Christchurch City Council

Water and Waste
Assets and Network Unit

SEWAGE PUMPING STATION
DESIGN STANDARD

Version	Status	Issue Date
10.6	final	November 2015

TRIM File Ref: 15/1197597

Contents

TABLES

1 Scope

The Sewage Pumping Station Design Standard (SPSDS) details the technical requirements for the design and construction, repair or renewal of Christchurch City's wastewater pump stations. It also explains the process required to transfer the asset to Council.

Council has classified pump station types by their flow rate, their connection to the network and their number of pumps. This standard, where practicable, covers all types of sewage pump stations with the below exceptions. Obtain acceptance through the Design Report for any item that is deemed essential in the pump station's design but that is not covered in this standard.

This document does not cover requirements for any pumped sewage system that is owned and maintained by the property owner that it serves. For such installations, refer to the *Requirements for Individual Private Sewage Pumping Stations*. This document also doesn't address the detailed design of lift stations. Refer to the *Lift Station Design Specification*.

This document has been endorsed by the Council's City Water and Waste Unit, Asset and Network Planning Unit and Capital Programme Group. Any future amendments will also be endorsed before being formally issued.

2 Referenced Documents

The following referenced documents shall be read and used in conjunction with the SPSDS. Where there is a conflict between the SPSDS and the referenced documents, the SPSDS takes priority but nothing in the SPSDS shall detract from the requirements of legislation.

- Christchurch City District Plan (*City Plan*)
- Banks Peninsula *District Plan*
- Christchurch City Council *Infrastructure Design Standards* (IDS)
- Christchurch City Council *Construction Standard Specifications* (CSS)
- Hazardous Substances and New Organisms Act 1996
- Health and Safety in Employment Act 1992
- New Zealand Machinery Act 1950
- New Zealand *Building Code* 1992
- New Zealand *Electricity (Safety) Regulations* 2010
- New Zealand *Radiocommunications Regulations* 2001
- 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 5807:1980 *Code of practice for industrial identification by colour, wording or other coding*
- Water New Zealand Industry Standard 2011 *Field testing of backflow prevention devices and verification of air gaps*
- 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 1554: 2011 *Structural steel welding set*
- AS/NZS 2280: 2012 *Ductile iron pipes and fittings*
- AS/NZS 2311: 2009 *Guide to the painting of buildings*
- AS/NZS 2845.1 *Water supply - Backflow prevention devices - Part 1: Materials, design and performance requirements*
- 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 4058: 2007 *Precast concrete pipes (pressure and non-pressure)*
- AS/NZS 4087: 2011 *Metallic flanges for waterworks purposes*
- AS/NZS 4680: 2006 *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*
- AS/NZS ISO 9001: 2000 *Quality management systems – Requirements*
- AS 1789: 2003 *Electroplated zinc (electrogalvanised) coatings on ferrous articles (batch process)*
- AS 2159: 2009 *Piling – Design and installation*
- BS ISO 3046-1: 2002 *Reciprocating internal combustion engines.* Performance
- ISO 10816: 2014 *Mechanical vibration -- Evaluation of machine vibration by measurements on non-rotating parts*
- 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* http://resources.ccc.govt.nz/files/CPTEDFull-docs.pdf
- Christchurch City Council *Requirements for Individual Private Sewage Pump Stations* http://www.ccc.govt.nz/homeliving/goaheadbuildingplanningS00/formsandguides-s07/designguides-s07-03.aspx#jumplink14
- Christchurch City Council City Water and Waste *Tagging Convention* Version 6.2[1]
- Christchurch City Council City Water and Waste *Station Asset 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 *Lift Station Design Specification*[6]

---

[1] TRIM ELEC06/6074

[2] TRIM 14/141308

[3] TRIM 14/1039203

[4] TRIM 09/367127

[5] TRIM 13/355959

[6] TRIM 14/1409685

- Christchurch City Council *Wastewater Pumping Station O&M Manual*[7]
- Christchurch City Council *Guidelines for Entering and Working in Confined Spaces*[8]
- Christchurch City Council *Pump Station Design Guide* August 2012[9]
- Environment Canterbury *Pollution Prevention Guide* http://tools.ecan.govt.nz/eppg/
- Relevant NZ Standards and Codes of Practice whether specifically mentioned herein or not.

3 Definitions

Acceptance - in writing, by fax 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 a full handover is completed.

4 Quality Assurance Requirements and Records

4.1 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 pump station design but that is not covered in this standard.

Provide Producer Statements PS1 – Design and Producer Statements PS2 – Design Review, prepared by a suitably qualified Chartered Professional Engineer, for:

- the pump station wet-well or dry well.
- the pump station building, where relevant.
- the screw pile design. Refer to clause 9.2 – Screw piles.

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 (clause 5.1 – Acceptance of Alternative Designs).

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.

Ensure that drawings comply with IDS clause 2.9 – Drawings and that they are legible at A3 size. Appendix 17.1 - Sample Pressure Main Drawings illustrates the minimum expected details on pressure main drawings, including directional changes.

[7] TRIM ELEC09/92

[8] TRIM 14/737123

[9] TRIM 13/969184

4.2 Construction auditing

Provide a copy of the draft Inspection and Test Plan, including the performance tests in clause 4.4 – Acceptance criteria and audit or hold point inspections by the Engineer, for example the control cabinet construction and site installation (Clause 10.0 - Electrical)

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 17.2 – Handover Flowchart.

4.3 Completion 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,
- Testing and commissioning records and
    - Pump test results. Refer clause 16.0 – Testing and Commissioning
    - Generator load test results. Refer clause 16.0 – Testing and Commissioning
- CEG Construction Work Pack including the Outstanding Work/Defect List (refer Appendix 17.3 – Outstanding Work/Defect List Example), the Practical Completion Certificate (refer Appendix 17.4 – Practical Completion Certificate), the Final Handover and Acceptance of Plant Ownership Certificate (refer Appendix 17.5 - Handover Certificate) and the Control System Commissioning Handover Certificate (refer Appendix 17.6 – Commissioning Certificate).
- Provide as-built information to the requirements of IDS Part 12, including any warranties. Data pick up sheet templates, for recording the assets installed under the project, are available from Council (CWW *Station Asset Templates*).

4.4 Acceptance Criteria

Specify a water test for all concrete tanks and below ground structures to *Testing Reinforced Concrete Structures for Watertightness* where testing is practical. All other pipe testing must comply with CSS: Part 3 clause 14.0 – Performance testing.

Specify testing and commissioning in accordance with the accepted Testing and Commissioning schedule. Council must be witness all commissioning tests, including pump and generator load tests. Refer clause 16.0 – Testing and Commissioning.

5 Design

5.1 Acceptance of alternative designs

For operational reasons it is a requirement that there be a large degree of uniformity, particularly with respect to electrical work, among the Council's pumping stations.

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 shall apply to that particular proposal only.

A full set of standard mechanical and electrical drawings can be purchased 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.

Submit a Concept Design Report providing an explanation of the design basis or construction method for acceptance in principle. Alternative designs may be permitted:

- 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.

5.2 Consents

Obtain the following consents, unless not required:

- Christchurch City Council Building Consent
- Christchurch City Council Water Connection
- Environmental Protection Authority Hazardous Substances Certifications and Licences for fuel storage
- Environment Canterbury Resource Consent for engine exhaust emissions
- Environment Canterbury Resource Consent for Stormwater discharge. Refer to IDS clause 5.3.3 – Consent from the Canterbury Regional Council.
- Environment Canterbury Resource Consent for Excavation, including where the pump station doesn’t comply with the City Plan Volume 3 Part 9 clause 4.4.4.

5.3 Design philosophy

Design the pumping station to:

- Pass a capacity not less than the Maximum Flow (MF) of the catchment when one pump at a station is not functioning. Refer to IDS clause 6.4 – Sanitary Sewer Design Flows for flow calculations.
- Eliminate overflows created through under capacity, poor design and difficult operating or maintenance procedures, as detailed in clause 11.0 - Overflows.
- Safeguard those who could be affected by the facilities, including members of the public and any person involved in maintenance of the facility. Keep equipment out of hazardous environments where possible and minimise the generation of confined spaces.
- Ensure the total life cost of the facility is as low as practical, whilst also considering reliability, security and functionality.
- Standardise sites and equipment wherever possible.

Consider how the siting, architectural treatment and landscaping of large pumping stations can be used to enhance the surrounding environment:

- 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.

Refer to *Pump Station Design Guide* for further information, particularly for large pump stations.

5.4 Design lifetime

Undertake a life cycle costing, considering both the initial costs borne by the Council and the ongoing maintenance and replacement costs. Assess both options within a proposal or the proposal as a whole, if relevant. Consider such factors as the company's past performance including its products or service. Operational reliability should not be compromised by the option selection.

Design pump station assets for the lives in Table 1.

Table 1 Operational Life

Asset Type	Sub-Group	Operational Life
Buildings	Buildings	100
	Screw piles	100
Electrical Equipment		50
Electronic Equipment		15
Mechanical Equipment and Plant	Short-life pumps	25
	Long-life pumps	100
	Motors	40
	Stand-by equipment	50
Site Pipe Work		100

5.5 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 6.7 – Wastewater Pumping Stations for further information.

Design the pump station 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 (R_u=1.8)
- Annual exceedance probability (Serviceability Limit State) of 1 in 25 years (R_s=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 7.3 – 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.

Use Appendix 17.15 – Pre-fabricated Below–ground Structure Design Example to aid in this consideration.

5.6 Noise

Ensure soundproofing limits the noise level at the property boundary to comply with the *City Plan* rules in Volume Three, Part 11 clause 1.3.3 - Noise Standards for all zones outside the Central City, the *Banks Peninsula District Plan* rules in Chapter 33 - Noise and the Environment Canterbury noise control standards.

5.7 Buoyancy

Check the structure for buoyancy, including at all stages of construction. If the station is to be constructed in soils that are liquefiable, include buoyancy under seismic conditions, with soil unit weights of 1.8kN/m^3.

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.

5.8 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 and clause 8.3 - Protection of Equipment, Surfaces, Coatings and Dissimilar Metals and clause 8.4 – Mechanical. 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 4.3 – Completion Documentation and IDS Part 12 – As-Builts, detail the application of a permanent label for this item, as required by *CWW Tagging Convention*.

5.9 Pressure Ratings

Design the components of the system to withstand the maximum operating pressures defined in IDS clause 6.8.1 – Maximum Operating Pressure.

5.10 Odour Control

Generally detail only vent pipes for the pump stations but design and construct the station to provide for future installation of odour control devices, whether active or passive. Design any odour control devices and sites to the *Odour and Corrosion Management Design Guide*.

Connect a 100mm diameter plastic vent pipe from the wet-well to the vent stack or odour control unit. Detail the vent height a minimum of 3 metres above ground level or 300mm above any local structure and brace it at the top.

6 Pumps

When designing the pumps, include an extra pump over the required number for redundancy. As lift stations include a gravity by-pass from the upstream manhole, an extra pump is not required for cases of pump failure.

Design the pumps to be capable of running separately or together and specify a manual duty switch for selecting the duty pump, when only one pump is required to run.

Specify pumps with a minimum spherical passing capacity of 100mm. For lift stations, specify vortex type impeller pumps with a 80mm spherical passing capacity where the discharge pipe has a minimum internal diameter of 100mm. Grinder pumps are generally necessary in lift stations as the passing capacity must be less than 100 mm. Comminutors should not be used.

Specify three 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. Specify lift station pumps with a power capacity under 5 kW.

The wet-well design, including its size, is specified in clause 9.3.2 – Wet-well. Ensure pumps are rated for a minimum of ten starts per hour and can achieve their design output at no more than 2900 rpm (nominal).

Where the suction height is adjustable, set it at between 50% and 75% of the suction's diameter off the wet-well floor. Limit pump running without water to a few seconds to prevent damage to the mechanical seals through the use of alarms and controls.

If submersible pumps are used, detail:

- Automatic slide couplings.
- Galvanised chains to lift the pumps from the wet-well, attached at the bottom end to the pump and the top wrapped around the top pump guide rail brackets and secured using a galvanised “D” shackle.
- Installation that obviates pumping out the wet-well to permit removal of the pumps.

If dry-well pumps are used detail:

- Suction pipework one size larger than the pump inlet size.
- Suction pipework with easy access from the dry-well to clear blockages and with access to the pump suction eye without lowering the wet-well level below the suction pipework.
- The mounting of surface pumps on a plinth 200mm above floor level.
- Any cables to be either below floor level in ducts with suitable removable gratings or fixed above head height.

6.1 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:

- Tapped holes for water, drainage and air release of at least 25mm internal diameter.
- 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 200mm 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.

6.2 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
- 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. This will be an iterative process, involving the pump chamber size and recalculated head losses from the pump off levels determined in clause 9.3.2 – Wet-well.

7 Pipework

Design pressure pipelines and fittings to minimise hydraulic losses in accordance with IDS clause 6.8 – Pressure Pipelines. Calculate the losses from each fitting using the information in Appendix 17.13 – Calculating Pressure Losses due to Fittings.

Provide a surge analysis 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. 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 fixings and supports complying with the requirements of clause 8.1 – Fixings, Restraints and Supports.

Locate pipework to facilitate access to and maintenance of equipment. Provide an uninterrupted accessway around pumps and detail any cables or pipework crossing this path either below floor level in ducts with suitable removable gratings or fixed above head height.

Specify pressure testing to the requirements of CSS: Part 3.

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.

7.1 Materials

All materials must comply with clause 5.8 - Materials.

Do not specify plastic pipe in the pump station. Where detailing connections to polyethylene pressure mains, the Council design memorandum Stub Flange and Backing Ring Tables provides details on dimensions and drilling patterns

http://resources.ccc.govt.nz/files/StubFlangeAndBackingRingTablesV1.pdf

Specify the internal diameters of pipes at least 50mm larger than the nominal pump size. This requirement reduces dynamic pressure losses and the possibility for blockages. As clause 6.0 – Pumps requires a minimum passing capacity of 100mm, the discharge pipework will usually be at least 150mm internal diameter. The increase in size may not be necessary where a large pump's discharge size is 50mm or greater in internal diameter than the passing capacity of the pump.

Specify ductile iron where pipe or fittings will be cast into concrete and design a central puddle flange, to positively locate the pipe or fitting within the concrete. 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, as described in clause 5.9 - Pressure Ratings, is greater than 1.37 MPa (200 psi).

Mild steel with a wall thickness greater than 9.5mm is preferred for the vertical discharge pipe from small or medium submersible pumps. This allows adjustment on the final fitting of pumps.

7.2 Pipe Fittings

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

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 3, unless approved otherwise. This increased wall thickness, compared to normal spun ductile iron pipes, is intended to mitigate internal abrasion.

Table 2 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

Note: as there can be long delays in manufacture, checking the delivery time from placement of order is recommended.

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

Where there is no bend in the pipe sections before a valve, or series of valves, incorporate a mechanical joint on the non-pressure side of the valve so that the valve can be removed easily for servicing. Similarly, 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.

Do not detail a pipe connecting vertically into the underside of another pipe carrying sewage. Instead detail a short section of horizontal pipe at this point, to prevent sedimentation blocking the vertical pipe and any valves installed on it.

7.3 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.

7.4 Pressure Gauges, Tapping Points and Flow Meters

Specify the installation of pressure gauges.

Specify test points on the pump inlet, where the pumps are fitted in a dry-well 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
- Outside of the wet-well
- On the pump side of any valves where possible

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.

7.4.1 Flow Meters

Specify a Mag-flow meter on the pressure main from the pumping station, using the *Magflow Meter Specification*:

- Specify its installation in a concrete chamber with adjacent mechanical fittings to allow for future removal of the meter for servicing. Specify fittings as detailed in clause 7.2 – Pipe fittings for the sections passing through the concrete
- Detail an isolating valve in the same or a separate concrete chamber downstream of the meter. This valve allows isolation of the pressure main if the meter has to be removed, eliminating the requirement to drain the whole pressure main
- Detail an electrical duct from the meter chamber back to the pumping station electrical control panel area, to allow the meter to be connected to the station's SCADA system

7.5 Valves

Detail sufficient valves to enable the pump station to operate while one pump, or any other major plant item, is being serviced. Specify valves rated to PN 16.

Incorporate an easily operated valve, preferably a gate or penstock valve, into the incoming sewer line so that the wet-well and associated pipework can be isolated from the sewer system. This can be a gate valve bolted and epoxied to the wet-well wall if it cannot be mounted in a separate manhole close to the station. Detail the fitting of a Tee type key to this valve, which can be fitted onto a valve extension shaft so that the Tee handle is approximately one metre above ground level.

Detail valves on the outlet of the pump with the isolating valve downstream of the reflux. Detail the fitting of a handle to reflux valves to open the valve for back flushing.

Detail a hand wheel to all sluice valves except those that are buried, which require the triangular spindle cap only. Specify clockwise opening valves for all wastewater applications.

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 from ground or street level. This will generally mean detailing a valve chamber around the valves with easy access to the chamber. Refer to clause 9.3.3 – Valve Chambers.

8 Detailing

8.1 Fixings, Restraints and Supports

Design restraints, fixings and supports to the fittings, including the ability to withstand seismic loading as detailed in clause 5.5 - 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 8.3 - 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.

8.2 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 all wet-well, dry-well and valve chamber accesses that are considered a confined space. Provide a noise hazard warning sign on the personnel door if there are pumps or diesel inside.

8.3 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 *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles* 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 *Electroplated zinc (electrogalvanized) coatings on ferrous articles (batch process)* with a minimum coating thickness of 12 microns or galvanise them as above.

Galvanised steelwork shall be painted in accordance with the paint supplier's recommended system for the applicable location, with a final colour to the Council's approved colours.

Electrically insulate dissimilar metals to prevent the potential for electrolysis.

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 *Guide to the Painting of Buildings*. 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)

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.

Specify a protective conformal coating for electronic equipment where hydrogen sulphide concentrations are detectable at greater than 1 part per million.

8.4 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.

Do not detail folded seam ductwork for foul air ducts as these ducts are prone to premature corrosion failure at the folded seams.

8.5 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.

8.6 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 prevent water transfer also.

Where flooding from stormwater, gorged sewers 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.

8.7 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 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 15.0 - Landscaping to afford visibility of the whole site and so to prevent anti-social, unsafe or destructive behaviour.

8.8 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.

8.9 Separations from and connections to services

Detail minimum parallel and crossing separation distances complying with IDS Part 9.5.3. Where the specified clearances cannot be achieved, provide a non-conformance report, in accordance with clause 3.7.1 of the IDS – 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 to the new reticulation prior to connection.

9 Structural

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. Design the superstructure in accordance with normal structural practice.

Specify protection against corrosive attack for the concrete. Refer to Appendix 17.8 – Concrete Protection Materials for Council approved concrete protection materials. Alternatively, cast in PVC or HDPE liners could be detailed. Consider external corrosion if the structure is located in areas of aggressive groundwater.

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.

Detail at least 50mm concrete cover over any puddle flanges cast into concrete.

9.1 Caissons

Detail an additional sealing slab with a water stop above the plug to prevent leaks. Design the sealing slab to resist full hydrostatic pressure by either adequate bonding to the plug, or by adequate bending strength.

Design wet-well walls to *Design of concrete structures for the storage of liquids* with a minimum 50mm cover for sacrificial purposes, using concrete to *Specification for concrete production*. Alternatively, specify protective coatings to risers manufactured to the requirements of *Precast concrete pipes (pressure and non-pressure)*.

9.2 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.
- Provide a Producer Statement PS1 – Design and a Producer Statement PS2 – Design Review for the screw pile design (number and diameter of helixes, pile diameter and wall thicknesses, etc.), prepared by a suitably qualified Chartered Professional Engineer.
- 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.
- Design to clause 5.5 – 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 150mm 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

9.3 Chambers and Pits

Pits include wet-wells and dry-wells. Chambers include valve and flow meter chambers.

Design the pit floor to drain to a 300mm cubed minimum sump, except in small self draining chambers or the wet-well of smaller submersible pump stations. On small installations, fit valve chambers and pits with a 50mm minimum diameter drain hole falling into the wet-well.

Provide a flooding alarm to all pits or chambers containing critical electrical equipment or cabling that are not free draining and detail an automatic sump pump. Where there is any risk of contamination, the sump pump must discharge to a separation system and then to a sewer.

9.3.1 Access to chambers or pits

Design all accesses for man entry with a clear diameter of 600mm or rectangular clearance of 500mm x 700mm, to provide adequate ventilation and safe access. Ensure access covers and electrical cabinet doors do not interfere with each other or obstruct access routes.

Design accesses, their covers and safety devices to comply with the *Health and Safety in Employment Act*.

Locate the covers to enhance equipment maintenance and to permit the setting up of davits or tripods for entry to confined spaces. Where standard portable safety tripods cannot be mounted above the wet-well to allow an unconscious person to be winched from the bottom of the wet-well to a safe level outside of the danger area, detail a davit anchor point.

Detail approved access covers as listed on the Council webpage www.ccc.govt.nz/business/constructiondevelopment/approvedmaterials.aspx. For chambers where complying approved covers are not practicable, e.g. aluminium or watertight covers, detail non-conforming covers in the Design Report.

Provide a fixed ladder or permanent ladder rungs to allow access to the bottom of chambers and pits if depth will cause an access problem. Construct the ladder or rungs from epoxy painted galvanised steel or aluminium. For safety reasons, ensure the ladder or rungs are not recessed, causing difficulty stepping onto or off them. Where possible, ladders should be inclined rather than vertical. Note that there are different standards for fixed access, compared to working from a ladder. Appendix 17.9 –Manhole Ladder details Council's requirements for fixed access.

9.3.2 Wet-well

Design the size of the wet-well with reference to clause 11.0 - Overflows.

Detail a drop structure on the inlet of the wet-well and benching in the bottom of the wet-well at an angle of at least 45 degrees to prevent the forming of vortices on pumping.

Proprietary packaged pumping station wet-wells will be considered provided they meet at least the following:

- Provided by a reputable manufacturer with field offices in New Zealand preferably Christchurch. The manufacturer must provide proof of manufacture to the appropriate world standard. This shall be in the form of a third party product accreditation system such as Standards Mark or an independent audit of a testing regime as defined by certain standards. The manufacturer must also provide proof of their quality management system certified as complying with *Quality management systems – Requirements*.
- Supplied by a supplier operating a quality management system certified as complying with *Quality management systems – Requirements*.
- Have a history of favourable use in other installations for a minimum of 10 years

Size the wet-well:

- to limit pump starts to no more than 10 per hour. Confirm this at the worst case - when inflow is equal to half the pump's flow,
- with a minimum 200mm between each pump start level,
- with the last pump start level below the incoming sewer invert level,
- with the stop level approximately halfway down the motor casing for submersible pumps, and
- with pump stop levels between 50mm-100mm apart.

Design the wet-well, pumps and incoming sewer symmetrically to prevent pre-rotation of the pumped effluent before it enters the pumps.

Design lift station wet-wells with a minimum diameter of 1.35m.

Large capacity installations will require specific hydraulic and layout design, which is not covered in this clause. For large capacity stations, detail a lockable inspection hatch approximately 300mm square in one of the main lids, in addition to the access cover in clause 9.3.1 – Access to chambers or pits.

For large capacity installations and other pump stations with a wet-well not designed to *Rotodynamic pumps for pump intake design standard*, submit a Computational Fluid Dynamics analysis (CFD) as part of the Design Report.

9.3.3 Valve Chambers

Design valve chambers with a minimum diameter of 1.05m.

In general, design valve chambers as a separate structure from the wet-well and to provide adequate working room around the valves. Where practicable, detail only one valve chamber for all incoming flows and one valve chamber for all outgoing flows. Lift stations do not require a valve chamber.

If air release valves (ARV) are installed inside the valve chamber, vent the ARV to the wet-well or the odour control unit.

10 Electrical

Design the electrical installation, including the generator and diesel engines, the motor starters and the three phase generator inlet plug, in compliance with the *Electrical and Automation Specification*, specifically clause 4.3 – Pump Stations and clause 11 - Generator and Diesel Engines.

11 Overflows

Design the total pumping station and catchment system storage to hold four hours Average Sewer Flow (ASF) as specified in IDS clause 6.4 – Sanitary Sewer Design Flows. Most of the storage will normally be in the associated pipe network.

Design at least one constructed overflow for each pumping station catchment to cater for emergency conditions and system failure. Select the level and position of the overflow to avoid overflows from the system during normal operation, but low enough to ensure the lowest property is not flooded with sewage..

Design the overflow/s to pass the peak system flow, considering the receiving water’s capacity to take this flow and to avoid flooding of private property. Ensure the receiving water, usually an approved drain or watercourse, has sufficient flow to dilute and carry away any overflow.

Design the overflow to spill from a manhole in the sewer catchment upstream of the valve that isolates the pumping station. This is usually at the lowest point in the catchment, close to the pumping station, where the occurrence of an overflow can be monitored by the pumping station alarm systems.

Locate the outlet below normal levels in the receiving waters where possible. Detail flap valves, rubber non-return valves and/or high points to prevent reverse flow overloading the sanitary sewer, if necessary.

12 Pumping Stations

Design the building to adequately house and allow the efficient operation of the pumping station. Design in a minimum clearance around and between pumps, diesels, open cabinet doors and extended racks of at least 600mm, as required by *Electrical installations* clause 2.9.2.2. Consider future expansion in the design of the building.

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

- 4.5 kg fire extinguisher

- Approximately A3 size blackboard on wall by personnel door
- Metal rubbish bin
- Standard Council lectern, or hinged plan table if space allows

12.1 Building Construction

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 8.7 - Security and 8.8 - 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 8.3 – Protection of Equipment, Surfaces, Coatings and Dissimilar metals, considering the site's context as explained in clause 5.3 – Design Philosophy. Design for the disposal of stormwater.

12.2 Noise, Ventilation and Air Conditioning

Design ventilation to the pump station, wet-well and dry-well to remove gases and control temperatures to a maximum of 40°C inside the room, regardless 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 SCADA

Specify a fully functional SCADA remote terminal unit, complete with all internal equipment, to Council's *Electrical and Automation Specification* and the project specification. Install the SCADA with the control equipment, as specified in clause 10.0 - Electrical.

Submit the full level 2 SCADA functional descriptions and code for pumping stations or processing plants that differ from standard to Council for review before coding. Use the Christchurch City Council *level 2 functional description template*. For standard pumping stations, provide only the as-built level 1 process description.

Council will update the Christchurch Treatment Work's SCADA base station configuration to include the new pumping station.

Specify a passive infrared (PIR) or cabinet door proximity switch intruder detector that is comparable to the units supplied to the Council by J & S Security Limited, Christchurch.

13.1 Aerials and cable

Specify a collinear aerial if fitted within four km of the Christchurch Treatment Works or a Yagi aerial if the distance above is exceeded, supplied by Qtech Data Systems Limited.

Locate the external line-of-site aerial on the furthest side of the building from the road boundary whilst maintaining line of sight. Detail securing of aerials against wind and snow loading. Mount the aerial on a 50mm diameter aluminium scaffolding tube extending two metres above the top of the electrical control cabinet or building. Ensure this pipe is easily lowered to the ground for aerial maintenance.

13.2 Level controls

Specify a high water alarm float.

Specify a 12-volt DC Milltronics MultiRanger 100 series ultrasonic level sensing unit with 6 relay outputs. Council will set the levels in the Milltronics level sensor, if fitted.

13.3 Council Involvement

Ensure a Council E & I representative is present during the SCADA functionality checking (minimum five days notice required).

14 Civil Works

14.1 Hard landscaping

Specify hard surfacing (concrete or asphalt) to all areas where sludge, raw sewage or chemicals are likely to spill, draining to the wastewater system or wet-well.

Prevent the automatic drainage of chemical and petroleum spills to the wastewater system. Design storage and secondary containment systems for hazardous substances including chemicals and fuel to the requirements of the *Hazardous Substances and New Organisms Act*. See http://www.epa.govt.nz/hazardous-substances/Pages/default.aspx for more information.

14.2 Site access

Detail sealing to all pedestrian accesses.

Provide all-weather vehicle access to the wet-well, valves, electrical and any other major equipment installed on site. Where indivisible components requiring servicing are between 20 and 200kg, design the access for a (crane mounted on a) light truck of:

- length = 5 metres,
- width = 2.5 metres and
- maximum axle loading on 7.00 x 15 single tyred axle = 2500 kg

ensuring that:

- the rear axle of the truck mounted crane can be brought to within 2m of the vertical centreline of the component to be lifted, and
- there is sufficient head room to operate the crane.

Where the components weigh over 200kg, consider providing access for a mobile crane.

Include access for a 22 tonne 3 axle truck to within five metres of the filling point of any diesel tank on site.

Ensure any service covers in trafficable areas are designed for vehicular loading.

14.3 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.

14.4 Water Supply

Apply to Council for a commercial water connection using WS1, available at http://www.ccc.govt.nz/homeliving/watersupply/waterconnectionandmeters/commercial.aspx.
Detail the fittings for wet-well flushing, capable of supplying at least 350 kPa at 1 litre/second, sized as detailed below. The water connection will not be completed until after the RPZ installation. If a booster pump is required, position it downstream of the RPZ. Locate the RPZ at the legal road boundary as close as practicable to the water meter. As the water supply is not potable past the RPZ, ensure pipework is identified as not potable in compliance with the *Building Code* G12/AS1 clause 4.2.1 and NZS 5807.

Table 3 RPZ size

Station type	**RPZ size**
Lift Station	20mm
Pump Station	25mm
Terminal Pump Station (Large Stations)	50mm

Detail the RPZ backflow prevention valve installation complying with Appendix 17.7 – RPZ Backflow Preventer, for lift and standard sized Pump Stations. Detail a detachable handle to both ball valves. When the distance from the RPZ to the wet-well opening is greater than ten metres, install a flushing hose tap without a valve, in a toby box separate from the RPZ and mount the tap near the wet well opening.

14.5 Benchmark

Provide a level reference mark in the pump station site that is accurate in the vertical plane to two decimal places with an accuracy of ±15mm to the origin of the level.

Obtain a 40mm stainless steel disk labelled "Survey Mark" from the Council or from fieldworksupplies.co.nz, as shown in the photograph. Fix it by 8mm concrete nail to the concrete nib or slab adjacent to the main pump access opening.

Provide the following documentation within the pump station'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.

15 Landscaping

Design the street side landscaping to reflect an average property in the area, including fencing. For large installations, 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.

Design the landscaping complying with IDS clause 10.9 – Landscape Planting to reduce ongoing maintenance in addition to:

- 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 the potential for security issues due to creating hiding places:

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

16 Testing and Commissioning

Council Pumping and Control staff must witness any commissioning work. Involve specialist suppliers and contractors as necessary. Provide at least five working days notice of any commissioning 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 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 17.3 – Outstanding Work/Defect List Example)

Provide draft Operations and Maintenance Manuals (OMM) and as-built plans to Council prior to commissioning. Use the *Wastewater Pumping Station O&M Manual*.

Provide generator load tests. Refer to Appendix 17.10 - Generator Commissioning – Load Test Report Sheet. Carry out commissioning of the RPZ in compliance with AS/NZS 2845, including the provision of test records. *Field testing of backflow prevention devices and verification of air gaps* contains methodologies and test report templates.

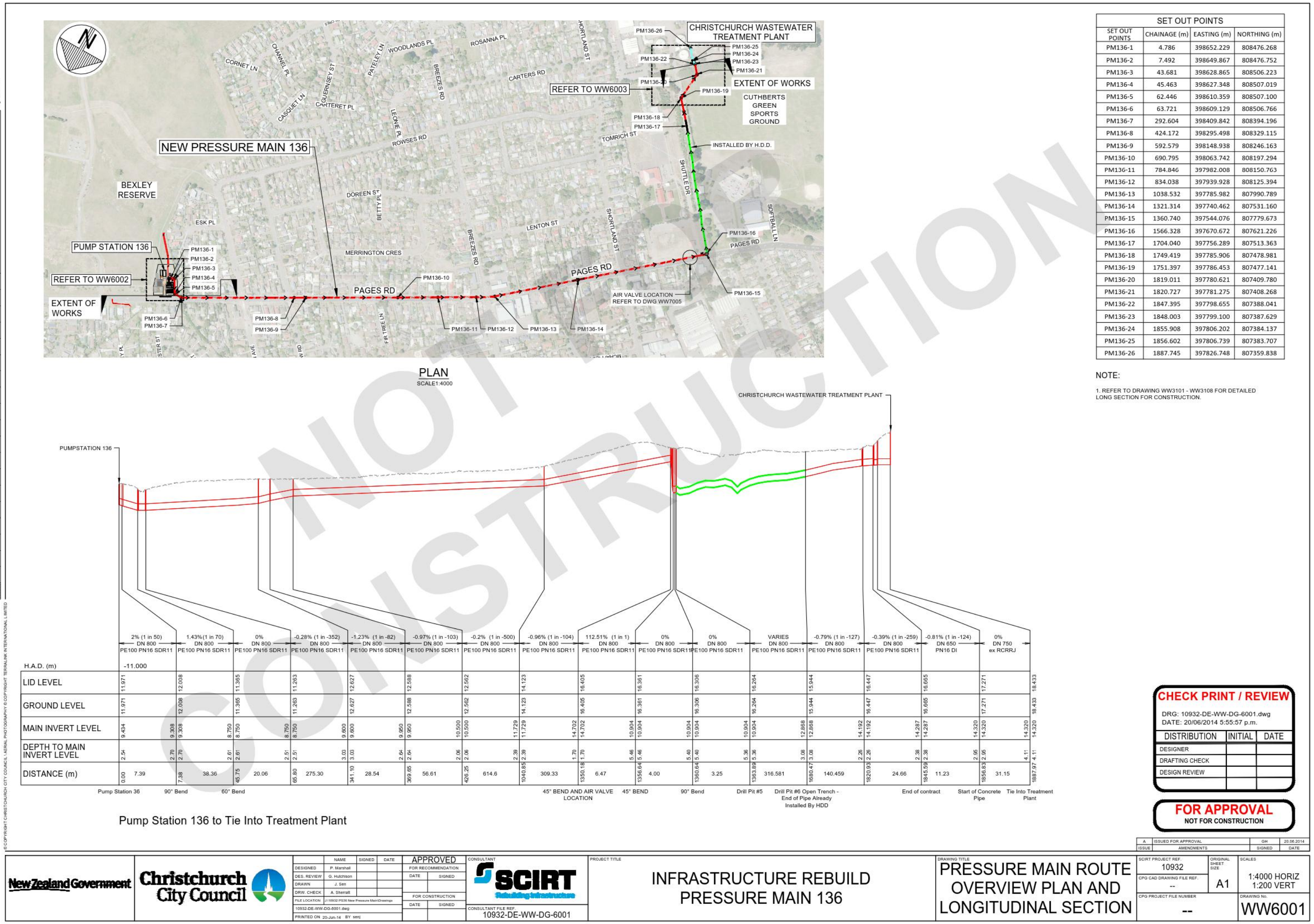
Provide pump tests to confirm that the finished station meets the design flows, using the method in Appendix 17.12 – Pump Test Methodology and providing results as detailed in Appendix 17.11 - Pump Test Sheet. If there are multiple head conditions, supply pump test results for all conditions. At least five days notice of the pump testing must be given to the Engineer to allow the testing method to be witnessed.

Complete the remaining certificates in the CEG Construction Work Pack including the Practical Completion Certificate (refer Appendix 17.4 – Practical Completion Certificate), the Final Handover and Acceptance of Plant Ownership Certificate (refer Appendix 17.5 - Handover Certificate) and the Control System Commissioning Handover Certificate (refer Appendix 17.6 – Commissioning Certificate).

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

17 APPENDICES

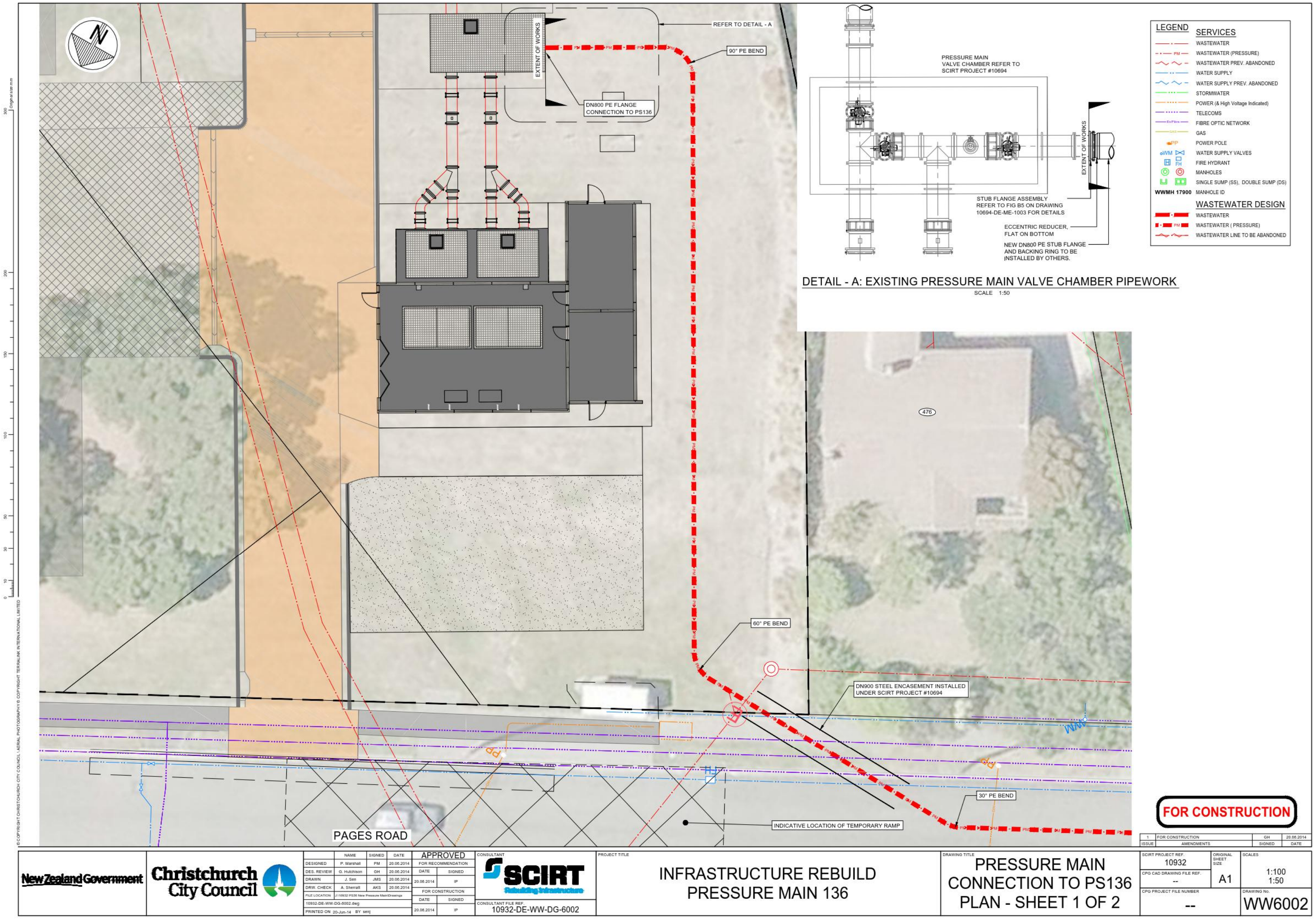
17.1 SAMPLE PRESSURE MAIN DRAWINGS



SET OUT POINTS			
SET OUT POINTS	CHAINAGE (m)	EASTING (m)	NORTHING (m)
PM136-1	4.786	398652.229	808476.268
PM136-2	7.492	398649.867	808476.752
PM136-3	43.681	398628.865	808506.223
PM136-4	45.463	398627.348	808507.019
PM136-5	62.446	398610.359	808507.100
PM136-6	63.721	398609.129	808506.766
PM136-7	292.604	398409.842	808394.196
PM136-8	424.172	398295.498	808329.115
PM136-9	592.579	398148.938	808246.163
PM136-10	690.795	398063.742	808197.294
PM136-11	784.846	397982.008	808150.763
PM136-12	834.038	397939.928	808125.394
PM136-13	1038.532	397785.982	807990.789
PM136-14	1321.314	397740.462	807531.160
PM136-15	1360.740	397544.076	807779.673
PM136-16	1566.328	397670.672	807621.226
PM136-17	1704.040	397756.289	807513.363
PM136-18	1749.419	397785.906	807478.981
PM136-19	1751.397	397786.453	807477.141
PM136-20	1819.011	397780.621	807409.780
PM136-21	1820.727	397781.275	807408.268
PM136-22	1847.395	397798.655	807388.041
PM136-23	1848.003	397799.100	807387.629
PM136-24	1855.908	397806.202	807384.137
PM136-25	1856.602	397806.739	807383.707
PM136-26	1887.745	397826.748	807359.838

NOTE:

1. REFER TO DRAWING WW3101 - WW3108 FOR DETAILED LONG SECTION FOR CONSTRUCTION.


REFER TO DETAIL - A
90° PE BEND
EXTENT OF WORKS
DN800 PE FLANGE CONNECTION TO PS136
60° PE BEND
DN900 STEEL ENCASEMENT INSTALLED UNDER SCIRT PROJECT #10694
30° PE BEND
INDICATIVE LOCATION OF TEMPORARY RAMP
PAGES ROAD
476
PRESSURE MAIN VALVE CHAMBER REFER TO SCIRT PROJECT #10694
STUB FLANGE ASSEMBLY REFER TO FIG B5 ON DRAWING 10694-DE-ME-1003 FOR DETAILS
ECCENTRIC REDUCER, FLAT ON BOTTOM
NEW DN800 PE STUB FLANGE AND BACKING RING TO BE INSTALLED BY OTHERS.
DETAIL - A: EXISTING PRESSURE MAIN VALVE CHAMBER PIPEWORK
SCALE 1:50
LEGEND
SERVICES
WASTEWATER
WASTEWATER (PRESSURE)
WASTEWATER PREV. ABANDONED
WATER SUPPLY
WATER SUPPLY PREV. ABANDONED
STORMWATER
POWER (& High Voltage Indicated)
TELECOMS
FIBRE OPTIC NETWORK
GAS
POWER POLE
WATER SUPPLY VALVES
FIRE HYDRANT
MANHOLES
SINGLE SUMP (SS), DOUBLE SUMP (DS)
WWMH 17900 MANHOLE ID
WASTEWATER DESIGN
WASTEWATER
WASTEWATER (PRESSURE)
WASTEWATER LINE TO BE ABANDONED
FOR CONSTRUCTION
1 FOR CONSTRUCTION GH 20.06.2014
ISSUE AMENDMENTS SIGNED DATE
New Zealand Government
Christchurch City Council
NAME SIGNED DATE
DESIGNED P. Marshall PM 20.06.2014
DES. REVIEW G. Hutchison GH 20.06.2014
DRAWN J. Sen JMS 20.06.2014
DRW. CHECK A. Sherratt AKS 20.06.2014
10932-DE-WW-DG-6002.dwg
PRINTED ON 20-Jun-14 BY senj
APPROVED
FOR RECOMMENDATION
DATE SIGNED
20.06.2014 IP
FOR CONSTRUCTION
DATE SIGNED
20.06.2014 IP
CONSULTANT
SCIRT
Rebuilding Infrastructure
CONSULTANT FILE REF.
10932-DE-WW-DG-6002
PROJECT TITLE
INFRASTRUCTURE REBUILD
PRESSURE MAIN 136
DRAWING TITLE
PRESSURE MAIN
CONNECTION TO PS136
PLAN - SHEET 1 OF 2
SCIRT PROJECT REF. 10932
CPG CAD DRAWING FILE REF. --
ORIGINAL SHEET SIZE A1
SCALES 1:100 1:50
CPG PROJECT FILE NUMBER --
DRAWING No. WW6002

PLAN

ISSUE	AMENDMENTS	SIGNED	DATE
1	FOR CONSTRUCTION	GH	20.06.2014

New Zealand Government | Christchurch City Council

	NAME	SIGNED	DATE
DESIGNED	P. Marshall	PM	20.06.2014
DES. REVIEW	G. Hutchison	GH	20.06.2014
DRAWN	J. Sen	JMS	20.06.2014
DRW. CHECK	A. Sherratt	AKS	20.06.2014
FILE LOCATION	J:\10932 PS36 New Pressure Main\Drawings		
10932-DE-WW-DG-6100.dwg			
PRINTED ON 20-Jun-14 BY senj			

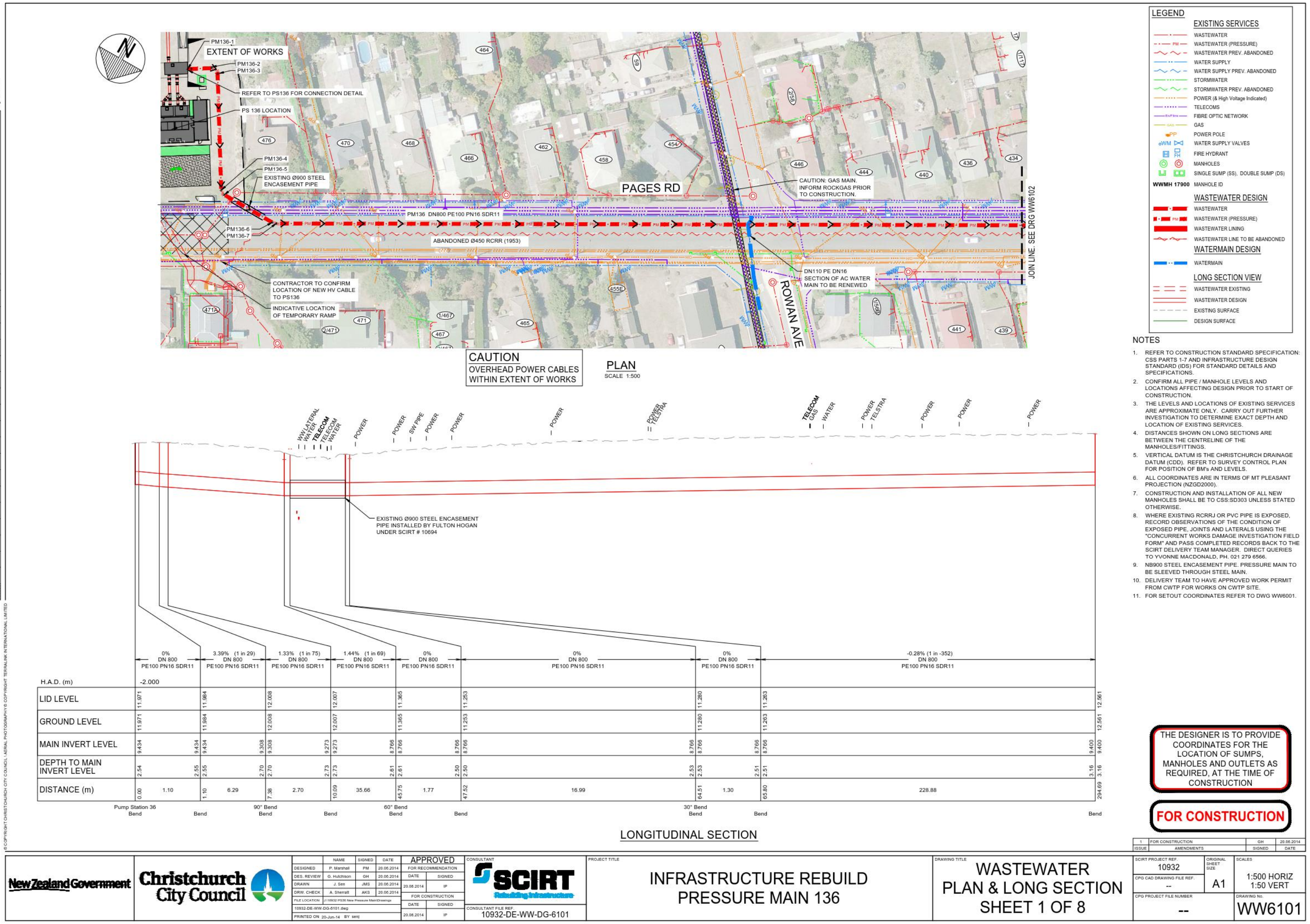
APPROVED	
FOR RECOMMENDATION	
DATE	SIGNED
20.06.2014	IP
FOR CONSTRUCTION	
DATE	SIGNED
20.06.2014	IP

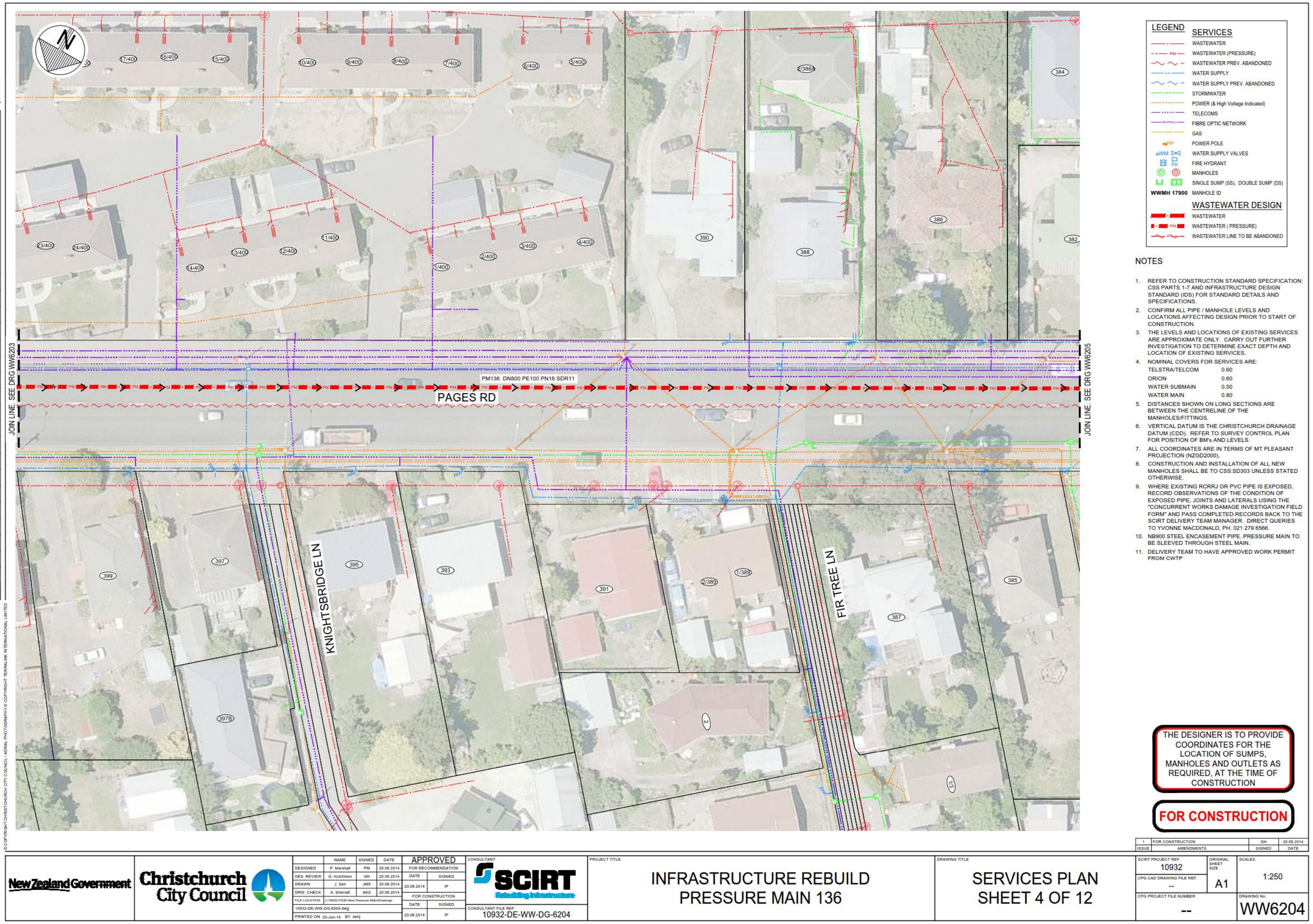
CONSULTANT: SCIRT Rebuilding Infrastructure
CONSULTANT FILE REF. 10932-DE-WW-DG-6100

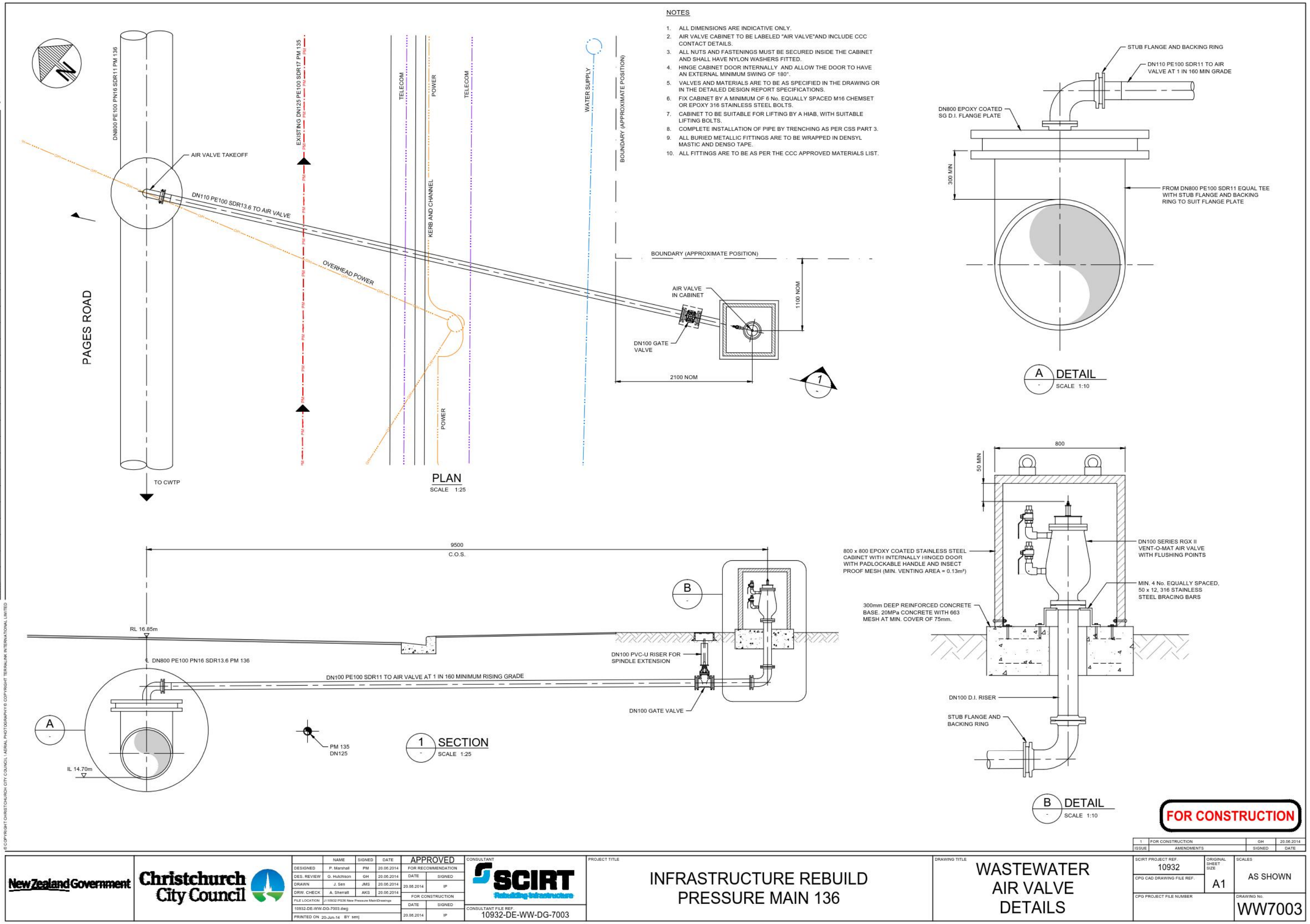
PROJECT TITLE: INFRASTRUCTURE REBUILD PRESSURE MAIN 136

DRAWING TITLE: WATEWATER OVERVIEW PLAN & SHEET LAYOUT

SCIRT PROJECT REF.	ORIGINAL SHEET SIZE	SCALES
10932	A1	1:2500
CPG CAD DRAWING FILE REF. --		
CPG PROJECT FILE NUMBER --		DRAWING No. WW6100


PLAN
SCALE 1:500
PAGES RD
ROWAN AVE
EXTENT OF WORKS
CAUTION
OVERHEAD POWER CABLES
WITHIN EXTENT OF WORKS
LONGITUDINAL SECTION
LEGEND
NOTES
THE DESIGNER IS TO PROVIDE COORDINATES FOR THE LOCATION OF SUMPS, MANHOLES AND OUTLETS AS REQUIRED, AT THE TIME OF CONSTRUCTION
FOR CONSTRUCTION
INFRASTRUCTURE REBUILD
PRESSURE MAIN 136
WASTEWATER
PLAN & LONG SECTION
SHEET 1 OF 8
1:500 HORIZ
1:50 VERT
WW6101
10932-DE-WW-DG-6101

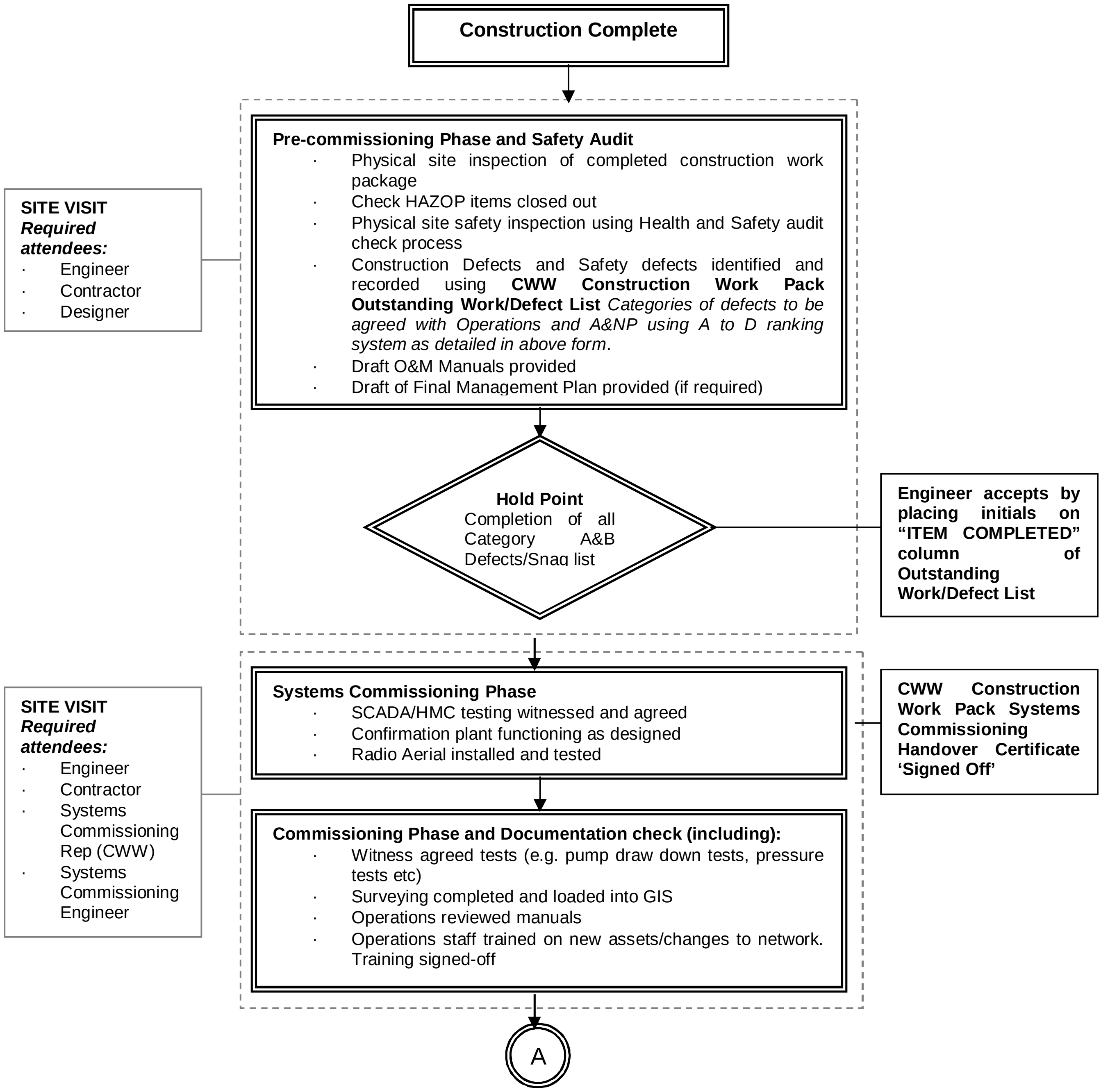

PM136 DN800 PE100 PN16 SDR11
PAGES RD
JOIN LINE. SEE DRG WW6203
JOIN LINE. SEE DRG WW6205
KNIGHTSBRIDGE LN
FIR TREE LN
LEGEND
SERVICES
WASTEWATER
WASTEWATER (PRESSURE)
WASTEWATER PREV. ABANDONED
WATER SUPPLY
WATER SUPPLY PREV. ABANDONED
STORMWATER
POWER (& High Voltage Indicated)
TELECOMS
FIBRE OPTIC NETWORK
GAS
POWER POLE
WATER SUPPLY VALVES
FIRE HYDRANT
MANHOLES
SINGLE SUMP (SS), DOUBLE SUMP (DS)
WWMH 17900 MANHOLE ID
WASTEWATER DESIGN
WASTEWATER
WASTEWATER (PRESSURE)
WASTEWATER LINE TO BE ABANDONED
NOTES
1. REFER TO CONSTRUCTION STANDARD SPECIFICATION: CSS PARTS 1-7 AND INFRASTRUCTURE DESIGN STANDARD (IDS) FOR STANDARD DETAILS AND SPECIFICATIONS.
2. CONFIRM ALL PIPE / MANHOLE LEVELS AND LOCATIONS AFFECTING DESIGN PRIOR TO START OF CONSTRUCTION.
3. THE LEVELS AND LOCATIONS OF EXISTING SERVICES ARE APPROXIMATE ONLY. CARRY OUT FURTHER INVESTIGATION TO DETERMINE EXACT DEPTH AND LOCATION OF EXISTING SERVICES.
4. NOMINAL COVERS FOR SERVICES ARE:
TELSTRA/TELCOM 0.60
ORION 0.60
WATER SUBMAIN 0.50
WATER MAIN 0.80
5. DISTANCES SHOWN ON LONG SECTIONS ARE BETWEEN THE CENTRELINE OF THE MANHOLES/FITTINGS.
6. VERTICAL DATUM IS THE CHRISTCHURCH DRAINAGE DATUM (CDD). REFER TO SURVEY CONTROL PLAN FOR POSITION OF BM's AND LEVELS.
7. ALL COORDINATES ARE IN TERMS OF MT PLEASANT PROJECTION (NZGD2000).
8. CONSTRUCTION AND INSTALLATION OF ALL NEW MANHOLES SHALL BE TO CSS:SD303 UNLESS STATED OTHERWISE.
9. WHERE EXISTING RCRRJ OR PVC PIPE IS EXPOSED, RECORD OBSERVATIONS OF THE CONDITION OF EXPOSED PIPE, JOINTS AND LATERALS USING THE "CONCURRENT WORKS DAMAGE INVESTIGATION FIELD FORM" AND PASS COMPLETED RECORDS BACK TO THE SCIRT DELIVERY TEAM MANAGER. DIRECT QUERIES TO YVONNE MACDONALD, PH. 021 279 6566.
10. NB900 STEEL ENCASEMENT PIPE. PRESSURE MAIN TO BE SLEEVED THROUGH STEEL MAIN.
11. DELIVERY TEAM TO HAVE APPROVED WORK PERMIT FROM CWTP
THE DESIGNER IS TO PROVIDE COORDINATES FOR THE LOCATION OF SUMPS, MANHOLES AND OUTLETS AS REQUIRED, AT THE TIME OF CONSTRUCTION
FOR CONSTRUCTION
1 FOR CONSTRUCTION GH 20.06.2014
ISSUE AMENDMENTS SIGNED DATE
New Zealand Government
Christchurch City Council
NAME SIGNED DATE
DESIGNED P. Marshall PM 20.06.2014
DES. REVIEW G. Hutchison GH 20.06.2014
DRAWN J. Sen JMS 20.06.2014
DRW. CHECK A. Sherratt AKS 20.06.2014
10932-DE-WW-DG-6204.dwg
PRINTED ON 20-Jun-14 BY senj
APPROVED
FOR RECOMMENDATION
DATE SIGNED
20.06.2014 IP
FOR CONSTRUCTION
DATE SIGNED
20.06.2014 IP
CONSULTANT
SCIRT
Rebuilding Infrastructure
CONSULTANT FILE REF.
10932-DE-WW-DG-6204
PROJECT TITLE
INFRASTRUCTURE REBUILD
PRESSURE MAIN 136
DRAWING TITLE
SERVICES PLAN
SHEET 4 OF 12
SCIRT PROJECT REF.
10932
CPG CAD DRAWING FILE REF.
--
ORIGINAL SHEET SIZE
A1
SCALES
1:250
CPG PROJECT FILE NUMBER
--
DRAWING No.
WW6204

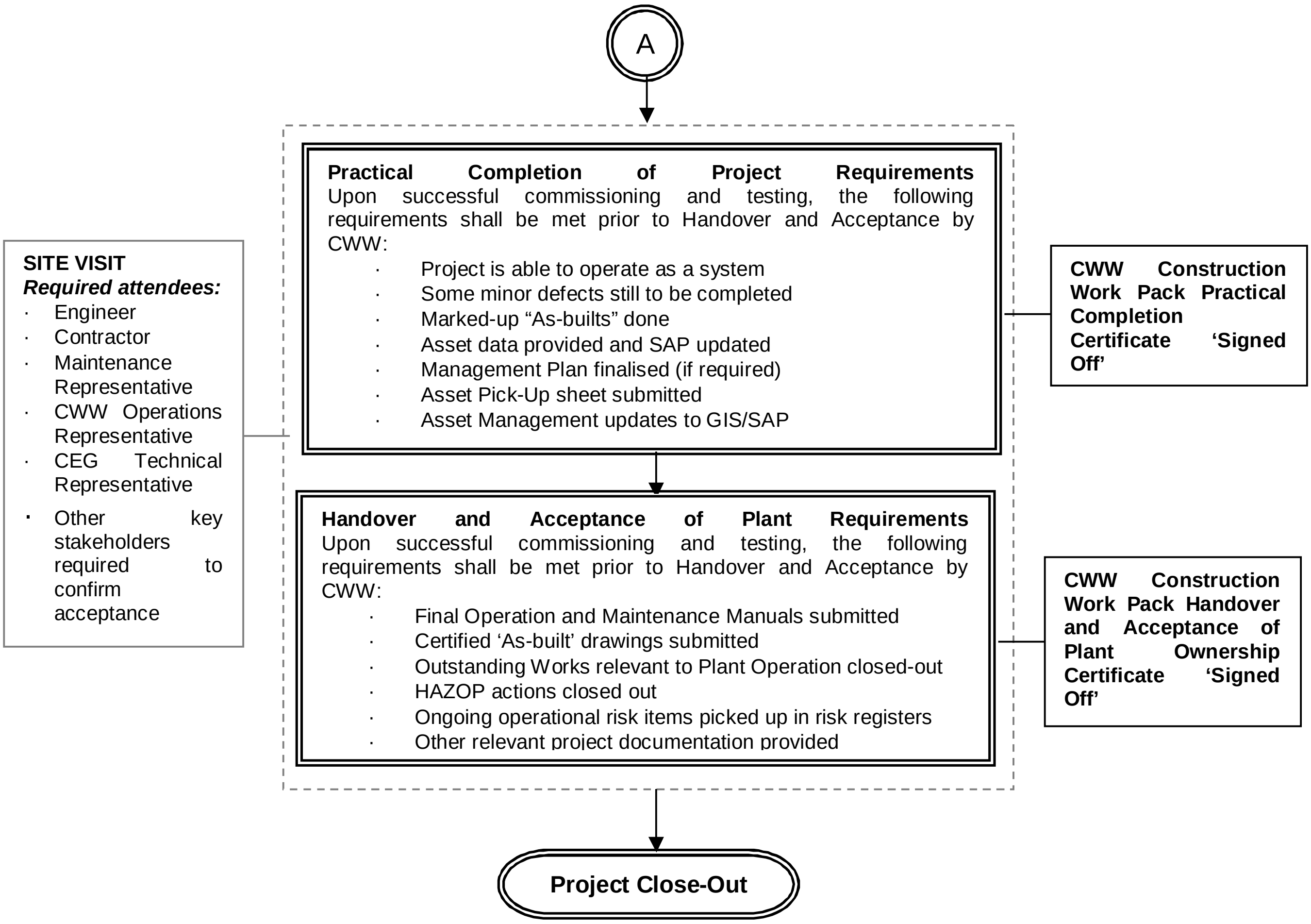

NOTES
1. ALL DIMENSIONS ARE INDICATIVE ONLY.
2. AIR VALVE CABINET TO BE LABELED "AIR VALVE"AND INCLUDE CCC CONTACT DETAILS.
3. ALL NUTS AND FASTENINGS MUST BE SECURED INSIDE THE CABINET AND SHALL HAVE NYLON WASHERS FITTED.
4. HINGE CABINET DOOR INTERNALLY AND ALLOW THE DOOR TO HAVE AN EXTERNAL MINIMUM SWING OF 180°.
5. VALVES AND MATERIALS ARE TO BE AS SPECIFIED IN THE DRAWING OR IN THE DETAILED DESIGN REPORT SPECIFICATIONS.
6. FIX CABINET BY A MINIMUM OF 6 No. EQUALLY SPACED M16 CHEMSET OR EPOXY 316 STAINLESS STEEL BOLTS.
7. CABINET TO BE SUITABLE FOR LIFTING BY A HIAB, WITH SUITABLE LIFTING BOLTS.
8. COMPLETE INSTALLATION OF PIPE BY TRENCHING AS PER CSS PART 3.
9. ALL BURIED METALLIC FITTINGS ARE TO BE WRAPPED IN DENSYL MASTIC AND DENSO TAPE.
10. ALL FITTINGS ARE TO BE AS PER THE CCC APPROVED MATERIALS LIST.
PAGES ROAD
AIR VALVE TAKEOFF
DN110 PE100 SDR13.6 TO AIR VALVE
OVERHEAD POWER
TELECOM
POWER
KERB AND CHANNEL
WATER SUPPLY
BOUNDARY (APPROXIMATE POSITION)
AIR VALVE IN CABINET
DN100 GATE VALVE
1100 NOM
2100 NOM
TO CWTP
PLAN
SCALE 1:25
STUB FLANGE AND BACKING RING
DN110 PE100 SDR11 TO AIR VALVE AT 1 IN 160 MIN GRADE
DN800 EPOXY COATED SG D.I. FLANGE PLATE
300 MIN
FROM DN800 PE100 SDR11 EQUAL TEE WITH STUB FLANGE AND BACKING RING TO SUIT FLANGE PLATE
A DETAIL
SCALE 1:10
9500
C.O.S.
RL 16.85m
DN800 PE100 PN16 SDR13.6 PM 136
DN100 PE100 SDR11 TO AIR VALVE AT 1 IN 160 MINIMUM RISING GRADE
DN100 PVC-U RISER FOR SPINDLE EXTENSION
DN100 GATE VALVE
IL 14.70m
PM 135
DN125
1 SECTION
SCALE 1:25
800
50 MIN
800 x 800 EPOXY COATED STAINLESS STEEL CABINET WITH INTERNALLY HINGED DOOR WITH PADLOCKABLE HANDLE AND INSECT PROOF MESH (MIN. VENTING AREA = 0.13m²)
DN100 SERIES RGX II VENT-O-MAT AIR VALVE WITH FLUSHING POINTS
MIN. 4 No. EQUALLY SPACED, 50 x 12, 316 STAINLESS STEEL BRACING BARS
300mm DEEP REINFORCED CONCRETE BASE. 20MPa CONCRETE WITH 663 MESH AT MIN. COVER OF 75mm.
DN100 D.I. RISER
STUB FLANGE AND BACKING RING
B DETAIL
SCALE 1:10
FOR CONSTRUCTION
1 FOR CONSTRUCTION GH 20.06.2014
ISSUE AMENDMENTS SIGNED DATE
New Zealand Government
Christchurch City Council
DESIGNED P. Marshall PM 20.06.2014
DES. REVIEW G. Hutchison GH 20.06.2014
DRAWN J. Sen JMS 20.06.2014
DRW. CHECK A. Sherratt AKS 20.06.2014
10932-DE-WW-DG-7003.dwg
PRINTED ON 20-Jun-14 BY senj
APPROVED
FOR RECOMMENDATION
20.06.2014 IP
FOR CONSTRUCTION
20.06.2014 IP
CONSULTANT
SCIRT
Rebuilding Infrastructure
CONSULTANT FILE REF.
10932-DE-WW-DG-7003
PROJECT TITLE
INFRASTRUCTURE REBUILD
PRESSURE MAIN 136
DRAWING TITLE
WASTEWATER
AIR VALVE
DETAILS
SCIRT PROJECT REF.
10932
ORIGINAL SHEET SIZE
A1
SCALES
AS SHOWN
DRAWING No.
WW7003

17.2 HANDOVER FLOWCHART

Christchurch City Council	CITY WATER AND WASTE FINAL HANDOVER PROCEDURE FLOWCHART and ROLE EXAMPLES

The following flowchart details the process of handover to City Environment 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.





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

17.3 OUTSTANDING WORK/DEFECT LIST EXAMPLE

Christchurch City Council	CITY ENVIRONMENT GROUP CONSTRUCTION / COMMISSIONING WORK PACK 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.

- **Category A** – Complete prior to handover to CEG for Control System Commissioning
- **Category B** – Complete prior to Clean Water Commissioning
- **Category C –** Minor items that do not prevent commissioning
- **Category D –** Items not part of project scope and SCIRT agreement required to incorporate

Type refers to the following:

- **Snag (S) -** any defects/faults/problems/issues/actions identified prior plant handover
- **Defect (D) -** any defects/faults/problems/issues/actions identified at plant handover and during Defect Liability Period

Station Name:

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

Discipline Codes:

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

17.4 PRACTICAL COMPLETION CERTIFICATE

Christchurch City Council	CITY ENVIRONMENT GROUP CONSTRUCTION WORK PACK (CWP) 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 __________________

CEG CLIENT / OPERATIONS / MAINTENANCE ACCEPTANCE

CEG CLIENT ACCEPTANCE

The scope of work covered by this CWP has been inspected by City Environment Group (CEG) 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 CEG Client requirements applicable to this scope of work have been met and the CEG 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 Councils 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 __________________

17.5 HANDOVER CERTIFICATE

Christchurch City Council	**CITY ENVIRONMENT GROUP** **FINAL HAND OVER AND ACCEPTANCE OF 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

17.6 COMMISSIONING CERTIFICATE

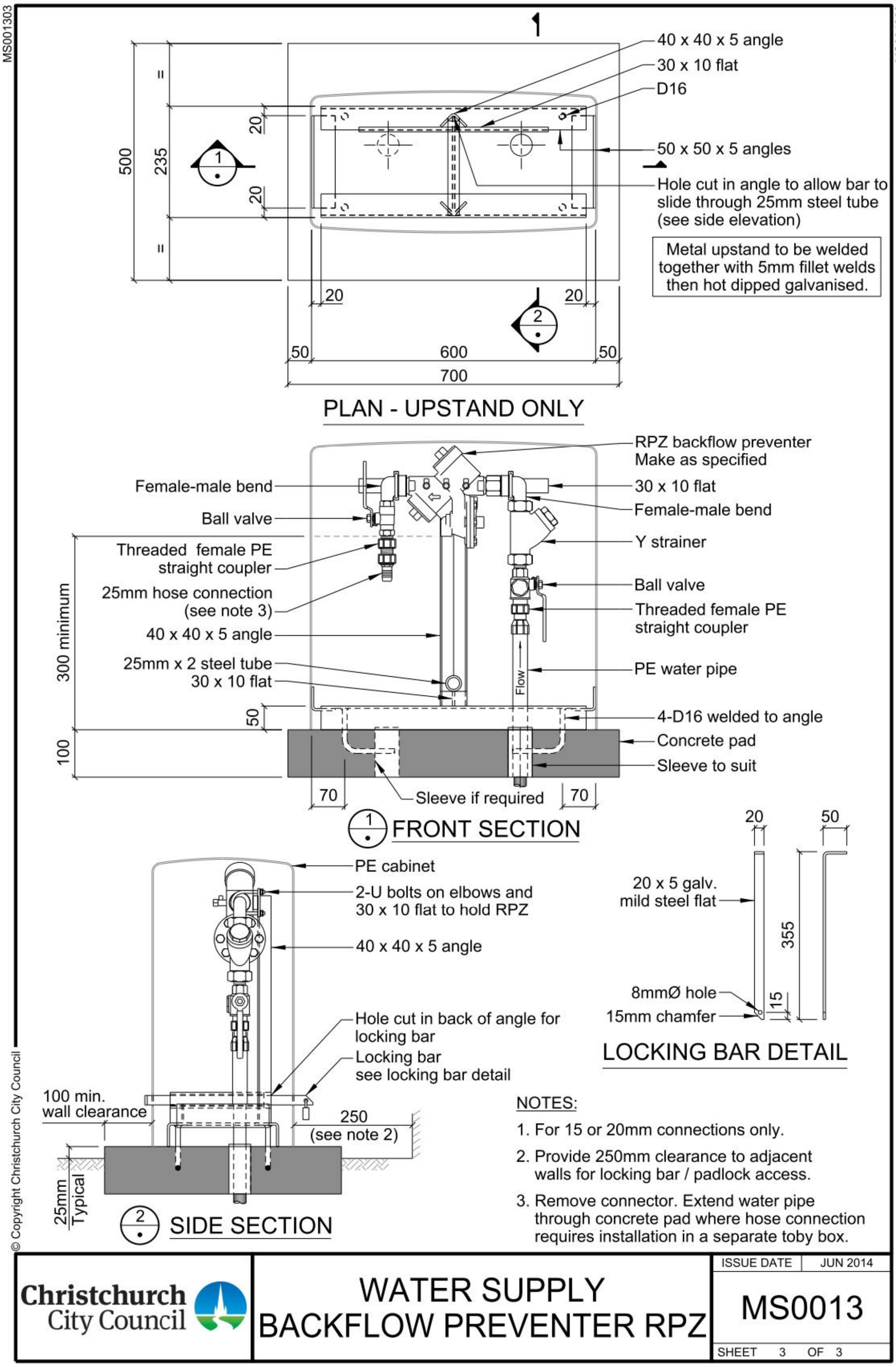
Christchurch City Council	**CITY ENVIRONMENT GROUP** **CONTROL SYSTEM COMMISSIONING** **HANDOVER CERTIFICATE**
PROJECT No.:	**STATION NAME:**
CWP No:	

COMPLETION OF CONTROL SYSTEM COMMISSIONING
SYSTEM COMMISSIONING MANAGER COMPLETION The scope of work covered by the Control System Commissioning phase of the CWP has been completed by ____ as confirmed by the CEG representative signature below. The System Commissioning Manager confirms that the CWP Control System has been tested and Clean Water Commissioning phase may commence. Name ____________________ Signed _____________________ Date ______________
COMMISSIONING MANAGER
CONTRACTOR COMMISSIONING MANAGER 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. Name ____________________ Signed _____________________ Date ______________
CEG CLIENT ACCEPTANCE OF CONTROL SYSTEM COMMISSIONING
CEG CLIENT ACCEPTANCE The scope of work covered by the Control System Commissioning phase of the CWP has been inspected by City Environment Group (CEG) Client representative and no outstanding “Category B” snags/defects are identified. The CEG Client requirements applicable to this scope of work have been met and The CEG Client representative confirms that the Clean Water Commissioning phase may commence. Name ____________________ Signed _____________________ Date ______________

Note:

1. System Commissioning Manager may be a 3rd Party Integrator or CCC E&I Personnel assigned to program the Work.
2. CEG 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.

17.7 RPZ BACKFLOW PREVENTER

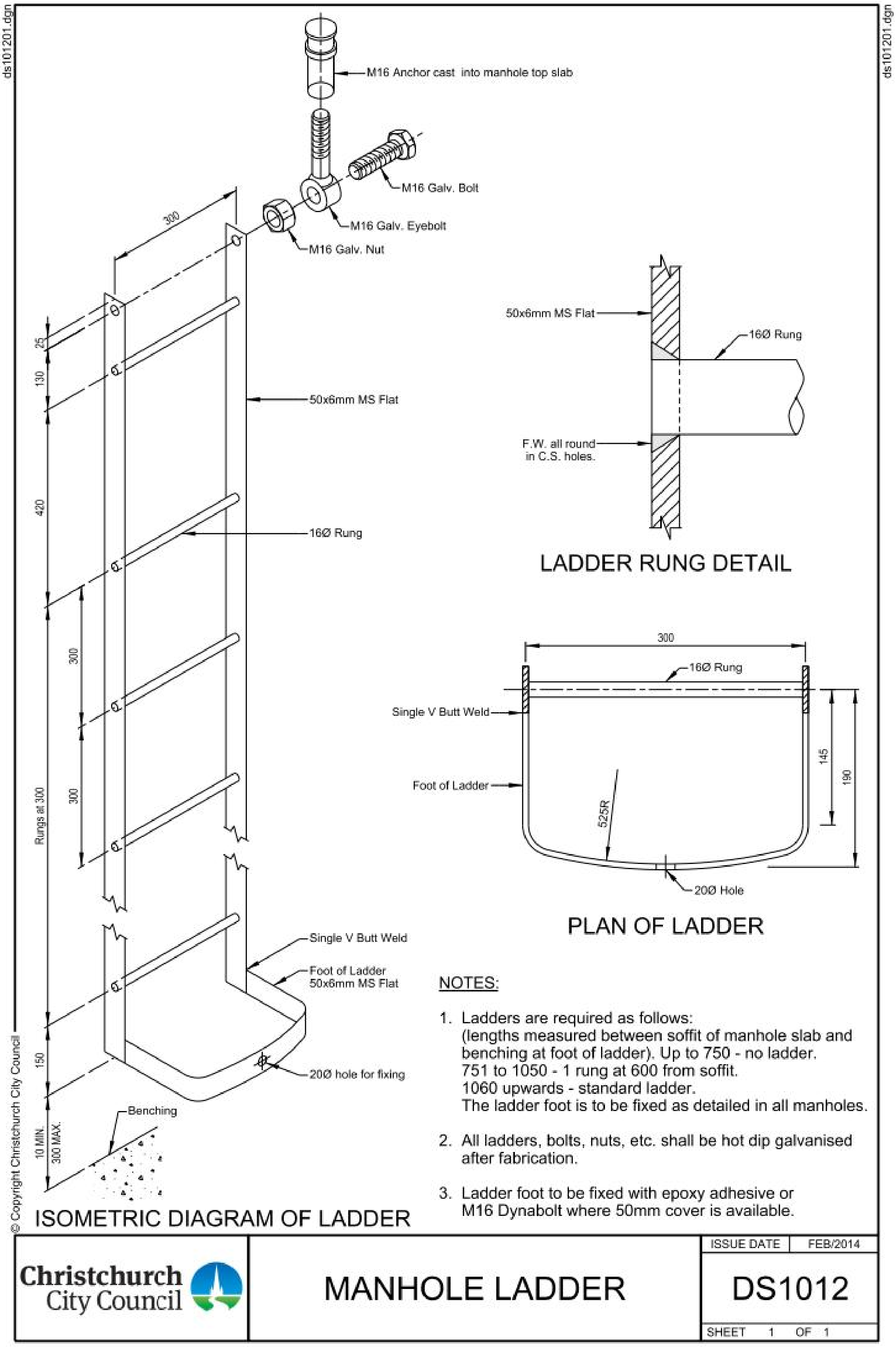


17.8 CONCRETE PROTECTION MATERIALS

This is a summary of materials used by SICRT up to February 2013. It is not exhaustive. Other approved methods include cast in PVC liners (Plastiline) or cast in HDPE liners (Studliner, Agruline, AKS).

Product	Armaline 3730	Situclad EHD	Sewer Guard Glaze 210G	EPAR733HV	Aquella
Supplier	Armatech	Nuplex	Sauriesen Pacific Concrete Protectors	Fraser Brown & Strathmore Ltd	Fraser Brown & Strathmore Ltd
Installer	Armatech approved	Various approved applicators	Various – e.g. TopCoat	Anyone	Anyone
Suggested Use	Very large pump stations but only where access is possible for inspection/repair. Likely to be too expensive to warrant use in smaller stations & MHs.	Situclad E for above water line only; EHD for permanently wet areas. Good for large pump stations in accessible areas. Could be expensive for very small pump stations.	Lower H_2S environments. Lift stations and small PS. Wouldn't recommend for large PS as access for inspection/ repair more difficult (need scaffolding)	Lower H_2S environments. Lift stations and small PS. Wouldn't recommend for large PS as access for inspection/ repair more difficult (need scaffolding)	Not suitable for wetwells or lift stations
Comments	Expensive product but likely to be more durable than others. Would expect high quality application.	Thinner coating than Armaline 3730 but cheaper. Expect shorter life than Armaline. Finished product depends on applicator.	Probably more likely to suffer pin-holing than Armaline/ Situclad	Probably more likely to suffer pin-holing than Armaline/ Situclad	Waterproofing agent only. Same acid resistance as concrete.

17.9 CHAMBER ACCESS LADDER



17.10 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		°C:	
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 (m^3/hr)						
Cooling water inlet (^{0}C)						
Cooling water discharge (^{0}C)						
dBA L_{95} at boundary *			N	E	W	S
dBA L_{10} 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.

17.11 PUMP TEST SHEET

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

Test Date : ____________________ **Witnessed by :** ____________________ **Test Date :** ____________________

		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 eg. Pipe, ladder, etc.	%	
3. Calculated capacity of pump sump per 300 mm depth of pump sump	litres	
4. Invert level of incoming sewer	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	Pump No. 2	Pump No. 1	Pump No. 2	Pump No. 1	Pump 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							

17.12 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 sewer. 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 sewer and centreline of riser mounted pressure gauges.
10. Tripod, harness[10], gas detector[11], 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 CCC “Permit to Work” form, available at

   http://resources.ccc.govt.nz/files/Business/constructiondevelopment/CCCPermitToWork.pdf.
2. Complete Confined Space Entry Form [12], 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.
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.

---

[10] Harnesses must have current useful life.

[11] All gas detectors used must be calibrated before use or have current calibration.

[12] It is required that all personnel doing confined space entry must have current CCC Confined Space Entry Authorisation Letter and are familiar with CCC *Guidelines for Confined Spaces*.

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[13]

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.

[13] 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.

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[14].

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).

[14] 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

17.13 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} m^2/s

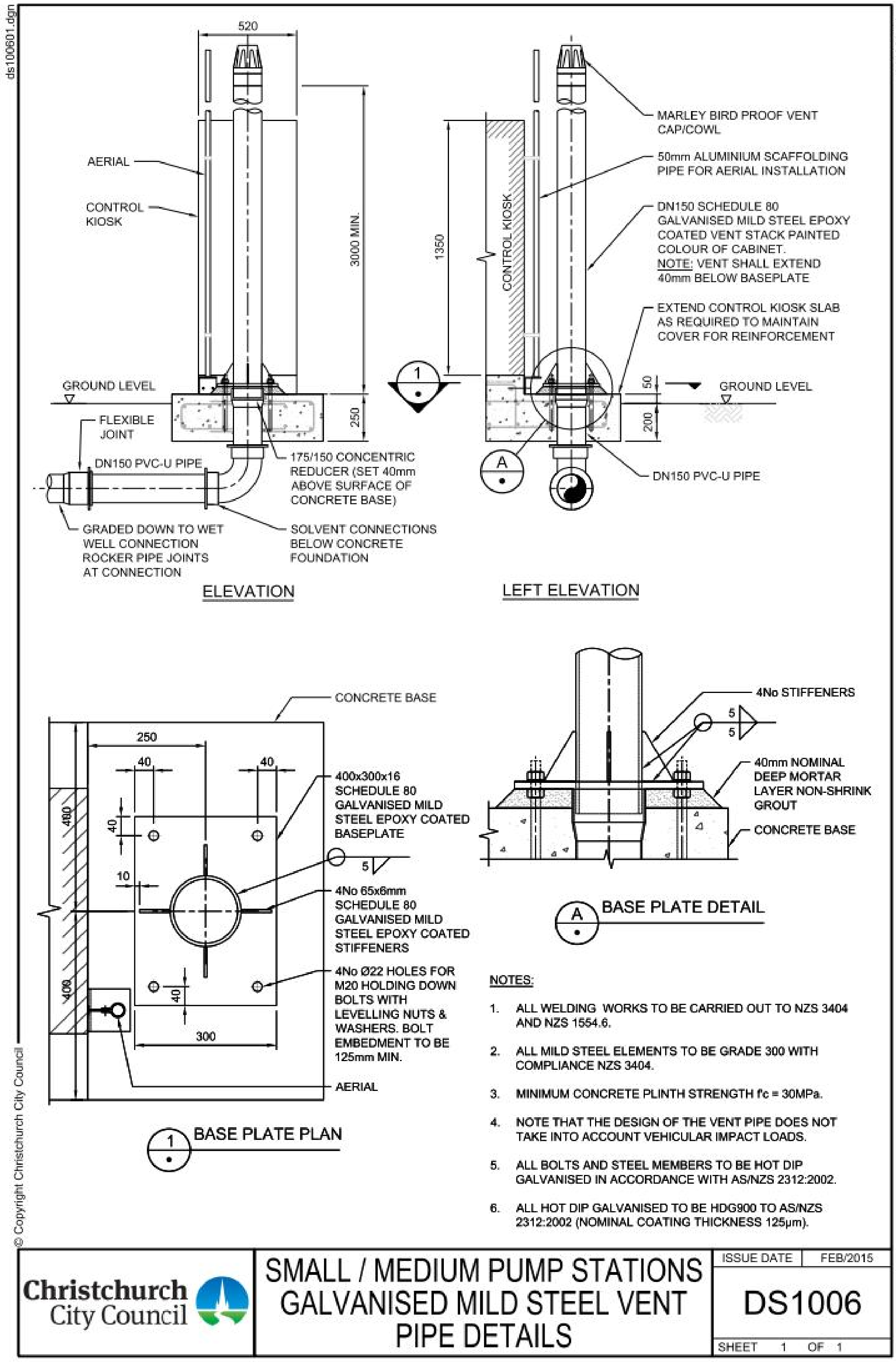
The Reynolds number will not be below 4000, i.e. always turbulent, unless velocities are extremely low, therefore λ can be calculated as shown.

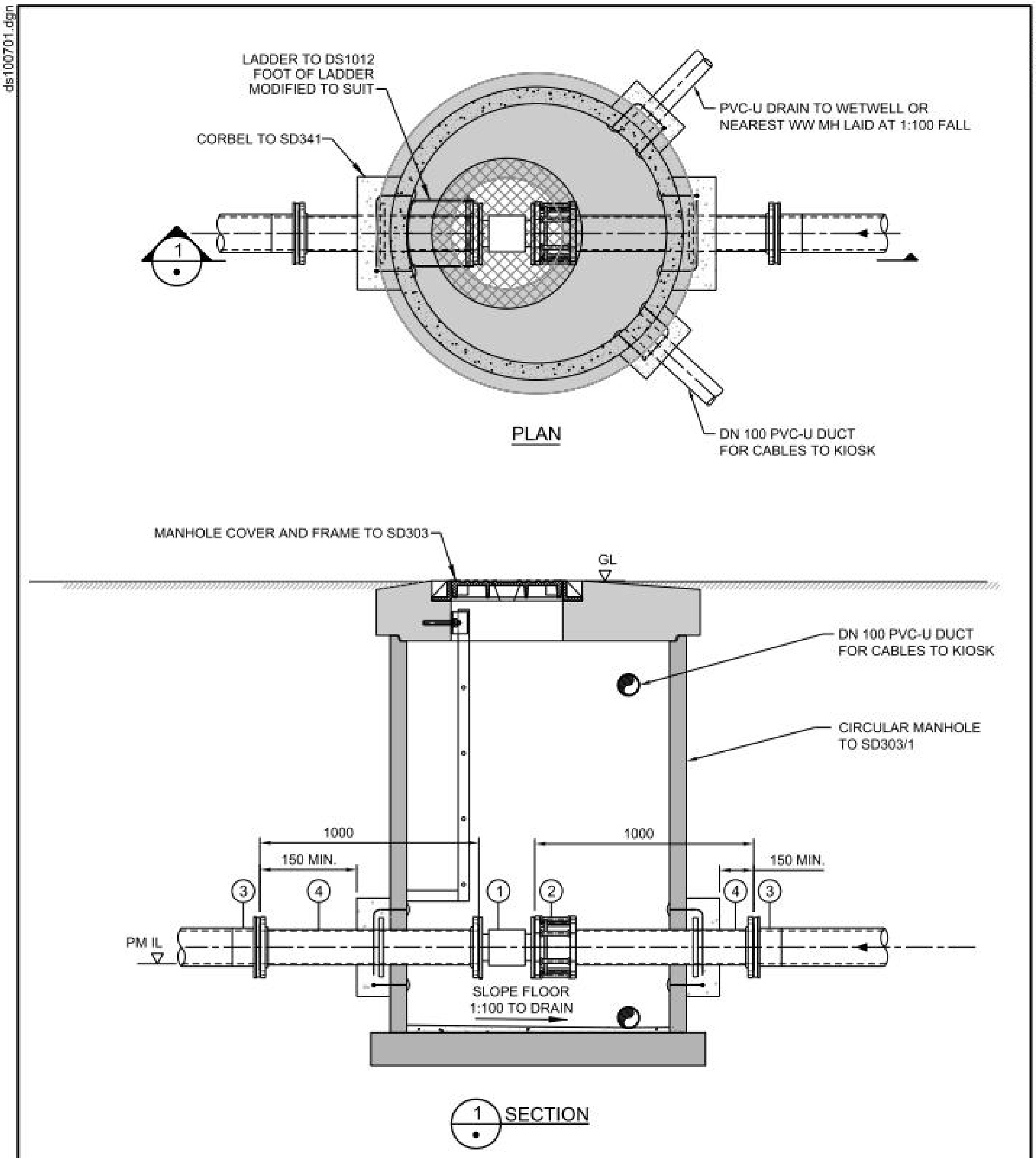
Head loss in each fitting (in metres of water)

$$hL = \frac{kV^2}{2g}$$

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

17.14 TYPICAL DETAILS





ITEM No.	DESCRIPTION
1	FLOW METER
2	DISMANTLING JOINT
3	PE STUB FLANGE (BUTT FUSION WELDED) AND PN16 BACKING RING
4	FLANGE DUCTILE IRON PIPE SHORT EPOXY COATED WITH PUDDLE FLANGE

NOTE:

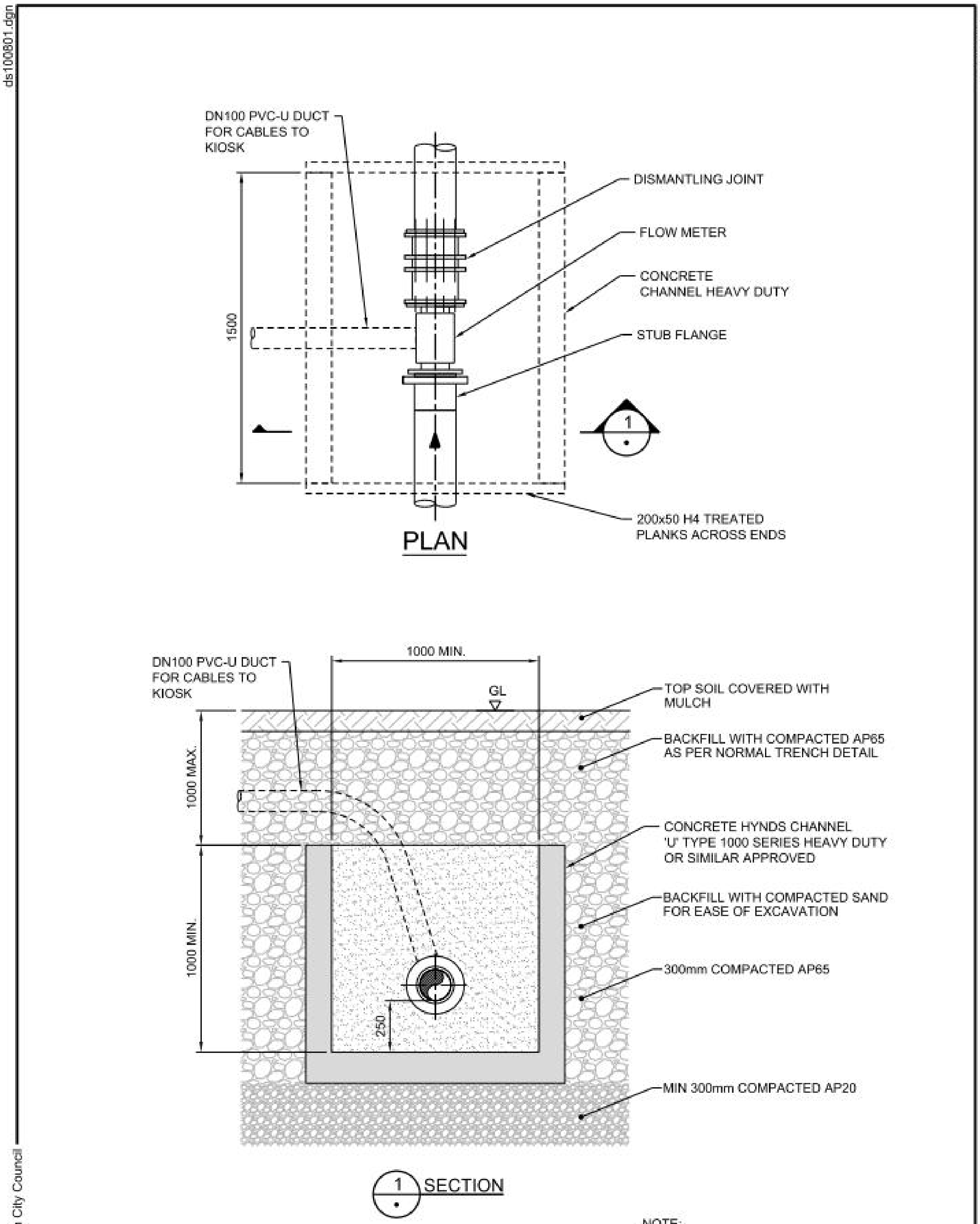
THE PREFERENCE FOR THE INSTALLATION OF FLOW METERS AS FOLLOWS:

1.VALVE CHAMBER
2.MANHOLE - AS SHOWN
3.DIRECT BURIED - STANDARD DETAIL DS1008

Christchurch City Council

SMALL / MEDIUM PUMP STATIONS
FLOW METER IN MANHOLE
UP TO DN200

ISSUE DATE	FEB/2014
DS1007	
SHEET 1	OF 1



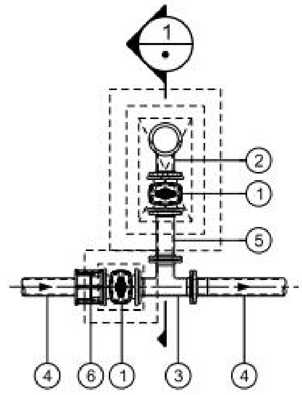
NOTE:

THE PREFERENCE FOR THE INSTALLATION OF FLOW METERS AS FOLLOWS:

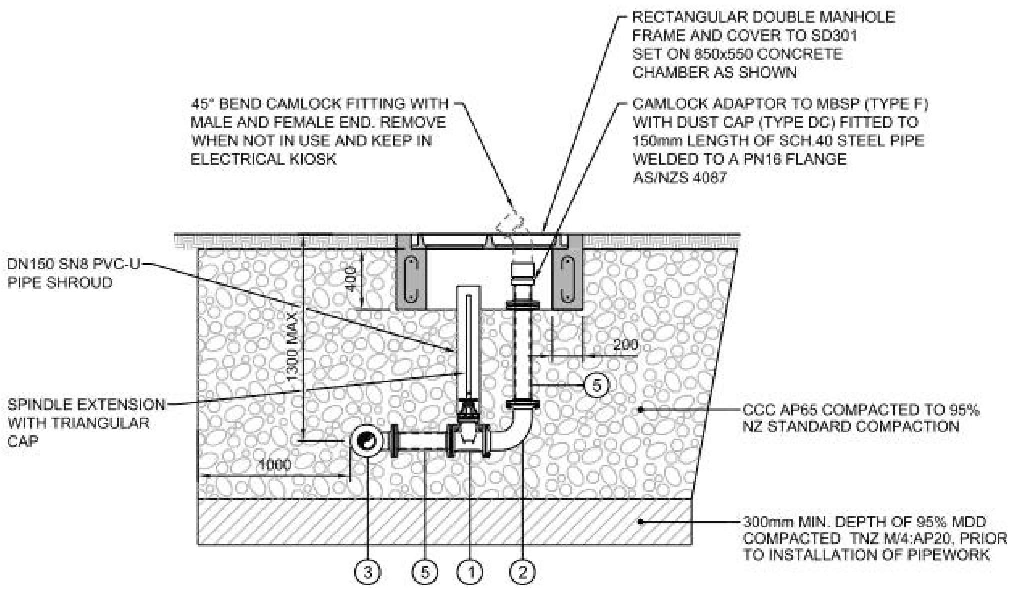
1.VALVE CHAMBER
2.MANHOLE - STANDARD DETAIL DS1007
3.DIRECT BURIED - STANDARD DETAIL DS1008

Christchurch City Council	SMALL / MEDIUM PUMP STATIONS DIRECT BURIED FLOW METER UP TO DN300	ISSUE DATE FEB/2014 — DS1008 — SHEET 1 OF 1

ds100901.dgn



PLAN



1 SECTION

NOTES:

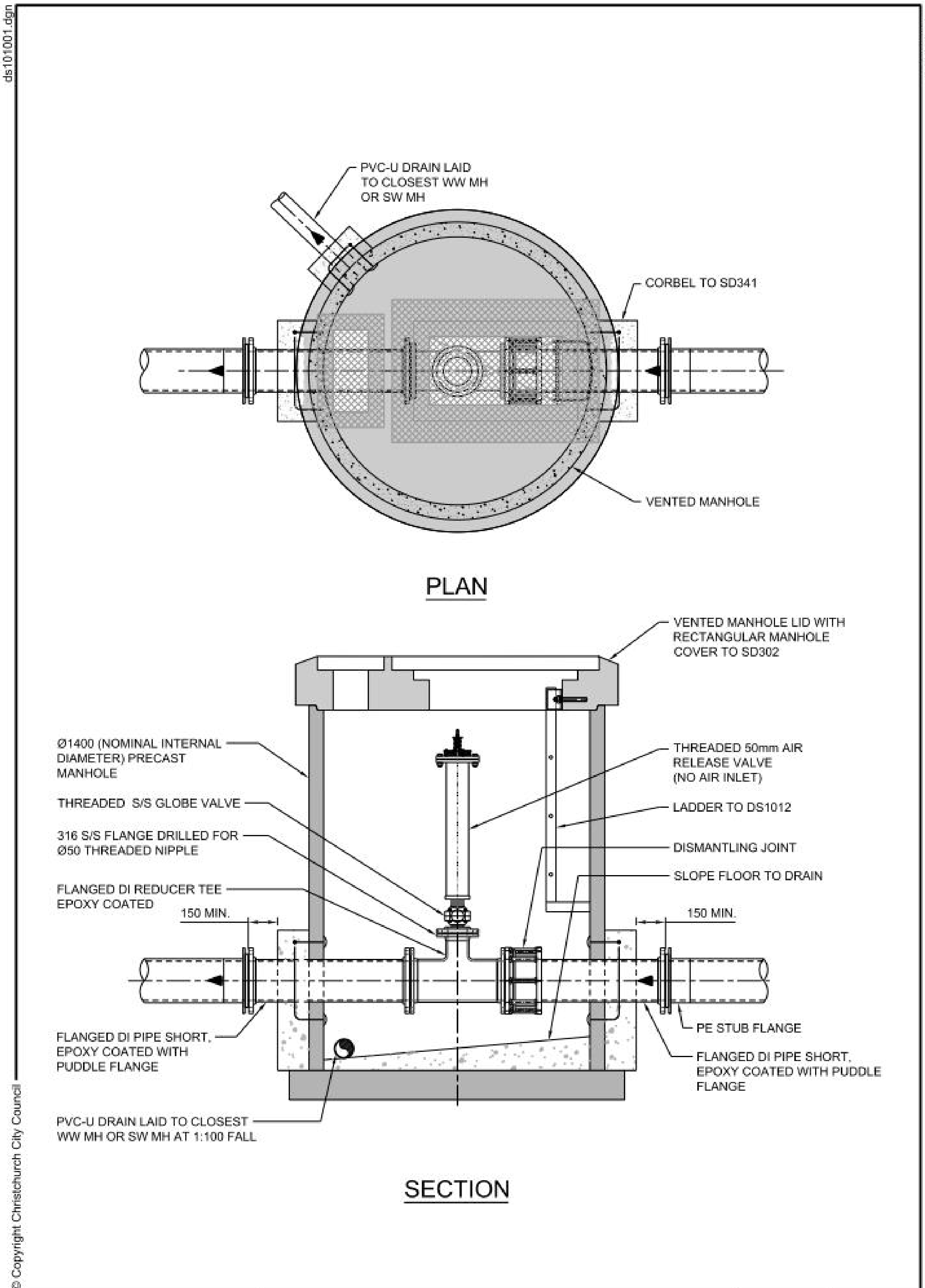
1. BYPASS TO BE LOCATED ON SEWER PRESSURE MAINS IN AN AVAILABLE LOCATION NEAR THE PUMP STATION TO PERMIT BYPASS PUMPING OF THE PUMP STATION WITH A MOBILE PUMP DIRECT TO PRESSURE MAIN.
2. BYPASS TO BE LOCATED DOWNSTREAM OF THE FLOW METER IF PRESENT.
3. BYPASS CONNECTION PIPE SIZE OFF MATCHING TEE TO BE SAME AS THE PRESSURE MAIN BUT NO LARGER THAN 200mm.
4. IF CAMLOCK IS SMALLER DIAMETER THAN THE BYPASS PIPE, THEN A REDUCER IS TO BE INSTALLED.

ITEM No.	DESCRIPTION
1	RESILIENT SEAT GATE VALVE
2	DUCTILE IRON 90° BEND PN16 EPOXY COATED
3	DUCTILE IRON TEE JUNCTION PN16 EPOXY COATED
4	PE STUB FLANGE (BUTT FUSION WELDED) AND PN16 BACKING RING
5	DI SPOOL FLANGED PN16 EPOXY COATED
6	DI DISMANTLING JOINT EPOXY COATED

Christchurch City Council

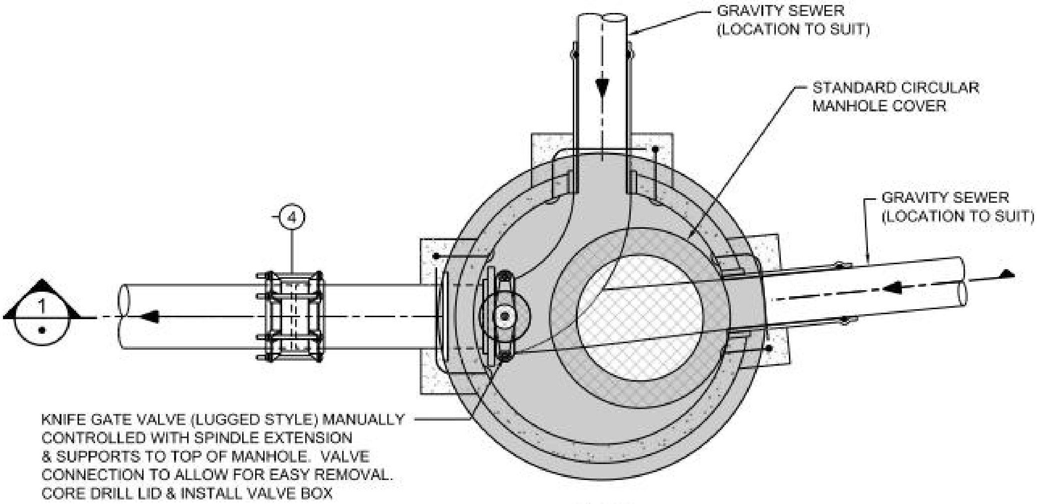
SMALL / MEDIUM PUMP STATIONS BYPASS DETAIL UP TO DN200

ISSUE DATE	FEB/2014
DS1009	
SHEET 1 OF 1	

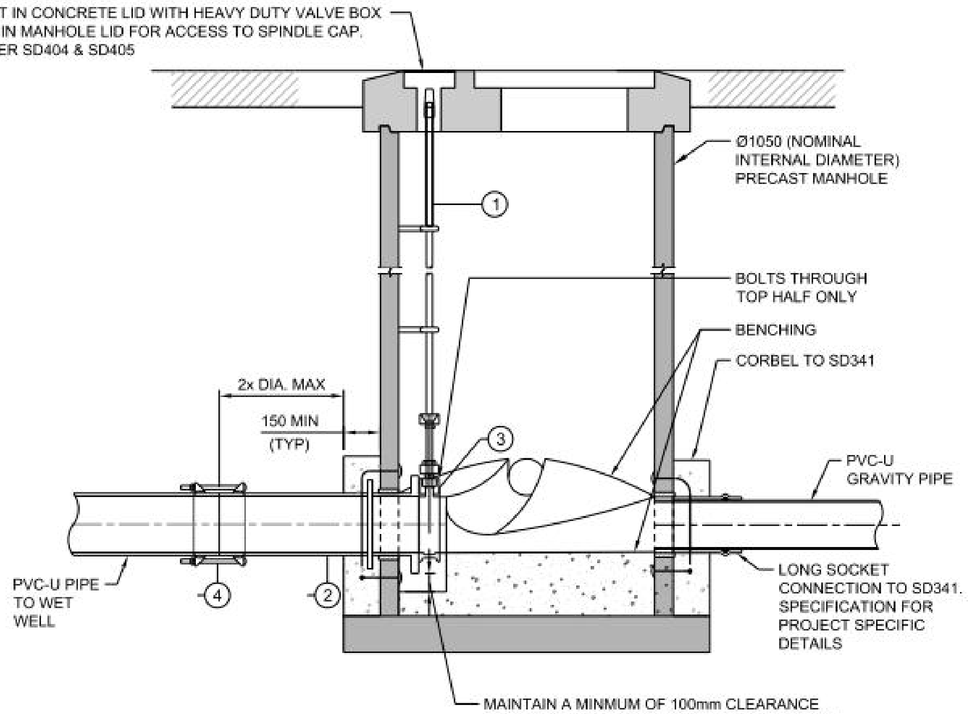


Christchurch City Council	SMALL / MEDIUM PUMP STATIONS AIR VALVE DETAILS	ISSUE DATE FEB/2014 DS1010 SHEET 1 OF 1

ds101101.dgn



PLAN



MAINTAIN A MINMUM OF 100mm CLEARANCE
BELOW & TO THE SIDES OF FLANGE TO ALLOW
REMOVAL OF BOLTS & VALVE. BACKFILL & HAUNCH
USING 5MPa GROUT FOLLOWING INSTALLATION.
USE FLANGE PATTERN PN16 AS/NZS 4087

1 SECTION

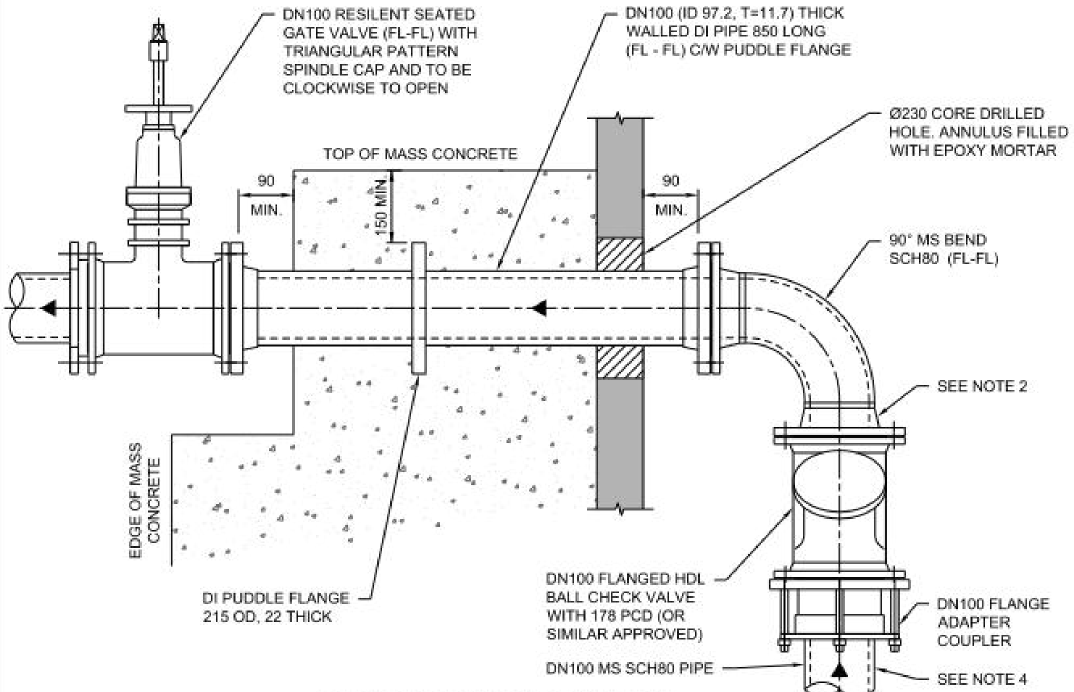
ITEM No.	DESCRIPTION
1	KEYSTONE EXTENSION SPINDLE WITH TRIANGULAR SPINDLE CAP, WALL BRACKETS AND UNIVERSAL JOINTS AS SHOWN OR SIMILAR
2	FLANGE/SPIGOT DUCTILE IRON PIPE SPOOL EPOXY COATED C/W PUDDLE FLANGE
3	DUCTILE IRON BODY KEYSTONE KNIFE GATE VALVE ALL OTHER PARTS S/S (LUGGED STYLE) OR SIMILAR APPROVED
4	LONG GIBAULT JOINT TO MATCH PIPE DIAMETER

Christchurch City Council

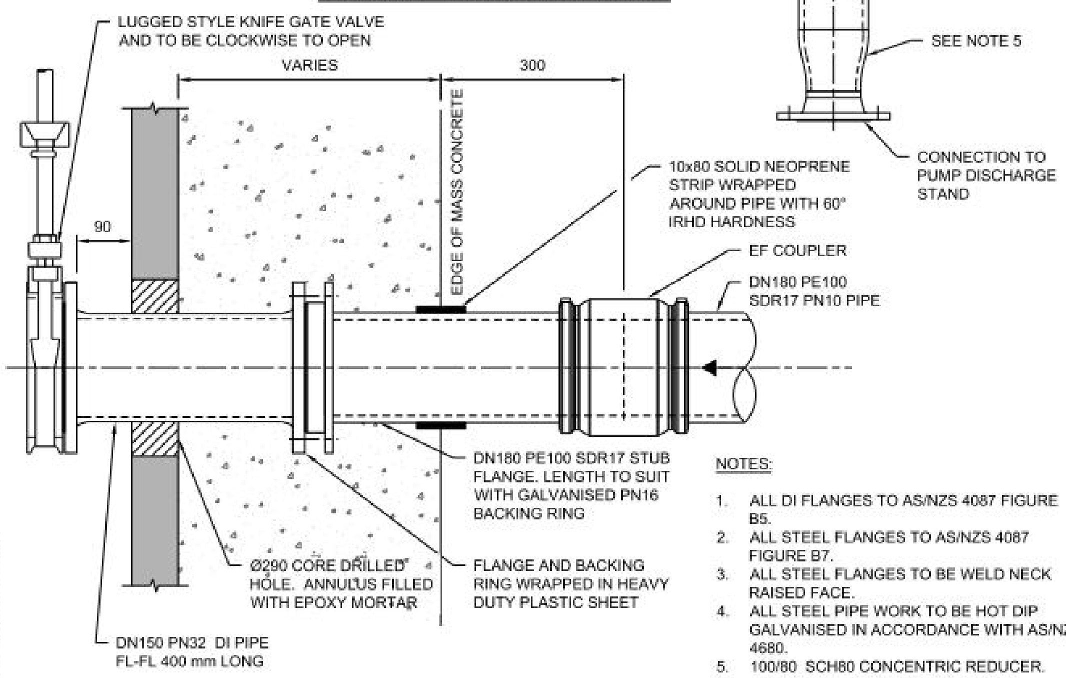
SMALL / MEDIUM PUMP STATIONS INLET MANHOLE

ISSUE DATE	FEB/2014
DS1011	
SHEET 1 OF 1	

DS100501.dgn



DN100 PIPE DISCHARGE



DN150 PIPE INLET

NOTES:

1. ALL DI FLANGES TO AS/NZS 4087 FIGURE B5.
2. ALL STEEL FLANGES TO AS/NZS 4087 FIGURE B7.
3. ALL STEEL FLANGES TO BE WELD NECK RAISED FACE.
4. ALL STEEL PIPE WORK TO BE HOT DIP GALVANISED IN ACCORDANCE WITH AS/NZS 4680.
5. 100/80 SCH80 CONCENTRIC REDUCER.
6. ALL DI PIPE AND FITTINGS TO HAVE EXTERNAL FUSION BONDED EPOXY COATING.
7. ALL GASKETS TO BE ELASTOMERIC TO AS/NZS 4087.

Christchurch City Council	WASTEWATER LIFT STATION WALL PENETRATIONS	ISSUE DATE FEB/2015 DS1005 SHEET 1 OF 1

17.15 PRE-FABRICATED BELOW-GROUND STRUCTURE DESIGN EXAMPLE

For underground structures (manholes and pump stations) the walls act as rigid retaining walls and will be acted upon by earth and ground water pressures. For the static case the soil pressures, assume the ‘at rest’ case. The ground around these structures will have well graded compacted hardfill.

For the seismic condition assess two different cases:

1. During the shaking, where there are additional inertial forces acting on the walls
2. After the shaking, where there is no shaking but there is a temporary increase in pore water pressure. This will act on the walls as well as the base of the structures

Static Condition

Include the following:

- Ground water at ‘x’m below ground level
- Surcharge load of 11 kPa for wet-well is considered conservative and accounts for temporary construction loads, the approximate compaction pressure of a roller and is also the pressure from 600mm of the granular fill material etc.
- Traffic loading

The total load is made up of:

- Ground water pressure that varies from 0 at ‘x’m below the top of the wall to γ_w (H – ‘x’m) at the bottom of the wall, and on the base
- Uniform surcharge pressure of K_0 x surcharge load (11 kPa), on the walls, or similar for traffic loads
- Soil pressure (using submerged weight) which will vary from 0 at the top of the wall to K_0 (γ_s - γ_w) H at the base

Where: H = depth of soil to the underside of the structure’s slab

γ_s = unit weight of soil

γ_w = unit weight of water

K_0 = coefficient of at rest pressure

Seismic Condition 1- For Pump Station

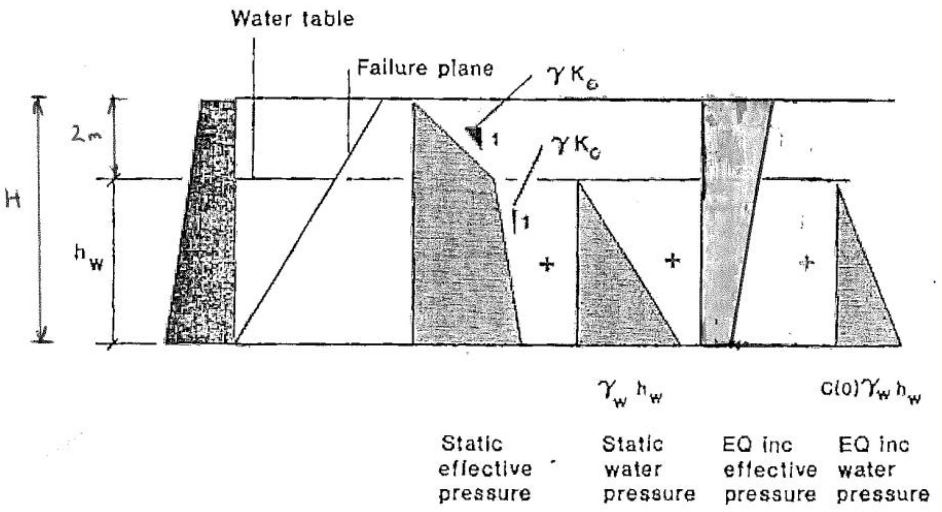
Consider this case during the actual shaking, based on:

- Ground water at ‘x’m below ground level
- No surcharge load around the structures
- Traffic loading

Base the seismic loading case on that recommended by Wood & Elms (1990), but modified to take into consideration the fact that the structures will act as rigid walls. Base the soil loads (including earthquake induced soil loads) on ‘at rest’ pressures. The total load on the structures is made up of:

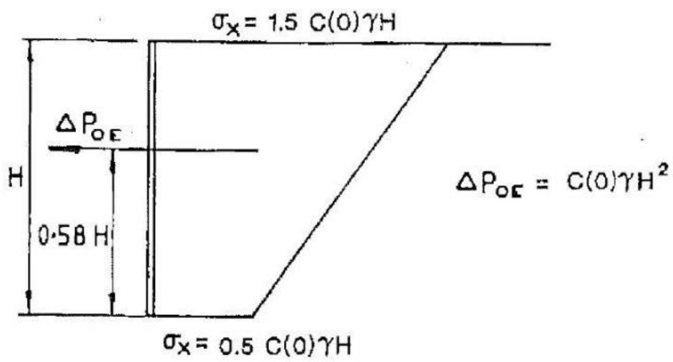
- Ground water pressure that varies from 0 at ‘x’m below ground level to γ_w (H – ‘x’m) at the bottom of the wall, and on the base
- Soil pressures on the walls based on ‘x’m of full soil weight (γ_s) and then submerged soil weight (γ_s - γ_w) below that
- Earthquake induced soil pressure on the walls
- Earthquake induced water pressures on the walls only (i.e. this water pressure does not act on the base of the structures)

- Adjacent traffic loads



Note that the above figure does not include the effects of adjacent traffic loading.

Base the earthquake induced soil loads on the recommendations of Wood & Elms (1990) (see figure below), but modified to take into consideration the effects of the water table. For simplicity the total seismic mass of soil (using submerged values where appropriate) of an area 'H' behind the walls can be used. Distribute the seismic loads in the same ratio as given by Elms & Woods.



Seismic Condition 1- For Manholes

Seismic Condition 1- For Manholes

This shall be the same as for the pump station except:

- Ground water to be at ground level, so all soil weights will be based on submerged values

Seismic Condition 2 – All Underground Structures

This condition shall be considered to result from a seismically-induced increase in the pore-water pressure (although the area is prone to liquefaction, localised ground improvements will mean that there will be no actual liquefaction, but there may be an increase in pore-water pressure). It is deemed to occur after the initial shaking and so does not need to be taken in conjunction with Seismic Condition 1.