Christchurch City Council

# Water and Waste
# Assets and Network Unit

# WATER SUPPLY, TREATMENT, PUMPING STATION AND RESERVOIR DESIGN STANDARD

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# Contents

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# 1. INTRODUCTION

The Water Supply, Treatment, Pumping Station and Reservoir Design Standard provides guidelines, minimum technical criteria and good practice for the planning, analysis and design of public potable water supply systems within the boundaries of Christchurch City Council. It also clarifies the engineering document submittal (reports, plans, specifications, estimates, calculations and manual) and review requirements.

This standard provides a standardised guide for public water supply systems within Christchurch City which presents, as far as practical, uniform concepts for water system design. It offers some flexibility, enabling design engineers and consultants to consider alternative designs for specific situations whilst still delivering the optimum design.

## 1.1. Scope

The key issues addressed in these standards are:

- general design principles;
- well and surface water sources, pump and headworks design;
- pumps and pump station design;
- reservoir sizing and design;
- pipeworks and valving;
- hydraulic considerations;
- mechanical and electrical design;
- structural design;
- telemetry and SCADA control systems;
- generators and power back-up;
- landscaping requirements;
- testing and commissioning requirements;
- operation and maintenance; and,
- document submittal.

# 2. REFERENCED DOCUMENTS

The following referenced documents shall be read and used in conjunction with this standard. Where there is conflict between the standard and the referenced documents, the standard takes priority but nothing in the standard shall detract from the requirements of legislation. It is the user of this standard's responsibility to ensure that they are referencing the latest version of the documents listed below.

- Christchurch City District Plan (*City Plan*)
- Banks Peninsula District Plan
- Environment Canterbury *Natural Resources Regional Plan* (NRRP) http://ecan.govt.nz/our-responsibilities/regional-plans/nrrp/Pages/Default.aspx
- Environment Canterbury *Land and Water Regional Plan* http://ecan.govt.nz/our-responsibilities/regional-plans/regional-plans-under-development/lwrp/pages/default.aspx
- Christchurch City Council *Trade Waste Bylaw* 2006
- Dangerous Goods Act 1985
- Hazardous Substances and New Organisms Act 1996
- Health and Safety In Employment Act 1992 & subsequent amendments (HASIEA)

- Machinery Act 1950 and Amendment Act 1989 (1989 No 88)
- Electricity (Safety) Regulations 2010
- Radiocommunications Regulations 2001
- New Zealand Building Code 1992
- Christchurch City Council *Infrastructure Design Standards* (IDS)
- Christchurch City Council Civil Engineering *Construction Standard Specifications* Parts 1-7 (CSS)
- Christchurch City Council City Water and Waste *Tagging Convention* Version 6.2[1]
- Christchurch City Council City Water and Waste *Station Asset Data Capture Templates*[2]
- Christchurch City Council City Water and Waste *Pro-forma Generic Electrical and Automation Specification*[3]
- Christchurch City Council *level 2 functional description template*[4]
- Christchurch City Council *Magflow Meter Specification*[5]
- Christchurch City Council *Pump Station Design Guide* August 2012[6]
- Christchurch City Council *Guidelines for Entering and Working in Confined Spaces*[7]
- Environment Canterbury *Pollution Prevention Guide* http://tools.ecan.govt.nz/eppg/
- Water New Zealand Industry Standard 2011 *Field testing of backflow prevention devices and verification of air gaps*
- ACI Committee 350.1 R-93/AWWA Committee 400-93 *Testing Reinforced Concrete Structures for Watertightness* 1993
- ANSI/HI 9.8:2012 *Rotodynamic pumps for pump intake design standard*
- Christchurch City Council Design Guide *Crime Prevention Through Environmental Design* (CPTED) http://resources.ccc.govt.nz/files/CPTEDFull-docs.pdf
- AS 1789: 2003 Electroplated zinc (electrogalvanised) coatings on ferrous articles (batch process)
- AS 2129: 2000 Flanges for pipes, valves and fittings
- AS 2159: 2009 Piling – Design and installation
- AS/NZS 1170 Structural design actions set
- AS/NZS 1365: 1996 Tolerances for flat-rolled steel products
- AS/NZS 1359.5:2004 Rotating electrical machines - General requirements - Part 5: Three phase cage induction motors - High efficiency and minimum energy performance standards requirements
- AS/NZS 1477: 2006 PVC pipes and fittings for pressure applications
- AS/NZS 1554: 2011 Structural steel welding Set
- AS/NZS 2032: 2006 Installation of PVC pipe systems
- AS/NZS 2033: 2008 Installation of polyethylene pipe systems
- AS/NZS 2280: 2012 Ductile iron pipes and fittings

1 TRIM ELEC06/6074
2 TRIM 14/141308
3 TRIM 14/1039203
4 TRIM 09/367127
5 TRIM 13/355959
6 TRIM 13/969184
7 TRIM 14/373123

- AS/NZS 2311: 2009 Guide to the painting of buildings
- AS/NZS 2566.2: 2002 Buried flexible pipelines installation
- AS/NZS 2845.1:2010 Water supply – Backflow prevention devices
- AS/NZS 2980: 2007 Qualification of welders for fusion welding of steels
- AS/NZS 3000: 2007 Electrical installations (known as the Australia/New Zealand Wiring Rules)
- AS/NZS 4020:2005 Testing of products for use in contact with drinking water
- AS/NZS 4058: 2007 Precast concrete pipes (pressure and non-pressure)
- AS/NZS 4087: 2011 Metallic Flanges for waterworks purposes
- AS/NZS 4130: 2009 Polyethylene (PE) pipe for pressure applications
- AS/NZS 4401: 2006 High density polyethylene (PE-HD) pipes and fittings for soil and waste discharge (low and high temperature) systems inside buildings
- AS/NZS 4680: 2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
- AS/NZS 5065: 2005 Polyethylene and polypropylene pipe and fittings for drainage and sewerage applications
- AS/NZS ISO 9001:2008 Quality management systems – Requirements
- BS ISO 3046-4:2009 Reciprocating internal combustion engines. Performance. Speed governing
- BS 4999-141:2004+A1:2010 General requirements for rotating electrical machines. Specification for standard dimensions AMENDMENT 1
- BS 5000-11:1973 Specification for rotating electrical machines of particular types or for particular applications. Small-power electric motors and generators
- BS 5514-4:1997 Reciprocating internal combustion engines. Performance. Speed governing
- ISO 10467: 2004 Plastics piping systems for pressure and non-pressure drainage and sewerage -- Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin
- ISO 10816: 2014 Mechanical vibration -- Evaluation of machine vibration by measurements on non-rotating parts
- NZS 3101: 2006 Design of concrete structures
- NZS 3104: 2003 Specification for concrete production
- NZS 3106: 2009 Design of concrete structures for the storage of liquids
- NZS 3404: Part 1:1997 Steel structures standard
- NZS 4219: 2009 Seismic performance of engineering systems in buildings
- NZS 4230: 2004 Design of reinforced concrete masonry structures
- NZS 6104:1981 Specification for emergency electricity supply in buildings
- SNZ/PAS 4509:2008 New Zealand Fire Service Fire Fighting Water Supplies Code of Practice (Fire Service Code of Practice)
- PIPA POP010A *Polyethylene Pressure Pipes Design for Dynamic Stresses*
- PIPA POP101 PVC *Pressure Pipes Design for Dynamic Stresses*
- UKWIR 10/WM/03/21 *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites*
- Relevant NZ Standards and Codes of Practice whether specifically mentioned herein or not

# 3. ABBREVIATIONS

A&N Unit - Asset & Networks Unit

COG - City Operations Group

PHD - Peak Hourly Demand

SCADA - Supervisory Control and Data Acquisition

# 4. DEFINITIONS

## 4.1. Acceptance

Acceptance shall be in writing or email from Council prior to any construction or installation. Any acceptance shall mean that the design procedure is per Council standards only and does not signify full acceptance of any defects or errors in the design calculations, equipment selection, specifications or construction until the end of the defects liability period.

## 4.2. Terminology

Throughout this manual the imperative or “must,” “will,” “shall," “required” is used when design practice is sufficiently standardised to permit specific delineation of requirements, or where specific Council policies and procedures justify definitive criteria or action. “Should”, “may” or “recommend” indicate procedures, criteria, or methods that are not required and that can be approached with some degree of flexibility.

# 5. SUBMITTALS AND QUALITY ASSURANCE REQUIREMENTS

Direct enquiries for acceptances to the Christchurch City Council - Operations Group’s City Water and Waste Unit Manager or a person appointed by the manager.

## 5.1. Design Records

Submit a Design Report that complies with IDS clause 3.3.2 – Design Report. Where the requirements of this standard are not complied with, provide a non-conformance report as detailed in IDS clause 3.7.1 – Control of Non-conforming Work. Obtain acceptance for any item that is deemed essential to the design of this infrastructure but that is not covered in this standard.

Instigate a risk assessment workshop prior to undertaking the detailed design, with the participation of Council. Present the resulting Risk Assessment Register, including any proposed mitigation with the Design Report.

Instigate a Hazard in Operation (HAZOP) workshop at the detailed design phase, with the participation of Council staff including a representative from the Council’s pump station maintenance contractor.

Submit design reports for review and acceptance at the following stages of design. Table 1 provides indicative milestones for the different design stages and reports.

**Table 1 – Suggested Design Milestones**

| Milestone | Design Stage | Description |
|---|---|---|
| Pre-Design Meeting | 5-10% | The pre-design meeting includes the following - Proposed service area, proposed water supply design parameters, site layouts, design criteria, submittal requirements, controls and instrumentation, consents, permits and authorisations. |
| Preliminary Design Report | 20-30% | Includes water sources, basis of design, overall site and location map with sufficient topographic information, showing water sources, pump station and reservoir locations and site layout (structure configuration, pump locations, capacities and capacity calculations, pump selection, hydraulic calculations, slope stability calculations, surge analysis, standby generator sizing calculations, noise analysis, geotechnical and site contamination assessments, preliminary equipment building mechanical layout, and a list of selected equipment and materials.<br><br>Also cover site design, landscaping, paving requirements, access points and roads, identification and application for consents, permits and authorisations required for the project, a preliminary cost estimate and preliminary project schedule. |
| Preliminary Plans and Specifications | 50-60% | Submit 50- 60% complete mechanical and civil design and infrastructure construction drawings and specifications. Incorporate Council's feedback from earlier stages. |
| Resource consents, permits and authorisations | 80% | Ensure those resource consents, permits and authorisations identified at the 5-10% stage and required before construction starts have been received. |
| Final Plans and Specification | 80-95% | 90% complete construction drawings, specifications, and final engineering design calculations, final costs. Incorporate Council's feedback from earlier stages. |
| Final Report | 100% | Submit for acceptance - final design calculations and 100% complete construction drawings and specifications. Include the general, civil, mechanical, architectural, structural, and electrical drawings showing all schedules, plans, sections, and details necessary for construction of the proposed infrastructure.<br><br>Ensure the report provides all design records in compliance with IDS clause 7.3.2 – Design Records. |

## 5.2. Design Quality Assurances

Provide Producer Statements PS1 – Design and Producer Statements PS2 – Design Review, prepared by a suitably qualified Chartered Professional Engineer, for the elements covered by the report.

Provide a Design Peer Review Certificate, complying with the requirements of IDS clause 3.3.2 –Design Report.

Ensure that drawings comply with IDS clause 2.9 – Drawings and that they are legible at A3 size.  Appendix 1 – Sample Submittal Drawings illustrates the minimum expected details for various components of the designed infrastructure. To assist with the design drawings, a full set of standard mechanical and electrical drawings can be obtained from the Council.

## 5.3. Construction Auditing

Provide a copy of the draft Inspection and Test Plan, including the performance tests in clause 5.4 – Acceptance Criteria and audit or hold point inspections by the Engineer, for example: hazard identification, auditing compliance with *Guidelines for Entering and Working in Confined Spaces*, the control cabinet construction and site installation.

Use the Final Handover Procedure Flowchart and Role Examples to determine the personnel to be present at audit or hold points e.g. commissioning (refer Appendix 7 – Handover Flowchart).

## 5.4. Acceptance Criteria

Specify testing and commissioning in accordance with the accepted Testing and Commissioning schedule. Council must witness all commissioning tests, including pump and generator load tests. Refer clause 17 – Testing and Commissioning.

## 5.5. Completion Quality Assurance Documentation

Provide records of performance tests and complying construction, including:

- a Certificate of Compliance for the electrical installation and proof of an independent inspection of the electrical works by a Registered Electrical Inspector
- Reduced Pressure Zone back flow prevention valve (RPZ) test certificate using the template in the appendices of *Field testing of backflow prevention devices and verification of air gaps*
- Consents and compliant monitoring reports or codes of compliance where relevant
- PS4 – Construction Review Certificates for the screw pile installation and testing, prepared by a Chartered Professional Engineer experienced in screw pile installation , where relevant
- Testing and commissioning records including pump test results and generator load test results. Refer clause 17 – Testing and Commissioning
- COG Construction Work Pack including the Outstanding Work/Defect List (refer Appendix 4– Outstanding Work/Defect List Example), the Practical Completion Certificate (refer Appendix 6 – Practical Completion Certificate), the Final Handover and Acceptance of Plant Ownership Certificate (refer Appendix 7 - Handover Certificate) and the Control System Commissioning Handover Certificate (refer Appendix 5 – Commissioning Certificate)
- Provide as-built information to the requirements of IDS Part 12: As-Built Records, including any warranties. Latest data pick up sheet templates, for recording the assets installed under the project, are available from Council (*Station Asset Data Capture Templates*[2]).

# 6. DESIGN AND CONSTRUCTION REQUIREMENTS

## 6.1. Acceptance of Alternative Designs

For operational reasons it is a requirement that there be a large degree of uniformity among the Council's wells, pumps, water supply pumping stations and reservoirs. Council will consider alternative designs on their merits, where the design results in an equivalent or better performing infrastructural development than that complying with this standard. Any acceptance of alternative designs applies to that particular proposal only.

Alternative designs may be considered:

- to provide flexibility to meet the circumstances and requirements of the site;
- as a means of encouraging innovative design;
- to produce a lower life cycle costing and / or greater operational reliability; or
- To provide the required resilience in case of land movement due to seismic events.

## 6.2. Approvals and Consents

Identify and apply for all necessary consents, authorisations and easements for the proposed infrastructure, which may include:

- Building Consent - Christchurch City Council
- Land Use Consent to drill for wells - Canterbury Regional Council
- Consent to take and use water from wells/surface water sources in compliance with the Natural Resources Regional Plan (NRRP) and the Land and Water Plan (pLWP) – Canterbury Regional Council
- Consent to discharge contaminants into air (from engine exhaust emissions and dust from earthworks) - Canterbury Regional Council
- Consent to discharge stormwater - refer to IDS clause 5.3.3 – Consent from the Canterbury Regional Council - Canterbury Regional Council
- Water connection application WS1 - Christchurch City Council
- Environmental Protection Authority Hazardous Substances Certifications and Licences for fuel storage
- Consent for excavation, including where the pump station doesn't comply with the *City Plan* Volume 3 Part 9 clause 4.4.4 - Canterbury Regional Council

## 6.3. Design Lifetime

Undertake a life cycle costing, considering both the initial capital costs and the ongoing maintenance, operation and replacement costs in deciding on the infrastructure elements such as:

- the type of water source options and pump types
- Pump station arrangement and pump types
- Reservoir type, size and associated components.
- Telemetry.

Life cycle costs should be used for the net present value analysis (NPV) to decide whether or not a project or an option is cost effective. Operational reliability should not be compromised by the option selection.

The operational asset lives of various water supply infrastructure covered by this manual are presented in Table 2.

**Table 2 - Operational Life for Water Supply Infrastructure (Years)**

| Asset Type | Sub-Group | Operational Life |
|---|---|---|
| Buildings | Buildings | 100 |
| Electrical Equipment | | 50 |
| Electronic Equipment | | 15 |
| Mechanical Equipment and Plant | Short-life pumps <20kW | 25 |
| | Short-life pumps > 20kW | 100 |
| | Long-life pumps | 100 |
| | Motors | 40 |
| | Gantry Cranes | 50 |
| | Stand-by equipment | 50 |
| | Diesel Engines. Fuel Tanks and Generators | 50 |
| | Air tanks | >30 |
| | Compressors | 25 |
| Site Pipework | | 100 |
| Reservoirs | | 100 |
| Wells | | 100 |

## 6.4. Site Requirements

Ensure that adequate land is secured or set aside for the planned water supply infrastructure, taking into account areas required for the wells, pump stations, reservoirs and their accompanying components. The preferred site should be, in order of preference:

- freehold land that can be vested with Council when the infrastructure.is complete
- Council owned land, with Council approval for this use.
- other land – privately owned, crown owned etc. including the appropriate access easements.

The site must also:

- not be subject to flooding
- be readily accessible at all times
- be shaped to divert stormwater around the wells, pumps and structure to an approved outfall conforming with IDS clause 5.3.3 – Consent from the Canterbury Regional Council
- be protected to prevent vandalism

Securing land that is fit for purpose will result in lower project costs in the long term. Consider noise issues (during construction and on-going operation), easements, access and site configuration before acquiring land to remove the requirement for later mitigation.

## 6.5. Site Amenities

Design landscaping and screening to clause 16 - Landscaping. Provide accesses to clause 15 - Civil Works. Specify fencing to clause 8.6 - Security and include lockable gates (refer clause 8.7 - Locks).

## 6.6. Seismic Considerations

Carry out a seismic study, including the liquefaction risk, and use the parameters when designing the methods to ameliorate any permanent damage to the works from seismic activity. Use a return period for the design seismic event of 1000 years, which is consistent with a Risk Factor, R = 1.3. Refer to IDS clause 7.7 – Pumping Stations and Reservoirs for further information.

Design the pump station and reservoir using seismic criteria in AS/NZS 1170.5 and the Building Code:

- Importance Level 3
- Annual exceedance probability (Ultimate Limit State) of 1 in 2500 years (Ru=1.8)
- Annual exceedance probability (Serviceability Limit State) of 1 in 25 years (Rs=0.33)
- Seismic Hazard factor Z of 0.30 (increased for Christchurch within the Building Code on the 19 May 2011 from 0.22)
- On the flat where sediments are deep, the soil class is D and the design peak ground accelerations are ULS = 0.61g and SLS = 0.11g

Provide resilience where the consequence and risk of failure is highest by focussing on the following areas in an approximate order of importance:

- Limiting differential settlement between structures or between structures and adjacent fittings and pipework, for example by transitioned ground improvement.
- Providing flexible connections capable of accommodating movement.
- Ensuring compatibility between the pump station foundation design and the anticipated settlement of the structure.

Detail connections between adjacent structures or inflexible services to accommodate relative movement between the structures. Refer to clause 7.5 – Seismic Detailing.

Design restraints for all plant and equipment, including cable support facilities, to comply with the Building Code Section B1/VM1, clause 13.0 – Seismic Performance of Engineering Systems in Buildings and NZS 4219.

## 6.7. Noise

Well drilling and pump station or reservoir construction works can be noisy. Heavy machinery in operation can have a noise impact on nearby residents and businesses. Efforts should be made to keep noise localised, minimised, reduced and eliminated where possible.

Plan and specify the construction including appropriate working hours to comply with the consent conditions, the *City Plan* rules in clause 1.3.3 - Noise Standards for all zones outside the Central City or the Banks Peninsula District Plan rules in chapter 33 Noise and with Environment Canterbury noise control standards.

For the built infrastructure, also ensure soundproofing limits the noise level at the property boundary to comply with these District Plan rules.

## 6.8. Buoyancy

For any underground structures e.g. tanks, chambers, foundations, check the structures for buoyancy, including at all stages of construction. If the pump station and/or reservoir will be constructed in soils that are liquefiable, also consider buoyancy under seismic conditions, with soil unit weights of 1.8kN/m3.

For caisson design pump stations, if the groundwater level requires lowering during the critical phase of pumping out the caisson after curing the plug, clearly indicate this in the associated specification, together with requirements for control. Also investigate the possibility of artesian conditions which give rise to water pressure equivalents higher than ground level.

In buoyancy calculations, use safety factors, at a minimum, of:

- 1.1, excluding skin friction, at critical early condition,
- 1.4 for permanent condition including skin friction, or
- 1.25 for permanent condition excluding skin friction.

## 6.9. Materials

All materials must comply with the requirements listed on the Council's web page for approved materials at www.ccc.govt.nz/DoingBusiness/ApprovedMaterials. Ensure plastic materials exposed to ultraviolet light comply with the Council's operating life requirements.

Where the equipment, instrumentation, pipeline or service is listed as an individual asset on the data pick-up sheets required under clause 5.5 – Completion Quality Assurance Documentation and IDS Part 12 – As-Built Records, detail the application of a permanent label for this item, as required by *Tagging Convention*.

## 6.10. Pressure Ratings

Design the components of the system to withstand:

- the maximum operating pressures defined in IDS clause 7.6.1 – Maximum Operating Pressure (Head).
- the safe working pressure which shall be:
  - at least 1.5 times the supply pump shutdown head *or*
  - 2 times the reservoir's maximum static head or the maximum expected operating head.

## 6.11. Operation and Maintenance

Design all system components for safe and convenient operational and maintenance procedures:

- Keep all equipment out of hazardous environments where possible and keep the number of confined spaces generated through the construction of the new facilities to an absolute minimum.
- Lay out the site, including vehicular access, to allow easy access to the infrastructure components
- Locate pipework to facilitate access to and maintenance of equipment. Provide an uninterrupted accessway around pumps and detail any pipework crossing this path either below floor level in ducts with suitable removable gratings or fixed above head height.
- Mount surface pumps on a plinth 200mm above floor level.

- Detail cables to be either below floor level in ducts with suitable removable gratings or fixed above head height.
- Place equipment to facilitate visual inspections and routine maintenance
- Specify guard rails or chains around the top of any potential hazard of falling
- Consider potential future expansions and make provisions for such
- Design the control and alarm system to enable operators to react quickly and properly in emergencies
- Size and select equipment that facilitates a long service life, low operational costs and low maintenance requirements
- Keep the system as simple as possible but as sophisticated as necessary, whilst considering the implications of a rural versus an urban setting;
- Prepare complete and useful records - system and equipment drawings and specifications, system calculations, hydraulic models, user manuals and manufacturer/supplier contacts, flow charts, diagrams and Process and Instrumentation Diagrams (P&IDs), legal survey plans and address maps, etc. Include this information in the Operations and Maintenance Manual (refer clause 16 - Testing and commissioning).

# 7. PIPEWORK

## 7.1. Pipe Hydraulics

Design pressure pipelines and fittings to minimise hydraulic losses in accordance with IDS clause 7.6.5 – Pipe Hydraulic Losses. Calculate the losses from each fitting using the information in Appendix 9 – Calculating Pressure Losses due to Fittings.

Velocities in pipes must not be greater than 2.0 m/s unless appropriate water hammer analysis has been done.

Surges (hydraulic transients) in water supply systems are usually caused by opening, closing or regulating valves or pumps starting and stopping. Water hammer, a result of hydraulic transients, will occur when the total surge pressure exceeds twice the value of the static pressure in the system when the fluid is at rest.

Provide a surge analysis (IDS clause 7.6.6 – Surge and Fatigue Re-rating of Plastic Pipes) appropriate to the pipeline e.g. pipes close to control valves require more detailed analysis or the selection of pipe materials that are not susceptible to surge and fatigue. Plastic pipes are susceptible to damage from cyclic loads. Provide a surge and fatigue analysis on all critical plastic pipelines including all pressure mains and where velocities in plastic pipes are greater than 1.0 m/s.

In the surge analysis consider:

the identified causative scenarios (e.g. power failure, pump trip, component failure, air valve operation, etc.)

the highest pressure along the pipeline

the lowest pressure along the pipeline

vacuum and air relief requirements along the pipeline.

Provide action points or mitigation measures to deal with the identified surges. Possible measures are described in clause 13.15 – Pump Hydraulics.

## 7.2. Pipe Fittings

Grey cast iron fittings are preferred with the exceptions in the clauses below. Provide shop drawings of all cast fittings.

Specify long radius bends where possible and change diameters gradually, rather than through sudden changes.

## 7.3. Wall and Floor Penetrations

Provide a water stop puddle flange, centred in the concrete for all pipes passing through walls below ground level. Detail the puddle flange with an outer diameter at least 15% greater than the pipe or fitting's outside diameter and with a thickness at least the nominal wall thickness of the pipe or fitting.

Specify flanges to AS/NZS 4087 Figure B5 except on valves where the maximum operating pressure is greater than 1.37 MPa (200 psi). Rate flange thicknesses for the test pressure of the system.

Where there is no bend in the pipework between sections which are cast into concrete; incorporate a mechanical joint to facilitate maintenance. Ensure there is sufficient clearance to these fittings to access the retaining bolts.

## 7.4. Fixings Restraints and Supports

Design restraints, fixings and supports to the fittings, including the ability to withstand seismic loading as detailed in clause 6.6 - Seismic Considerations. Where these items are not detailed on the drawings, ensure that the Contractor designs and supplies these fixings to comply with the Building Code.

All fixings to concrete or masonry shall be by bolts, cast-in fixings or chemical. Terrier and powder charged fixings shall not be used.

Specify corrosion protection on fixings, which exhibits equivalent or better corrosion resistance than the material to which they are connected and that complies with clause 8.2 - Protection of Equipment, Surfaces, Coatings and Dissimilar Metals.

Detail clamping to connect fixings to structural steelwork rather than welding or drilling.

Provide a Design Peer Review Certificate, complying with the requirements of IDS clause 3.3.2 – Design Report, for any welded or drilled connections for seismic restraints.

## 7.5. Seismic Detailing

Design flexible connections into pipework on the external side of exterior walls, to allow for relative movement during seismic events. Locate these joints no further than 1.0m from the external wall where possible. Consider punching shear when detailing both the pipework and the wall construction.

Flexible connections can be provided by rubber joints, polyethylene pipe or mechanical couplings. If rubber bellows are used, specify that the flexible element is EDPM rubber.

# 8. DETAILING

## 8.1. Health and Safety Signage

Provide safety signage (no smoking, confined spaces, power, speed limits, potable/non potable water sources, hearing protection areas, site visitor instruction board, rotating machinery etc.) on all facilities prior to commissioning. Detail confined space warning signs for pump house and reservoir accesses that are considered a confined space. Provide a noise hazard warning sign on the personnel door if there are pumps or diesel inside.

## 8.2. Protection of Equipment, Surfaces, Coatings and Dissimilar Metals

Provide protection against corrosion, deterioration, absorption of moisture, ultraviolet degradation and the like for all materials and equipment. Specify protective coatings with an operational effectiveness of ten years and require warranties to this effect.

Specify galvanising complying with AS/NZS 4680 for all structural steel except stainless steel but including ducts installed in concrete and steel pipework that is exposed to the weather or an otherwise moist environment. Galvanising must be undertaken after fabrication.

Either electroplate the remaining steel components and fittings (with the exclusion of the stainless steel) including those cast in concrete, to AS 1789 with a minimum coating thickness of 12 microns or galvanise them as above.

Paint galvanised steelwork in accordance with the paint supplier's recommended system for the applicable location, with a final colour to the Council's approved colours.

Paint floors wherever installed machinery may be damaged by dust and grit. Unless supplied powdercoated, specify the preparation and painting of the below items and all timber in accordance with AS/NZS 2311. Specify painting or powdercoating to the following colours (or their equivalent):

- Gutters, Fascias, Door Frames – White Gloss
- Exterior walls - New Orleans – Y84-066-078 (Resene)
- Internal walls – Milk Punch – Y94-033-084 (Resene)
- Ceiling – Half and Half – G93-026-093 (Resene)
- Roof – Mid Grey – N55-005-250 (Resene)
- Doors – Don Juan – BR45-009-002 (Resene)
- Crane, pipework and valves – Endeavour – B48-102-250 Enamel (Resene)
- Electrical cabinets external finish – Off White – 8015 Enamel (Dulux)
- Floor – Pebble Grey – G78-012-098 (Resene)

Electrically insulate dissimilar metals to prevent the potential for electrolysis.

Prevent ultraviolet degradation of cables by detailing protective covers to cables where they are exposed to direct sunlight. Detail weatherproof protection hoods for any instruments exposed to sunlight to prevent degradation of liquid crystal displays by ultraviolet light or moisture ingress from heating and cooling effects.

## 8.3. Mechanical

Seal weld welded joints to prevent water entry.

Use ductile iron with the following properties unless otherwise specified:

- Ultimate tensile strength greater than 420 MPa

- Yield strength greater than 250 MPa

Ductile iron must not be welded as the iron reverts to cast iron and loses its strength in the weld's heat affected zone.

## 8.4. Ducts and Trenches

Ensure cable ducts, service pits and trenching are of adequate dimensions to install power cables and pipes without causing damage. Terminate ducts flush with the wall or the motor plinth.

## 8.5. Penetrations and Watertightness

Ensure the location and nature of any unstipulated penetrations do not conflict with other services.

Specify restoration of the integrity of all fire or acoustically rated compartments compromised by those penetrations. Ensure all penetrations are sealed to also prevent water transfer.

Where flooding from stormwater or tsunamis is possible, consider sealing openings such as doors or windows. Specify flexible sealants with durability and watertightness guaranteed for a minimum of 10 years. Consider how, under flooded conditions, air circulation will be provided without forced ventilation. One opening, or multiple openings at the same level, will not provide this.

## 8.6. Security

Vandalism is likely at all sites. Detail the building architecture, façade, features and external equipment to discourage vandalism and to minimise damage. Provide an external security light, controlled by a passive infrared sensor for all but simple electrical cabinet installations.

Fence all facilities for site delineation and where necessary to restrict access by humans or animals where:

- there is a safety issue for any person that is on the site,
- significant vandalism or damage to the site could be expected, or
- there is potential for theft or sabotage.

Design fencing and planting complying with clause 16.0 - Landscaping to afford visibility of the whole site and so to prevent anti-social, unsafe or destructive behaviour.

## 8.7. Locks

Provide standard Council locks to all buildings, chambers and pits, gates and any sensitive or dangerous areas to prevent unauthorised access. Detail locking systems that prevent levers or bolt cutters being used to remove the locks.

Council locks and keys can be obtained by contacting the Council Network Operations Control Room. Use only Council locks during construction. A loan key will be made available for the duration of the project. Return the loan key to the Pumping and Control Manager on completion of the project.

## 8.8. Separations from and connections to services

Detail minimum parallel and crossing separation distances complying with IDS Part 9.5.3 - Typical services layout and clearances.

Where the specified clearances cannot be achieved, provide a non-conformance report, in accordance with IDS clause 3.7.1 – Control of nonconforming work (Quality Assurance).

Include the connection of water, drainage, electrical and other services to existing systems where required by the project i.e. no further work should be required to commission the project. Ensure the particular network utility operator has tested and approved the new reticulation prior to connection.

# 9. WATER SUPPLY SOURCES AND DEVELOPMENT

Groundwater is the only form of public drinking water supply in Christchurch City. The water quality is such that no treatment is necessary to provide safe and wholesome drinking water.

Conversely, Banks Peninsula settlements have a combination of groundwater and surface water supplies. The quality of both the surface and the groundwater sources is variable and they require treatment in most cases.

In selecting the source of water to be developed, demonstrate that an adequate quantity of water will be available, and that the water delivered to the consumers will meet Council's current requirements with respect to microbiological, physical and chemical qualities. Each water supply should take its raw water from the best available, economically reasonable and technically possible source.

Treat the water supply to achieve standards in DSNZ 2005/08 as described in clause 12.0 - Water Treatment.

## 9.1. Groundwater Supplies

All groundwater sources within the Christchurch City shall be drilled deep bores. The minimum depth for the water supply bores shall be 50m i.e. target second aquifer and below.

The same minimum depths may not be achievable in Banks Peninsula.

Further design requirements are provided in clause 10.0 - Water Wells.

## 9.2. Surface Water Supplies

A surface water source includes all rivers, tributary streams, springs, natural lakes, infiltration galleries and artificial reservoirs above the point of water supply intake. This is typical of a number of the water supply schemes in Banks Peninsula.

Further design requirements are provided in clause 11.0 - Surface Water Sources.

## 9.3. Resource Consents

Environment Canterbury consents required may include:

- Landuse consent to install the bore/s
- Consent to take and use the water
- Consent to discharge water from any aquifer tests or pumping tests that may be required
- Landuse consents for works in or within the margins of a waterway for surface water takes.

A bore completion report should be prepared and submitted to Environment Canterbury if required by the conditions of that land use consent.

# 10. WATER WELLS

Locate wells to protect them from possible sources of contamination related to the adjacent land use or from the well's recharge area.

A well designed wellhead is the first step toward maintaining a safe water supply.

Obtain consent to drill the wells and to take and use the water.

Ensure adequate investigations are undertaken to collect groundwater specific data during the planning phase. This includes liaising with well drillers and Environment Canterbury, who may have detailed knowledge of the local aquifers.

Drill wells to their nominated target depth with the intention of developing them to achieve their maximum yield. Place the final well screens across the highest yielding strata encountered around their respective depths.

Use the results from the well drilling report (Appendix 2 – Well Development Procedures) to determine the suitability of the water supply at the nominated depth with respect to flow rate and drawdown if pumped. If found suitable, screen the well and then develop and test it to confirm its performance.

## 10.1. Artesian Wells

If artesian conditions are encountered when constructing or supervising construction of a well, the qualified well driller or qualified professional must ensure the artesian flow is controlled. An artesian well is considered “under control” when the entire flow is through the production casing to the wellhead and the flow can be stopped or directed indefinitely without leaking on the surface of the ground and with no leakage into any other aquifer penetrated by the well.

Place bentonite mud, if necessary, in the wells to stop/control artesian flow (up to heads of 10m above ground level) during drilling.

## 10.2. Well Site Selection

General site selection factors are detailed in clause 6.4 - Site Requirements.

Well interference between bores impacts the operations of the bore pumps and may increase the cost of pumping. As a rule, observe the following minimum separation distances between wells:

- 100 m between two wells within the same aquifer.
- 50 m for wells in two separate aquifers.

Wells close to the coast or penetrating some aquifers may be vulnerable to seawater intrusion. A qualified hydrogeologist should be engaged to assess the potential for seawater intrusion and oversee well testing. Wells that are at risk of saltwater intrusion should not be used as sources of water supply.

## 10.3. Water Quantity and Well Capacity

Pump test wells to determine their capacity. This will normally be done as part of Environment Canterbury’s consenting requirements. Prior to commencing constant discharge tests advise all neighbours within 200 m of the proposed activity and take positive action to ensure noise is kept to a minimum. Advise the Council a minimum of 24 hours prior to commencing the tests.

Demonstrate through the well pump test data the source’s capacity to meet or exceed proposed water system demand during a range of conditions likely to occur over the course of a year and the life of the well. Obtain pump test information including:

- Static water level
- Sustainable yield
- Time Drawdown graph
- Recovery rate
- Duration of pumping to demonstrate sustainable yield.

Ensure the total developed groundwater capacity or sustainable yield of the well (or combination of wells) can provide a sustainable and reliable yield equal to or exceeding the minimum supply requirements.

The total daily source capacity, in conjunction with storage designed to accommodate peak use periods, must be able to reliably provide sufficient water to meet the Peak Hourly Demand (PHD) for the water system.

Obtain the network pressures, the PHD and the expected level of service for the infrastructure from the Council.

## 10.4. Water Quality

Test all wells proposed to be used as drinking water supply sources to ensure that the water quality meets or will meet the Drinking Water Standards 2005/08 with appropriate mitigation measures.

After quantity testing, provide a report on the chemical quality of the water.

Collect and analyse the water sample to the requirements of the Drinking Water Standards of New Zealand, in an approved laboratory. Analyse the chemical constituents as shown in Table 3.

**Table 3 – Determinants for the Water Tests**

| Constituent | Units of measurement |
|---|---|
| E Coli | - |
| pH | - |
| pH after aeration | - |
| Conductivity at 25oC | mS/m |
| Total Dissolved Solids | mg/L |
| Turbidity | NTU |
| Absorbance (at 270nm) | - |
| Total Hardness | mg/L |
| Total Sediment Concentration | mg/L |
| Fluoride | mg/L |
| Lead | mg/L |
| Nickel | mg/L |
| Zinc | mg/L |
| Arsenic | mg/L |

| Constituent | Units of measurement |
|---|---|
| Chloride | mg/L |
| Nitrate Nitrogen (NO3) | mg/L |
| Nitrite Nitrogen (NO2) | mg/L |
| Ammonia | mg/L |
| Sulphate | mg/L |
| Boron | mg/L |
| Potassium | mg/L |
| Iron | mg/L |
| Chromium | mg/L |
| Copper | mg/L |
| Calcium | mg/L |
| Magnesium | mg/L |
| Acidity to pH 8.3 as CO2 | mg/L |
| Alkalinity to pH 8.3 as CO3 | mg/L |

| Constituent | Units of measurement |
|---|---|
| Selenium | mg/L |
| Cadmium | mg/L |
| Reactive Silica (as SiO2) | mg/L |
| Colour (calculated from Absorbance 270nm) | TCU |
| Langelier Saturation Index (calculated) | |

| Constituent | Units of measurement |
|---|---|
| Manganese | mg/L |
| Bromide | mg/L |
| Soluble Phosphate (as P) | mg/L |
| Sodium | mg/L |
| Total Alkalinity to pH4.5 as HCO3 | mg/L |

## 10.5. Well Development Procedures

Use the Council's well development procedures summarised in Appendix 2 – Well Development Procedures.

## 10.6. Well Pumping Design Philosophy

Clearly identify in the Design Report which one of the following well pumping configurations is applicable and tailor the design to the requirements for that scenario:

- a submersible pump in a well pumping directly to the network
- a submersible pump in a well pumping into a suction tank or reservoir and a pump station upstream of the suction tank/reservoir pumping into the network
- free flowing artesian well flowing into a suction tank or reservoir and pumping station upstream of the suction tank or reservoir pumping to the network

Design the well pumps:

- to operate at the design duty point to meet the flow demand and delivery pressure requirements
- for maximum efficiency at the design condition
- to optimise energy use and operational efficiency
- to minimise head loss by designing the pipework and fittings according to the IDS clause 7.6 - Reticulation Design

Where the well is directly pumped and does not free flow into a suction tank, install flow limiting to prevent over pumping of the well.

## 10.7. Well Pump Design Scenarios and Controls

Adopt the appropriate well pump design scenario for the water supply system from the following alternatives:

- Well pump is the only pump in the system and generating enough flow and pressure to supply at least the design flow which should be the Peak Hourly Demand (PHD). This is typical of some Banks Peninsula schemes current and future systems.
- Well pump directly to a reservoir or suction tank.
- Well pump into the distribution mains to serve some zones between the wells and the reservoir and then into the reservoir at the end of the mains.

Where the well pump conveys to a suction tank (clause 14.6 – Suction Tanks) or reservoir (clause 14.0 – Reservoirs), base the pump control on the suction tank or reservoir volume/levels between pump “on” and pump “off,” and the well pump discharge. Provide the volume required in the suction tank or reservoir design to prevent excessive cycling (starting and stopping) of the pump motor.

## 10.8. Well Pump Selection and Hydraulics

Specify submersible pump types. Other types e.g. line shaft pumps will require submission of a Non-conformance Report.

*Minimum Well Pump Discharge Rate*

Base the well design flow rates on the pump test data (clause 10.3 - Water Quantity and Well Capacity and Appendix 2 – Well Development Procedures) and the consented flow rates.

If the well is not able to deliver up to PHD, select the well pump for this maximum flow rate. A reservoir may be necessary to then provide the zones' PHDs and, depending on the location of the reservoir, additional equipment (e.g. booster pump(s)) may be necessary. Ensure that the design is optimised based on the available flow and location of infrastructure to minimise the capital and operational costs for the system.

If the well flow rate exceeds the PHD, select the well pump to deliver the greater of PHD or the consented flow rate even though in the short term the pumps may be controlled to meet the staged demand.

For simple water supply systems, such as those in some of Banks Peninsula settlements, a well pump capable of meeting the PHD of the proposed water system eliminates the need for balancing storage (clause 14.5 – Reservoir Sizing).

*Minimum Well Pump Discharge Pressure*

Obtain information on the PHD and the level of service pressures for that part of the network from the Council's Assets and Networks Planning (Water and Wastewater) staff.

Determine the minimum well pump discharge pressure (or the corresponding Total dynamic Head) taking into account the well water level seasonal variations, the well drawdown depth, static height of the discharge point or the pressure level of service for direct supply to consumers, frictional losses in the system.

*Minimum and Maximum Duty Scenarios*

Pumping minimum and maximum duty scenarios at the selected flow rate (greater of PHD or consented flow rate) must be evaluated to ensure the pump is capable of operating over the duty range.

Minimum duty scenarios are:

- Pumping direct into the mains: minimum system operating pressure combined with maximum seasonal (winter) aquifer level
- Pumping into suction tank/reservoir: minimum suction tank/reservoir level (normally 1.0 m above floor level) combined with maximum seasonal (winter) aquifer level

Maximum duty scenarios are:

- Pumping direct into the mains: maximum system operating pressure combined with minimum seasonal (summer) aquifer level
- Pumping into suction tank/reservoir: maximum suction tank/reservoir level combined with minimum seasonal (summer) aquifer level

For well pumping into suction tanks/reservoirs the duty range can be minimised by having the well discharge line deliver water at the tank maximum level rather than at the bottom of the tank

*Other Pump Selection Factors*

In addition to the flow-head combination described above, consider the following factors when selecting the pump:

- Number of installed pumps
- Allowance for loss of performance because of wear through applying a multiplier of 1.2 to the total losses
- Pump closed head
- Net positive suction head available (NPSHa) and Net positive suction head required (NPSHr)
- Pump's compatibility with other pumps running in parallel. Series connection of pumps is not acceptable.
- The pump set must be capable of starting against zero pressure without overloading.

Use a system curve with required maximum and minimum values to aid in pump selection, including the NPSHa for large submersibles.

Ensure the pump selected operates within the pump's preferred operating region, which is approximately 75% to 120% of the Best Efficiency Point. This is especially important for some pumping situations e.g. pumps operating at very low flows and high heads, near shutoff heads or "runout" conditions. These conditions can result in excessive hydraulic loading or cavitation damage to impellers, casings and shafts, rapid bearing and mechanical seal wear and high vibration. In exceptional situations the Council may allow a pump to operate between 50% and 125% if the pump manufacturer approves.

## 10.9. Installation of Well Pumps, Pipework and Fittings

Specify the following requirements for submersible installations:

- The vertical pipe from a submersible pump discharge is to be Standard Weight, galvanised mild steel
- Supply the pump complete with a non-return (reflux) valve integral with the pump, or screwed, or bolted to the discharge bowl. Design and construct this valve to ensure a long trouble free life without jamming or leakage in the expected service conditions.
- Provide over temperature detection in the motor housing and a low water level detector on submersible pumps larger than 3 kW.
- Include a low level sensor, which will stop the pump when the water level is 1 metre above the pump's inlet or when the minimum water level specified by the pump manufacturer is reached, whichever is larger.
- If the wells are artesian or pumped artesian, specify a control valve to shut-off the flow from the well when the water level in the suction tank gets to high level. If the well is pumped this control valve is not required as the pump can simply be deactivated when a high reservoir or suction tank level occurs.
- For artesian flow wells, install control valves on the inlet to the reservoir or suction tank so that flow can be shut off at high level. This system involves a hydraulically actuated control valve on the inlet pipe from each artesian well and a float switch activated by the water level in the suction tank. House all the control valves for the stage 1 flow in a single underground chamber adjacent to the suction tank.

No flexible joints shall be fitted to well heads.

## 10.10. Well Pump and Motor Information

Provide the details of all proposed pumps with the Design Report, specifically:

*Pump Details*

- Make and model.
- Physical information (mass, dimensions, delivery diameter etc.)
- Mechanical details (materials, bearing and seal types etc.)
- Manufacturing and testing standards
- Maximum noise pressure level of 70 dBa @ 1 m.
- Guaranteed performance details (Q/H curves, total pumpset efficiency, rpm, absorbed energy, power factor and associated limits)
- Submersible pump's expected minimum life (based on 15% time running and 4 starts per week.)
- Submersible non-return valve details.
- Minimum operating speed for a variable speed set-up and the reason for this limit if the limit is not zero R.P.M.

*Motor Details*

- Rating (kW, rpm, voltage).
- Maximum starts per hour.
- Confirmation of continuous rating.
- Efficiency to IEC 3 to IEC 60034-30:2008 at 75%-100% full load.
- Electrical details (insulation rating, starting current, full load current, noise rating)
- Power factor at 75%-100% full load.
- Methods of protection.
- Details of cables supplied (number of cables, number of cores, sizes and cable rating).

Refer to the *Pro-forma Generic Electrical and Automation Specification*[3] for further details.

## 10.11. Well SCADA

Specify the following functions in the control system for the well pumps:

- Control of pumps based on reservoir/suction tank levels or water treatment system capacity, and water levels in wells.
- Run signal for each pump.
- Well production rate in L/s for each pump.
- Totalised flow volume for each pump – this is useful for compliance with consented daily and annual volumes
- Well water level in metres for each well.
- Continuous pump discharge pressure.
- Discharge valve positions.
- Elapsed well pump run time in hours and pump cycle counter.
- Total kilowatt demand of each well pump motor and the wells.
- Generator run signal (where installed).
- Low well water level alarm.

- Well pump run time alarm.
- Pump failure alarm.
- High/low temperature alarms.
- Fire/smoke alarm.
- Power failure alarm.
- Well discharge high-pressure alarm.

Refer to the Pro-forma Generic Electrical and Automation Specification[3] for further details.

### 10.12. Other Well Appurtenances

General appurtenances required have been specified in clauses 7 - Pipework, 0 - Detailing, 13.12 - Pump Suction and Discharge and 13.19 - Appurtenant Design. Consider these additional appurtenances on discharge piping, depending on the specific situation and the control requirements desired:

- A water supply tap between the pump and the check valve
- Combination air release valve
- Non-return valve (reflux)
- Water sampling point

## 11. SURFACE WATER SOURCES

A number of consents will be required from Environment Canterbury depending on the scale of the proposed take and the physical works.

Most surface waterways have minimum flow requirements that are specified by Environment Canterbury. In some waterways, the minimum flow varies from month to month or season to season. Minimum flows provide for the requirements of downstream users or uses and/or maintaining the in-stream ecological values for the waterbody. When minimum flows are taken into account the amounts able to be abstracted may be less than the projected demands.

### 11.1. Surface Water Site Selection

Consider the site selection factors in clause 6.4 - Site Requirements.

Surface water sources can be inaccessible as often the best abstraction points may be in awkward locations. Select the optimum site and design an appropriate access, even if this means carrying out additional earthworks. The benefits to the operation and maintenance work in future can often outweigh the additional earthworks.

### 11.2. Water Quantity

Ensure the quantity of water at the source is sufficient to meet the current and/or future demand with or without storage after accounting for normal losses such as seepage, from silting and evaporation.

Where a surface water source has low reliability (i.e. highly variable flows), consider the provision of off-stream storage to increase the reliability of supply. Base the capacity of off-stream storage on the hydrological and the resource consenting requirements.

The design flows shall be estimated as discussed in clause 10.3 - Water Quantity and Well Capacity.

## 11.3. Water Quality

Undertake an assessment of the water source to identify factors that may affect the water quality in the waterway:

- Source of the stream/river/spring etc. and upstream activities
- Potential catchment contaminants and how the water source will need to be protected
- Compliance with the Drinking Water Standards
- Minimum treatment required.
- Procure water quality tests for the proposed water take sources as described in clause 10.3 - Water Quantity and Well Capacity. In addition, for new stream sources of water, undertake sufficient testing of the raw water at peak stream flow times to accurately determine the mass per unit volume and particle size distribution of the suspended solids to ensure accurate treatment design that will comply with the Drinking Water Standards at all times, and particularly at times of peak flow in the stream when turbidity is at the maximum

Prepare a preliminary Water Safety Plan as part of assessing the surface water source. Identify potential threats to the water source and create an inventory of potential contaminants. Include a risk analysis and design requirements or improvements necessary to provide acceptable protection.

## 11.4. Intake and Surface Water Pumps Design Philosophy

Design surface water pumps and intake infrastructure to meet objectives similar to those in clause 10.6 – Well Pumping Design Philosophy. In addition to these, consider the following criteria specific to surface water takes:

- Reliability of supply, as this changes during the year depending on source minimum flows and on catchment hydrological conditions including rainfall.
- Conflict with others uses e.g. agriculture and recreational uses.
- Minimum flow requirements to sustain in-stream ecology.
- Ease of water abstraction – design to minimise clogging from debris, aquatic growth and gravel etc. and to abstract water efficiently.
- Providing a means for flushing the intake regularly.
- Construction, operation and maintenance practicalities
- Water quality should be protectable against erosion and catchment activities.
- Efficient and effective water treatment at a reasonable cost.
- Designing the intake to protect the surface water source from contamination.
- Providing suction pipes large enough to abstract the desired flows and maintain low velocities.
- Self-cleaning screens.
- Location above the minimum water level (a weir may need to be constructed on small rivers)
- Protecting fish or outside fish migratory paths. The fish screen shall allow fish passage at all times.
- Flow metering of water take rate and volume and residual stream flow.

### 11.5. Surface Water Pump Design and Selection

Adopt the appropriate surface water pump design scenario for the surface water supply system. Examples of these are provided in clause 10.7 – Well Pump Design Scenarios and Controls.

Specify the best possible pump for the situation - this may be centrifugal, split casing, submersible (e.g. in infiltration galleries) pumps.

Further details of surface water pumps are provided in clause 0 – Pumping unit types.

Design the surface water pump hydraulics to IDS clause 7.6.6 – Surge and Fatigue Re-rating of Plastic Pipes. Further design requirements are also provided in clauses 10.8 – Well Pump Selection and Hydraulics and clause 13.10 – Pump Selection.

Provide the details of all installed pumps and motors in the Design Report - see clause 0 – Well Pump and Motor Information.

### 11.6. Surface Water Supply Pump Station SCADA

At a minimum, provide a control system for the surface water pumps complying with clause 10.11 – Well SCADA and clause 13.17– Pump Station SCADA.

### 11.7. Other Surface Water Appurtenances

Provide the appurtenances specified in clauses 7 - Pipework, 0 - Detailing, 10.12 – Other Well Appurtenances, 13.12 - Pump Suction and Discharge and 13.19 - Appurtenant Design.

## 12. WATER TREATMENT

DWSNZ 2005/08 specifies that community water supplies require treatment for microbiological and chemical contaminants where the water quality test results from clause 10.4 – Water Quality do not meet the Maximum Allowable Values in the standard.

In central and eastern parts of the city north of the Heathcote River, groundwater generally meets the Drinking Water Standards without treatment and is considered to be secure. However, groundwater from shallower wells in rural areas is often not appropriate for community water supply without treatment. Some areas in the southwest of the city have groundwater that is high in nitrates.

For a groundwater source to be classified as “secure” it must meet the following three criteria:

- less than 0.005% of the water drawn from the bore has been in the aquifer for less than one year.
- the bore must have a secure borehead that prevents the infiltration of surface water.
- there must be no E. coli detected.

### 12.1. Design Philosophy

The objectives of a public water supply water system are to provide: adequate, safe and aesthetically appealing water to the customers, without interruption, at a reasonable cost and at sufficient pressure.

Design water treatment systems to produce treated water that meets regulatory guidelines and requirements and in particular Drinking Water Standards New Zealand requirements at reasonable cost.

Design the treatment process and plant that is:

- simple with flexibility of operation
- effective, reliable, durable and cost-effective
- able to provide two treatment trains in parallel if possible for redundancy
- compliant with the multi-barrier approach in DWSNZ 2005/08

Consider the treatment plant's:

- Proximity to the water source and the served network
- Topographical and geotechnical situation
- Hydraulics
- Land ownership
- Whole-of-Life Costs
- Operation and Maintenance requirements

Site layouts should consider:

- functional aspects of the layout taking into account the proposed treatment system
- site access including driveways
- storage facilities for the chemicals
- site levels and drainage
- security
- future expansion requirements including connections, space, power etc.

## 12.2. Treatment Process Assessment

Consider undertaking a pilot assessment to determine the treatability and the processes that can be adopted for the large scale plant.

Demonstrate through the pilot assessment the extent to which the treatment system will meet the design objectives above.

Select the water treatment process that best suits the water supply and contaminants of concern. The selection of the treatment process will determine the treatment plant design.

Design water treatment infrastructure to facilitate future expansion, where this may be required e.g. in staged developments or known future growth areas. Consider modularity and expandability as an alternative to the provision of surplus capacity.

Base the final selection of a treatment plant on:

- raw water quality and flow rates
- service standards (i.e. drinking water quality)
- ability to treat high turbidity water under different turbidity conditions
- operational flexibility
- future operation and maintenance costs
- future network expansion requirements
- cost effectiveness of the proposed treatment process

## 12.3. Treatment Capacity

Design the treatment plant capacity to provide a reliable supply of treated water equal to or exceeding the maximum demand or PHD, taking into account current and future flows. Note this may be limited by the consented rates and volumes.

## 12.4. Treatment Processes

This manual does not provide detailed design guidance of treatment processes for individual systems. It only provides a general discussion of the requirements.

Select the best treatment system for the water source based on the raw water quality, the desired treated water quality, costs etc. Provide details of the proposed treatment processes in the Design Reports, for Council input.

### 12.4.1. Screening

Where screening is included in the design to remove suspended matter and organic, it must not be in lieu of filtration or coagulation.

Consider in the screen design:

- the nature of the suspended matter to be removed
- the screen mesh size (must be between 6mm and 10mm). Coarse screens may be desirable upstream of the finer mesh
- fish passage
- continuity of operation during equipment maintenance e.g. allowing for a by-pass system. This can be achieved by providing a minimum of two screens.
- cleaning of the screen
- ease of operation and maintenance
- headloss through the screen at peak flow. This shall not exceed 1.5 m
- the flow velocity through the mesh. It should be < 0.9 m/s at the maximum design flow.
- durability of the screen.

### 12.4.2. Chemical Treatment

Where chemicals are proposed for treatment of water supplies, evaluate the treatment process for:

- treatment efficiency
- health and safety
- ease of mixing
- antagonistic effects of different chemicals
- operation and maintenance of the dosing systems and the pipework
- long term operation and maintenance costs.

### 12.4.3. Filtration

Council will consider the following filtration systems:

- Sand filtration processes e.g. Granulated Activated Carbon (GAC), open, pressure, Automatic Valveless Gravity (AVG) and slow.
- Mechanical filtration processes e.g. Cartridge, bag, and strainers.
- Membrane filtration processes e.g. Micro, ultra, nano, reverse osmosis, pressure, and vacuum.
- Diatomaceous earth filtration processes e.g. pressure and vacuum.
- Design filtration systems to provide:
- duplicate filtration systems. Each duplicate set should have a design working capacity equal to the plant capacity and capable of independent operation and backwash.
- overflow pipes to prevent flooding

- sufficient plumbing to allow for future growth
- an auxiliary water or air wash system

### 12.4.4. Chorine Disinfection

The Bacterial Compliance Criteria in the DWSNZ requires a minimum chlorine contact time of 30 minutes, taking into account short circuiting in the contact tank (clause 4.3.2.1 Drinking Water Standards New Zealand 2005 Revised 2008).

Provide a chlorine dosing facility in the reservoir or suction tank for dosing.

For larger systems, specify a metering pump for dosing. The chlorine dosing facility shall be designed to deliver a dose of up to 1mg/L to the water discharged into the reticulation.

Provide chlorine storage in a separate room in the pump station building, to protect the electrical components in the plant room from contamination. Provide a containment bund for the storage tank.

### 12.4.5. UV Treatment

Design the UV disinfection system considering:

- flow rates
- turbidity of the water
- required UV dose
- reliability of the UV sensor
- operating pressure
- The number of lamps needed and lamp life
- power usage
- alarms
- target pathogen(s) and log inactivation
- validation testing and data analysis by a person independent of the UV reactor manufacturer
- sizing based on an appropriate fouling aging factor of 0.70
- UV transmittance at 254 mn
- instrumentation (clause 12.8 – Water Treatment Instrumentation and Controls).

Provide as a minimum UV control and monitoring equipment including:

- UV dose setpoints
- UV reactor manual and automatic control
- UV intensity set points or UV transmittance setpoints as appropriate
- UV reactor local and remote control
- UV lamps, on and off control
- UV reactor, on and off control
- manual lamp cleaning cycle control
- manual lamp power level control
- automatic lamp cleaning cycle setpoint control.

### 12.5. Back-up Power Supplies

Provide back-up power supplies for the treatment plant. This may be independent or shared with the pump station if the two are in close proximity. Back-up power requirements for pump stations are discussed in clause 13.24 – Generators - Back-up Power Supplies.

### 12.6. Treatment Plant Appurtenances

Design minor process equipment such as piping, valves and chemical dosing systems to accommodate future design flow, within the life expectancy of the components.

### 12.7. Packaged Treatment Plants

Council will consider pre-engineered packaged treatment plants for the smaller schemes provided they generally meet the requirements of this manual.

### 12.8. Water Treatment Instrumentation and Controls

Develop the P&ID diagrams for the complete treatment plant proposal. Provide detailed design drawings, including all processes and the support equipment.

Determine the instrumentation and control systems in water treatment plants with regard to the level of complexity, operation and maintenance capabilities and operation control required for the network.

Consider the following instruments and controls for water treatment plants:

- continuous monitoring and recording treated water turbidity, pH, chlorine residuals
- water temperature,
- volume, flow rate and pressure
- head loss

## 13. PUMPING STATIONS

This Standard covers three types of pumping facilities. These are:

- raw water pumping, which could be from wells or surface water sources.
- treated water supplies. This also includes water stored in suction tanks and reservoirs.
- booster pump stations. This applies to inline pumps providing additional boost to maintain or increase the pressure to deliver the flow to the desired point in the network. Booster pumps are discussed in clause 13.7 – Booster Pumps.

### 13.1. Design Philosophy

Design the pumping station, ensuring it:

- clearly defines the type of pump and pumping scenario (clause 10.7 – Well Pump Design Scenarios and Controls and clause 0 – Surface Water Pump Design and Selection) in order to provide an optimal design for the system
- meets the water peak demand, consented requirements or pre-determined rate as determined in consultation with Council
- Is based on peak demand e.g. PHD, when maximum storage is available
- Is based on the consented rate or the supply source instantaneous flow rate available whichever is larger, for systems with no or minimal storage

- accommodates initial and future operating conditions. Pumps should be specified to operate in the vicinity of their optimum efficiency points

Design the pumping station with:

- a total life cost of the infrastructure which is as low as practical, whilst also considering reliability, security and functionality
- standardised equipment wherever possible
- The ability to meet all the environmental requirements e.g. noise, building consents conditions
- infrastructure of durable construction, fire and weather resistant
- all floors drained such that the potable water supply will not be contaminated
- control equipment which meets the requirements specified in the *Pro-forma Generic Electrical and Automation Specification*[3.]

## 13.2. Raw Water Pumping Facilities

Raw water from wells within the City requires no treatment. Design requirements for these well supplies are provided in clause 10.6 – Well Pumping Design Philosophy and clause 0 – Pumping Unit Types.

Design raw water supplies from surface water takes, which are predominant in Bank Peninsula, as specified in clause 11.4 – Intake and Surface Water Pumps Design Philosophy.

Consider the relevant design requirements in clause 13 - Pump Stations when designing raw water supply pump stations.

## 13.3. Treated and Reservoir Water Pumping Facilities

Design the treated and reservoir water pumping supplies as specified in this section (clause 13 – Pumping Stations) of the manual.

Design the minimum pumping capacity to be equal to the demand unless Council determines otherwise.

## 13.4. Pump Station Location and Layout

Consider the land and siting requirements in clause 6.4 – Site Requirements.

Use the siting, architectural treatment and landscaping of large pumping stations to enhance the surrounding environment as detailed in the Pump Station Architectural Design Guide and taking into account the following minimum requirements:

- Respond to context - The site layout, architecture and landscape design should respond to the scale and urban fabric of the surrounding environment.
- Sustainable design - Consider sustainable design principles and aim to minimise the impact on the environment.
- Increase amenity for the area – Consider each site as an opportunity to increase the area's amenity and be recognised as a positive addition to its environment.
- Integrate Crime Prevention through Environmental Design (CPTED) Principles – Examine the seven principles of CPTED to enhance each site in terms of safety, access and the creation of quality environments.

Design in a minimum clearance around and between pumps, diesels, open cabinet doors and extended racks of at least 600mm.

## 13.5. Pumping Unit Types

Specify submersible pumping units for wells as described in clause 10.6 – Well Pumping Design Philosophy. These may or may not have suction tanks or reservoirs, in which case they will pump directly into the network.

Surface water pumps for surface water intakes generally pump into pre-treatment storage. Post treatment, the treated water is pumped into storage reservoirs or directly into the distribution network.

Provide a design that is in alignment with the design objectives in clause 11.4 – Intake and Surface Water Pumps Design Philosophy.

## 13.6. Open vs Closed Systems

Water supply pump station pumping scenarios will either be open systems or closed systems as described in:

- clause 10.6 – Well Pumping Design Philosophy
- clause 11.4 – Intake and Surface Water Pumps Design Philosophy.

The designer can determine whether the system is closed or open in some situations. In making this decision, consider:

- available source flows rates and demands
- topography
- operation and Maintenance considerations
- capital costs
- reliability of power supply.

Consult with Council as one option may be optimal on considering outputs from the water supply model and/or institutional knowledge of the network.

*Open Systems*

An open system has its own reservoir i.e. it is open to the atmosphere. Typical pump operation is controlled by the water levels in the reservoir.

Design an open water system:

- so that the pump station and pumps can be sized based on the lower of consented flows or water source yield
- to include back-up power supplies (clause 13.24 – Generators Back-up Power Supply). These can be permanent or portable as the storage reservoir gives Council the time to rectify the problem before the reservoir empties. Exceptions to the requirement for back-up power supplies may be granted were the water pump station has low criticality as confirmed with Council.

*Closed Systems*

A closed water supply system is without its own reservoir i.e. it is closed to the atmosphere. Water is pumped from the source directly into the network.

Design a pump station for a closed system to:

- have sufficient controls to regulate pressure and flow variations due to changes in demand. This can be achieved by optimally selecting the number and sizes of the pumps and by the use of appropriate control equipment (clause 13.17 – Pump Station SCADA).
- supply the peak hourly demand (PHD) to meet the instantaneous demands

- include permanent back-up power supplies (clause 13.24 – Generators Back-up Power Supply). Where an exception to this requirement is required, approval shall be sought from Council.

Limit the number of properties supplied from a closed pump station to 50. This is based on the "50 property" constraint in IDS clause 7.10.1 - Sluice valves, for shutting off sections of the network and is subject to ongoing review for new pumping systems.

## 13.7. Booster Pumps

Booster pumps may be in an open or closed system. Therefore, design the booster pump to either fill a reservoir or to directly supply the network.

Each booster pumping station should contain at least two pumps (one duty pump and one standby pump) as discussed in clause 13.8 – Number of Pumps.

Design in-line booster pumps so that:

- negative pressure is not produced in their suction lines.
- total dynamic head and flow for the system curve can be obtained by all combinations.

## 13.8. Number of Pumps

When designing the pumps, include an extra pump over the required number for redundancy i.e. small pump stations shall have a minimum of two pumps. Ensure standby pumps are available for service at all times. Where possible, pumps in a pump set should be identical for operational purposes.

Council may accept installation of a single pump if:

- a replacement pump can be installed within Council's target level of services of 2 hours for most of the city or as the case may be in some small Banks Peninsula schemes with on-property storage tanks.
- the pump station supplies restricted water supplies and individual properties have on-site storage tanks that are at least 2,000 litres (24 hours storage per property).
- the pump station feeds an elevated reservoir from which individual properties can be supplied under gravity.

For larger pump stations, base the number of duty pumps on the pump station design flow rate(s) and system curves. Install a minimum of three pumps.

As a guide, where the pump station has the minimum three pumps, the likely set-up and operation may be as follows:

- Two duty pumps and one stand-by.
- Both pumps on VSD - The pump will run up to close to its maximum before the VSD is disengaged and the pump runs at constant speed. The second pump will pick up and provide additional demand up to its maximum duty point.
- One pump on VSD and one on a Soft start. Once the first pump reaches close to its maximum duty point, the VSD is disengaged and the soft start pump will start and run at its full speed. The VSD pump will then start again and provide any additional capacity required up to the maximum.
- In both cases the standby pump will be called on if one of the duty pumps goes down.

Provide an optimal control scenario for the specific pump station. This approach ensures that the pumps are operated at the maximum possible efficiency for the duties.

Specify 3-phase 415 volt pumps if their motors are greater than 3 kW. Specify water detection and over temperature detection in the motor housing of pumps larger than 3 kW.

Rate pumps to achieve their design output at no more than 2900 rpm.

## 13.9. Pump Features

Specify pumps with hard metal-to-metal face mechanical seals, high quality stainless steel or high tensile steel shafts and high grade bronze, stainless steel or cast iron impellers.

Specify a dynamically balanced unit to ensure long life and vibration-free operational conditions, confirmed by specifying a vibration test to ISO 10816 on the installed unit to confirm alignment, vibration and base harmonics.

Detail grease lubricated, heavy duty ball or roller bearing type bearings and renewable shaft sleeves and wear rings.

For dry-well mounted pumps, specify:

- Suctions with easy access to clear the impellor eye. This can be a special access cover or an easily removable section of pipe. For example, pumps with suctions greater than 200 mm diameter can be fitted with inspection plates for hand access into the volute and impellor.
- End suction pump sets complete with a substantial base plate to mount the pump and motor. Detail the mounting plate to ensure correct alignment at all times and to minimise harmonic vibrations.
- “Back pullout” design end suction pump sets, with the motor and wet end of the pump able to be slid out of the volute with minimal work.

For in-line pumps ensure that:

- The inlet and outlet are placed at the same level where the inlet and outlet pipe diameters are the same.
- Accessibility is easy when the pumps are installed in parallel as the pipework can be in the way.
- Pumps are installed in a position to permit proposer lubrication and servicing.

## 13.10. Pump Selection

Consider the following when selecting the pump:

- Number of installed pumps
- Maximum Flow rate - allow for loss of performance because of wear through applying a multiplier of 1.2 to the Maximum Flow
- Total head in metres of water
- The static and friction head
- Pump closed head
- Pump efficiency
- Operation and maintenance costs and impact on Whole-Life -Costs
- Net positive suction head (actual) NPSHa and NPSHr (required)
- Pump’s compatibility with other pumps running in parallel. Series connection of pumps is not acceptable.
- The pump set must be capable of starting against zero pressure without overloading.

Use a system curve with required maximum and minimum values to aid in pump selection, including the NPSHa for end suction pumps and large submersibles.

Ensure the pump selected operates within the pump's preferred operating region, which is approximately 75% to 120% of the Best Efficiency Point or 50% to 125% with confirmation from the manufacturer.

## 13.11. Allowance for Future Capacity or Extension

For staged developments such as in Greenfield areas, pump stations can be staged with fewer pumps in the early stage(s) and provision made for the ultimate development scenario. Size these early stage pumping units for the ultimate design flow rate. If an intermediate design flow rate is required, select the pumping units for both conditions, intermediate and ultimate development.

Consider the feasibility of using smaller pump impellers for the earlier stages and upsizing the impellers for the later and ultimate development stages as this could be cost effective if the higher duties can be achieved without overloading the pump. Additional future capacity could also be achieved by replacing pumps installed in the early stages with larger pumps. The starters could be sized for the larger pumps from the start and fitted with circuit breakers and overloads.

If additional pumps are required, make provision for these pumps in the pump station building, the manifold pipework and switchgears.

Analyse the various pumping combinations to arrive at the most cost effective combination of staging options.

Where staged developments are carried out by private parties, the Council may accept staging or uncompleted works subject to bonding the uncompleted work, plus a margin to cover additional costs.

## 13.12. Pump Suction and Discharge

Design the suction and discharge manifold for future flows without having to take a pump out of service for extended periods of time. Design and size suction pipework so that:

- it is one size larger than the pump inlet size.
- suction pipe is easily accessible to clear any blockages.
- suction pipe velocities in Table 4 are not exceeded. Higher velocities should only be allowed on short-term basis (e.g. emergency conditions)
- suction cavitation is avoided by flooded suction or having a NPSHa > NPSHr
- eccentric reducers have the obvert horizontal to prevent air entrapment.
- suction lift is within allowable limits for the pump.
- if suction lift is required, provision for priming is made for the pumps.
- a strainer or screen is installed where necessary to prevent debris, stones etc. entering the pumps. This is especially important on surface water intakes in Banks Peninsula. Where installed, keep the strainer head loss below 1 m so as not to compromise the NPSHa.

Design and size discharge pipework so that:

- it is one size larger than the pump inlet size.
- discharge pipe velocities in Table 5 are not exceeded. Higher velocities should only be allowed on short-term basis (e.g. emergency conditions).
- it can withstand the total maximum pressure (including surge)

**Table 4 – Suction and Discharge Velocities (m/s)**

| Pipe Diameter | Velocity (m/s) |
|---|---|
| Suction Pipe Velocities | |
| ≤ 250 mm | ≤1.0 |
| >250 mm | ≤ 1.5 |
| | |
| Discharge Pipe Velocities | |
| ≤ 250 mm | ≤ 1.5 |
| >250 mm | ≤ 2.0 |

Provide calculations of:

- flow velocities for minimum, prevailing and maximum flow conditions.
- the NPSHa for the maximum flow and maximum temperature.

Avoid conditions that are conducive for cavitation in centrifugal pumps. These are:

- operating heads much lower than rated head at peak efficiency of the pump.
- operating capacities much higher than rated capacity at peak efficiency of the pump.
- suction lift higher or positive suction head lower than recommended by the manufacturer.
- water temperatures higher than that for which the system was originally designed.
- pump speeds higher than manufacturer's recommendations.

Detail additional 25 mm threaded sockets and plugs on the suction (2 No) and discharge (2 No) pipework to allow for possible future monitoring or dosing.

## 13.13. Pump Priming

If pump priming is required ensure that the priming:

- water is treated water or is better quality than the pumped water
- pump is automated as far as practicable as manual priming can be difficult in some settings in the Banks Peninsula area.

## 13.14. Pipework

Do not specify plastic pipe in large pump stations i.e. >15 kW or > 40 m maximum head. Small pump stations (<15 kW or < 40 m maximum head) in the Banks Peninsula may have PVC or PE pipe work.

Detail flanges to all pipe work in the pump station. All mating flanges with flexible joints must be "full face". If welded flanges are fitted, machine the face flat after welding and seal weld. The faces must extend continuously from the pipe's ID to the flange's OD.

Where detailing connections to polyethylene pressure mains, Council design memorandum *Stub Flange and Backing Ring Tables* provides details on dimensions and drilling patterns.

Design the pipework in accordance with clause **Error! Reference source not found.** - Pipework. This includes protection of all pipework as described in clause 8.2 – Protection of Equipment, Surfaces, Coatings and Dissimilar Metals. Seal weld all welded joints to prevent water entry into the welded joint.

Specify galvanised steel, ductile iron, stainless steel or suitably protected API steel for

Specify galvanised steel, ductile iron, stainless steel or suitably protected API steel for all pipework inside or beneath the pump station and all above ground pipework. Specify the delivery pipe from the pumps in steel or ductile iron to at least the station's land boundary.

Where stainless steel is used, detail bolting of stainless flanges using stainless steel bolts, washers and nuts.

Velocities in pipes must not be greater than 2.0 m/s unless appropriate water hammer analysis has been done. Refer to clause 13.12 – Pump Suction and Discharge for velocity requirements for suction and discharge pipework.

Specify cast fittings complying with AS/NZS 2280. Specify any ductile iron fittings that will be cast into concrete and all bends within the pump station site with wall thicknesses complying with Table 5, unless approved otherwise. This increased wall thickness, compared to normal spun ductile iron pipes, is intended to mitigate internal abrasion.

**Table 5 – Wall Thickness**

| Internal Diameter (mm) | Wall thickness (mm) |
|---|---|
| 100 | 11.7 |
| 125 | 13.2 |
| 150 | 14.5 |
| 175 | 15.5 |
| 200 | 16.5 |
| 225 | 17.5 |
| 250 | 18.5 |
| 300 | 20.3 |
| 375 | 22.6 |
| 450 | 24.9 |
| 525 | 26.9 |
| 600 | 28.7 |
| 675 | 30.5 |
| 750 | 32.0 |
| 900 | 35.1 |
| 1050 | 38.1 |
| 1200 | 40.6 |

Council will confirm whether the pressure main can be drained back through the pumping station reflux valves and pumps or whether a separate drain line is required.

No Gibaults will be permitted above ground or within the station. Use Victaulic or similar in place of Gibaults.

Ensure that adequate clearance is provided around all pipework as described in:

- Clause 7.3 – Wall and Floor Penetrations; and,
- Clause 13.20 – Building Construction.

## 13.15. Pump Hydraulics

Design pressure pipelines and fittings to minimise hydraulic losses in accordance with IDS clause 7.6.5 – Pipe Hydraulic Losses. Calculate the losses from each fitting using the information in Appendix 9 – Calculating Pressure Losses due to Fittings.

Provide systems curves for the following scenarios:

- Minimum demand and high head conditions
- Maximum demand and low head condition
- Normal operating condition i.e. average head and average demand condition.

Show the scenarios on the pump curves. For booster stations with multiple parallel pumps, plot combined pump head/capacity curves for each duty pump combination. For the booster stations with variable speed pumps, plot pump curves for both the high and low end of the proposed pump speed on the system curves.

Carry out a surge analysis to check if damaging pressure surges could occur in a system. The level of detail of the surge analysis should be appropriate to the pipeline in question.

Submit hydraulic calculations together with a description of any potential for water hammer. Where surge analyses indicate damaging surge pressures or formation of vapour cavities in the piping, recommend surge protection measures. Possible surge mitigation measures are:

- provision of suitable pump controls such as soft starters and variable speed drives
- emergency shutdown for valves when there is a power failure to prevent flow reversal
- use of vacuum relief valves
- installation of pressure relief/surge relief valves on the system
- surge tanks or air vessels on discharge pipelines
- optimising the mains pipe work size and alignment
- pump discharge control valves (butterfly or PRV)
- reservoir inlet control valves (altitude valves or PRV)

## 13.16. Pump Motors

Select motors with sufficient capacity to drive the pump and to meet the requirements in the *Pro-forma Generic Electrical and Automation Specification*[3]. Ensure the motor is non-overloading over the range of duties at which the pumps is expected to operate.

Where these requirements cannot be met, submit a non-conformance report to Council.

Do not unnecessarily oversize the motors to achieve the above requirements or the future capacity requirements described in clause 13.11 – Allowance for Future Capacity or Extension. Select motors with care as efficiency and the power factor drops in motors running below the load rating.

## 13.17. Pump Station SCADA

Provide instrumentation and control at pump stations to measure, control, and monitor the pumping system, as covered in the *Pro-forma Generic Electrical and Automation Specification*[3Error! Bookmark not defined.].

Starters may be soft (electronic) starters or variable speed drive (VSD) to reduce inrush currents during pump starts for all pumps/motors of 4 kW or more. Other starting methods such as direct on line (DOL), star delta and auto transformer may be approved on a case by case basis for the smaller Banks Peninsula surface water intake pumping schemes. Orion will not accept DOLs for systems > 4kW.

In deciding on whether to use a variable speed or fixed speed control panel, take into account appropriate technical and cost information. VSDs work well when pumps with variable flow rates are pumping directly into the network while required to maintain the same delivery pressure.

A full set of standard mechanical and electrical drawings showing the required standard of detailing can be obtained from the Council. These drawings include the preferred Aucomm soft starters or Schneider Electric Variable Speed Drives (VSD). If the Aucomm soft starters and Schneider Electric VSD units are not used, specify comparable equipment that gives the same functionality.

Include the following notifications and alarms in addition to those specified in the *Pro-forma Generic Electrical and Automation Specification*[3].

- Control of pumps based on tank levels and/or system pressure.
- Run signal for each pump.
- Pump flow rate for each pump.
- Total Volume
- Reservoir levels
- Suction and discharge pressures
- Pumping hours i.e. elapsed time
- Power drawn in kW
- Generator run status signal (if installed)
- High/low alarms for inlet and outlet pressure.
- Pump bearings temperature
- Pump motor overload alarm.
- High/low reservoir level alarms.
- Pumps and valves failure alarms.
- Pump station temperature alarms (high/low)
- Fire/smoke alarm.
- Power failure alarm.
- Generator running alarm.
- Low generator fuel alarm.
- Surge relief activation alarm (if applicable).

## 13.18. Pressure Tanks

For the small closed system pump stations (clause 13.6 – Open vs Closed Systems) such as those in Banks Peninsula specify pressure tanks in order to reduce pump cycling. Design the pressure tank based on the following:

- Size the pressure tank to provide sufficient volume for the peak demands.
- Mark the maximum allowable working pressure on each tank.
- Provide a means to isolate the pressure tank to allow maintenance while still meeting demand requirements.
- Provide adequate control equipment to allow for efficient operation. Most manufacturers will provide adequate control options.

## 13.19. Appurtenant Design

If the pump station's electrical panel is located in a building as defined by the Building Code, specify as a minimum:

- 4.5 kg fire extinguisher
- Approximately A3 size blackboard on wall by personnel door
- Metal rubbish bin
- Lectern, or hinged plan table if space allows

### 13.19.1. Pressure Gauges

Specify the installation of pressure gauges which read in kPa, with a pressure range such that the maximum pressure reading is around 50% to 60% of the range.

Specify test points on the pump inlet and on ALL delivery pipes. Detail test points that are:

- 1/4 inch BSP female thread
- fitted with a pipe plug
- installed as close to the pump as possible
- on the pump side of any valves where possible
- with an accuracy to ±5% or better

Specify test points flush with the inside wall of the pipe, with the test point positioned to minimise the potential for the various velocities or turbulence inside the pipe to affect the gauge reading.

Detail a hole diameter through the test point fitting of less than 4mm to minimise turbulence. This diameter can be increased at distances greater than 4mm from the inside pipe wall.

### 13.19.2. Flow Meters

Specify a Mag-flow meter on the pressure main from the pumping station, using the *Magflow Meter Specification* and as also specified in the *Pro-forma Generic Electrical and Automation Specification*[3].

### 13.19.3. Valving

Detail sufficient isolation valves to enable the pump station to operate while one pump, or any other major plant item, is being serviced. Specify valves rated to PN16.

Detail reflux valves to be installed downstream of the pump and upstream of the isolation valve. These should ideally be inside the pump station building. Wafer type non-return valves can be specified for smaller pump headworks (<80 mm pipe diameter).

Locate isolation valves on the discharge pipe at least three pipe diameters from the pump control valves. As far as practicable provide each section of piping which may be isolated with a valved pipe drain.

Install pump control valves (valves to control flow during the start-up or shut-down of the pump) even when a variable speed drive is provided. Configure and connect the control valves so that:

- the pump starts on a closed valve
- they open slowly during start-up
- when the pump is signalled to stop the pump continues to run whilst the control valve slowly moves to the shut position, to avoid water hammer.

Detail a hand wheel to all sluice valves except those that are buried, which require square spindle caps only. Specify clockwise opening valves for all water applications (IDS clause 7.10.1 - Sluice valves).

Design the system to ensure the force required to open or shut a manually operated valve, with operating pressure on one side of the valve only and using a standard valve key or wheel, does not exceed 15kg on the extremity of the key or wheel. Detail a valve bypass arrangement to reduce pressure across the valve and/or provide geared operation where the force is exceeded. Specify motorised valves if the allowable force cannot be met.

Ensure all valves are easily accessible and identifiable. Cast iron valve covers shall be labelled “V”, painted white for normally open and red for normally closed if on the road.

Show on the design drawings all valves to be used to isolate equipment or sections of piping, or that are used for normal operation or control procedures. Other small valves, which are part of packaged equipment or instrument systems required by codes or indicated in equipment specifications, do not have to be shown unless deemed important.

Number all valves and provide a valve schedule on the drawings, including the valve number, pressure rating, type of valve, type of actuator, and sheet number of the drawing where the valve is shown.

### 13.19.4. Tapping Points

Provide adequate service tapping points including but not limited to:

- tapped holes for water, drainage and air release of at least 25mm internal diameter.
- pressure gauge and transducer tappings (clause 13.19.1 – Pressure Gauges) made directly to the pump headworks or via a tapping band.
- 15mm bronze sampling point tapping on the pump discharge pipe. The tap is to be mounted at approximately 1.5 metres above ground or floor level and inside the building.

Fit tapped fittings with stainless or bronze ball valves and copper pipe tubing fitted to the equipment.

## 13.20. Building Construction

The pump station building and the reservoir can be attached or separate structures.

Design the building to adequately house and allow the efficient operation, servicing and removal of all equipment in the building. Provide adequate space to move tools and equipment required to perform the entire spectrum of operation and maintenance procedures. Consider future expansion in the design of the building.

Provide a minimum clearance around and between pumps, diesels, open cabinet doors and extended racks of 600 mm.

Locate electrical equipment away from wet areas.

Design a minimum 1.2m wide x 2.0m high personnel service door. Specify solid timber or aluminium doors, with heavy-duty hardware, complying with clauses 8.6 - Security and 8.7 - Locks. Detail that large doors fitted for machinery access will open from the inside.

Specify pre-painted long run steel roofing to the colours in clause 8.2 – Protection of Equipment, Surfaces, Coatings and Dissimilar metals, considering the site’s context as explained in clause 6.4 – Site Requirements.

## 13.21. Structural Design

Design the structural aspects of the pumping station using low values for the concrete and steel stresses. This is customary practice for water retaining structures and should apply to the entire substructure. The higher resulting mass is useful for combating buoyancy.

When designing the superstructure, consider seismic risks as described in clause 6.6 - Seismic Considerations.

Do not build over pipes or fittings as they require replacement at a future date. If pipes are built over, detail a service pit to contain them, which is large enough for workman to replace the pipe without any excavation or demolition.

### 13.21.1. Screw piles

For structures using screw pile systems, comprising a central pile shaft with helical welded bearing plates, design piles with a minimum design life of 100 years and design and install to AS 2159

Design screw piles:

- with a minimum factor of safety of two (F-2.0) against ultimate mechanical failure of 800kN in compression, 100kN in tension and a maximum lateral deflection of 170mm at the seismic design load.
- to clause 6.6 – Seismic Considerations for liquefaction and the site conditions, while satisfying the pile tension capacity requirements.

Specify steel circular hollow sections:

- complying with API5L
- to a minimum grade of 350 MPa
- with a maximum yield strength no greater than 500 MPa
- with a maximum elongation no less than 20%

The use of second hand or used pipes is not acceptable.

Specify construction of the steel helix and end plate plug using Grade 350 plate to AS/NZS 1365 and with the following criteria:

- The pitch at the inside and outside of the helix must be equal (+/- 5mm)
- The gradient of the spiral should be constant
- Any radial measurement across the helix should be perpendicular to the shaft. (+/- 2%)
- Welds must be SP (Structural Purpose) to AS/NZS 1554.1 and NZS 3404, performed by a welder certified to AS/NZS 2980.
- Welding procedures and welds must be inspected by an independent third party inspector, to AS/NZS 1554.

Detail filling of the piles with minimum 30 MPa concrete in accordance with the *Specification for concrete production*.

Include the following in the Design Report:

- The pile material dimensional and manufacturing specification including ancillary products and treatments
- The individual pile foundation design loads and requirements
- The calculated ultimate pile capacities and requirements
- The calculated pile connection details and loads

- A corrosion assessment.

Include the following in the construction specification:

- The minimum foundation effective torsional resistance
- The maximum allowable installation torque and a requirement to monitor this at no less than 150 mm intervals
- The minimum required embedment lengths and inclinations and any other embedment depth or location requirements
- The contingency plan if the pile fails to found as designed
- Testing required under AS 2159 and AS/NZS 1554.1 that is to be covered by the Inspection and Test Plan

## 13.22. Electrical and Instrumentation Design

Design the electrical installation, including the generator and diesel engines, the motor starters and the three phase generator inlet plug, in compliance with the *Pro-forma Generic Electrical and Automation Specification*[3].

## 13.23. Noise, Ventilation and Air Conditioning

Design ventilation to the pump station and control temperatures to a maximum of 40°C inside the room, regardless of the outside temperature. Consider heat contributions from all sources inside the building or cabinet. Design the ventilation in tandem with the soundproofing, as ventilation may increase external noise levels directly or indirectly.

If air conditioning is required to control the maximum temperature in an electrical room, include measures to maintain internal relative humidity between 40% - 60%, to avoid condensation and static electrical shock.

For intermittent ventilation i.e. active only when there are personnel inside the pump station, specify a fan capable of 30 complete air changes per hour.

## 13.24. Generators – Backup Power Supply

Backup generators are required on most pumps.  Whether or not a proposed project will require a backup generator will be confirmed by Council at the pre-design meeting (clause 5.1 – Design Records) and will depend on the risks associated with power failure. Generators may be permanent and fixed or portable as discussed with and agreed to by Council.

As a minimum specify a unit capable of powering the largest pump, plus all auxiliary equipment (ventilation fans, battery chargers, lighting etc.). It must be capable of powering the pump sets from stand still and zero reticulation pressure and, if required, of starting the standby pump when the duty pump is already running at full load.

Size the generator to match the load and method of starting employed at the pumping station. The generator must be a minimum size in relation to VSDs and must have advanced speed control in order to avoid “hunting” of the generator. The generator set must be able to run continuously at the rated output for several days at a time.

Design the installation to withstand seismic loading in accordance with the Building Code, Section BI, VMI, clause 12.0. Refer to the Pro-forma Generic Electrical and Automation Specification3 manual for further design and control requirements.

A consent for discharge of contaminants to air may be required from Environment Canterbury (clause 6.2 – Approvals and Consents).

Specify generators that meet the noise requirements of clause 6.7 – Noise and also as detailed in the *Pro-forma Generic Electrical and Automation Specification*[3].

Include in the commissioning procedure all tests required to complete Appendix 10 - Generator Commissioning – Load Test Report Sheet.

# 14. RESERVOIRS

This standard uses the words reservoirs and tank interchangeably.

## 14.1. Standard Reservoirs

The Council has design and standard drawings for a 250 $m^3$ reinforced concrete reservoir and a 500 $m^3$ reinforced reservoir. A full set of design drawings, specifications showing the required standard of detailing can be purchased from the Council. Read the 250 $m^3$ and 500 $m^3$ standard reservoir specifications in conjunction with this standard.

Carry out specific site investigations even if one of these designs is being considered for a site.

## 14.2. Reservoir Design Philosophy

A reservoir may be specified to fulfil one or more of the following objectives:

- Minimise the chance of contamination of the treated water.
- Reduce the water age and promote water turnover to reduce long detention times. This will facilitate good circulation to reduce microbial growth, prevent excessive decay of chlorine and possible formation of disinfection by-products etc.
- Ensure continuity of supply and maintain pressure
- Allow a balanced flow through pipelines and serve as a buffer between the source and the treatment plant or distribution system
- Supply water during peak demand periods
- Provide an emergency supply for fire protection.
- Minimise temperature differences in the reservoirs. Temperature differences can cause thermal stratification.

Consider the following:

- Site the reservoir to promote turnover and the age of the water in the tank.
- Allow in the tank design for one side of the tank to be cleaned out while the other is still in use.
- If baffles are required. A standard tank with baffle walls allows one side to be accessed for cleaning. As a guide a baffle factor of 0.7 – 1.0 has been accepted by the Council on recent projects e.g. Wilmers Pump Station and Preston Pump Station. Refer to the DWSNZ2005/08 for guidance on the level of baffling required
- Visual impact

Reservoirs must turnover at least every 1-2 days based on average demand.

## 14.3. Types of Reservoirs

Any combination of material, location and use can be adopted in selecting the type of reservoir to be used for a site. The reservoir can be designed for installation:

- below ground (in-ground/buried) – a water storage tank that is partially or totally below the nominal surface of the ground.
- elevated – where a water tank is supported by a steel or concrete tower that does not form part of the storage volume. There are no examples of this set-up within

Christchurch. These could be relevant for some future sites in the Banks Peninsula area.

- ground level reservoir – a water tank that is located on the ground where the width/diameter is greater than the height.

Site ground level and below ground tanks above flooding areas. Site and size elevated tanks to reduce the pumping requirements. Design elevated tanks to supply the peak demand for that zone.

Reservoir materials can include:

- reinforced concrete
- welded or bolted steel
- timber
- polyethylene
- fibreglass

In selecting the tank materials consider:

- design performance criteria and design life;
- construction considerations – this includes the ease of construction/installation of the tanks at each site;
- maintenance requirements; and,
- cost.

All other materials and products used inside the reservoir must be compatible with the storage of potable water. Sealants that can support long term biological growth, in the absence of a chlorine residual, are not acceptable. Most sealants will support a biological growth for the first two to three months after installation

Select the final reservoir type to provide stability and durability as well as protect the quality of the stored water. Tanks with flexible liners or with expected design lives significantly less than 100 years are acceptable only as a temporary installation where provisions for permanent storage have also been made.

Provide appropriate design calculations and justifications to support the final selection, for review by Council.

## 14.4. Reservoir Site Selection

Assess options for locating the reservoir against the following factors:

- Availability of sufficient area to build and maintain the facility. Future expansion requirements should also be considered.
- Distance from the source and to the served zones/areas.
- Existing ground-surface elevation and conditions e.g. site drainage
- Geotechnical considerations and soil conditions/suitability including foundation design requirements, soil bearing strength, groundwater elevation (clause 6.6 – Seismic Considerations)
- Accessibility (as described in clause 6.4 – Land Requirements),
- Hydraulic suitability (elevation)
- Availability of services e.g. power
- Visual impact

Ensure there is unobstructed access around the reservoir to allow for inspection and maintenance at all times, clear of obstructions.

Provide a permanent power supply the site. This can be single phase or three phase, depending on the local supply condition.

## 14.5. Reservoir Sizing

A smaller reservoir or a suction tank may be accepted if reliable source water is available to meet all demands at the required flow rate and duration.

Determine the total reservoir storage using the following equation:

*Total Tank Storage = Balancing Storage + Emergency Storage + (Fire Storage)*

The total storage should balance inflow and peak day demand for at least four hours during an operation and maintenance event or in the event of interruptions to the inflows. Where fire protection is provided, ensure the fire requirements as defined in SNZ/PAS 4509 are met.

Provide balancing storage to meet demands in excess of inflows during the 4 hours of peak demand (16:00 – 20:00 hrs) each day. Where the source supply is not limited or water treatment is not needed, a smaller suction tank (clause 14.6 - Suction Tanks) would be an economic alternative to provide flow balancing and also manage the surges in the network from the supply wells.

Emergency storage volumes shall be provided to supply demands in the event of pipeline or equipment breakdowns or maintenance shutdowns. Avoid excessive storage as it reduces the turnover frequency and increases the water age in the tank (to >4 days) and this affects the water quality.

Where chlorine disinfection is required in the reservoirs, include in the storage calculation the minimum contact time required (clause 12.4.4 – Chlorine Disinfection).

## 14.6. Suction Tanks

Design suction tanks to:

- cater for multiple well pump situations so the tanks balance the flow and pressures from the wells both from the same aquifer or from different aquifers
- provide flow equalisation between the sources and the pumps as a way to manage short term peaks
- control surges on wells
- settle sand from the water source.
- provide the hydraulic retention time based on general water quality
- achieve the plug flow of the water for the desired contact time
- provide maximum sand settlement based on the sand particle sizes from the water source.

Design all other aspects of suction tank design and controls for full size reservoirs.

## 14.7. Reservoir Structural Design

Assume an allowable bearing stress of 100 kPa for the foundation material design unless specific testing shows a higher allowable pressure.

Design wall to floor joints so that leaks are obvious under visual inspection without the need to open or remove any accesses. A collector system should trap water leaking from the reservoir’s floor. The collected water should be piped to a point that can be easily monitored without the need to open or remove any accesses.

Specify concrete floors with a minimum finish equivalent to “U3” as defined in NZS3114 – clause 305.3 Concrete Surface Finishes i.e. a finish with abrupt changes not exceeding 3mm and gradual variations not exceeding 5mm.

## 14.8. Reservoir Pressure Management

Pressure in a water network system including reservoirs may need to be managed more strictly to ensure a consistent level of service to the supplied zones.

## 14.9. Break Pressure Tanks and Pressure Regulating Valves

Consider installing break pressure tanks in the Banks Peninsula area, primarily to manage pressure in the lower lying zones and also provide secondary storage.

Consider using pressure regulating valves (PRVs) with pressure relief to the storage reservoir under low demand conditions. PRVs may, if required, be provided for pressure regulation in the distribution system. Should PRVs be used, consider locations that are easy to access and identify for operation and maintenance purposes.

## 14.10. Reservoir Pipework

Hot dip galvanise all exposed steel pipework. All buried pipework within the reservoir site boundaries and the main in the roadway can be ductile iron or PVC-u depending on ground conditions, pressure variations and other variables that would affect reliability and life.

Determine the maximum likely differential movement between the reservoir and pipework (e.g. due to liquefaction or significant long-term settlement). Provide flexible joints that allow for the greater of this movement, or 25 mm. Detail the joint surround to provide protection and allow full joint movement, and allow inspection where appropriate. Also refer to clause 6.6 – Seismic Considerations for seismic design requirements.

Provide for chlorination. Include a 20mm PVC pipe in the tank for hypochlorite dosing. Chlorination control is to be driven from SCADA (clause 12.4.4 – Chlorine Disinfection).

Design the inlet and outlet pipes for maximum efficiency and to achieve the design objectives in clause 14.2 – Reservoir Design Philosophy.

Endeavour to achieve passive mixing by using 'inlet/outlet strategies':

- replacing a common inlet/outlet with separate pipes
- altering the location or orientation of the inlet and outlet pipework or the distance between them. Mixing can be maximised by deliberately creating turbulence at the inlet and avoiding a straight stream or jet from the inlet to the outlet. This can minimise the temperature differential within the reservoir and avoid stagnant zones. Temperature variations (≥10°C) can cause thermal stratification - this can be prevented by locating the inlet pipe as low as possible.
- reducing the diameter of the inlet. A smaller inlet pipe will assist in increasing the inlet momentum (velocity x flow rate) and so reduce thermal stratification.
- installing a duckbill or check valve to increase the velocity of the inlet jet

or 'flow direction strategies':

- installing baffles, walls or other obstructions

or 'operational strategies':

- forcing turnover of water in tank by reducing minimum operational water level.
- reducing maximum water level in tank.

Where possible adopt longer fill cycles to promote mixing by increasing the time for circulation to develop.

Specific design considerations for the inlet and outlet pipes include:

- provision of a riser on the inlet and outlet pipes to clear the reservoir bottom to prevent sand and debris from entering into the pipes. Provide a minimum riser clearance above the sump floor of 250mm and locate it 1- 2.5 m from the external wall.
- an easily accessible motorised isolating sluice valve mounted on the reservoir side of all the other valves and fittings. Use a battery and charger separate from the SCADA system for the electric actuator. The actuator shall:
  - be selected to match the valve.
  - incorporate a hand wheel to enable the valve to be opened manually. This will require sufficient space to be provided for a person to access and operate the valve manually.
- a combined air release/vacuum valve fitted on the reticulation side of the main isolating valve. The valve can either be screwed into a pipe socket or flange mounted. Ensure the combination air/vacuum valve is capable of allowing sufficient air into, or out of, the pipe when the main isolating valve is closed and:
  - water velocity in the pipeline ≤2 m/s
  - pressure in the pipeline is between 0.75 and 4 bar.
- a combination air/vacuum valve that:
  - has an extension long enough to take the outlet/inlet point above the flood level.
  - is protected to prevent contamination of the water supply.
  - is sited such that water leaking past the valve can be seen without the need to open or remove any access.

Allow for separate pipelines from each well to the suction tanks or reservoirs. This provides redundancy in the system should one pipe or valve become damaged.

## 14.11. Reservoir Appurtenant Design

Design and install all appurtenances to be water tight and protected from freezing, which will interfere with proper functioning. Include these fittings on the reservoir, in addition to those in the following clauses:

- Reservoir isolation valve(s)
- Altitude valves or equivalent level control
- Air release/vacuum release valve on the distribution system side of the isolation valve
- High- and low-level alarm system that directly notifies operations personnel
- Level controls

### 14.11.1. Overflow Piping

All storage reservoirs must have a separate overflow pipe. Detail the overflow to:

- pass three times the maximum possible flow into the reservoir.
- operate automatically when the reservoir’s water level exceeds a maximum designed height
- as a guide, a level set enough above the normal maximum operating level to give at least an hour’s warning of an overflow if there is potential of damage to the area below the tank. If there is no risk of damage to the area, set the overflow 200 mm above the normal maximum operating level.

- where overflow discharge is into an existing stormwater drainage pipe, provide an air gap to protect the potable water supply.
- never discharge directly into a wastewater pipe.
- not cause erosion where it discharges into a waterway or landscaped area
- terminate 500mm above finished grade for above-ground reservoirs and to discharge to an engineered drainage inlet structure or a splash plate
- screen the overflow pipe to prevent birds and vermin from entering into the system.
- allow draining the reservoir for maintenance purposes.

#### 14.11.2. Venting

Reservoirs should be properly vented. Design the vents:

- to prevent access/contamination by birds, vermin and dust.
- with a non-corrodible screen/mesh
- to stop external water from entering into the reservoir.

Overflows are not considered to be vents. To be effective, vents should be able to allow air into the reservoir at a rate greater than or equal to the rate that the water is withdrawn from the reservoir to prevent structural damage. This is particularly important for plastic reservoirs.

#### 14.11.3. Roof and Access Hatches

_Roofs_

Construct the reservoir roof to completely cover the top of the reservoir and prevent the ingress of birds, vermin, insects, dust, rubbish and other extraneous matter. Reservoir roofs must be watertight and adequately sloped and drained to prevent ingress or pooling of rainfall.

Ensure the roof does not come into contact with the stored water.

For larger concrete and steel reservoirs, provide ladder access to meet the following requirements:

- Design or lock the ladder to prevent unauthorised access to the roof.
- Detail handrails and barriers on the reservoir roof and surrounds that comply with “OSH Construction Bulletin No 16 Stepladder Safety Jan 2001.
- Fit fall restraint anchors at the high point on the top of the reservoir roof. Consider a mesh or webbing catch frame installed in the hatch around probes to protect staff from falls.
- Where possible, ladders should be inclined rather than vertical. Ensure all ladders, barriers, hatches, handrails and other safety devices comply with standards that will satisfy the Health and Safety in Employment Act.

_Hatches_

Design reservoirs to be accessible for inspection, cleaning and maintenance.

Size access hatches to conveniently accommodate personnel and equipment access. Detail sealed access hatches with a locking device. They should be operable by one person (i.e. an opening weight of ≤20 kg).

Detail one hatch in a manner that the hatch can be completely removed for ventilation and rescue purposes using a tripod. Hinge the other hatch’s lid with the hinge adjacent to the reservoir wall, near but not over the inlet.

Position each access hatch no closer than 2.0 m from the reservoir edge, unless the roof is level with the ground.

Access hatches on reservoir roofs should be elevated 200 mm minimum to prevent drainage water from entering the reservoir through potentially compromised seals.

*Safety Requirements*

For larger reservoirs, include in the design:

- A walkway between manholes on the roof
- Safety ropes and anchor points able to support 2 x 100 kg people.

### 14.11.4. Water Sampling Points

Provide lockable water sampling points which are normally taps. Install these for easy and safe access to enable safe collection of water samples for both bacteriological and chemical analysis. Also refer to clause 13.19.4 – Tapping Points.

### 14.11.5. Sump and Scour Pipe

Provide a sump in the floor of large reservoirs adjacent to the end of the inlet pipe, which allows the reservoir to be completely drained. Fall the floor at 1:50 towards the sump, dimensioned at 600mm x 600mm x 600mm.

Provide a scour pipe:

- with a ≥ DN80 mm external manually operated valve.
- connecting the reservoir sump to an approved outfall
- and valve capable of handling the same flow of water as the overflow.

Ensure that release of water from the scour pipe does not cause erosion or damage. Install a restrictor e.g. a valve or orifice to control the discharge if there is risk of damage.

As with the overflow pipe discharges, seek confirmation from Canterbury Regional Council that a resource consent for the discharge from the scour pipe is not required.

### 14.11.6. Electrical Ducts

Provide mild steel galvanized 40mm pipe for electrical cables ducts/conduit for reservoir level sensors and extend it to the inside of the control building.

Where possible, place pipework, the access hatch and access ladder as close to the control building location as possible to keep conduit and cable runs as short as possible. The access hatch on top of the reservoir should be placed as close as possible to the access ladder and location of the duct. The duct is intended to be secured to the ladder where possible.

### 14.11.7. Breather

Fit a breather with a minimum diameter of 50mm above the maximum possible water level in the reservoir. The breather design must be such that there is no possibility of the interior of the reservoir being subject to pressures above or below atmospheric pressure.

Design the breather to prevent any contamination of the reservoir's interior. This can be by gauze or similar. The open end of the breather will normally be turned down to prevent contamination falling into the system. Ensure any filtration system is easily serviced and secure from vandalism.

### 14.12. Reservoir Control and Monitoring

Provide reservoir controls and monitoring equipment not limited to:

- a system to monitor and control storage volumes
- altitude valves or equivalent level controls showing the position and status of the valves
- high and low level pressure sensitive switches
- isolation valve status
- alarms must include high level, low level, and pump failures
- electronic level control device linked to the supply pump
- overflow and Low level alarm

House control equipment in a secure structure. Generally, this structure will be adjacent to the reservoir, but it could be placed on top of the reservoir. If the structure is placed on top of the reservoir, place it adjacent to the access ladder and hatch housing the level controls.

Refer to the *Pro-forma Generic Electrical and Automation Specification*[3] for further control requirements.

## 15. CIVIL WORKS

### 15.1. Site access

Provide all-weather vehicle access to site buildings i.e. the reservoirs, pump station, valves, electrical and any other major equipment installed on site. Detail sealing to all pedestrian accesses.

Where indivisible components requiring servicing are between 20 and 200kg, design the access to be capable of handling a (rear mounted crane on a) light truck with the following dimensions:

- Length = 5 metres.
- Width = 2.5 metres.
- Maximum axle loading on 7.00 x 15 single tyred axle = 2500 kg.

Provide unobstructed access for lifting any component on site with a mass greater than 20 kg, where there is no permanent lifting gear. Ensure the rear wheels of the truck can be brought to within 2.0m of the vertical centreline of the component to be lifted.

When a diesel tank is installed on site, provide easy access for a 22 tonne 3 axle truck to within 5 metres of the filling point.

### 15.2. Crane

Where indivisible components requiring servicing exceed 40kg and it is not practicable to use a temporary lifting device, provide a crane rated at 125% of the maximum indivisible load mass. The crane may be a simple gantry or an overhead travelling crane dependent on the size of the lift.

Detail the crane to allow the handling of equipment from the deck of a truck or utility to the equipment's final mounting position.

### 15.3. Benchmark

Provide a level reference mark within the site that is accurate in the vertical plane to two decimal places with an accuracy of ±15mm to the origin of the level, a Council benchmark. Install it:

- at reservoirs, externally in a concrete nib, slab or manhole lid surround as close as practical to the level control equipment.
- for pump stations including those associated with a reservoir, in the concrete nib or slab adjacent to the main pump access opening.
- for other structures, in a concrete nib or slab adjacent to the main structure.

Obtain a 40mm stainless steel disk labelled "Survey Mark" from the Council or from fieldworksupplies.co.nz and fix it by 8mm concrete nail, as shown in the photograph.


Provide the following documentation within the structure's Operations and Maintenance manual:

- a finder diagram (an example is provided in IDS Part 2: General Requirements Figure 3 - Finder diagram), showing the reduced level to three decimal places e.g. 13.225, 13.250;
- certification from a Licensed Cadastral or Registered Professional Surveyor (a sample certificate is provided in IDS Part 2: General Requirements Appendix III – Benchmark Certificate);
- the methodology used e.g. differential levelling, GPS, precise levelling.

## 16. LANDSCAPING

Design the street side landscaping to reflect an average property in the area, including fencing. Submit the landscaping plans as part of the Design Report for acceptance and comment, Design the landscaping to comply with the *City Plan* rules relating to visual impact and consistency.

Ensure landscaping does not hinder access, operation or maintenance of the facilities. Present the operation and maintenance costs of the proposed landscaping for acceptance. Design the landscaping complying with IDS clause 10.9 – Landscape Planting to reduce ongoing maintenance by:

- selecting low maintenance plant varieties,
- keeping lawn areas to a minimum and sowing them with low maintenance grasses (Slow Grow),
- selecting drought resistant plantings and lawn varieties,

- making the landscaping at the rear of the station, out of public view, very basic e.g. mulch chip, and
- Locating trees further than 1 metre from, and incapable of, overhanging any fence line.

Specify common plants that won't become a target for thieves.

In addition to the plants listed in IDS Part 10 – Reserves, Streetscapes and Open Spaces Appendix I, Inappropriate Trees and Plants, do not use the following plants, due to their high maintenance costs or potential for security issues (creating hiding places):

- Cordyline australis (Cabbage tree)
- Cortaderia (pampas grass)
- Flax spp
- Berberis spp (Barberry)
- Ilex spp (Holly)
- Myoporum laetum (Ngaio)

# 17. TESTING AND COMMISSIONING

Council Pumping and Control staff must witness any commissioning work and testing. Involve specialist suppliers and contractors as necessary. Provide at least five working days' notice of the SCADA functionality checking, any commissioning or testing to Council. Also notify Council of the expected date of handover of operation of the pumping station.

Pre-test any work required to be tested in the presence of Council, to prove it is satisfactory. Prior to pre-testing, ensure that:

- the installation is in accordance with the specification and drawings, except as varied by accepted non-conformances
- all equipment is in proper working order
- programming and settings have been completed and checked
- any automatic controls that might invalidate the tests have been overridden
- the testing and commissioning schedule (including has been prepared and presented to the commissioning personnel and to Council **two weeks** before the start of commissioning
- rotation of installed pumps is correct
- the Outstanding Work/Defect List is completed (refer Appendix 4– Outstanding Work/Defect List Example)

Specify a water test for all concrete tanks and below ground structures to *Testing Reinforced Concrete Structures for Watertightness* where testing is practical.

Provide draft Operations and Maintenance Manuals (OMM) and as-built plans to Council at least 5 days prior to commissioning. Use the *Water Supply Pumping Station O&M Manual Template.*

Provide generator load tests. Refer to Appendix 10- Generator Commissioning load Test Report Sheet (also refer to clause 13.24 – Generators - Backup Power Supply).

Provide pump tests to confirm that the finished station meets the design flows, using the method in Appendix 11– Pump Test Methodology and providing results as detailed in Appendix 12 - Pump Test Sheet. If there are multiple head conditions, supply pump test results for all conditions.

Complete the remaining certificates in the COG Construction Work Pack including the Practical Completion Certificate (refer Appendix 6 – Practical Completion Certificate), the

Final Handover and Acceptance of Plant Ownership Certificate (refer Appendix 7 - Handover Certificate) and the Control System Commissioning Handover Certificate (refer Appendix 5 – Commissioning Certificate).

In conjunction with the commissioning process, Council will calibrate the analogue control loops.

# APPENDIX 1 SAMPLE SUBMITTAL DRAWINGS

Sample drawings are still under development.

Contact Council for the most relevant examples.

# APPENDIX 2 WELL DEVELOPMENT PROCEDURES

The following well development procedures are to be considered during the design and specification of wells and pumps.

**Drilling**

Bore construction shall comply with the NRRP Chapter 4, Schedule WQL4 and the pLWP.

Specify the method of well drilling to suit the site constraints. The Well Driller must confirm his equipment has the capacity to drive the casing to the desired depth.

Specify the collection of logs of the thickness, type, depth and location of the various strata encountered during drilling. Record the depth of all intermediate water bearing aquifer levels with any other relevant data e.g. the rate of water flow and pumping draw down of any significant water flows.

Supply one copy of these logs to the Council, and a further copy to Environment Canterbury, as required by the Resource Consent.

In the area of the proposed screen zone, specify the taking of sediment samples at a minimum of two intervals. To isolate the area to be sampled, drive the casing to one metre depth and then clean it out. Take two sand pump full samples at each depth.

Each sample shall contain the entire contents of a sand pump. Retain all the water contained in the sand pump with the sample and allow fine sediments to settle before siphoning off excess.

Record the depth of the samples on the sampling containers and on the bore log.

Samples shall be analysed for particle size distribution and the results provided to the Council.

In order to minimise the impact of the well drilling on pumping from any existing operational wells on the pump station site, shut existing wells down when passing through the aquifer these wells are in and put them back in service (after flushing to waste) once the drilling has penetrated past this aquifer.

Shut down any existing operational wells in the target aquifer until the completion of development and testing of the new well.

**Casings**

Drive casings straight and vertical. Join casings by continuous welding carried out in accordance with good trade practice.

*Outer Casing*

Supply and sink an outer casing to the specified depth. The Well Driller must confirm that his equipment has the capacity to drive the casing to the desired depth.

Terminate the outer casing in a clay layer near the target depth to ensure casing is sealed against artesian water intrusion. On completion of sinking the casing, pressure grout between the casings to a minimum depth of 4.0m at bottom the casing and backfill remaining cavity with bentonite to 1.0m from top surface of well chamber base. On completion of construction of the headworks chamber, fill remainder of cavity to top surface of well chamber base and the casing with RL 1035/1 two component polyurethane adhesive in accordance with the manufacturer’s instructions and safety data sheets.

*Well Casing*

Specify a well casing of 300 mm (12”) diameter API 5L STD line pipe (9.53 wall). Line pipe with wall thickness less than 9.53 is not acceptable.

Centralise the DN460 and DN300 casings at the surface to give maximum seismic flexibility.

Supply the well casing epoxy coated on the inside surface. The weld affected area at the casing joints does not require treatment. Specify epoxy coating in accordance with:

- “Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines”; American Water Works Association Document Number C210-07 (01 May 2008), or
- an equivalent epoxy coating system that can be demonstrated to be as effective as the method described in (a), above.

*Finished Grade (below-ground wellhead and chamber only)*

Detail that the chamber extends a minimum distance of 200mm above ground level finished grade.

In areas with potential for contamination, extend the top of the chamber for public supply wells at least 200 mm above the recorded or 20-year flood level. Detail any extension greater than 200 mm above the ground level to be removable.

**Preliminary Testing**

When it is thought that a suitable aquifer has been reached, carry out preliminary testing before development, to determine the suitability of the water supply at this aquifer, with respect to flow rate and drawdown at the target final developed flow rate.

For pumped wells, such preliminary testing may be done with an air lift or direct pumping measured in a manner approved by a qualified engineer or hydrogeologist.

During drilling of the well, preliminary testing may be carried out at the target aquifers of any other wells to be drilled at the site, if confirmed by the Engineer and suitable screening positions can be found in these aquifers.

**Sand Screening**

When a suitable aquifer has been located, install a stainless steel screen. After preliminary tests, undertake sediment analysis, and water analysis, regarding the type, slot size and length of screen, to allow the best screen dimensions to be determined.

**Pulling Back**

In order to install the sand screen at the predetermined level in each well, pull back the casing first to the level of the bottom of the screen; then backfill the lower well with grout and gravels. After the screen has been positioned, pull back the casing to the top of the screen, which shall be fitted with a suitable leader, properly swaged into the casing to make a sand tight joint. The Well Driller must undertake that his equipment has the capacity to pull the casing back to the appropriate depth, and make good any loss or damage to the casing and/or screen which may have been caused during the pulling back operation. Bailing in of screens is not acceptable.

**Development and Proving Wells**

After the screens have been placed in position, develop the well until the sand content in the water, at the target final developed flow rate, is less than 3 g/$m^3$.

Measure the volume of water with an approved meter and pump the well for a period of not less than four hours continuously. Determine the drawdown during pumping by measurements in a standpipe and/or pressure gauge (for water pressures above the casing) or by the electric plumb-bob method.

Keep an accurate and frequent record during the early stages of pumping, to establish the drawdown curve for the well. Undertake sampling of the water to confirm the sand content. Unless advised otherwise, pump testing cannot commence until the sand content is less than 3 grams/$m^3$.

**Capping**

Cut off the 460mm casing 400mm below ground level and the 300mm casing 150mm above ground level, weld on the casing valve flange and install the casing valve. Grout and SEAL. **Actual** internal diameter of the casing valve **shall not** be less than the **actual** well casing internal diameter. Level grounds and make good ready for headworks installation.

**Sealing of Existing Out of Service or Replaced Wells**

Where any existing wells are to be sealed, grout, seal, and disconnect the well from the discharge. Seal the discharge line by bolting or welding a blanking flange at the disconnected end. Demolish the existing headworks and chamber down to 1.0m below ground level and reinstate the grounds.

Pack over and above the screen section with gravels to allow continuity of the aquifer over the screened section. Fill remainder of bore to ground level with bentonite or concrete grout.

**Testing**

On completion of development of the wells, undertake the following tests:

- both free-flow artesian and pumped artesian (can flow unaided but requires a submersible pump to provide sufficient flows); or
- pumped test only if well is non-artesian

If the wells at a site are in different aquifers, carry out the tests on completion of development of each well. Tests of any wells at a site in the same aquifer shall be carried out on completion of all wells in that aquifer, so that their interference effects can be measured.

**Free Flow Artesian Test (for Artesian Well Only)**

Carry out step draw down (5 steps) on the free flowing artesian well.

Commence the constant discharge test on the free flowing artesian well the day after the step draw down. The test duration will be up to 72 hours dependent on the requirements of Environment Canterbury. If an 8 hour test is permitted by Environment Canterbury and the drawdown level has not stabilised within the 8-hour testing period, extend the test period as required to give a stable draw down level.

**Pumped Test (for both Artesian and Non-Artesian Wells)**

Carry out step draw down (5 steps) on the pumped well.

Commence the constant discharge test on the pumped well the day after the step draw down. The test duration will be up to 72 hours dependent on the requirements of Environment Canterbury and shall start before 10 am with measurements of water level and water flow made at the frequency specified in Conducting Pumping Tests until completed. If an 8 hour test is permitted by Environment Canterbury and the draw down level has not stabilised within the 8-hour testing period, extend the test period as required to give a stable draw down level.

**Water Level Recordings**

Make four static water level measurements at 15-minute intervals in the test well during the hour prior to the commencement of each test.

Following the constant discharge tests, monitor the recovery water levels for a 240-minute period, at the frequency specified in Conducting Pump Tests.

Liaise with Environment Canterbury on their requirements for monitoring other wells in the vicinity.

If a new well is in the same aquifer as any existing wells at the station (or in the same aquifer as another new well), while testing the new well(s) also concurrently monitor and record the static water levels and recovery water levels as noted below in the existing or new wells in the same aquifer.

Monitor groundwater levels for 24 hours before and 24 hours following the test. This will be required when there is a likelihood of potential interference effects on neighbouring wells due to operation of the new well.

**Water Disposal**

Dispose of water during the development and testing of the wells in a manner that does not cause a nuisance either on or off the site. Approved drainage intakes shall be discussed and agreed to on site prior to the commencement of drilling. Any discharge into a territorial authority drainage or stormwater system will require the consent of that authority.

Comply with any consent and with the Canterbury Regional Council's General Authorisation for the Discharge of Aquifer or Bore Test Water, which requires the concentration of suspended solids in such discharges not to exceed 50 parts per million. Supply any settling tanks, or other equipment required to dispose of water in a complying manner.

Prior to commencing discharge into any open drains or waterways, notify the Council's Land Drainage Team so that the waterway can be inspected. Arrangements should also be made for re-inspection of the waterway after the work is completed.

Silt build-up in waterways is a major concern and the contractor will be responsible for any subsequent waterway clearing required as a result of silt build-up during development and testing.

# APPENDIX 3 HANDOVER FLOWCHART

**CITY WATER AND WASTE**
**FINAL HANDOVER PROCEDURE FLOWCHART**
**and ROLE EXAMPLES**

The following flowchart details the process of handover to City Operations Group for all City Water and Waste Projects. It is assumed that all required processes and documentation prior to the handover have been completed, e.g. Approved Commissioning Plan, Inspection and Test Plan, HAZOP results reflected in Construction Drawings, etc. The Engineer is responsible for ensuring the Handover and Acceptance procedure is completed to the following requirements. The signed forms referenced in this flowchart are to be provided as completion records.

**Construction Complete**

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**Pre-commissioning Phase and Safety Audit**

- Physical site inspection of completed construction work package
- Check HAZOP items closed out
- Physical site safety inspection using Health and Safety audit check process
- Construction Defects and Safety defects identified and recorded using **CWW Construction Work Pack Outstanding Work/Defect List** *Categories of defects to be agreed with Operations and A&NP using A to D ranking system as detailed in above form*.
- Draft O&M Manuals provided
- Draft of Final Management Plan provided (if required)

**SITE VISIT**
***Required attendees:***
- Engineer
- Contractor
- Designer

↓

**Hold Point**
Completion of all Category A&B Defects/Snag list

**Engineer accepts by placing initials on "ITEM COMPLETED" column of Outstanding Work/Defect List**

↓

**Systems Commissioning Phase**

- SCADA/HMC testing witnessed and agreed
- Confirmation plant functioning as designed
- Radio Aerial installed and tested

**CWW Construction Work Pack Systems Commissioning Handover Certificate 'Signed Off'**

↓

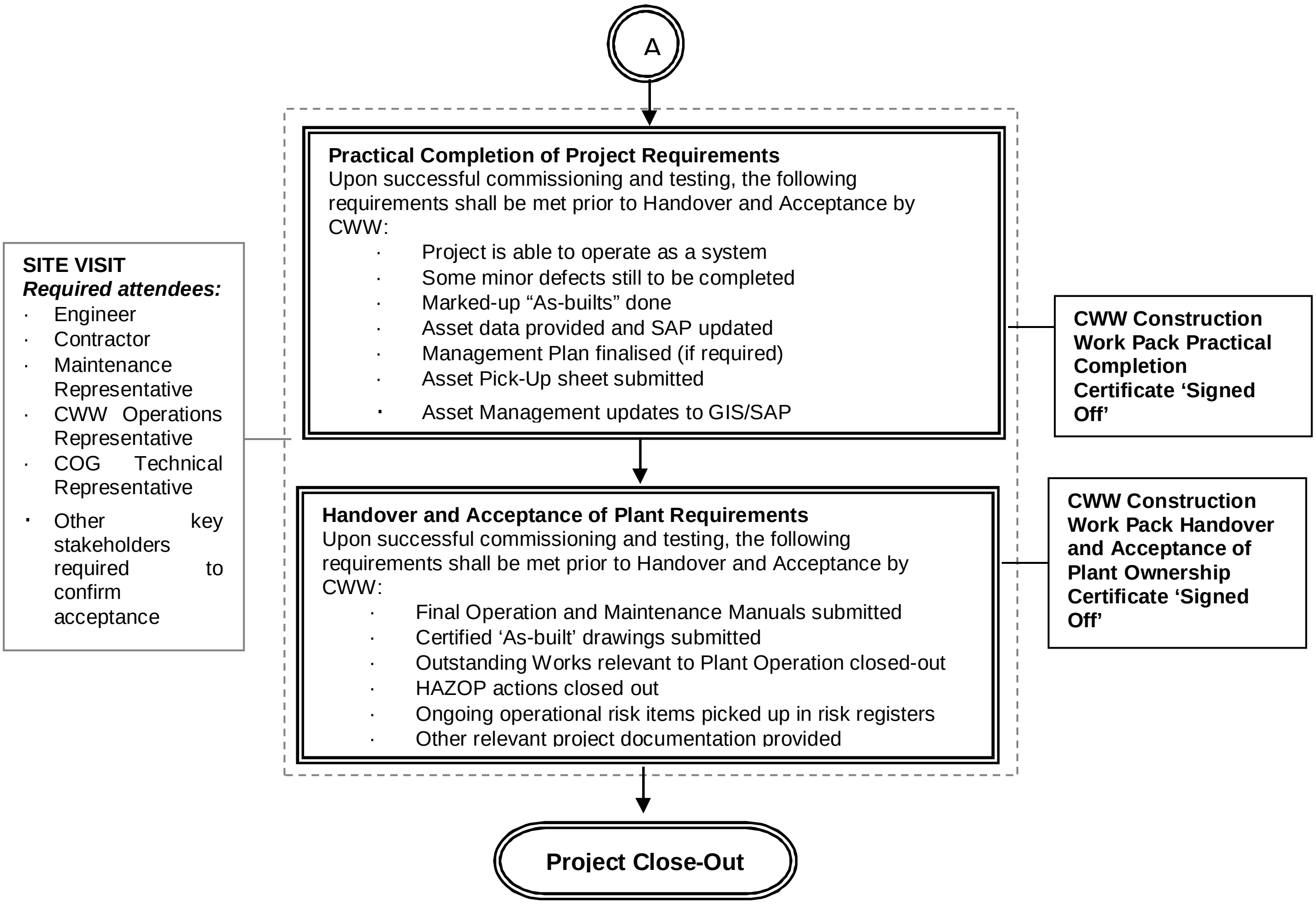
**Commissioning Phase and Documentation check (including):**

- Witness agreed tests (e.g. pump draw down tests, pressure tests etc)
- Surveying completed and loaded into GIS
- Operations reviewed manuals
- Operations staff trained on new assets/changes to network. Training signed-off

**SITE VISIT**
***Required attendees:***
- Engineer
- Contractor
- Systems Commissioning Rep (CWW)
- Systems Commissioning Engineer

↓

A




*ROLE EXAMPLES*

The table below details examples of staff required to sign-off the forms referenced in the above flowchart. Note that responsibilities differ according to assets and their location (i.e. Banks Peninsula or Christchurch City).

| Title | Example |
|---|---|
| Engineer | Technical Services and Design Project Manager/Engineer or External Project Manager/Consulting Engineer |
| Contractor | Construction company project manager |
| Maintenance Department Representative | City Care (CWW's Maintenance Contractor)<br>Pump Stations - Chris Barron<br>Banks Peninsula Treatment Plants – Hugh Blake-Manson |
| Operations Department Representative | Christchurch City Council<br>Pump Stations Christchurch City<br>Pump Stations Banks Peninsula – Rob Meek/Steve Pink<br>Treatment Plants – CWW Water and Wastewater Treatment Manager |
| COG Technical Representative | Project Client e.g.<br>Pump Stations and Reservoirs – Don Gracia<br>SCADA Systems Engineer – Mark Johnson |

# APPENDIX 4 OUTSTANDING WORK/DEFECT LIST EXAMPLE

| Christchurch City Council | CITY OPERATIONS GROUP<br>CONSTRUCTION / COMMISSIONING WORK PACK<br>OUTSTANDING WORK/DEFECT LIST | **WORKPACK REF:** |
|---|---|---|
| The listed Defect List items **must** be completed as dictated by the stated Category before the commissioning of the asset covered by this Construction Work Pack proceeds to the next phase. Phases and Categories are detailed in the Pump Station Pre-Commissioning, Commissioning and Testing Procedure.<br>· **Category A** – Complete prior to handover to COG for Control System Commissioning<br>· **Category B** – Complete prior to Clean Water Commissioning<br>· **Category C –** Minor items that do not prevent commissioning<br>· **Category D –** Items not part of project scope and SCIRT agreement required to incorporate<br>Type refers to the following:<br>· Snag (S) - any defects/faults/problems/issues/actions identified prior plant handover<br>· Defect (D) - any defects/faults/problems/issues/actions identified at plant handover and during Defect Liability Period | | **Station Name:**<br><br>**Page No.: of** |

| ITEM NO. | ITEM REPORTED BY, CATEGORY, AND DISCIPLINE: | | | | | DETAILS | PERSON TO ACTION | PROGRESS REPORT | | | ITEM COMPLETED | | ACCEPTED BY CEG | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | Date | Category | Discipline | Type | | | Initial | Date | Report | Initial | Date | Initial | Date |
| | | | | | | | | | | | | | | |
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*<u>Discipline Codes:</u>*

General – **Gen**; Civil – **Civ**; Mechanical – **Mech**; Electrical / Control / SCADA - **EICA**

# APPENDIX 5 COMMISSIONING CERTIFICATE

| Christchurch City Council | CITY OPERATIONS GROUP<br>CONTROL SYSTEM COMMISSIONING<br>HANDOVER CERTIFICATE |
|---|---|
| **PROJECT No.:** | **STATION NAME:** |
| **CWP No:** | |
| ***COMPLETION OF CONTROL SYSTEM COMMISSIONING*** | |
| **SYSTEM COMMISSIONING MANAGER COMPLETION**<br>The scope of work covered by the Control System Commissioning phase of the CWP has been completed by ________________________________________ as confirmed by the COG representative signature below. The System Commissioning Manager confirms that the CWP Control System has been tested and Clean Water Commissioning phase may commence.<br><br>Name ____________________Signed ____________________Date ______________ | |
| ***COMMISSIONING MANAGER*** | |
| **CONTRACTOR COMMISSIONING MANAGER**<br>The scope of work covered the Control System Commissioning phase of the CWP has been inspected and no defects are noted by the Commissioning Manager. There are no outstanding "Category B" snag/defect items. The plant is ready for the Clean Water Commissioning phase. The Commissioning Manager accepts control for the Clean Water Commissioning phase.<br><br>Name ____________________Signed ____________________Date ______________ | |
| ***COG CLIENT ACCEPTANCE OF CONTROL SYSTEM COMMISSIONING*** | |
| **COG CLIENT ACCEPTANCE**<br>The scope of work covered by the Control System Commissioning phase of the CWP has been inspected by City Operations Group (COG) Client representative and no outstanding "Category B" snags/defects are identified. The COG Client requirements applicable to this scope of work have been met and the COG Client representative confirms that the Clean Water Commissioning phase may commence.<br><br>Name ____________________Signed ____________________Date ______________ | |

Note:

1. System Commissioning Manager may be a 3rd Party Integrator or Council E&I Personnel assigned to program the Work.
2. COG Client refers to the E&I Team Leader if E&I Personnel were assigned to do the programming for the station or any E&I Personnel assigned to witness the system commissioning if the programming was done by a 3rd Party Integrator.

# APPENDIX 6 PRACTICAL COMPLETION CERTIFICATE

| Christchurch City Council | CITY OPERATIONS GROUP<br>CONSTRUCTION WORK PACK (CWP)<br>PRACTICAL COMPLETION CERTIFICATE |
|---|---|
| **PROJECT No.:** | **STATION NAME:** |
| **CWP No:** | |

***PRACTICAL COMPLETION (OPERATIONAL HANDOVER)***

**CONTRACTORS CONSTRUCTION SUPERVISOR / CONSTRUCTION SUPERVISOR (BAU)**

The scope of work covered by this CWP is complete and QA/QC is checked and complete. The 'For Construction' drawings have been field checked and marked up 'As Built'. There are no outstanding **"Category A"** snag/defects items. Other outstanding snags are listed on the attached Outstanding Work/Defect list. The CWP is released to the Commissioning Manager/Project Manager for their acceptance and handover.

Name ______________________ Signed ________________________ Date __________________

**CONTRACTORS COMMISSIONING MANAGER / PROJECT MANAGER (BAU)**

The scope of work covered by this CWP has been inspected and outstanding work recorded by the Commissioning Manager / Project Manager. The CWP drawings have been field checked and marked up 'As-Builts' and issued. There are no outstanding **"Category A"** snag/defects items. The Commissioning Manager / Project Manager will ensure that the outstanding snags listed on the attached Outstanding Work/Defect list are addressed prior to final handover. The project covered by this CWP is handed over to the Maintenance and Operations Department to manage following the acceptance requested below.

Name ______________________ Signed ________________________ Date __________________

***COG CLIENT / OPERATIONS / MAINTENANCE ACCEPTANCE***

**COG CLIENT ACCEPTANCE**

The scope of work covered by this CWP has been inspected by City Operations Group (COG) Client representative and no outstanding **"Category A"** snags/defects are identified. Any outstanding **"Category C"** items have been added to the attached Outstanding Work/Defect list. The COG Client requirements applicable to this scope of work have been met and the COG Client accepts initial handover of the plant covered by this Construction Work Pack for Practical Completion and Operational Readiness checks and commissioning.

Name _____________________ Signed _________________________ Date __________________

**MAINTENANCE CONTRACTOR (COUNCIL'S MAINTENANCE CONTRACTOR)**

The scope of work covered by this CWP has been inspected by Council's Maintenance Contractor representative and no outstanding **"Category A"** snags/defects are identified. Any outstanding **"Category C"** items have been added to the attached Outstanding Work/Defect list. The Maintenance Contractor requirements applicable to this scope of work have been met and the Maintenance Contractor accepts initial handover of the plant covered by this Construction Work Pack for Practical Completion and Operational Readiness checks and commissioning.

Name _____________________ Signed _________________________ Date __________________

**OPERATIONS TEAM**

The scope of work covered by this CWP has been inspected by an Operations Team representative and no outstanding **"Category A"** snags/defects are identified. Any outstanding **"Category C"** items have been added to the attached Outstanding Work/Defects list. The Operations Team requirements applicable to this scope of work have been met and the Operations Team accepts handover of the plant covered by this Construction Work Pack for Practical Completion and Operational Readiness checks and commissioning.

Name _____________________ Signed _________________________ Date __________________

# APPENDIX 7 HANDOVER CERTIFICATE

| Christchurch City Council | CITY OPERATIONS GROUP<br>FINAL HAND OVER AND ACCEPTANCE OF<br>PLANT OWNERSHIP CERTIFICATE |
|---|---|

**PROJECT No.:** ...................... **TITLE:** ................................................................................

**FROM:** ............................................................................................ (Contractor)

**TO:** ............................................................................................ (Maintenance Manager)

............................................................................................ (Operations Manager)

............................................................................................ (Asset Management)
(Print Name)

As from..............................(hours) on....................................(date) the Construction, Commissioning and Handover Phases of this Project are complete and the Plant is operating under the following conditions:

All Snag items on the Outstanding Work/Defect List have been completed satisfactorily and signed off. No additional outstanding work relating to this Project is required.

**Description of Work/Work Packs covered by this Project:**

**Delivery Team Project Manager** .......................................... .....................................
Signature Date

***ACCEPTANCE OF PLANT OWNERSHIP***

We the undersigned from Operations, Maintenance and Asset Management Departments accept ownership of the Plant covered by this Project from this date onwards.

**Maintenance Manager** ............................................................ ..................................................
Signature Date

**Operations Manager** ............................................................ ..................................................
Signature Date

**Asset Management** ............................................................ ..................................................
Signature Date

# APPENDIX 8 CONFIRMATION OF CONTRACTORS' HEALTH AND SAFETY MANAGEMENT PLAN

**To**: Christchurch City Council

PO BOX 73-014,

CHRISTCHURCH

**From**: ........................................................................................... (Name of Contractor)

................................................................................................................ (Address)

CONTRACT NUMBER XXXXX - DESCRIPTION

We confirm that this Company has a Health and Safety Management Plan which complies with the requirements of the Health and Safety in Employment Act 1992, Health and Safety in Employment Regulations 1995 and all other relevant legislation. This plan will remain in force for the duration of this contract and will not be amended or cancelled during this time.

We confirm the following requirements are part of the Plan:

- Health and Safety responsibilities are assigned to designated staff.
- A system is in place for the identification, assessment and control of hazards. Hazards are documented and control measures reviewed at intervals appropriate to the site and the contract.
- Company staff regularly inspect the workplace to ensure compliance with current health and safety legislation and other legislation relevant to the work processes being carried out.
- An Accident Register is kept on site. All instances of "serious harm" are reported to the Occupational Safety and Health Service.
- A company emergency plan is in place for dealing with a variety of emergencies.
- Health and Safety training is carried out on a regular basis for staff and documented.
- All staff working on site have the necessary knowledge and skills to perform their job competently and safely, or that they will be adequately supervised.
- A planned on site induction exists for employees, contractors and subcontractors.
- Any subcontractors working on this site must comply with safety rules and procedures.
- A system is in place to induct and monitor on site visitors. Any visitor is supervised.
- A system is in place to ensure the public is not endangered by work carried out on the site.
- The Company has issued a Company Health and Safety Manual/Booklet to all staff.

Other Information Required:

- The name of the company on site contract supervisor for this contract will be:
- A site specific Health and Safety Management Plan is to be submitted and approved prior to commencement of the work.

I the undersigned confirm that the above information is true and factual. I confirm that I am the authorised signatory for this matter.

Authorised Signatory: Title : ________________________________________

Name & Position: Date : ________________________________________

# APPENDIX 9 CALCULATING PRESSURE LOSSES DUE TO FITTINGS

It is important to include losses due to all fittings between the pump suction and the pressure main outfall as they can add significantly to the total head loss. The total loss in a station with smaller pipe diameters than the pressure main and with a significant numbers of fittings can easily equal or exceed the pressure main losses. Use a long section plot of the pressure main indicating all fittings to determine the losses, as it is essential to include the actual numbers and types of fittings to calculate the total head losses.

*Head loss for the pipe (in metres of water)*

$$hL = \frac{\lambda L V^2}{2gD}$$

Where:

$$Re = \frac{VD}{\gamma} \qquad \lambda = \frac{0.316}{Re^{0.25}}$$

L = length of pipe in metres

V = velocity in metres per second

g = gravitational constant

D = diameter in metres

Re = Reynolds number

γ = kinematic viscosity for water @ 15°C = 1.11 x 10-6 m2/s

The Reynolds number will not be below 4000, i.e. always turbulent, unless velocities are extremely low, therefore λ can be calculated as shown.

*Head loss in each fitting (in metres of water)*

$$hL = \frac{kV2}{2g}$$

| Fitting types | K |
|---|---|
| 45° bend | 0.25 |
| 90° bend | 0.60 |
| T (straight through) | 0.90 |
| T (side entry or discharge) | 1.40 |
| Open gate valve | 0.20 |
| Non-return (reflux) valve | 2.00 |
| Gradual expansion in diameter | 0.50 |
| Sudden decrease in diameter | 0.50 |
| Sudden increase in diameter | 1.00 |

# APPENDIX 10 GENERATOR COMMISSIONING – LOAD TEST REPORT SHEET

| | | | |
|---|---|---|---|
| DATE: | | SITE: | |
| CUSTOMER: | | CONTACT: | |
| JOB No.: | | PHONE No:. | |
| GENERATOR MAKE: | | MODEL: | S/No. |
| ENGINE MAKE: | | MODEL: | S/No. |
| ALTERNATOR MAKE; | | MODEL: | S/No. |
| CONTROL PANEL MAKE: | | MODEL: | S/No. |
| kVA: | Hz: | VOLTS: | HOURS: |

| VISUAL CHECKS | | TICK | REMARKS / FURTHER ACTION REQUIRED | |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | Door stays fitted | | | |
| | Internal lighting | | | |
| | Door Keys received | | | |
| | Hoses secure | | | |
| | Batteries Secure | | | |
| | Oil Level ok | | | |
| | Coolant Level ok | | | |
| | Coolant water backflow fitted | | | |
| | Coolant water solenoid fitted | | | |
| | Discharge water thermostat fitted | | | |
| | Discharge water to waste | | | |
| | Fuel storage compound fenced with gate and Padlock | | | |
| | Access ladder to refuelling point | | | |
| | Fuel Tank refuelling cap Padlocked | | | |
| | Fuel Tank signage fitted | | | |
| | Paintwork condition | | | |
| | Hazardous Substances Certificate sighted and attached* | | | |
| | Fuel pipes labelled | | | |
| | Fuel shut off valve operational | | | |
| | Fuel tank level at 50% | | | |
| | Fuel leak detection fitted | | | |
| | Fuel tank filled | | | |
| | Exhaust Pipes lagged | | | |
| | Exhaust system visual emissions | | | |
| | Flexible joints fitted to ducting & service connections | | | |
| | Generator set paint work condition | | | |
| | Alternator circuit breaker setting | | Thermal | Magnetic |
| | Alternator circuit breaker secondary injected | | | |
| | Flexible Load cables installed | | | |
| | Load cables size and connection | | | |
| | Charger operational | | | |
| | Battery state of charge | | | |
| | Engine Heater operational | | | |
| | Control panel wiring diagram | | | |
| | Control panel mounting | | | |
| | Control Panel Certification and labelling | | | |
| | Control panel equipment labelled | | | |
| | Control cables terminated and labelled | | | |
| | Instruction legend fitted | | | |
| | Electrical code of compliance certificate sighted & attached* | | | |
| | Parameters settings reviewed and agreed | | | |
| | Printout attached | | | |
| | Electronic file received | | | |
| | All Protection equipment secondary injected* | | | |
| | Instrumentation functional | | | |
| | Emergency stop shutdown | | | |
| | | | | |

| OPERATIONAL CHECKS | TICK | REMARKS / FURTHER ACTION REQUIRED |
|---|---|---|
| | | |
| Emergency stop shutdown | | |
| Fire Detection shutdown | | |
| Low oil pressure shut down | | PSI: |
| High engine temperature shut down | | oC: |
| Under / over Voltage shutdown | | LV: |
| Under / over speed shut down | | U Hz: |
| Earth Fault protection | | |
| Failed to start lockout after 3 attempts | | |
| Neutral voltage displacement | | |
| Phase rotation shutdown | | |
| Charger Fault alarm | | |
| Low cooling water flow shutdown | | |
| Loss of Network supply in Export mode | | |
| Auto Synchronising & interlocks | | |
| Stability of load and VAr control | | |
| Auto start on Mains Fail (if applicable) | na | Set should not start automatically on Mains Fail |
| Automatic Load start on reticulation low pressure | | |
| Manual, off load start from Generator controller | | |
| No break return to Mains supply | | |
| Non Export start from Main Switchboard Control Switch | | |
| Export start from Main Switchboard Control Switch | | |
| Non Export start from HMI | | |
| Export start from HMI | | |
| Generator Run signal to SCADA | | |
| Export start from Shift Operator | | |
| Non Export Start from Shift Operator | | |
| In Auto signal to SCADA | | |
| Generator Fault signal to SCADA | | |
| Charger fault signal to SCADA | | |
| Mains contactor energised signal to SCADA | | |
| Generator contactor energised signal to SCADA | | |
| Ventilation fan fault to SCADA (if applicable) | | |

| LOAD TEST | | | | BUILDING: | | | | LOADBANK: | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | Hz | Volts Ph-Ph | Time | Hz | Volts Ph-Ph | Time | Hz | Volts Ph-Ph | Time | Hz | Volts Ph-Ph | Time |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

| OPERATIONAL MEASUREMENTS AT 90% LOADING | | | | | | |
|---|---|---|---|---|---|---|
| | 1 Pump Operating | 2 Pumps Operating | Export | | | |
| Fuel consumption (l/hr) | | | | | | |
| Cooling water flow (m3/hr) | | | | | | |
| Cooling water inlet (0C) | | | | | | |
| Cooling water discharge (0C) | | | | | | |
| dBA L95 at boundary * | | | N | E | W | S |
| dBA L10 at boundary * | | | N | E | W | S |
| Gen Set foundation Vibration level (mm/sec)* | | | | | | |
| Isolated foundation vibration level (mm/sec)* | | | | | | |
| Station internal temperature rise over 12 hour period* | | | | | | |
| | | | | | | |

| SITE TIME | TRAVEL TIME | km RETURN |
|---|---|---|
| CUSTOMERS COMMENTS | | |
| ENGINEER'S NAME (Print): | ENGINEER'S SIGNATURE: | |
| CUSTOMER'S NAME (Print): | CUSTOMER'S SIGNATURE: | |

* Certification to be provided and signed off by approved specialist Consultant.

# APPENDIX 11 PUMP TEST METHODOLOGY

## A. Prerequisites

1. Tapping points for pressure gauge/pressure transducer on the individual pump riser pipe and on the common delivery main (not inside the wet well)
2. Tapping point to be 12 mm NB comprising a male tee and ball valves with female sockets on two sides of the tee. One ball valve to be used for mounting the pressure gauge and the other for releasing trapped air in the pipe. Threads to be to BSP/ISO pipe thread.
3. 12 mm NB plugs to seal the tapping points once the pump tests have been successfully carried out.
4. Sufficient number of pressure gauges with current certificates of calibration and appropriate thread to enable simultaneous readings. Pressure gauges to accommodate the design pump pressure between 50% and 80% of the gauge full scale.
5. Device for measuring 300mm fall in water level in the wet well.
6. Stopwatch to measure time it takes for the water level in the wet well to fall by 300 mm.
7. Verify internal dimensions of the wet well by actual site measurements.
8. Verify invert level of the inlet pipe. Pump start level for the test is approximately the invert level of the inlet. This shall be the upper position of the level measuring device.
9. Verify static head difference between invert level of the inlet pipe and centreline of riser mounted pressure gauges.
10. Tripod, harness[8], gas detector[9], PPE, signs, lock-outs, protective barriers, emergency communication equipment and ventilation fan with flexible duct to enable manual entry into the wet well.
11. Minimum of three personnel to carry out the test: one supervisor for confined space entry, one person to enter the confined space and one stand-by personnel as required by OSH.

## B. Test Documentation

1. Complete and sign off “Permit to Work” form, available at

   http://resources.ccc.govt.nz/files/Business/constructiondevelopment/CCCPermitToWork.pdf.
2. Complete Confined Space Entry Form [10], using OSH templates.
3. Complete pump and motor details sheet.
4. Complete dry testing (installation check).
5. Provide list of equipment and instruments provided for the pump test.
6. Provide installation drawings showing all the relevant levels and tapping point positions.

---

8 Harnesses must have current useful life.

9 All gas detectors used must be calibrated before use or have current calibration.

10 It is required that all personnel doing confined space entry must have a current Confined Space Entry Authorisation Letter and are familiar with *Guidelines for Entering and Working in Confined Spaces*7

7. Provide pipeline flow-head curve with pump performance curve superimposed on it.
8. Once items 1–7 above have been satisfactorily completed, the check sheet shall be signed by the parties witnessing and carrying out the pump tests.

**C Pump Test**

1. Install pressure gauges at tapping points.
2. Ensure that inlet valve of the wet well is tightly shut with no apparent leakage visible. Use inflatable plugs if necessary.
3. For each pump, throttle pump discharge valve, start pump and open ball valve at tapping point slowly to ensure that all air in riser pipe is released. Once all air is released, shut ball valve. Close pump discharge valves and ensure it is tightly shut.
4. Install level measurement device in wet well and ensure the upper (start level) is at approximately at the same level as the incoming pipe invert.
5. Fill wet well with water until it submerges the level measuring device.

**C.1 Shut-off Head Test**

1. Start Pump no. 1 and record readings for current and pressure once the readings are stable. Once readings have been taken, stop Pump No. 1. Do not run pump for more than 30 seconds with the discharge valve closed.
2. Check level measuring device. If level has fallen, check for tightness on riser outlet valve and redo step 1 above.
3. Repeat the process 1 and 2 for the rest of the pumps doing the test one pump at a time.
4. If readings taken for all pumps are widely inconsistent, redo steps 1 to 5 in item C and repeat item C.1

**C.2 Single Operation Pump Flow Test**

5. Open the discharge valve for the pump to be tested.
6. Fill wet well as required until level measuring device is submerged by about 25mm.
7. Start the pump and start measuring time when the water level reaches the upper position of the level measuring device.
8. Stop the pump and stopwatch when water level reaches the lower position of level measuring device.
9. Record readings of all pressure gauges and running amps while the pump is running.
10. Repeat steps 2 to 5 twice to record three test results.
11. Close the discharge valve for the pump tested.
12. Repeat steps 1 to 7 for the rest of the pumps doing the test one pump at a time.

### C.3 Parallel Operation Pump Flow Test[11]

13. Open all discharge valves for the pumps to be tested.
14. Fill wet well as required until level measuring device is submerged by about 50mm.
15. Start the pumps and start measuring time when the water level reaches the upper position of the level measuring device.
16. Stop the pumps and stopwatch when water level reaches the lower position of level measuring device.
17. Record readings of all pressure gauges and running amps while the pumps are running.
18. Repeat steps 2 to 5 twice to record three test results.
19. Repeat steps 1 to 6 for all pumps running combination[12].

Upon completion of the pump tests, the parties witnessing and carrying out the pump tests are to sign the test sheets showing the recorded readings.

## D Analysis of the Pump Test Results

The pump test results are to be analysed by the party conducting the tests. In the analysis, the following will be required:

1. The readings as recorded
2. Assumptions made, if any
3. Error factors and areas where errors have been introduced
4. Conversion factors used, if any
5. Comparison of test performance against designed performance for new installation. For existing pump stations, comparison to previous test result is required.

Pump test operating point to be marked on pump performance curve for both solo and parallel pump operation (if applicable).

11 Only applicable to stations designed to run pumps in parallel. Do not use for stations not designed to run in parallel as pressure main may not be able to cope with the higher flow or electrical system is only applicable to run a single pump.

12 E.g. for a two pump station, parallel operation combination is only between Pump 1 and 2, for three pump stations, parallel operation may happen between Pump 1 and 2, Pump 1 and 3 and Pump 2 and 3

# APPENDIX 12 PUMP TEST CHECKLIST, POLICIES AND PROCEDURES

**Pumping Station No. :** __________ **Carried out by :** __________

**Test Date :** __________ **Witnessed by :** __________ **Test Date :** __________

| Item | Check | Unit | Comments |
|---|---|---|---|
| **A. Prerequisites check** | | | |
| 1. Provision of tapping points with appropriate fittings and valves | | | |
| 2. Scale range of pressure gauges are appropriate for the tests | | | |
| 3. Level measuring device provided | | | |
| 4. Stop watch provided | | | |
| 5. Safety gear provided | | | |
| **B. Test Documents** | | | |
| 1. Pump data sheet | | | |
| 2. Motor data sheet | | | |
| 3. Installation drawings with all relevant levels | | | |
| 4. Design pipeline flow-head curve with pump performance curve (solo and parallel operation) superimposed on it | | | |
| **C. Pre-test Measurements** | | | |
| 1. Internal dimensions of pump sump | | mm | |
| 2. Error allowance for items affecting surface area of pump sump e.g. Pipe, ladder, etc. | | % | |
| 3. Calculated capacity of pump sump per 300 mm depth of pump sump | | litres | |
| 4. Invert level of incoming pipe | | m RL | |
| 5. Static head difference between pressure gauge and water level in pump sump | | m | |
| 6. Location of bench mark | | | |
| 7. Bench mark RL | | m | |
| **D. Pre-test Checks** | | | |
| 1. Inlet to pump sump shut | | | |
| 2. Pressure gauges installed | | | |
| 3. Level measuring device installed | | | |
| 4. Pumps are operational and ready for testing | | | |
| 5. Water for pump tests is available | | | |

**E. Shut-Off Head Test** (Follow procedure prescribed in part C of Pump Test Methodology)

| | | Pump No. 1 | | | Pump No. 2 | | | Comments |
|---|---|---|---|---|---|---|---|---|
| | | **Test 1** | **Test 2** | **Test 3** | **Test 1** | **Test 2** | **Test 3** | |
| Motor FLC | Amps | | | | | | | |
| Pressure gauge No. 1 (for Pump No. 1) or 2 (for Pump No. 2) | kPa / m | | | | | | | |
| Common delivery pressure gauge (used as check) | kPa / m | | | | | | | |
| Adjustment for static head difference | m | | | | | | | |
| Calculated shut-off head | m | | | | | | | |
| Selected pump shut-off head (as per manufacturer's data) | m | | | | | | | |

**F. Flow Test** (Follow procedure prescribed in part C of Appendix 17.12 - Pump Test Methodology)

| **1. Solo Operation** | | **Pump No. 1** | | | **Pump No. 2** | | | **Comments** |
|---|---|---|---|---|---|---|---|---|
| | | **Test 1** | **Test 2** | **Test 3** | **Test 1** | **Test 2** | **Test 3** | |
| Motor FLC | Amps | | | | | | | |
| Pressure gauge No. 1 (for Pump No. 1) or 2 (for Pump No. 2) | kPa / m | | | | | | | |
| Common delivery pressure gauge (used as check) | kPa / m | | | | | | | |
| Adjustment for static head difference | m | | | | | | | |
| Calculated pump duty head | m | | | | | | | |
| Selected pump duty head (as per manufacturer's data) | m | | | | | | | |
| Time taken to pump 300 mm depth of pump sump | sec | | | | | | | |
| Calculated pump flow rate | lit/sec | | | | | | | |
| Calculated average solo pumping rate | lit/sec | | | | | | | |
| Selected pump flow rate (as per manufacturer's data) | lit/sec | | | | | | | |
| **2. Parallel Operation** | **Pump** | **No. 1** | **No. 2** | **No. 1** | **No. 2** | **No. 1** | **No. 2** | **Comments** |
| | | **Test 1** | | **Test 2** | | **Test 3** | | |
| Motor FLC | Amps | | | | | | | |
| Pressure gauge No. 1 (for Pump No. 1) or 2 (for Pump No. 2) | kPa / m | | | | | | | |
| Common delivery pressure gauge (used as check) | kPa / m | | | | | | | |
| Adjustment for static head difference | m | | | | | | | |
| **Calculated pump duty head for parallel operation** | m | | | | | | | |
| Selected pump duty head (as per manufacturer's data) | m | | | | | | | |
| Time taken to pump 300 mm depth of pump sump | sec | | | | | | | |
| **Calculated pump flow rate for parallel operation** | lit/sec | | | | | | | |
| **Calculated average pumping rate for parallel operation** | lit/sec | | | | | | | |
| Selected pump flow rate (as per manufacturer's data) | lit/sec | | | | | | | |