Part 7: Water Supply

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7.1 Referenced Documents

Planning and Policy

- The *Christchurch District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- New Zealand Building Code (1992)
- Christchurch City Council *Development Contributions Policy* 2021 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/building-and-planning-policies/development-contributions-policy
- Christchurch City Council *Water Supply and Wastewater Bylaw* (2022) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/water-supply-and-wastewater-bylaw-2022
- *Christchurch City Council Water Supply Service Plan* (2018) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/long-term-plan-and-annual-plans/ltp/long-term-plan-documents/
- Ministry of Health *Drinking Water Standards for New Zealand* (revised 2018)

Design

- Christchurch City Council *Water Supply, Treatment, Pumping Station and Reservoir Design Specification* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/watersupply
- SNZ/PAS 4509:2008 *New Zealand Fire Service Fire Fighting Water Supplies Code of Practice* (*Fire Service Code of Practice)*
- NZS 4404:2010 *Land development and subdivision infrastructure*
- AS/NZS ISO 9001:2016 *Quality Management Systems – Requirements*
- AS/NZS 4020:2005 *Testing of products for use in contact with drinking water*
- AS/NZS 2566.1:1998 *Buried flexible pipelines structural design*
- AS/NZS 2566.1:1998 *Buried flexible pipelines structural design, supplement 1*
- AS/NZS 2845.1:2010 *Water supply – Backflow prevention devices*
- AS/NZS 4130:2009 *Polyethylene (PE) pipes for pressure applications*
- PIPA POP010A *Polyethylene Pressure Pipes Design for Dynamic Stresses*
- PIPA POP101 *PVC Pressure Pipes Design for Dynamic Stresses*
- Australasian Society for Trenchless Technology *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking* www.astt.com.au/guidelines
- UKWIR 10/WM/03/21 *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites*

Construction

- Christchurch City Council *Authorised Water Supply Installer Specification* www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-contractors/authorised-water-supply-installers
- Christchurch City Council *Civil Engineering Construction Standard Specifications Parts 1-7* (*CSS*) www.ccc.govt.nz/consents-and-licences/construction-requirements/construction-standard-specifications/download-the-css
- Christchurch City Council *CWW Tagging Convention* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/as-built-survey-and-data-requirements
- Christchurch City Council *Pumping Station O&M Manual Template Draft* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/as-built-survey-and-data-requirements

Where a conflict exists between any Standard and the specific requirements outlined in the Infrastructure Design Standard (IDS), the IDS takes preference (at the discretion of the Council).

7.2 Introduction

This Part includes:

- the assessment of required infrastructure;
- technical design requirements;
- material requirements.

The *Water Supply, Wastewater and Stormwater Bylaw* defines the Council's requirements for protecting the water supply.

7.2.1 Description of the water supply system

Christchurch City Council's water supply is essentially an integrated citywide scheme that sources high quality groundwater from confined aquifers. This water is pumped into 1600km of watermains and 2000km of submains throughout the City.

The city's residential and commercial water users are supplied from approximately 150 wells at over 50 sites, eight main storage reservoirs, 37 service reservoirs and 26 secondary pumping stations. Monitoring and control of pumps and pressures are undertaken from a central control room at the main wastewater treatment plant, via telemetry, using a SCADA (Supervisory, Control and Data Acquisition) system.

The system is divided into distinct pressure zones, due to a combination of historical and topographical reasons. Bulk storage reservoirs provide for emergencies and also assist in meeting the peak demand in zones extending towards the Port Hills. Riccarton and zones further north have sufficient pumping capacity to meet instantaneous peaks, with diesel-powered pumps and generators providing for emergencies.

Mains and submains, located almost exclusively within legal roads, provide the necessary distribution system. Wells and pumping stations are relatively evenly distributed throughout the city, providing efficient delivery of water at a relatively even pressure within each zone. Secondary pumping stations and reservoirs are required to serve most properties in hilly areas.

7.2.2 Banks Peninsula water supply system

Banks Peninsula has eight Council operated water supply systems, of which three are groundwater supplies and five are surface water supplies. The reticulated areas make up 108km of water mains and 76km of submains.

7.2.3 Effects of development on the water supply network

The water supply system can usually be expanded incrementally without any adverse effect on the infrastructure. Additional pumping capacity must be added to the city's water supply system at the rate of one pumping station for the equivalent of each 2,000 new dwellings. Banks Peninsula water resources are restricted by surface water quantity and quality.

System extensions, upgrading headworks and any other specific works required to provide water for a new development will be funded in accordance with the Council's *Development Contributions Policy*.

7.2.4 Water supply resource constraints

Christchurch is fortunate in having readily available groundwater resources that can be developed very cost effectively, as required, to meet the increased need resulting from development. It should be remembered that this is a finite source and maintaining water quality is critical to its continued use.

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

Consents to take groundwater in the Christchurch area are required for both public supply and private purposes from the Canterbury Regional Council (Environment Canterbury). It may not be possible to get a consent in the Woolston industrial and Ferrymead areas, where low aquifer pressures have resulted in saline contamination from estuarine water. The City has reduced its take-up from these areas by double pumping from outside the zone, and a users' group composed of industrial and municipal consent holders has been formed to manage demand within the zone. Developers in this area should note that consents for private wells for industrial use in this area may be refused or constrained. Environment Canterbury must be consulted for information on likely consent conditions. Any development reliant on the municipal supply may be required to contribute to the infrastructure necessary for double pumping.

Soils at the western urban boundary and to the west of the city have a high permeability and pose an increased risk of groundwater pollution. Industrial land use in this area is of particular concern when considering environmental effects in relation to resource consent applications. Wells in this area can be affected by the quality of surface water and may be unsuitable for public water supply use unless treated.

7.2.5 Supply alternatives

Residential, commercial and industrial zones require a level of service that includes peak pressure and flows as defined in clause 7.5.1 – Flow and pressure for residential zones in on-demand water supply areas Chart 1, and fire fighting provision, as defined by the *Fire Service Code of Practice*.

The urban reticulated area does not necessarily extend to all parts of existing residential and commercial or industrial zones. The urban reticulated area is defined as all land north of the Port Hills and within 100 metres of an existing operational fire hydrant. The developer is responsible for the cost (or part cost) of any system extension.

Upon consent application, developments with infrastructure that will be vested in the Council will be issued with design parameters.

In some cases, pumping and reservoir systems may be required to provide an appropriate level of service. For example, variable speed systems without storage may be appropriate for small groups of houses that otherwise have adequate fire-fighting capacity. A decision by the Council to accept responsibility for maintaining such systems will be made on cost-benefit grounds, and capitalised maintenance charges may be required to ensure that the lifecycle costs expected by the Council can be recovered.

On-demand water supply systems, without fire-fighting capacity to Fire Service requirements, will not be approved within residential zones. In rural zones, approval for a restricted rural supply for domestic purposes only, without specific fire-fighting provision, may be granted at the discretion of the Council and special conditions may apply. Parameters for these systems will be specific to the development and will depend on the intended land use and availability of supply.

Subdivision without a reticulated supply may be approved, if a private potable source is available and if other options are impractical. Small community systems will normally be approved only if provision is made to ensure management in perpetuity without the Council's assistance.

If, for any reason, the Council approves a development without public supply to the Council's level of service, in an area where such a supply could reasonably be expected, the Council reserves the right to add a note to the property file advising of the situation.

7.3 Quality Assurance Requirements and Records

Provide quality assurance records that comply with the requirements in Part 3: Quality Assurance, during design and throughout construction.

7.3.1 The designer

The designer of all water supply systems that are to be taken over by Christchurch City Council must be suitably experienced. This experience must be to a level to permit membership in the relevant professional body. Refer to clause 2.7.1 – Investigation and design (General Requirements) for further information.

The design peer reviewer must have at least equivalent experience to the designer.

7.3.2 Design records

Provide the following information, to support the Design Report:

- hydraulic calculations, preferably presented in electronic form;
- all assumptions used as a basis for calculations, including pipe friction factors;
- calculations carried out for the surge analysis of pressure pipes, where appropriate;
- design checklists or process records;
- design flow rates;
- system review documentation as detailed in clause 7.6.7 – System review;
- thrust block design calculations, including soil bearing capacity;
- trenchless technology details.

7.3.3 Construction records

Provide the information detailed in Part 3: Quality Assurance and the *Construction Standard Specifications (CSS)*, including:

- pressure test results;
- chlorination test results;
- bacteriological test results;
- material specification compliance test results;
- compaction test results;
- subgrade test results;
- confirmation of thrust block ground conditions and design;
- site photographs.

The developer must provide the Council with a certificate for each pipeline pressure tested, including the date, time and pressure of the test. Provide details of the pipes in a form complying with the requirements of Part 12: As-Built, including manufacturer, diameter, type, class, date of manufacture, serial number, jointing and contractor who laid the pipe.

7.3.4 Acceptance criteria

All pipelines must be tested before acceptance by Council. Provide confirmation in accordance with the Contract Quality Plan that they have been tested, inspected and signed off by the engineer. Perform testing in accordance with *CSS: Part 4* clause 17.0 – Performance Testing.

All pump stations must be commissioned before acceptance by Council. Provide the following pre-commissioning documentation before requesting Council witness commissioning:

- confirmation that HAZOP items are closed out
- completed Health and Safety audit of constructed works
- construction and safety audit defect record using Appendix XIX – Pump Station Outstanding Work/Defect List (Quality Assurance)
- draft Operations and Maintenance Manuals
- draft of Final Management Plan (if required)

Further information is available in *Water Supply Wells, Pumping Station and Reservoir Design Specification*.

7.4 Water Supply Design

All pipe diameters are internal unless otherwise noted.

7.4.1 Design considerations

Consider the:

- hydraulic adequacy of the system;
- ability of the water system to maintain acceptable water quality, including consideration of materials and their disinfection demand, and prevention of back siphonage and stagnation;
- structural strength of water system components to resist applied loads, including ground bearing capacity;
- seismic design - all structures must be designed with adequate flexibility and special provisions to minimise risk of damage during earthquake. Provide flexible joints and isolation valves at all junctions between rigid structures (e.g. reservoirs, pump stations, bridges, buildings, manholes) and natural or made ground;

- pipeline's ability to withstand both internal and external forces, taking into account any transient temperature changes;
- Poisson's effect and end restraint designs to compensate where necessary;
- requirements of the *Fire Service Code of Practice*;
- impact of the works on the environment and community;
- "fit-for-purpose" service life of the system;
- maintenance in design and future serviceability including the provision of adequate isolation and drain points;
- best way to minimise the "whole-of-life" cost;
- resistance of each component to internal and external corrosion or degradation. Refer to clause 6.13.4 – Aggressive groundwater (Wastewater Drainage) for further information;
- installation requirements expressed in *CSS: Part 4*;
- capacity and ability to service future extensions and development;
- location of major reticulation and its potential for significant traffic disruption. Discuss at an early stage with Council.
- networking, redundancy and security of supply.

Design all parts of the water supply system that are in contact with drinking water using components and materials that comply with AS/NZS 4020. Select the pipe material to ensure a minimal impact on water quality within the system.

7.4.2 Design life

All water supply distribution systems are expected to last for an asset life of at least 100 years with appropriate maintenance, and must be designed accordingly to minimise life cycle costs for the whole period.

7.4.3 Future system expansion

Design watermains with sufficient capacity to cater for all existing and predicted development within the area to be served. Make allowance for areas of subdivided or un-subdivided land capable of future development, as specified by the Council in the design parameters.

7.4.4 Contaminated sites

Avoid contaminated sites wherever possible. If a contaminated site cannot be avoided, provide details about the following issues with the Design Report:

- compliance with statutory requirements;
- options for decontaminating the area;

- selection of ductile iron submains, wrapped in accordance with *CSS: Part 4* clause 12.0 - Fittings, and jointing techniques that will maintain the water quality (in accordance with the pipe selection chart shown in Appendix II – Water Distribution Mains – Materials Selection Flow Chart);
- safety of construction and maintenance personnel;
- any special pipeline maintenance considerations;
- seletion PE-Al-PE barrier pipe for submains, crossovers and laterals as per CCC approved materials;
- ductile iron mains and PE-Al-PE barrier pipe submains, crossovers and laterals shall be installed outside of bulk fuel storage facilities including petrol stations. Length of installation shall include the entire length of the property boundary plus extending a minimum of 15 m additional on each side.

Refer to *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* for further information.

7.4.5 Specific structural design

Avoid installing mains (≥150 mm ID) at depths greater than 1100 mm to top of pipe and submains and crossovers at depths greater than 700 mm as per CSS Part 4 and IDS Section 7.9.5 – Cover Over Pipes. Under exceptional circumstances when a pipe requires installation that exceeds these depths, design to resist static and dynamic loads. The design must comply with AS/NZS 2566.1 including Supplement 1. Provide details of the final design requirements in the Design Report.

Any ground that has an allowable bearing capacity less than 50 kPa is unsatisfactory for watermain construction. In such environments, engage a geotechnical specialist to investigate the site and to design and supervise the construction of an appropriate support or foundation remediation system for the watermain. Refer to clause 4.6.3 – Peat (Geotechnical Requirements) for further information.

Wherever it is necessary to fill an area before laying a watermain across it, or to build an embankment in which to lay the watermain, seek advice from a geotechnical specialist, to ensure that the weight of the fill will not cause failure or leakage of the pipe joints, after the main is laid.

7.4.6 Reducing waste

When designing the development, consider ways in which waste can be reduced.

- Plan to reduce waste during demolition e.g. minimise earthworks, reuse excavated material elsewhere.
- Design to reduce waste during construction e.g. prescribe waste reduction as a condition of contract.

- Select materials and products that reduce installation waste.
- Use materials with a high recycled content e.g. recycled concrete subbase.

See the Resource Efficiency in the Building and Related Industries (REBRI) website for guidelines on incorporating waste reduction in your project www.rebri.org.nz.

7.5 Design Parameters

In developments where adequate system pressure and coverage from hydrants already exists, the Council will advise the point of supply and the minimum pipe size for the supply pipe. The developer is responsible for the full cost of the supply pipe from the point of supply to the individual connection points.

When the developer is providing water reticulation for vesting in the Council, the Council will provide the following parameters, after receipt of the application plan:

- point of supply;
- mains size at the point of supply;
- supply type (e.g. on-demand or restricted);
- design number of connections, as provided by the developer;
- additional development to be allowed for in the design;
- static pressure;
- residual pressure at peak system demand in the network;
- residual fire pressure during fire demand at point of supply;
- fire water classification at point of supply;
- the minimum residual pressure at house site at peak system demand;
- networking requirements;
- other requirements (e.g. minimum mains size).

On-demand water supply areas are Christchurch City, Lyttelton Harbour Basin (including Governors Bay and Diamond Harbour) and Akaroa.

7.5.1 Flow and pressure for residential zones in on-demand water supply areas

Develop residential zones to comply with the definitions in the *District Plan*. The design average flow rates for the city are based on a peak flow rate of 0.42 litres/second/connection for allotment sizes of 500 to 1000m^2, but with a reducing diversity factor applied for more than six connections, in accordance with Chart 1. Provide the design flow rates, for developments other than standard residential zones (e.g. multi-unit developments or older persons' housing), with the Design Report.

The minimum residual pressure at the house site is shown in Table 1 and applies to ground level at the highest likely building site on each allotment.

Table 1 Minimum residual pressure at the house site

Lowest Residual Mains Pressure (kPa)	Minimum Residual Pressure at House Site at Peak System Demand (kPa)
less than or equal to 450	200
between 450 and 600	300
greater than 600	400

These requirements may be varied by the Council to suit specific usage or geographic conditions. Reasons for significant changes to the average figures will be outlined in the design parameters for the development, when applicable.

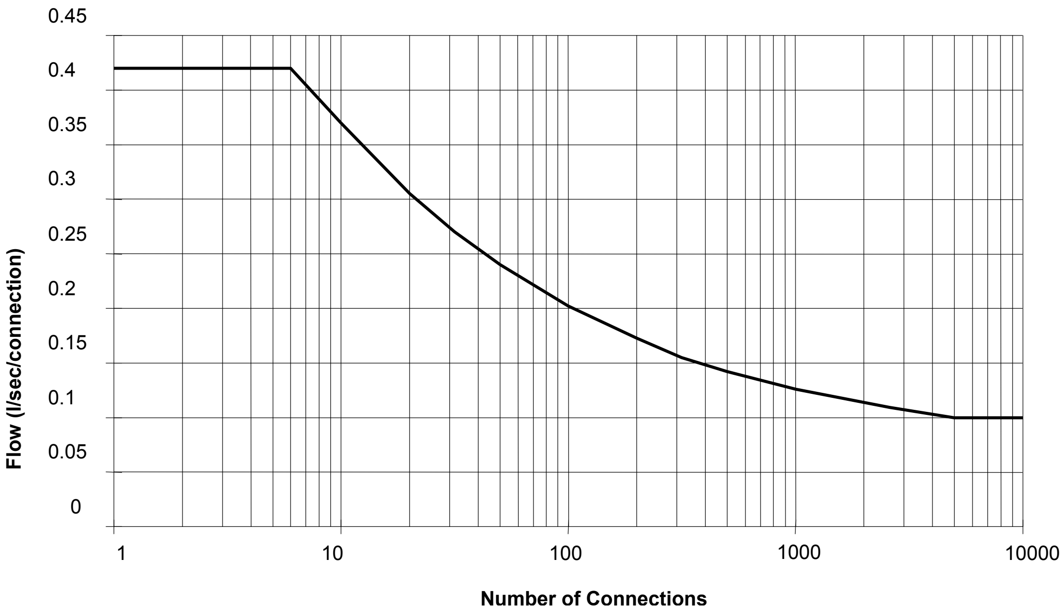


Chart 1 Peak residential design flow rates

7.5.2 Flow and pressure for business zones in on-demand water supply areas

Develop business zones (commercial and industrial) to comply with the definitions in the *City Plan* and the *Banks Peninsula District Plan*. Base the design industrial flow rate on the peak flow from a standard 25mm diameter connection of 1.20 litres/second/allotment, unless it is known that the proposed business zone consumption will be higher. In this case use the known consumption figures. A diversity factor can be applied for more than six business zone sites, in accordance with Chart 2. For more than 100 sites, a value of 0.46 litres/second/allotment can be used, which is the approximate average for peak business zone demand for Christchurch.

The minimum residual pressure at the boundary (rather than the point of use as for residential development) is shown in Table 2. Increase this minimum pressure by any rise in elevation between the point of supply and the highest likely building site.

Table 2 Minimum residual pressure at boundary

Lowest Residual Mains Pressure (kPa)	Minimum Residual Pressure at Boundary of Industrial Allotment at Peak Total Demand (kPa)
less than or equal to 450	250
between 450 and 600	350
greater than 600	500

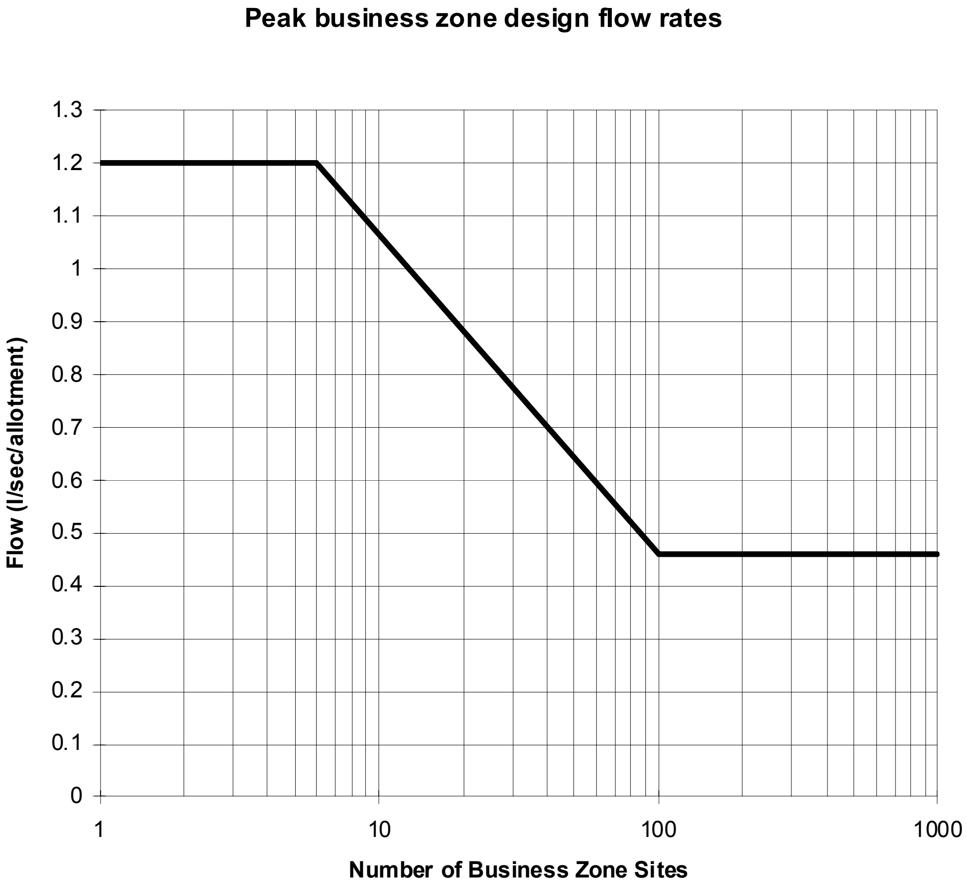


Chart 2 Peak business zone design flow rates

7.5.3 Design for restricted water supply areas

Restricted water supply areas apply to:

> developments outside the urban area;

> developments not within 100 metres of an operational fire hydrant;

> Banks Peninsula water supplies at Birdlings Flat, Duvauchelle, Little River, Pigeon Bay, Takamatua, Wainui.

Design any rural restricted supply to provide $3m^3$/day for each property. Provide each property with a restrictor at the time of connection that will pass 1, 2, or $3m^3$ over a 24-hour period, depending on the volume applied under the building consent.

Each property is required to provide on-site storage, at the time of building consent. The minimum storage capacity must be 48 hours normal gross supply. The supply must plumb into the storage vessel using a ballcock (to provide air gap separation) located above the overflow for the tank. Any other sources of water on any property must not be connected to the reticulation upstream of the air gap separation. Design rural restricted supplies for domestic purposes, rather than for stock water or irrigation purposes.

Individual sites may provide their own water bores for domestic purposes. These bores must be established in accordance with the consent requirements of Environment Canterbury. The water must be tested to show that the water quality is potable in accordance with the *Drinking Water Standards*.

If the water supply design proposes to establish an independent bore and reticulation to serve more than one property, the rules of urban supply apply (except for the fire fighting provision) if the development is within a rural zone. In addition, the Council may not necessarily take over an independent scheme, as it is unlikely to be an economic extension of service. If the Council does take over such a scheme, it reserves the right to require a capitalised maintenance fee based on the expected long-term operation and depreciation cost, capitalised at the current official cash rate. Provide proof to the Council, for schemes in private multiple use, that the scheme will be maintained in perpetuity, for the benefit of the users and to the satisfaction of the Ministry of Health. Present this proof as a legal document, prior to application for the 224(c) certificate.

New residential or commercial properties constructed within the Council water supply areas of Akaroa (including Takamatua), Duvauchelle, Wainui, Pigeon Bay, Little River and Birdlings Flat must provide supplementary water storage as per the *Water Supply and Wastewater Bylaw* 2022.

7.5.4 Fire service requirements

Design the water supply reticulation to comply with the *Fire Service Code of Practice*. In particular, the reticulation must meet the requirements for fire fighting flows, residual fire pressure and the spacing of hydrants. The minimum size of the principal main must be in accordance with Table 3.

Table 3 Minimum size of the principal main

Location of Main	Minimum Main Diameter (mm)
All residential zones, all zones on Banks Peninsula and B1 and B2 Zone	150
Remaining business, CCB and CCMU Zones	200

7.5.5 Fire services

Many industrial and commercial sites require the installation of fire services. The site owner is responsible for providing these fire services, which must be designed to meet the requirements of the New Zealand Building Code and the *Water Supply & Wastewater Bylaw* 2022. Detail full restraint to the connection on the main through anchor block installation (refer to clause 7.10.7 - Thrust and anchor blocks on mains) except where both the main and the fire service are fully welded polyethylene.

Specify materials for fire services within legal road that comply with clause 7.12.1 – Material selection. The requirement for weld testing on polyethylene fire service laterals between the watermain and the road boundary is waived but audit records of the welding may be requested by Council. Ensure authorised installers carry out the work, as specified in clause 7.13 – Authorised Installers.

All fire service connections to the Council reticulation will have a meter fitted by Council to detect any unlawful water use.

Do not assume that current pressure and flow will be available in the future when designing private fire services. Pressure and flow available is likely to reduce in the future, due to demand growth and pressure management.

7.6 RETICULATION DESIGN

7.6.1 Maximum operating pressure (head)

Calculate the maximum operating pressure for the mains as follows:

Equation 1 Maximum operating pressure at E

Maximum Operating Pressure (m) = Hs + S - E

where Hs = static pressure (m)

S = surge allowance (m)

E = lowest ground level of the proposed main (m)

Figure 1 illustrates the relationship between these pressures.

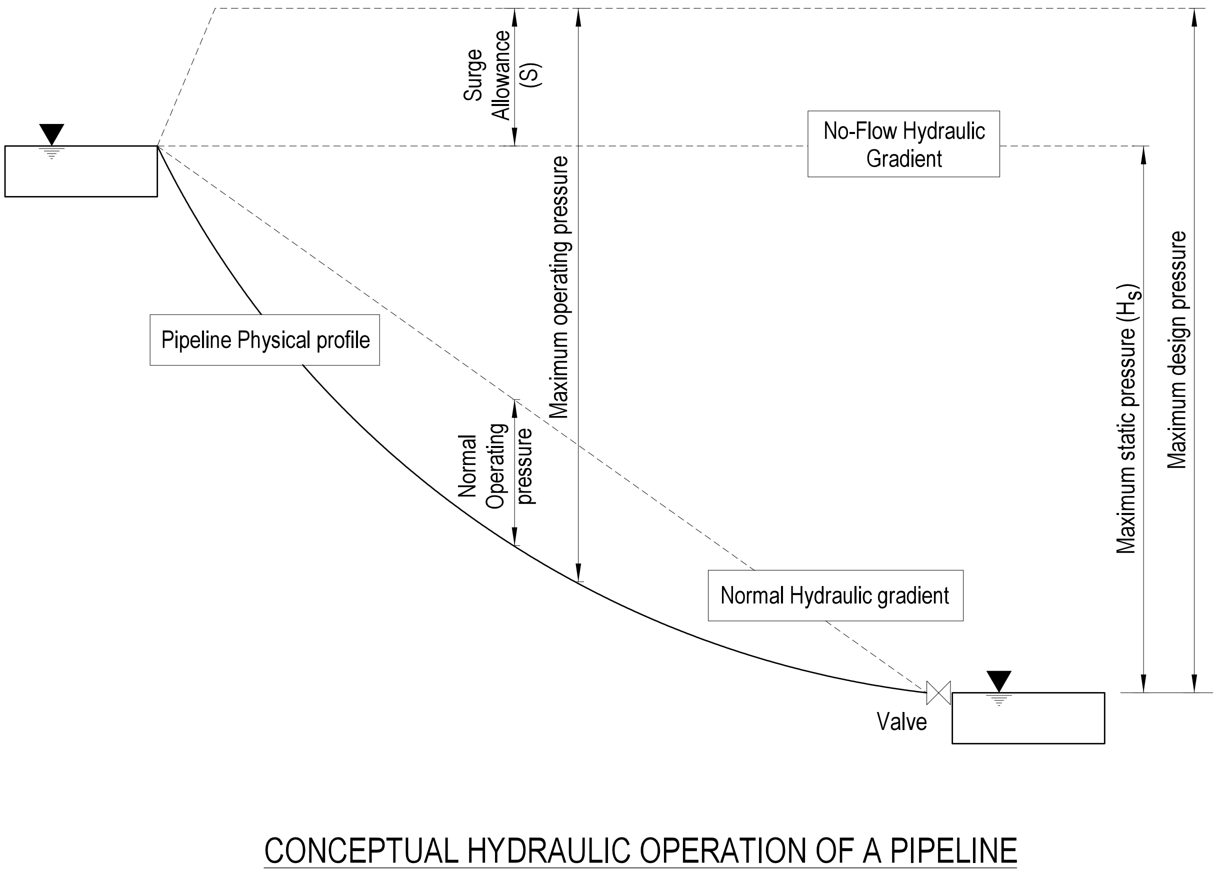


Figure 1 Pressure definitions

Use the calculated operating pressure when:

- selecting pipe materials and classes.
- selecting pipe fitting types and classes.
- designing thrust and anchor blocks.
- specifying the test pressure.

Where the main supplies directly to the reticulation system, the proposed maximum operating pressure must comply with the maximum operating pressure normally supplied in that zone. Alternatively, if supply is required to a small area adjacent to the trunk main, the supply pressure may be reduced using a pressure reducing valve before its transition to a reticulation main.

Specify at least PN15 for the first 200m of watermain downstream of any pump station.

7.6.2 Standard main and submain sizes

Acceptable standard nominal bore (DN) main diameters are 150, 200, 300, 375, 450 and 600mm inside diameter (ID). The only acceptable standard nominal outside (OD) diameters for submains is 63mm. Polyethylene pressure pipe only is specified by a nominal outside diameter (OD).

7.6.3 Minimum pipe and fitting class

The minimum pipe class for reticulation mains is PN 12. The minimum class for fittings is PN 16. Check the Council's minimum requirement, using Appendix II – Water Distribution Mains – Materials Selection Flow Chart, before specifying the required pipe class.

7.6.4 Losses

When determining the residual pressure at each site, take into account the minimum residual pressure to be available at the point of supply, as specified in the design parameters for the development, and, for residential developments, also consider any friction losses through the supply pipe at peak flow rate.

Assume all private service pipes on the street side of the meter are not more than 20mm diameter, unless a statement specifying the service pipe diameter is registered on the Property File relating to that allotment.

For residential developments, design losses through meter(s) and the submain must be such that the design flow rate downstream of any point corresponds with the value given in clause 7.5.1 – Flow and pressure for residential zones in on-demand water supply areas Chart 1 above. Alternatively, design the submain in accordance with Appendix I – Submain Design Charts.

Assume connections to individual allotments on the house side of the meter are 15mm diameter, unless consent has been given to design for a larger connection. Determine mains losses using flow rates in accordance with Chart 1 or clause 7.5.2 – Flow and pressure for business zones in on-demand water supply areas Chart 2, for the number of allotments downstream.

7.6.5 Pipe hydraulic losses

Take differences in elevation across the subdivision or development into account.

Calculate pipe friction losses from the pipe supplier's technical information or from representations of the Darcy-Weisbach/Colebrook-White formula. Use friction factors that take into account the effects of pipe aging.

Table 4 Friction factors

Pipe material	Ks (mm)
PVC-U, PE	0.015
Ductile Iron	0.06

Note:

1) These friction factors are extracted from NZS 4404, Table 6.1.
2) Manufacturers' design charts may be based on smoother pipe assumptions than these (e.g. Ks = 0.003) but such charts usually assume 'as new' laboratory conditions and ignore effects such as fittings and pipe ageing.

All of Christchurch's water must be pumped, so keep hydraulic gradients (other than for fire fighting purposes) below 0.01m/m. The Council may approve exceptions to this rule in isolated cases where the pressure is independent of pumping rates.

7.6.6 Surge and fatigue re-rating of plastic pipes

Although plastic pipes may be permitted in zones affected by dynamic pressure variations (e.g. pump zones), in locations downstream of pressure reducing valves, and in high surge areas, it is essential that the pipe class be reclassified (rerated) for both surge and fatigue (cyclic dynamic pressure variations) in accordance with the criteria set out in *Polyethylene Pressure Pipes Design for Dynamic Stresses* or *PVC Pressure Pipes Design for Dynamic Stresses*.

7.6.7 System review

When the pipe selection and layout have been completed, perform a system review, to ensure that the design complies with both the parameters specified by the Council and detailed in the IDS. The documentation of this review must include a full hydraulic system analysis. Compliance records must cover at least the following requirements:

- minimum residual pressure can be maintained at all property connections;
- maximum operating pressure will not be exceeded anywhere in the system;
- pipe class is suitable for the pipeline application (including operating temperature, surge and fatigue);
- pipe and fittings materials are suitable for the particular application and environment;
- pipe and fittings materials are approved materials;
- minimal likelihood of water quality problems or water stagnation;
- valve spacing and positioning allows isolation of required areas;
- mains layout and alignment meets the Council's requirements;
- meets minimum fire fighting demands;
- control valves, where required, are positioned to provide the required control of system;
- watermains are extended to boundaries;
- connections, to existing or future subdivisions, form a cohesive network and provide security of supply;
- capacity provided for future adjacent development.

7.7 Pumping Stations and Reservoirs

Any requirement for a secondary pumping station will become apparent during the preliminary reticulation design. The Council will take into account the long-term cost-effectiveness (i.e. total life-cycle costs) of the structure before accepting any infrastructure to be vested in the Council. Design and construct any such infrastructure to accord with the *Water Supply Wells, Pumping Station and Reservoir Design Specification*. Design secondary pumping stations that supply residential zones to supply 0.05 litres/second/connection unless otherwise specified.

Obtain requirements for pumping stations from the Council prior to design. On hills, all pumping stations must pump to a reservoir to even out any fluctuations in demand, unless the Council states otherwise in the design parameters.

When designing and sizing reservoirs, refer to the *Water Supply Wells, Pumping Station and Reservoir Design Specification*.

Consider the seismic effects on foundations, connections and liquefiable ground, and take these into account in the design and construction of any pumping station or reservoir. The "Vulnerability Map" tab at apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer indicates the vulnerability of land to liquefaction-induced damage. Pump stations and reservoirs in areas identified as medium or high liquefaction vulnerability require seismic specific designs as per IDS Part 4. Areas where the liquefaction category is undetermined or liquefaction damage is possible require geotechnical investigation to define the liquefaction vulnerability level.

Provide operations and maintenance manuals using the *Pumping Station O&M Manual Template*. Include SCADA functional descriptions and code. For standard pumping stations, level 1 process description only is required. For pumping stations that differ from standard, submit full level 2 functional descriptions before coding, using the *Level 2 functional description template*.

7.8 Reticulation Layout

Lay watermains in public roadways. Remove any existing reticulation between new lots. Section 9.5.3 of the IDS covers typical reticulation layout and specifies minimum horizontal and vertical clearances of water supply reticulation assets from other services.

7.8.1 Mains layout

Consider the following factors when deciding on the general layout of the mains:

- the need for mains to be replaced due to their physical condition and/or inadequate capacity or whether new mains are required to provide additional capacity;
- providing easy access to the main for repairs and maintenance;
- whether system security, disinfectant residual maintenance and mains cleaning meet operational requirements;

> the location of valves for shut off areas and zone boundaries. Note the '50 property' constraint in clause 7.10.1 – Sluice valves, for shutting off sections of the network;

> provision for scour and air valves;

> required clearances to other utilities. Refer to clause 9.5.3 – Typical services layout and clearances (Utilities);

> topographical and environmental considerations;

> avoidance of dead ends;

> providing dual or alternate feeds to minimise customer disruptions;

> no more than 50 properties to be serviced by a single end feed main.

Generally, the connection of reticulation to trunk mains is not permitted, as these mains may be shut down for servicing over extended periods, disrupting supply to reticulation where alternate feeds have not been provided.

Identify obstructions along the pipeline route and specify clearances. Specify clearances from other utility services, such as electricity, telecommunication cables, gas mains, stormwater drains and sewers. Where bending pipes or deflecting flexible joints, comply with the requirements of clause 7.9.7 - Working around structures.

7.8.2 Duplicate mains

Provide duplicate mains to provide adequate fire protection in these situations:

Table 5 Duplicate mains

Situation	Duplicate main
Roads with split elevation	Required
Parallel to large distribution/trunk mains that are not available for service connections	Required
Industrial/commercial areas	May be required
Arterial and dual carriageway streets	May be required

7.8.3 Reticulation in legal road

Evaluate and incorporate the following design considerations when locating reticulation in legal roads:

> Situate the pipeline in the least costly location, such as on the side of the legal road that serves the most properties;

> Wherever roads are cut into the hillside, situate pipes on the cut or high side, to make best use of road drainage and limit the risk of consequential damage;

> Excavate for the pipeline in undisturbed ground;

> Consider the balance between initial capital cost versus ongoing operational and maintenance costs, for factors such as access and soil type;

> Consider special cover requirements when renewing or laying new pipes in streets with a high crown and dish channels (refer to clause 7.9.5 – Cover over pipes);

> Allow for known future utility services and road widening.

Lay principal mains on one side of all residential streets to within 65m of the end of the cul-de-sac. In commercial and industrial streets, lay principal mains to within 20m of the end of the cul-de-sac. Measure the distance to the terminal hydrant from the road boundary at the end of the cul-de-sac. If the cul-de-sac is short enough to provide adequate fire protection from the intersecting road, locate the fire hydrant at the intersection.

The accepted location for principal mains is in the carriageway, between 2.0 and 2.5m offset from the kerb. Lay principal mains in new subdivisions only after the kerb and channel has been laid, unless the Council has given prior approval. Principal mains must not be less than 150mm diameter and must be fitted with fire hydrants in accordance with the *Fire Service Code of Practice*.

The preferred position of surface boxes, e.g. sluice valves and fire hydrants, is in line with either side of property entranceways, to avoid interference with parked vehicles. Locate surface boxes clear of feature paving such as cobblestones, and within roundabout islands where possible.

7.8.4 Watermains in easements

The preferred solution for water reticulation is to avoid easements over private property. This is generally only used as a temporary solution to landlocked developments, pending the future provision of a permanent supply within a legal road.

Typical situations where the Council may approve mains in easements include those where there is the need for a link main to provide continuity of supply or to maximise water quality, or where fire protection is required for multiple properties within a private right-of-way. Easements may be located over private property, public reserves, crown reserves, other government-owned land, private roads or accessways in both conventional and community title subdivisions.

Equation 2 Easement width

The easement width is the greater of:

> 2x (depth to invert) +OD

> 3.0m

where OD = outside diameter of pipe laid in easement

The easement registration must provide the Council with rights of occupation and access and ensure suitable conditions for watermain operation and maintenance.

Construct principal mains, which are in any easements excluding over private rights of way, of steel, ductile iron, PE 80 or PE 100. Install valves in order to isolate that section of pipe.

7.8.5 Submains

All submains must be 63mm diameter OD. The maximum number of allowable connections based on submain arrangement and pressure zone are shown in Appendix I – Submain Design Charts. Do not assume that current pressure and flow will be available in the future. Pressure and flow is likely to reduce in the future due to demand growth and pressure management. For areas currently located in high pressure areas (greater than 600 kPa), assume that pressure will be reduced in the future to medium pressure (between 450 and 600 kPa).

Lay the submain at least one metre along the allotment's street frontage, including corner properties. Serve corner properties from one side only unless future subdivision is expected.

Install submains approximately 150mm from boundaries to serve all allotments. In category V roads (as defined in Appendix I – Lighting categories (Lighting)), amend the submain's design location to allow for the location of the lighting poles on the road boundary.

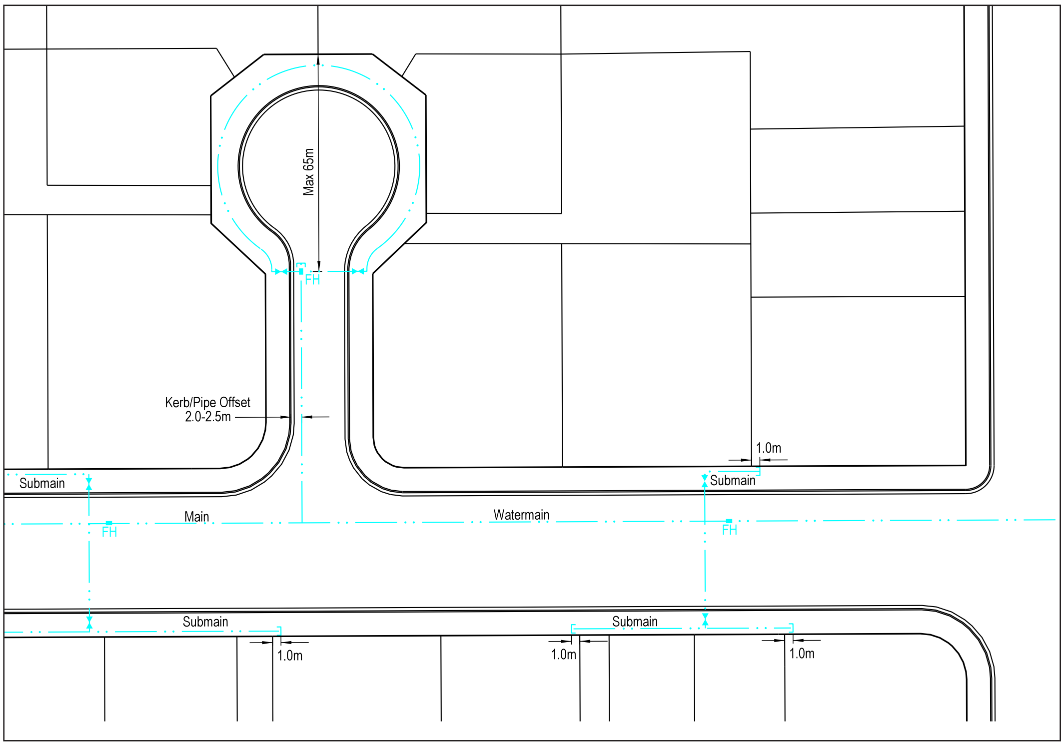


Figure 2 Submain layout

Serve submains from crossovers, which are usually located at fire hydrants. The preferred method of connection is into a tapped hydrant riser or into the main at a hydrant tee. All crossovers must be 50mm diameter, regardless of the submain size. Locate 50mm diameter valves next to the submain on the crossover. Wherever a crossover serves both directions and more than ten properties each way, locate valves on the submain on either side of the crossover.

The preferred submain layout on straight roads is to locate crossovers at every second hydrant, with submains laid in an H-pattern. The ends extend back adjacent to the intermediate hydrant but do not connect, that is submains will be single-end fed.

On Level 2 roads or State Highways or where the watermain size is ≥ 300 mm, consider connecting submains to the watermains in the abutting street(s).

7.8.6 Termination points and hydrants at the end of mains

Avoid termination points or dead ends, in order to prevent poor water quality. Consider alternative configurations such as a continuous network, link mains and use of submains to serve properties off the end of mains.

A hydrant must be placed within 1.5m of the end of all permanent and temporary sections of dead end mains greater than or equal to 100mm diameter. Apart from the fire fighting function, this also allows the section of dead end main to be flushed regularly to ensure acceptable ongoing water quality. This is particularly important in new subdivisions, where only a small number of properties may be connected initially.

7.8.7 Temporary ends of watermains

Lay watermains to within 1.0m of a subdivision boundary, where it is intended that the road will extend into other land at some future time.

In new development areas, construct mains to terminate approximately 2.0m beyond finished road works, with a hydrant within 1.5m of the temporary end, as detailed in clause 7.8.6 - Termination points and hydrants at the end of mains. The hydrant must be suitably anchored, to ensure that future works do not cause disruption to finished installations.

7.8.8 Connecting new mains to existing mains

When specifying the connection details, consider the:

- pipe materials, especially capacity for galvanic and other corrosion;
- relative depth of mains;
- standard fittings;
- pipe restraint and anchorage;
- limitations on shutting down major mains to enable connections;
- existing cathodic protection systems.

Anchor valves unless they are secured by restrained joint pipes.

Where connecting to mains that are deeper than the standard cover, obtain the correct cover on the proposed reticulation main by utilising joint deflection of the reticulation pipes downstream of the valve that is attached to the branch connection.

Design connections from the end of an existing main to address any differing requirements for the pipes being connected, particularly restraint, spigot/socket joint limitations and corrosion protection. Use standard fittings and pipework to connect to non-metallic mains. Confirm all sluice valves near the connection are restrained.

Any alterations or connections to the existing reticulation system must be done at the developer's expense.

7.8.9 Temporary works

The Council may, at its discretion, approve a delay in providing the total infrastructure requirements for large developments that will be developed over a period of several years. Such approval is conditional on the provision of a temporary infrastructure of sufficient capacity for the immediate development and a bond to ensure construction of the remaining infrastructure when necessary.

7.9 Reticulation Detailing

7.9.1 Proposed method of installation

There are a number of methods of installing underground services. These include open trenching, directional drilling, pipe bursting or slip lining. Factors that may influence the selection of installation method include the ground conditions, disruption to traffic, need to work around trees, topographical and environmental aspects, site safety and the availability of ducts or redundant services, e.g. old gas mains or their offsets.

Wherever the intention is to lay a number of utilities with a submain in a common trench, pay particular attention to obtaining the required minimum cover and clearances for each utility in the trench cross-section. Mains must always be laid in a separate trench. These clearances are summarised in clause 9.5.3 – Typical services layout and clearances (Utilities).

Where a polyethylene watermain is installed within a duct, detail flanges at each end.

7.9.2 Hillsides

Give special consideration to the design and installation of pipelines on hillsides, as defined in clause 6.13.3 – Scour (Wastewater Drainage). Refer to clause 6.14.3 - Scour (Wastewater Drainage) for lime stabilisation specifications.

7.9.3 Backfill and bedding

Specify backfill materials for the specific installation location. The material used must be capable of achieving the backfill compaction requirements set out in *CSS: Part 1* clause 29.0 - Backfilling.

Bedding materials should comply with *CSS: Part 4* and the pipe manufacturer's specifications. Highlight in the Design Report wherever there is a conflict in bedding specifications between the requirements of the *CSS* and the pipe manufacturer and state what was specified for the design.

7.9.4 Trenchless technology

Trenchless technology can be considered for alignments passing through:

- environmentally sensitive areas.
- built-up or congested areas.
- areas not suitable for trenching (e.g. railway and main road crossings).
- difficult hill crossings.
- private land.

Installation by methods such as directional-boring, thrust-boring, micro-tunnelling and pipe-jacking may be considered in order to lessen the impact of the works on pavements and trees. Pipe bursting is not permitted for water supply infrastructure.

Submit the following, with the Design Report:

- Plans and long sections showing the design vertical and horizontal alignment, how the required clearances from other services and obstructions will be achieved and the expected construction tolerances (including annulus dimensions);
- The location and site space requirements of launch and exit pits and their impacts on traffic and existing services;
- How the alignment will be tracked and as-built records provided over the whole length, including joint locations;
- Reticulation details, including structural pipe design, jointing methods, connections, inline structures and excavation treatments to prevent groundwater movement;
- Geotechnical investigation results and how these have affected the choice of trenchless installation method;
- The method of spoil removal;
- A risk management and assessment study including environmental management, to mitigate potential constructed, installed and operational issues.

Refer to *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking*.

Specify hold points for, for acceptance and for inclusion in the Contract Quality Plan and required material or performance tests to be included in the Contractors Inspection and Test Plan including:

- Presentation of drilling contractor details, including experience with method, pipe diameter and expected ground conditions, to Council for acceptance of trenchless installation.

> Presentation of installation methodology to Council for acceptance, including location tracking.

> Determination of design tensile forces/stresses on the pipe and auditing against these values during pipe pull.

> Determination of design slurry pressure rates and auditing against these values during directional drilling.

> Relaxation period for polyethylene pipe post installation.

7.9.5 Cover over pipes

Watermains 150mm diameter and above must have not less than 0.75m cover at all times. Large mains will require increased cover to allow valve and fitting installation. The maximum cover must not exceed 1.1m and only to be used in exceptional circumstances.

CCC approval must be sought to exceed these maximum allowable depths during the design stage. Non-compliant pipeline depths will only be allowed under exceptional circumstances. These include avoiding an existing structure or other obstacle and when it is not possible to install the pipeline above the structure or other obstacle. A formal non-conformance report must be submitted for Council consideration during the design phase when these circumstances are encountered. The length of pipe at greater than allowable maximum depth must be minimised through use of appropriate bends and fittings to reduce depth of cover once past the structure or obstruction.

Special design considerations apply to the installation of pipes in streets with high crown and/or dish channels. These roads are likely to get reconstructed in future years, which usually results in a lower crown, hence pipes must be installed at greater depths so that the 750mm cover is maintained after road reconstruction. To estimate future road levels, take spot levels along the property boundaries, which will most likely be the future crown level. Deduct 125mm from that level to get the future kerb level. Install water mains with 750mm cover over those future levels.

Watermains smaller than 100mm diameter must have minimum pipe covers complying with Table 6. The maximum cover must not exceed 0.7m.

Table 6 Minimum cover for watermains smaller than 100mm diameter

Material and location	Cover (mm)
Metal pipes in carriageways or where likely to be crossed by vehicles	500
Metal pipes elsewhere	300
Plastic or other than metal pipes in carriageways or where likely to be crossed by vehicles	600
Plastic or other than metal pipes elsewhere	450

7.9.6 Clearances to other services or obstructions

Become familiar with the required clearances from existing and proposed overhead and underground utilities. Identify all underground and surface obstructions, or utility assets that may be hazardous, on the engineering drawings. Refer to clause 9.5.3 – Typical services layout and clearances (Utilities) for clearances for utility services.

When using a trenchless technology installation method, apply the clearances required for watermains laid in an open trench.

New parallel water reticulation services must cross as close as practicable to 45°.

7.9.7 Working around structures

Watermains that are located close to structures, such as foundations for walls and buildings, must be clear of the "zone of influence" of the structure's foundations, to ensure that the stability of the structure is maintained and that excessive loads are not imposed on the watermain. Refer to the table below for guidance on minimum clearances from structures.

Table 7 Minimum clearance from structures

Pipe Diameter (mm)	Clearance to Wall or Building (mm)
<100	300
100-150	1000
200-300	1500
375	2000

Minimum clearance requirements in Table 7 above also apply to proposed structures around existing water assets (structures).

No structures or trees shall be placed within the Maintenance Access Corridor of the water supply systems. Structures include temporary or relocatable buildings (such as sheds), shipping containers, storage tanks, decks, hard landscaping, etc. Tree pits and root barriers are required for all trees at the clearances specified below where the drip line will overhang the Maintenance Access Corridor.

For pipes the Maintenance Access Corridor width will be the greater of:

a) twice the burried depth of pipe (surface to trench base), plus the outside diameter of the pipe; or

b) 1.5 metres from either side of the centre of the pipe.

Where the infrastructure or asset is not a pipe (example a valve box), the Maintenance Access Corridor is one metre off the asset's border in all directions.

Watermains that are constructed from metallic materials must not be located within 30m, measured horizontally, of overhead electricity transmission towers having a voltage 66kV or higher, especially if cathodic protection will be provided. Galvanic anodes for cathodic protection should be located away from the transmission lines or approximately midway between the transmission towers.

Deviate a mains pipeline around an obstruction or when a curvature alignment is required by cold bending pipes or with bends. Cold bending is only allowed for polyethylene pipes. The maximum cold-bending radii for a polyethelene pipe is 100 x the pipe OD for tapped bends and 75 x OD otherwise. A deflection angle of no more than one-half of the manufacturer's recommendation is permitted for flexible joints including rubber-ring joints in PVC pipes. Provide a detaild design, showing the route of the watermain around the obstructions or when a curvature alignment is required.

7.9.8 Crossings

Wherever watermains cross under roads, railway lines, waterways, drainage reserves or underground services, make the crossing, as far as practicable, at right angles. Design and locate the main to minimise maintenance and crossing restoration work. Make all crossings of natural waterways below the invert level of the waterway.

Wherever pipelines are located under major infrastructure assets, carriageways, intersections or waterways, determine whether the pipeline may require mechanical protection, or if different pipeline materials are needed for the crossing. Consider seismic loading and its potential to cause abutment movement or bridge approach slumping when detailing pipes traversing bridges.

Consider network redundancy and maintenance in design when crossings are required. This may include the requirement for duplicate pipelines.

7.9.9 Pipe Ducts

Pipe ducts shall be required for all pipes crossing the alignment of a newly constructed NZTA expressway or motorway. Pipe ducts shall be considered when a pipeline crosses an NZTA designated road, railway crossing, stream crossings or other instances where above-ground features obstruct or impede the ability to access a pipe for maintenance or renewal. Install duplicate or oversize ducts where growth modelling indicates a capacity increase with a 50 year timeframe.

Pipe ducts crossing a railway shall comply with Kiwi Rail ducting requirements. In all other instances, pipe ducts shall be constructed out of PE100, RCRR, DI or steel. Pipe ducts shall meet maximum anticipated loading and asset life of the greater of 100 years or the theoretical lifespan of the pipeline to be placed within the duct. Minimum class strengths allowed shall be SDR 11 for PE100, Class 4 (Z) for RCRR and PN35 for DI and steel. Steel ducting requires corrosion protection.

Duct design shall provide for removal and replacement of the pipeline within the duct with the duct remaining in place. Minimum duct design requirements include:

- Minimum duct diameter shall be the diameter of largest diameter flange, coupler or other fitting on the pipeline plus the greater of 50mm or 20% of diameter.
- Assume minimum duct internal diameter and maximum external diameter of pipe, flange, coupler or other fitting within the tolerances in the relevant manufacturing standards.
- Pipelines within ducts shall not have high points.
- High points at either end of a duct shall allow for air valves.
- At least one end of the duct shall provide a staging area sufficiently sized for removal of the entire flange-to-flange or coupler-to-coupler pipeline length.
- Duct end designs shall minimise forces on the pipeline from bending, shear and differential settlement. Mitigation measures shall include over excavation and compaction under duct ends and installation of compressible rubber at the duct ends as per AS/NZS 2566.2:2002 figure 5.6.
- Centraliser and casing separation systems shall support the pipe within the duct and be removable. Design drawings shall detail any and all such systems.
- Seals at duct ends shall prevent ground or surface water ingress and be removable. Design drawings shall detail any and all such seals.

Pipelines in ducts shall be SDR11 PE100 pipe material to allow for pipe de-rating and mitigate risk of scratching or gouging the pipe during installation. Detail flange connection and fitting details at each end.

Grouting or installation of any flowable fill within the annulus is prohibited.

7.9.10 Above-ground watermains

Include the design of pipeline supports and loading protection with the design of above-ground watermains. Address any exposure conditions such as corrosion protection, UV protection and temperature re-rating. Provide details of mechanical protection to prevent vandalism and rockfall.

7.9.11 Abandoned infrastructure

Abandoned watermains are generally left in the ground. Specify removal of hydrants, valves and surface boxes and detail that the ends of abandoned pipework, including at these fittings, are capped.

Where the abandoned pipe is asbestos, ownership of the in-ground abandoned pipe located on private property shall be transferred into private ownership in terms of a mutual agreement or alternatively abandoned AC pipes shall be removed and disposed as hazardous waste.

7.9.12 Tracer wire

Specify the installation of tracer wire or tape directly above watermains in rural areas or within easements, including where the watermain is installed by trenchless methods. Detail connections to fittings, overlaps and jointing that comply with the manufacturer's instructions. Confirm the effectiveness of the tracer wire and record in the Contract Quality Plan.

7.10 Reticulation Fittings

Detail jointing of polyethylene pipes and fittings with diameters greater than or equal to 125mm OD using only electrofusion couplers or butt welds.

7.10.1 Sluice valves

Sluice valves specified in Christchurch are defined as clockwise opening valves with diameters greater than or equal to 100mm and gate valves are defined as clockwise opening valves with diameters below 100mm.

Sluice valves are required next to the branch of any tee. Other valves must also be provided to ensure that turning off a maximum of five valves can isolate the network in any area. The maximum five-valve shut off must not isolate more than 50 properties.

Locate sluice valves at street intersections and also along the line of the main as required. Consider the following when deciding on the location of sluice valves:

- the operational needs of the system so that continuity of supply is maximised;
- operation and maintenance requirements;
- the safety of maintenance personnel.

Keep the number of valves to a minimum, without compromising the ability to easily identify and isolate a section of the network.

Attach sluice valves to flanged fittings at junctions rather than plain-ended fittings. Flanged spools shall be specified, including specification of a minimum length, where required to provide 300mm minimum clearance between valve and hydrant boxes.

The force required to open or shut a manually operated valve, using a standard valve key, with pressure on one side of the valve only, must not exceed 15kg on the extremity of the key. Specify geared operation, motorised valves or a valve bypass arrangement, to reduce pressure across the valve, if the allowable force cannot be met.

7.10.2 Backflow

Design and equip drinking water supply systems to prevent back siphonage. Locate air valves and scours to avoid water entering the system during operation. Backflow prevention devices must meet the requirements of AS/NZS 2845.1.

7.10.3 Scour valves

Scours are required on mains of 300mm diameter and larger. Generally, valves must be 150mm diameter in size. Scours are required on mains less than 300mm diameter where there are no fire hydrants. Install scour valves at the lowest point between isolating valves, and discharge to an approved outfall.

7.10.4 Air valves

Air can accumulate at high points when it is drawn into the system at reservoirs and pumps. Mains should be laid evenly to grade between peaks to ensure all possible locations of potential air pockets are known. Investigate the need for air valves at all high points, particularly those more than 2.0m higher than the lower end of the section of watermain, or if the main has a steep downward slope on the downstream side.

Air may also come out of solution in the water due to a reduction in pressure, such as when water in a main flows uphill or at pressure reducing valves. Air valves may be required to allow continuous air removal at these locations.

The number and location of air valves required is governed by the configuration of the distribution network, in terms of both the change in elevation and the slope of the watermains. Install air valves in a secure enclosure above the ground, with an isolating valve to permit servicing or replacement without needing to shut down the main.

Air valves are not normally required on reticulation mains in residential areas, as the service connections usually eliminate air during operation. Where the need is primarily for admission and exhaust of air during dewatering and filling operations, a high-point hydrant usually adequately serves reticulation networks.

On hillsides, locate a fire hydrant adjacent to and downhill from any sluice valve where the main descends from that location to release air.

300mm and 375mm diameter reitculation mains, with only a few service connections, may require single-acting air release valves, to automatically remove accumulated air that may otherwise cause operations problems in the water system.

Hydrants shall be located at sufficient spacing for operational purposes so that they can be opened to allow air ingress in the event that the main needs to be isolated and drained for maintenance purposes. The nominal diameter of the orifice of air valves must be 50 mm, for installation on mains less than or equal to 300 mm diameter.

7.10.5 Additional hydrants and scour valves for maintenance activities

Hydrants, additional to those required by the *Fire Service Code of Practice*, may be needed to facilitate maintenance activities, such as flushing the watermains. Ensure that there are approved and adequate drainage facilities to cope with the contents of the watermain from dewatering and flushing operations.

Where automatic single-acting air valves are not installed at high points on the watermains, install a hydrant to release air during charging, to allow air to enter the main when dewatering and for manual release of any build up of air as required. Install a fire hydrant at the top section of a hillside main, to act as an air intake and prevent the creation of a vacuum.

Provide hydrants at low points on watermains, to drain the pipeline when scours are not installed. As a general rule, place a hydrant or scour at the lowest point of elevation where the volume of water unable to be drained exceeds 15m^3. This normally applies to mains greater than or equal to 200mm diameter.

7.10.6 Pressure reducing valves and check valves

Pressure reducing valves are preferred over break pressure tanks, and must be sized for minimum and maximum demand. The pressure reducing valves must have V-porting and relief valves, capable of taking full flow to an approved outfall, which is visible to the public.

Consider and allow for increased pressures as a result of pressure reducing valve failure.

Pressure reducing valves and check valves that are 100mm diameter and larger must have bypass pipe work and shutoff valve arrangements. This allows the valve to be isolated for maintenance or to reverse the flow if necessary.

Council may direct the installation of a SCADA telemetered flow meter upstream and a high frequency pressure transient sensor downstream of a new pressure reducing valve in order to aid in operational monitoring. When required, the flow meter and pressure sensor shall be supplied and installed per Council specifications.

7.10.7 Thrust and anchor blocks on mains

Design thrust blocks for all fittings and valves including in-line valves on mains with unrestrained joints, to withstand the greater of:

> maximum operating pressure and test pressure, including transient and pump shut off head;
> adjacent pipeline class rating;
> a minimum pressure of 1200kPa.

The precast thrust block detailed in *CSS: Part 4*, SD 406 may be used if all of the following criteria are met:

> the fitting or valve is up to and including 200mm diameter;
> the maximum operating pressure is up to and including 700 kPa;
> the trench ground conditions can sustain an allowable bearing capacity greater than 150 kPa, as established by testing;
> the thrust block will not experience up-thrust.

The thrust block must have a minimum surface area of 0.18m^2 in contact with an undisturbed trench wall.

If the above criteria are not all complied with, design and detail thrust blocks individually for the site bearing capacity. Consider the buoyancy effect of any alteration in the watertable.

Confirm the bearing capacity of the in-situ soil and the installed thrust or anchor block design and record in the Contract Quality Plan prior to installation.

Consider the Poisson's effect in flexible pipes and design end restraints to compensate for this, where necessary. Also detail anchorage for in-line valves on pipelines that are not capable of resisting end bearing loads.

7.10.8 Restrained joint watermains

Restrained joint watermain systems can be used in place of thrust and anchor blocks to prevent the separation of elastomeric seal-jointed pipelines.

Restrained joint systems include welded steel joints, flanged pipes and fittings and factory made mechanical restrained joint systems. Polyethylene pipe fabricated joints are not acceptable. Specify details of factory made mechanical restrained joint systems in the Design Report, including the:

- length of restrained pipeline and adjacent fittings required to ensure the transfer of thrust forces to the ground strata;
- requirement for placing suitably worded marking tape in the trench over the pipeline to define the limits of the restrained joint system;
- requirement for details of the commercial restrained jointing systems to be shown on the as-built records, including the location of restrained portions of pipelines.

7.10.9 Provision for sterilisation

The fittings and reticulation layout must provide for chlorination. At the point of connection, provide a 20mm diameter tapping band for chlorination. The connection to the existing main must be capable of 500 litres/minute capacity from the reticulation. Provide an outlet (normally 50mm diameter, or a fire hydrant) to flush the chlorinated water out of the reticulation, at the end of each section of main and specify the outfall in the Design Report.

7.10.10 Connections

For design purposes, assume a 15mm diameter connection and meter, unless Council consent has been granted for other sizes.

Individual connections (including air gap separators required for the development) will not be installed until applied for by the consumer, using form WS1. More information is available at www.ccc.govt.nz/services/water-and-drainage/water-supply/connections/connect. Any connections (including meters) will become the property of, and be maintained by, the Council, whether or not they are in private property and regardless of the ownership of the supply pipe.

7.11 Reticulation On Private Property

Supply pipes in private property and mutually owned right-of-ways are considered to be privately owned and must be protected by easements in favour of the dominant tenants.

Fee simple, cross lease, unit title or multi-storey developments must have multiple meters. A single connection for high rise buildings will be only given at Council's discretion.

Locate all the meters at the legal road boundary. For one to four dwellings with access from the right of way, locate the meters in the footpath. For five or more dwellings, locate the meters within the property, immediately (less than 1.0m) behind the legal road boundary and in the common property as shown in Figure 3.

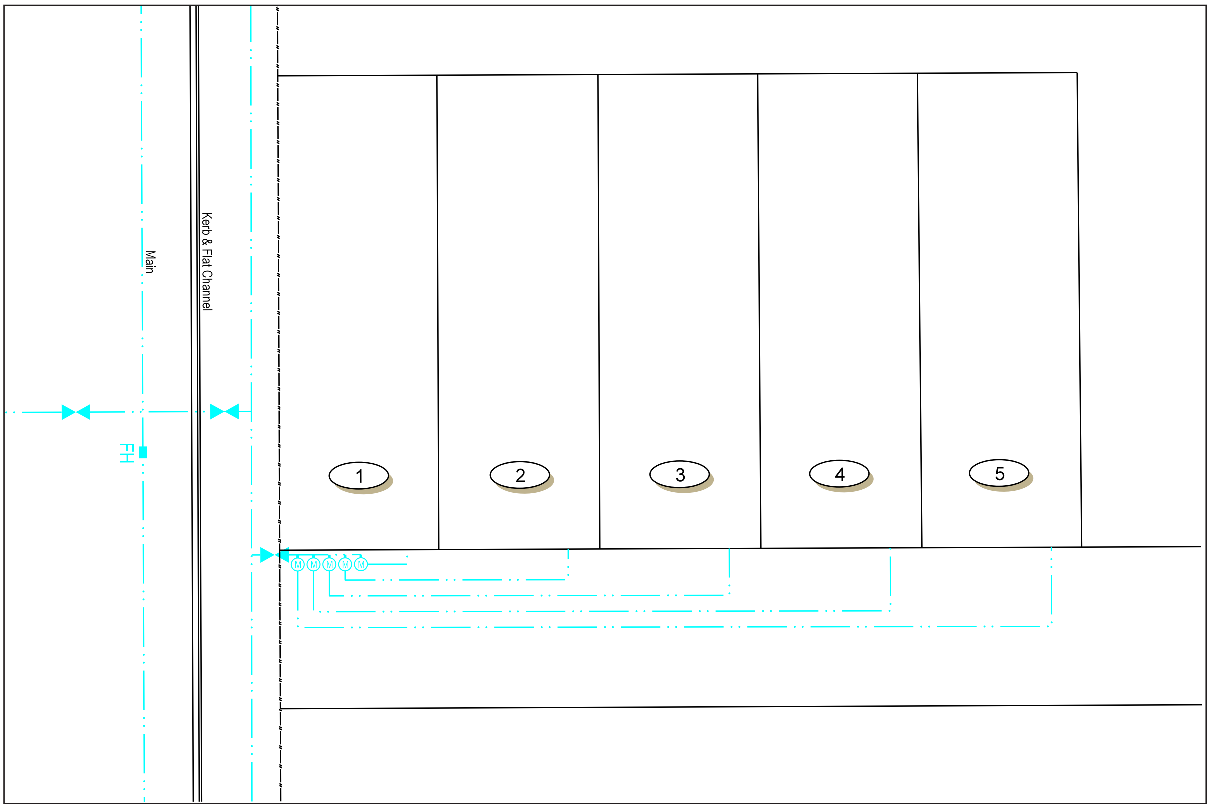


Figure 3 Multiple meters at boundary

7.12 Materials

The Council has adopted specifications for most material components of the reticulation system. These specifications apply equally to Council contracts and to infrastructure installed as a condition of subdivision and development. They are available on the Christchurch City Council web page at: www.ccc.govt.nz/webapps/approvedmaterials/frmAPRSearch.asp. Each specification refers to relevant standards and any other requirements that must be met. In some cases, materials may have an interim approval date, as the Council phases out materials that do not conform to the latest requirements.

7.12.1 Material selection

Select watermain materials in accordance with the pipe selection chart in Appendix II – Water Distribution Mains – Materials Selection Flow Chart and the material specifications on the Council website: www.ccc.govt.nz/webapps/approvedmaterials/frmAPRSearch.asp. Interpretation of this flow chart shall be at the discretion of the Council.

The "Vulnerability Map" tab at apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer indicates the vulnerability of land to liquefaction-induced damage. Areas of high liquefaction vulnerability are particularly prone to liquefaction induced infrastructure damage. Consider this when selecting watermain materials and detailing connections or trench cross-sections. Specify polyethylene or restrained joint ductile iron in areas of high liquefaction vulnerability, areas where liquefaction damage is possible or areas where the liquefaction category is undetermined.

Use engineering judgment where proposed infrastructure traverses the boundaries of liquefaction vulnerability areas. Clauses 4.4.9 – Liquefaction and 4.6.2 – Seismic considerations provide further detail on the application of these maps when designing piped infrastructure.

Water reticulation materials have specific design and installation issues, as identified in the manufacturers' design manuals, specifications and other literature. Consider these issues, as tabulated below, when specifying materials.

Table 8 Material design issues

Mains Pipeline Material	Issues to be Considered
Ductile iron and steel	Internal lining and external coatings must be undamaged or fully restored after repairs or fabrication work. Potential problems with stray electric currents and bimetallic corrosion.
PVC-U	Tests pressure not to exceed 1.25 times the rated pressure of the lowest rated component but to be at least 1.25 times the maximum operating pressure. UV degradation. Scratching, gouging and impact damage. Proper bedding and installation required. Permeation by contaminants possible.
PE 80, PE 100	Susceptible to permeation by some hydrocarbon contaminants. Sophisticated equipment and highly skilled workers required. UV degradation (Blue pipe). Bedding support to prevent excessive deformation. Pulling forces for PE are not to exceed the manufacturer's recommendations. Minimum radii. Poisson's effect and end restraint.

All plastic pipes used in the Christchurch public supply must have a nominal pressure rating (PN) of not less than 12 bar or PN 12 (1200 kPa). PVC-M pipe will not be accepted.

Submains must be made from polyethylene pipe of resin type PE 80B, with a minimum pressure rating of PN 12.5. Contaminated sites will require careful material selection. Refer to clause 7.4.4 – Contaminated sites.

7.12.2 Material specifications

The specific requirements for reticulation materials that are to be incorporated within the supply network are listed on the Council web page at: www.ccc.govt.nz/webapps/approvedmaterials/frmAPRSearch.asp. Bedding and backfill materials must comply with the requirements of *CSS: Part 1*.

The Council has an asset service life requirement of 100 years. Pipes and fittings must have a minimum required design life of 100 years and a minimum warranty period of 50 years. All products must be fit for their respective purpose and comply in all respects with the Council's current specification for the supply of that material and the standards referenced.

Manufacturers of any pipes and fittings intended for use in the Christchurch distribution system must have a certified quality management system in place that complies with AS/NZS ISO 9001. This system must apply to all aspects of the manufacturing processes, including product handling, administration and stock control.

The Council requires the right to verify that any and all contracted and subcontracted products conform to the specified requirements (clause 7.5.2 of AS/NZS ISO 9001). Full product identification and traceability is required (clause 7.5.3 of AS/NZS ISO 9001). Protection of the quality of the pipe and fittings includes transportation and off-loading at the delivery point (clause 7.5.5 of AS/NZS ISO 9001). Full quality records (as per the manufacturer's Quality Assurance manual) must be available on request for evaluation by the Council and be kept for a minimum period of 10 years.

Both the developer and the contractor are responsible for ensuring the appropriate handling, storage, transportation and installation of pipes and fittings to avoid damage and to preserve their dimensions and physical properties. The total exposed storage period from the date of manufacture to the date of installation for all PVC and PE pipe must not exceed 12 months. Store fittings under cover at all times.

The Council reserves the right to require full details of the manufacturer's means for demonstrating compliance. Irrespective of the means of demonstrating compliance and the supplier's and manufacturer's quality assurance systems, responsibility remains with the developer to ensure the installation of products that conform with the requirements of the IDS and the appropriate standards. The Council may arrange for independent testing to be carried out on randomly selected samples or assembled joints.

Positive verification inspections or testing results obtained by the Council shall not limit the supplier's responsibility to provide an acceptable product, nor shall it preclude subsequent claims made under warranty due to manufacturing defects, faulty design, formulation or processing.

7.13 Authorised Installers

Authorised installers are the only persons who may connect onto the Council's water supply reticulation network. Authorised installers are also the only persons who may install pipework, which will be vested into the Council. The three categories of installer are:

> Installation of submains (pipes up to and including 63mm diameter)
> Installation of watermains (pipes 100mm diameter and above)
> Connections to the water supply network (excluding water meter connections).

A full list of authorised installers and conditions of approval may be found on the Council web page www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-contractors/authorised-water-supply-installers.

7.14 Connection and Sterilisation

Design a chlorination point in the reticulation.

Construction of the water supply system must not start until approval in writing has been given by the Council.

Wherever works are installed within existing legal roads, obtain a Works Access Permit (WAP) for that work. Apply for a Corridor Access Request (CAR) at www.beforeudig.co.nz. The works must comply with requirements as set out in *CSS: Part 1* for this type of work.

7.14.1 Connecting into existing system

New pipe work must not be connected to the Council reticulation until after the mains have been sterilised and passed a pressure test. The pressure test must be carried out as specified in *CSS: Part 4* clause 17.0 – Performance Testing, in the presence of the Council.

7.14.2 Sterilisation

The Council will organise sterilisation of the new reticulation or infrastructure, which may include bacteriological testing of the water to confirm compliance with the *Drinking Water Standards*, prior to commissioning. Bacteriological testing takes 24 hours. Further details are set out in *CSS: Part 4* and the *Authorised Water Supply Installer Specification*. Give the Council at least 24 hours notice to carry out this work.

7.15 As-Built Information

Present as-built information which complies with Part 12: As-Built Records and this Part.

APPENDIX I

Submain Design Charts

The following tables show the minimum submain sizes (OD) required to restrict head losses to the following:

Table 9 Maximum head losses in different pressure areas

Pressure Area	Loss (kPa)
Low Pressure (less than 450 kPa)	50
Medium Pressure (463 – 600 kPa)	100
High Pressure (greater than 600 kPa)	250

> A 20 kPa allowance for minor and metering losses, assuming 15mm diameter connections, is included.

> A maximum flow rate of 0.42 litres/second per connection is assumed, with a diversity factor applied for more than six properties on a submain.

> The charts apply to Polyethylene PE 80 pipe to AS/NZS 4130. Other materials will require calculations to support sizings.

> All submains must be 63 mm diameter OD. Minimum submain sizes in the tables below showing 50 mm OD are shown for information only based on past practice that is no longer acceptable. Do not assume that current pressure and flow will be available in the future. Pressure and flow is likely to reduce in the future due to demand growth and pressure management. For areas currently located in high pressure areas (greater than 600 kPa), assume that pressure will be reduced in the future to medium pressure (between 463 and 600 kPa)

Low Pressure Areas (less than 450 kPa)

Table 10 Submain fed from one end. Connections evenly spaced

Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
1	50	50	50	50	50	50	50	50	50	50
2	50	50	50	50	50	50	50	50	63	63
3	50	50	50	50	50	63	63	63	63	63
4		50	63	63	63	63	63	63	63	
5			63	63	63	63	63			
6			63	63	63					
8			63	63						
11			63							

Table 11 Submain fed from one end. Connections from opposite end

Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
1	50	50	50	50	50	50	50	50	50	63
2	50	50	50	50	50	50	63	63	63	63
3	50	50	50	50	50	63	63			
4		50	63	63	63					
5			63	63						
6			63							
8										
11										

Table 12 Submain fed from both ends

Number of connections	Length in Metres									
	50	100	150	200	300	400	500	600	700	800
2	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	63	63
6	50	50	50	50	50	63	63	63	63	63
8		50	63	63	63	63	63	63	63	
11			63	63	63	63	63			
14			63	63	63					
25			63	63						
27			63							

Medium Pressure Areas (between 463 and 600 kPa)

Table 13 Submain fed from one end. Connections evenly spaced

Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
2	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	63
6		50	50	50	50	63	63	63	63	63
8			50	50	63	63	63	63		
11			50	63	63	63				
14			63	63	63					

Table 14 Submain fed from one end. Connections from opposite end

Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
2	50	50	50	50	50	50	50	50	50	63
4	50	50	50	50	63	63	63	63	63	63
6	50	50	50	63	63	63				
8		50	63	63	63					
11			63	63						

Table 15 Submain fed from both ends

Number of connections	Length in Metres									
	50	100	150	200	300	400	500	600	700	800
4	50	50	32	50	50	50	50	50	50	50
8	50	50	50	50	50	50	50	50	50	63
14		50	50	50	50	63	63	63	63	63
25			50	50	63	63	63	63		
27			50	63	63	63				
30			63	63	63					

High Pressure Areas (greater than 600 kPa)

Table 16 Submain fed from one end. Connections evenly spaced

Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
2	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50
6	50	50	50	50	50	50	50	50	50	50
8		50	50	50	50	50	50	50	63	63
11			50	50	50	50	63	63	63	63
15			50	50	63	63	63	63	63	63
25				63	63	63	63	63		
30				63	63					

Table 17 Submain fed from one end. Connections from opposite end

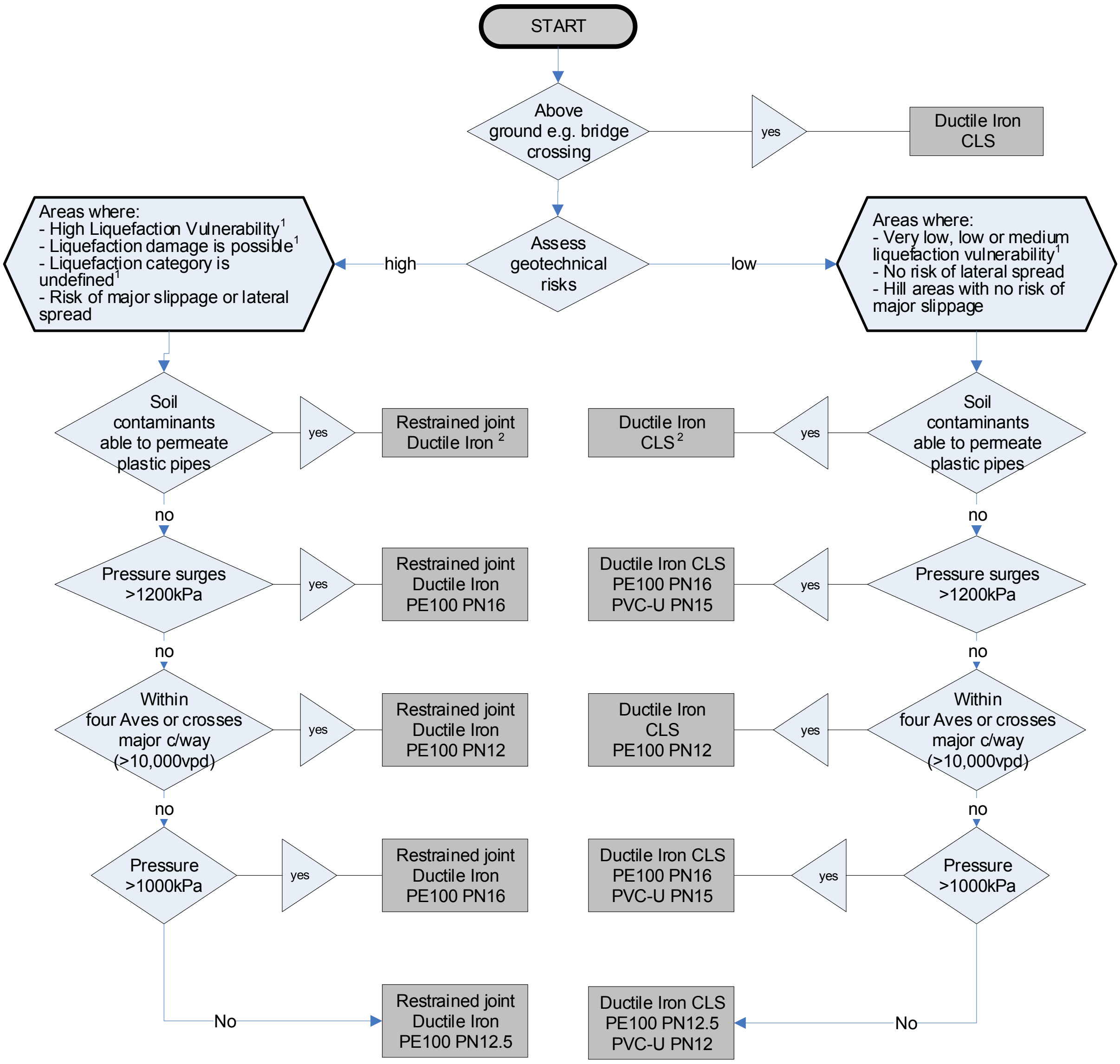
Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
2	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50
6	50	50	50	50	50	50	63	63	63	63
8		50	50	50	50	63	63	63	63	63
11			50	50	63	63	63	63		
15			63	63	63	63				
25				63						

Table 18 Submain fed from both ends

Number of connections	Length in Metres									
	50	100	150	200	300	400	500	600	700	800
4	50	50	50	50	50	50	50	50	50	50
8	50	50	50	50	50	50	50	50	50	50
14	50	50	50	50	50	50	50	50	50	50
25		50	50	50	50	50	50	50	63	63
27			50	50	50	50	63	63	63	63
63			63	63	63	63	63	63		

APPENDIX II

Water Distribution Mains – Materials Selection Flow Chart



[1] refer to the Vulnerability Map tab of https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer for liquefaction vulnerability areas

[2] refer to *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* for pipe and fitting material specifications related to the contaminants found