in accordance with the Watercare Design principles for transmission water and wastewater pipelines.

Part C – Electrical, Control and telemetry

1. Electrical, Control and Telemetry

a) Electrical, control and telemetry design and installation shall comply with the Watercare electrical and control standards and template drawing set DW18 for pumping stations.

b) Electrical and control equipment shall be 500mm above the 100 year flood level.

1.1 Electrical

Additional to the electrical standards the following requirements for establishing electrical power on site shall also be completed:

- Sites owned by Watercare shall be coordinated for connection through Watercare. Early engagement with the electrical mains provider is required.
- Where mains electricity is not available at the site a new installation point (ICP) will be provided.
- Mains electricity shall be of sufficient capacity taking into account future expansion.
- Unless otherwise approved, substations on a consumer's premises shall be for the sole supply of the Watercare facility.
- Information required for the ICP include: supply phase; maximum demand load in amps; physical address of connection; name and contact of the electrical contractor undertaking the works.
- Any easement requirements for electrical mains and transformers must be referred to Watercare.

1.2 Control system and Telemetry

a) Watercare will complete a connection suitability study for the location, to establish the telemetry requirements for the proposed pumping station site. A desk study will determine if there is an available connection for the location.

b) If a connection is possible, the desktop study is followed by a site check to establish the signal to noise level ratio to ensure a good quality signal is available.

c) Should there be no communications available or the signal strength is less than -90dB a specific design will be required.

d) The telemetry and radio system shall be from a Watercare standardised supplier, refer to Watercare's material supply standard. The installation shall be carried out by a Watercare approved contractor.

e) The designer shall obtain a facility code from Watercare that is used to provide the tag information used to configure the control system. The information required to obtain the facility code is:

- GIS location of the site
- The physical address associated with the site
- Lot number or Land Registry identification

f) The SCADA software shall be developed and implemented by a Watercare approved developer.

g) Watercare has five different control systems that operate in various areas, they are:

- Emerson DCS
- In Touch SCADA
- IFIX LNT SCADA
- Citect SCADA
- Abbey Systems Powerlink

In order for Watercare to complete the SCADA the following will be developed and supplied by the designer:

i. A level 1 Functional Description (FD), to be reviewed and accepted by Watercare Service Delivery before software programming commences.

ii. Liaise with Watercare point of contact in the production of the Electrical/ Control system design.

iii. Process and instrumentation diagrams (P&IDs).

iv. Bill of materials.

v. Confirmed Input and Output lists (I/O).

Part D – Infrastructure and support systems

1. Water supply

a) A site water connection shall be installed for cleaning purposes when specified. The connection shall be a typical domestic connection fitted with a tap connection with ¾" BSP thread to allow fitting of a hose. See G12/AS1 of the Building Code, for the methods and devices required to comply with Watercare's requirements.

b) Where firefighting supply is not within reach as per the New Zealand code of practice for firefighting water supplies, then a suitable firefighting supply shall be installed in accordance with the Watercare Code of Practice for Land Development and Subdivision, Chapter 6.

2. Lighting

a) Where considered an operational requirement or for safety reasons, site lighting must be specified. The designer must confirm the requirement and location such as to provide adequate lighting not have obstructive and obtrusive effects. The lighting shall be adequately controlled to prevent annoyance to the neighbouring properties.

b) Lighting shall be provided at the pump station control and machinery rooms

c) Fluorescent lights shall be phase shifted to stop strobe effects on machine rotating shafts.

d) Positioning of lights shall be such as not to cast shadows or unlighted areas in the drywell and control room.

e) The design shall take into account the types of activities to ensure the safety of people for the task types in the pumping station environment so that any hazards are visible and well lit.

3. Site drainage

a) The site shall have adequate drainage and fall to prevent standing or ponding water and prevent inflow into dry areas.

b) Overland drainage shall not affect neighbouring properties and may require a storm water system to be installed for discharge to a suitable location.

4. Noise control and vibration

a) Noise generated by the pumping station shall not exceed the Council permitted levels. The design shall include measures to reduce noise appropriately. Where the maximum noise level has not been specified in the resource consent the maximum shall level be 45 dB $L_{Aeq\ (15min)}$ measured at the pumping station boundaries.

b) Strong and long term vibrations can cause soil settlement in certain soil types as well as long-term structural problems. Apart from the effects on physical structures vibration may also cause discomfort to adjacent property occupiers. The vibration velocity level shall not exceed 1mm/s measured at the pumping station wet well.

5. Lifting equipment

a) Lifting devices shall comply with AS1418, AS4991 and the Worksafe NZ Approved Code of Practice for Cranes.

b) Adequate access shall be provided for mobile lifting plant around the pumping station installation and suitable hard stand areas.

c) Overhead gantry cranes shall be provided for handling large pumps, motors and valves. If the equipment requires low maintenance and can be removed by mobile plant through suitable access arrangements in the building design, then dedicated lifting equipment is not required.

The design of lifting equipment shall reflect:

d) The design safe working load (SWL shall be suitable for the heaviest component in the plant.

e) Equipment may need to be lifted in part or assembled.

f) Positioning of equipment and the lifting cover area. In some instances the layout may require more than one gantry. The positioning shall provide for lifting equipment or parts onto and off trucks.

g) Structural design required where the crane girders and runways form part of the building design. It should be considered that cranes may be used as part of the temporary works when the pump station is constructed to lift materials and component into the build.

h) Permanent access needs to be provided for overhead cranes. Isolators must be provided adjacent to the crane access.

6. Ventilation

a) The ventilation characteristics must be documented.

b) The pump room shall have 4-6 air changes per hour.

c) Where the control panel is situated inside the pump room, the room shall have a minimum of 10-15 air changes per hour within the limitations of AS/NZS61439 and be fitted with replaceable filters.

7. Security and access lids

a) All cabinets and other access points to the main pump station building shall be lockable.

b) Traversable access lids shall comply with the appropriate loading class under AS3996.

c) All entry points shall be fitted with an alarm that will signal unauthorised access through the Watercare security system. Security systems are fitted with a dual communications option that provides alarm to Watercare's security supplier and the Watercare central control room.

d) Pump stations shall be fitted with fire detection equipment to meet building act requirements.

e) Fire alarms shall be monitored for high priority pumping stations. Fire alarm systems are fitted with a dual communications option that provides alarm to Watercare's service supplier and the Watercare central control room. Lower priority pumping stations may only be fitted with a smoke alarm at the control panel that provides a fire alarm to the Watercare central control room.

8. Signage

a) Signage shall be provided that identifies the pumping station as the property of Watercare

b) Informative operational, health and safety signage that shall be required at the pumping station perimeter.

9. Site access road

a) The site access road shall comply with Watercare's general civil construction standard.

b) Adequate vehicle turning area shall be provided within the site.

c) The access road shall be sealed have a minimum laden load bearing capacity of 25tons (unless otherwise stated) and a minimum width of 3.5m.