Infrastructure Design Standard

April 2022

Christchurch City Council

Infrastructure Design Standard

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Part 1: Introduction

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1.1 Referenced Documents

Planning and Policy

- The *Christchurch City District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- Resource Management Act (1991)
- Local Government Act (2002) and Local Government Act 2002 Amendment Act 2014
- New Zealand Building Code (1992)
- Christchurch City Council *Long Term Plan*
- Christchurch Central Development Unit *Central City Recovery Plan* https://ceraarchive.dpmc.govt.nz/documents/christchurch-central-recovery-plan
- Canterbury Regional Council *Land Use Recovery Plan* www.ecan.govt.nz/our-responsibilities/regional-leadership/Pages/LURP.aspx

Design

- Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō Ngā Arawai Rēpo (WWDG)* (2003) www.ccc.govt.nz/environment/water/policy-and-strategy/waterways-wetlands-and-drainage-guide/
- Christchurch City Council Design Guide *Crime Prevention Through Environmental Design* www.ccc.govt.nz/assets/Documents/Culture-Community/Community-Safety/CPTEDFull-docs.pdf
- 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
- Transit New Zealand *Guidelines for Planting for Road Safety*
- All New Zealand Transport Agency (NZTA) guidelines (including RTS series) and manuals (including TNZ standards and the *Bridge Manual*)
- NZS 3910 *Conditions of contract for building and civil engineering construction*
- NZS 4404 *Land development and subdivision infrastructure*
- AS/NZS 1158 Set *Lighting for roads and public spaces set*

Construction

- Christchurch City Council *Civil Engineering Construction Standard Specifications Parts 1-7* www.ccc.govt.nz/consents-and-licences/construction-requirements/construction-standard-specifications/download-the-css

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).

1.2 Introduction

The Infrastructure Design Standard (IDS) is revised on a regular basis. It started with the Christchurch Metropolitan Code of Urban Subdivision, which was written in 1987. That document was developed at a time when Christchurch consisted of five local authorities and it was a testament to the cooperation between council staff in those organisations, the engineering and surveying professions and the construction industry.

Since then the 1991 Resource Management Act has been introduced, which removed the control of subdivision from the Local Government Act. More importantly, the face of local government in Christchurch underwent major change in 1989 with local government amalgamation and the current code also no longer reflects the Council's organisational structure.

Consultation with the surveying profession in 2001 showed that the Metropolitan Code was still the principal document used in the design of subdivisional works. However, a large number of uncoordinated and informal amendments had started to erode the document's integrity. It did not relate to the many Council publications, both planning and engineering related, which were intended to directly impact on land and asset developments. Also the code was seen by many as failing to recognise technological advances in the construction industry.

A team, comprising designers from Technical Services and Design (formerly City Solutions and Capital Programme Group) and asset managers from the asset groups, wrote each Part of the IDS. The teams perused current documentation, industry standards and codes from other local bodies. Each of the twelve parts can therefore be aligned with the relevant asset group but is particularly related to the type of infrastructure.

The IDS 2010 was adopted through a Council resolution on 24 June 2010, for immediate application to both Council funded assets and assets that will be vested on subdivision. It replaced the use of both the Metropolitan Code of Urban Subdivision and NZS 4404 within Christchurch City.

The 4 September 2010, 22 February 2011 and subsequent earthquake series caused significant damage in some areas of Christchurch. The effect of the earthquakes prompted a progressive reassessment of the standards for the design of infrastructure in liquefaction prone areas. The IDS 2013 therefore included recommendations on matters to consider when designing infrastructure in those areas likely to be affected during an earthquake. These recommendations were compiled with the assistance of the Natural Hazards Platform and external personnel experienced in geotechnical and drainage engineering. Further developments in the design of three water's infrastructure were reflected in the 2015 IDS amendments.

The IDS 2016 reflects changes arising from the review of the current operative *City Plan* and *Banks Peninsula District Plan* and the resulting replacement *District Plan*. It also includes best practice developed in tandem with Stronger Christchurch Infrastructure Rebuild Team (SCIRT). This project is part of an on-going review of how the Council goes about designing and building the City, to support the *Central City Recovery Plan* and the *Land Use Recovery Plan*. For those wanting to know more about creating great environments through urban design, visit the Council's website www.ccc.govt.nz/the-council/future-projects.

The IDS 2018 reflects changes primarily due to submissions. These include the recently released New Zealand Fish Passage Guidelines, the requirement to include indicative bus routes on plans, and updates to street light specifications.

The IDS 2022 includes minor changes due to updated Council policies and sustainable and affordable alternatives. A comprehensive review is planned to implement Council's climate change strategy, along with additional sustainability aspects.

1.3 Document Purpose

The purpose of the Infrastructure Design Standard is to provide the design standard for both Council funded assets and assets that will be vested with Council, through processes such as subdivision.

The purpose of this revision is to incorporate the changes arising from submissions and to update the technical engineering aspects of the Infrastructure Design Standard to current practice.

There may be examples within the city where infrastructure does not comply with the requirements of the IDS. It is not the intention that compliance with the IDS be used as a vehicle to justify inclusion in or reprioritise the Council's programme of work determined by the *Long Term Council Community Plan*.

Where the *District Plan* is referred to, this means those objectives and provisions in the operative district plan (either the *Christchurch City Plan* or the *Banks Peninsula District Plan*) that have not been replaced by the *Christchurch Replacement District Plan (District Plan)*, unless specifically stated otherwise.

The parts of the IDS are summarised below and are intended to be read together as one document:

> Part 1: Introduction introduces the major changes and includes those definitions specific to the IDS.

> Part 2: General Requirements covers a number of regulatory details and sets out the process from design to acceptance by the Council of land developments.

> Part 3: Quality Assurance sets out the requirements for the application of quality assurance to the construction of all assets. Each project will require the implementation of a project quality system, with documentation and certification presented to the Council at both the design and construction stages; the traditional Council role of Clerk of Work-type inspections will be replaced with a structured audit-based system.

> Part 4: Geotechnical Requirements sets out the requirement for geotechnical input in land development and what must be considered by the geotechnical engineer. It emphasises the Council's desire to work with the landforms and preserve natural features. It also details issues to be considered on Hazardous Activity and Industries List (HAIL) sites and under erosion, sediment and dust control.

> Part 5: Stormwater and Land Drainage builds on the *Waterways and Wetlands Drainage Guide*, which sits behind the IDS as a supporting document. Part 5 provides more prescriptive design and compliance criteria than is found in the *WWDG* but reinforces the change of emphasis to include water quality and ecological protection. Fish passage design is included

Waterways, Wetlands and Drainage Guide

> Part 6: Wastewater Drainage incorporates both an explanation of Christchurch's reticulation system and how the Council's philosophy has changed. It provides the design and compliance criteria for wastewater systems and includes modern materials. The requirements for private drains have been tied to the New Zealand Building Code and it references the two pumping station specifications.

> Part 7: Water Supply covers the design and compliance criteria of the water reticulation. It references the *Water Supply Wells, Pumping Station and Reservoir Design Specification* for larger infrastructure and includes modern materials.

> Part 8: Roading sets out both the design and compliance criteria for the road layouts e.g road classification and the roads themselves e.g. footpaths, construction depths. It includes the National Roads Board specifications for the design and construction of roads replaced with Austroads specifications.

> Part 9: Utilities covers the Council's compliance requirements for telecommunication, electricity and gas. It excludes the utility design itself, as this must be to the network operator's requirements.

> Part 10: Reserves, Streetscape and Open Spaces is a section on landscaping and reserves, based on NZS 4404 and modified to suit the Christchurch context. It sets criteria for reserves, including layout, facilities, structures and furniture. It also applies to landscaping in legal roads.

> Part 11: Lighting sets the Council's requirements in an environment in which private companies can carry out street lighting design and construction. It builds on *AS/NZS 1158*. It includes LED requirements.

> Part 12: As-Built Records sets the Council's requirements for as-built information on completion of the development.

1.4 Definitions

The following definitions apply in the Infrastructure Design Standard, unless inconsistent with the context. These definitions are additional to those definitions in the *District Plan*.

Accessible – as defined in NZS 4121: 2001
Annulus – gap between the original pipe and an inserted pipe
Arboriculture – the management of individual trees or groups of trees primarily for their amenity value
Basic boundary fence – treated timber post and three rail fence with vertical 1.8m timber palings
Canopy – the branches and foliage of a tree out to the drip line
Check valve – one way, no return valve
Corridor Access Request – a formal application to Christchurch City Council for the installation of a network service within legal roads
Designer – the principal designer
Developer – as defined in NZS 4404: 2010
Diameter – all pipe diameters are nominal internal, unless specifically stated otherwise
Drainage – as defined in NZS 4404: 2004

Drip line – from one outer extremity of the canopy of a tree(s) to the other outer extremity of the canopy in a 360^{o} aspect

Earthworks – as defined in NZS 4404: 2010

Engineer – equivalent to "*Developer's professional advisor*" as defined in NZS 4404: 2004

Engineering Acceptance – the written confirmation of the Council's acceptance of the Design Report and design, including drawings, calculations, specifications

Environment Canterbury – Canterbury Regional Council

Establishment (landscape) – as defined in *CSS: Part 7* clause 14.0 - Establishment

Frangible (tree) – as defined in Transit *Guidelines for Planting for Road Safety*, mature trees, not hardwoods, with a trunk diameter less than 100mm at 400mm above the ground

Frangible (street lighting column) – as defined in NZTA M/26: 2012

Geoprofessional – as defined in NZS 4404: 2010

HN-HO-72 – as defined in *Bridge Manual* Section 3: Design Loading

Hydrogen sulphide – H_2S

Maximum operating pressure – this is specified by the Engineer and is the maximum pressure the pipeline must sustain, including surge.

Network Utility Operator – as defined by s. 166 of the Resource Management Act 1991

Owner – as defined in NZS 4404: 2010

Private way – as defined by s. 315 of the Local Government Act 1974

Qualified arborist – a person who is in possession of a recognised arboriculture degree, diploma or certificate, and on the job experience, is familiar with the equipment and hazards involved in arboriculture operations, has demonstrated proficiency in inspecting, analysing and treating hazardous trees and has demonstrated the ability to perform the tasks involved. A Certificate shall consist of a minimum of 240 credits of learning (i.e. Level 4).

Qualified horticulturalist – a person who is in possession of a recognised horticulture degree, diploma or certificate, and on the job experience, is familiar with the equipment, hazards and techniques involved in horticulture operations, and has demonstrated the ability to perform the tasks involved. A Certificate shall be a minimum of Level 3 i.e. the equivalent to one year full time study.

Rated pressure – this is specified by the manufacturer as the limit that the particular component can sustain in use

Residential Zone – as listed in Chapter 14 and delineated on the planning maps in the *District Plan*

Residual pressure – remaining pressure at a point under a particular demand

Reticulation – a system of interlacing pipes, wires and other connections, constructed like a net, which feed out from a central supply to customers

Riparian – of, inhabiting, or situated on the bank of a river

Street – has the same meaning as "road" as defined by s. 315 of the Local Government Act 1974

Surface water run-off – as defined in NZS 4404: 2010

Test pressure – this is the pressure the pipeline must sustain during the test

Utility – as defined in the *District Plan* but excluding those utilities owned and operated by Christchurch City Council

Wastewater – as defined in NZS 4404: 2010

Water hammer – transient pressure surges, can be positive and negative pressure

Works Access Permit – permission from Christchurch City Council to install network services within legal roads

1.5 Abbreviations

The following abbreviations apply in the Infrastructure Design Standard. These abbreviations are additional to those abbreviations in NZS 4404.

AADT – Average annual daily traffic
AEP - annual exceedance probability
ASF (l/s) – average wastewater flow is the daily average flow from domestic, industrial and commercial sources, excluding infiltration and surface entry, as determined in clause 6.4 – Sanitary Sewer Design Flows (Wastewater Drainage)
CAR – Corridor Access Request
CPTED – Christchurch City Council Design Guide *Crime Prevention Through Environmental Design*
CSS – Christchurch City Council *Construction Standard Specifications*
GPS – global positioning system
HAIL – Hazardous Activity and Industries List
IDS – *Infrastructure Design Standards*
ISO – International Standards Organisation
LTCCP –*Long-Term Council Community Plan - Our Community Plan*
MF (l/s) – maximum flow is the instantaneous design total peak
NUO – Network Utility Operator
NCR – Non-Conformance Report
OD – outside diameter
P/A ratio – peak to average ratio PSF/ASF
PE 80B – Polyethylene type 80B
PE 100 – Polyethylene type 100
PN – Pressure nominal
PSF (l/s) – peak wastewater flow
PVC-o – Oriented Poly-Vinyl Chloride
PVC-u – Unplasticised Poly-Vinyl Chloride
PWAP – Parks and Waterways Access Policy
RAMM – Road Asset and Maintenance Management
RMA – Resource Management Act
RON – road opening notification
SCADA – Supervisory, Control And Data Acquisition
SCIRT – Stronger Christchurch Infrastructure Rebuild Team
SN – Stiffness number
SPF – Storm peak factor
STMS – Site Traffic Management Supervisor
TNZ – Transit New Zealand
WAP – Works Access Permit
WWDG – Waterways, Wetlands and Drainage Guide

Part 2: General Requirements

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2.1 Referenced Documents

Planning and Policy

- The *Christchurch District Plan (District Plan)* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- Resource Management Act (RMA) (1991)
- Building Act (2004)
- Local Government Act (2002) and Local Government Act 2002 Amendment Act 2014
- Heritage New Zealand Pouhere Taonga Act 2014
- Health and Safety at Work Act (2015)
- Wildlife Act 1953
- New Zealand Building Code (Schedule 1, Building Regulations 1992)
- Christchurch City Council *Long Term Council Community Plan - Our Community* Plan Christchurch O-Tautahi 2018-2028 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/long-term-plan-and-annual-plans/ltp/
- Christchurch City Council *Safer Christchurch Strategy* 2016 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies/safer-christchurch-strategy-2016
- Christchurch City Council *Climate Resilience Strategy* www.ccc.govt.nz/assets/Documents/Environment/Climate-Change/Otautahi-Christchurch-Climate-Resilience-Strategy.pdf
- Christchurch City Council *Integrated Water Strategy* www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Strategies/Integrated-water-strategy.pdf
- Christchurch City Council *Christchurch Transport Strategic Plan* (2012) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies/transport-strategic-plan-2012
- Greater Christchurch *Urban Development Strategy* Update 2016 www.greaterchristchurch.org.nz/background/background-strategy-update-2016
- Christchurch City Council *Sustainability Policy* 2008 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/sustainability-policies/sustainability-policy
- Canterbury Regional Council *Land Use Recovery Plan* 2013 www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/land-use-recovery-plan/
- Christchurch City Council *Christchurch Central Recovery Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/central-city-recovery-plan/ including
  - *An Accessible City: Transport Chapter* www.ccc.govt.nz/transport/road-improvement-projects/aactransportprojects and
  - *A Liveable City: Residential Chapter* https://ceraarchive.dpmc.govt.nz/documents/liveable-city and
  - *South Frame Chapter* https://ceraarchive.dpmc.govt.nz/sites/default/files/Documents/south-frame-addendum-december-2014.pdf
- Canterbury Regional Council *Regional Plans* www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/

- Ministry for the Environment *National Policy Statements* www.mfe.govt.nz/rma/rma-legislative-tools/national-policy-statements
- Ministry for the Environment *National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health* including the *Hazardous Activities and Industries List (HAIL)* https://environment.govt.nz/publications/hazardous-activities-and-industries-list-hail
- *Tonkin and Taylor Coastal Hazard Assessment* for Christchurch and Banks Peninsula (2017) www.ccc.govt.nz/assets/Documents/Environment/Land/Costal-Hazards/2017-Coastal-Hazards-Report.pdf
- Christchurch City Council *A City for People Action Plan* 2010 www.ccc.govt.nz/assets/Documents/The-Rebuild/Strategic-Plans/JanGehlAction-Plan-web.pdf
- Christchurch City Council *Suburban Centre Master Plans (Edgeware Village, Ferry Road, Linwood Village, New Brighton Centre, Selwyn Street, Sumner Village, Lyttelton, Main Road, and Sydenham*) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/suburban-centres-master-plans
- Christchurch City Council *Sumner Village Centre Design Guide* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides
- Christchurch City Council *Sydenham Suburban Centre Design and Character Guide* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/suburban-centres-master-plans/sydenham-master-plan/
- Christchurch City Council *Health Promotion and Sustainability through Environmental Design* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides/
- Christchurch City Council *Large Buildings in Lower Density Living Zones* 1999 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides/
- Christchurch City Council *Urban Design Guides* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides
- Christchurch City Council *Exploring New Housing Choices www*.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides/

Design

- Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō Ngā Arawai Rēpo (WWDG)* (2003) www.ccc.govt.nz/environment/water/policy-and-strategy/waterways-wetlands-and-drainage-guide
- Christchurch City Council *Central City Lanes Design Guide* 2008 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides/
- Christchurch Central *Streets and Spaces Design Guide* 2008 www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides/
- Christchurch City Council *A Liveable City: Residential Chapter* https://ceraarchive.dpmc.govt.nz/documents/liveable-city
- NZS 3910:2013 *Conditions of contract for building and civil engineering construction*
- NZS 4404:2010 *Land development and subdivision infrastructure*

> *United States National CAD Standard* www.nationalcadstandard.org

> New Zealand Transport Agency M30: 2016 *Specification and Guidelines for Road Lighting Design* www.nzta.govt.nz/resources/specification-and-guidelines-for-road-lighting-design/index.html

Construction

> 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

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).

2.1.1 Source documents

This Part of the IDS is based on Part 1 of NZS 4404:2010, by agreement, and with the consent of Standards New Zealand

2.2 Introduction

The IDS serves as a basis of compliance for projects carried out by the Council as part of its capital works programme, as well as the subdivision and development of land, where these activities are subject to the Resource Management Act.

This Part of the IDS includes both those components of the design process common to all developments or not restricted to one asset type and those components particular to the subdivision of land.

The provisions of the Infrastructure Design Standard must be read subject to the provisions of the *District Plan* and to any applicable statutes, regulations and bylaws.

2.3 Relationship with Acts of Parliament

2.3.1 Resource Management Act

The Resource Management Act is the principal statute under which the use and subdivision of land is controlled.

The *District Plan* is a resource management instrument with the purpose of achieving the promotion of sustainable management of natural and physical resources, which is the overarching purpose of the RMA.

The IDS serves as a technical compliance manual and, although outside the *District Plan*, its provisions are referred to and given effect through conditions of resource consent and through capital works' project briefs.

2.3.2 Building Act

The Building Act provides a national focus for building control to ensure that buildings are safe and sanitary and have suitable means of escape from fire, and the Building Regulations made under the Act provide the mandatory requirements for building control in the form of the New Zealand Building Code. The Building Code contains the objective, functional requirements and performance criteria that building works must achieve.

Where infrastructural development associated with capital works and the subdivision or development of land involves the creation of structures with associated site works, observe the requirements of the Building Act. Nothing in the IDS shall detract from the requirements of the Building Act or the Building Code.

2.3.3 Local Government Act

The mechanism for requiring contributions under the Local Government Act, through land or cash, is set out in the *Long Term Council Community Plan*.

2.4 Determining Requirements for Consents

The design and construction of utilities carried out as part of a land development or subdivision is controlled by the subdivision and the building consent processes.

The Building Act Part 1 Section 8 includes within its definition of a building "*a mechanical, electrical or other system*" but only if the system is attached to a temporary or permanent movable or immovable structure and "*the system is required by the building code... or if installed, is required to comply with the building code*." The provision of water, stormwater and sewer reticulation within private land, e.g. an access lot or new access, therefore requires consent under the Building Act. Evidence of compliance is provided by obtaining a building consent, carrying out the works in accordance with that consent and the issue of a code compliance certificate by the Council. Producer statement templates are available on the Council website www.ccc.govt.nz/consents-and-licences/building-consents/building-consent-forms-and-guides.

The Council will accept the IDS as an alternative design solution under a Building Consent but only for reticulation which is not covered by an acceptable solution in the Building Code. This enables the IDS to be used to design both private and public systems, removing inconsistencies in standards between these ownership types.

Systems owned or operated by a network operator (e.g. the Council) that are external to a building and are connected to, or intended to be connected to, the building to provide for the successful functioning of the network utility operator's (NUO) system in accordance with the system's intended design and purpose are not included in the definition of a building and therefore are exempt from the provisions of the Building Act. Authorisation to carry out this work is provided through the conditions of a subdivision consent. Evidence of compliance is provided through certification in accordance with Part 3: Quality Assurance.

Figure 1 indicates those parts of a subdivision that remain in private ownership and therefore would be covered by a building consent, and those covered by the subdivision consent and through this the requirements of the IDS. This diagram applies equally to infill, unit title, greenfields or brownfields development.

Figure 1 Relationship between public and private ownership

As shown, reticulation of any size installed in private land will remain private, with the exception of residential pressure sewer system laterals, up to and including the boundary kit, and any other reticulation covered by an easement in gross in favour of the Council. The only exception, to the requirement for private reticulation to be installed under a building consent, is for a gravity lateral laid from a main 600mm into a lot. The portion which is private i.e. the 600mm over the legal boundary and within the lot, does not require installation under a building consent. Further information about pressure sewer systems in private property is in clause 6.9.5 – Detailing.

2.5 Expanding on District Plan Requirements

2.5.1 Fees

The Council has a set scale of fees covering most types of subdivision application. Applications are not accepted without the fee being paid. For those types of application not covered by the fixed fees, a deposit is required. The balance of the full cost of processing the application is payable before the release of the Section 224(c) certificate.

2.5.2 Pre-application meeting

Developers and designers of "greenfields' subdivisions that will result in substantial infrastructural assets being vested in the Council, or smaller complex subdivisions on the hills, are strongly advised to request a pre-application meeting at which issues and options can be discussed with the Council.

Submit a concept plan before this meeting.

2.5.3 Future development

Where further development, upstream of or adjacent to the area under consideration, is provided for in the District Plan, the Council may require infrastructure or additional capacity to be constructed to the upper limits of the development.

Make allowance for these requirements where specified by the Council in the consent conditions or project brief.

2.5.4 Balancing landform choices

The final choice of landform for a development is dependent on many factors, which may be specific to the particular site. Figure 2 illustrates the relationship between some of these factors. These include the:

> relationship with surrounding landscapes.

> natural drainage patterns.

> size of the development.

> proposed and existing roading patterns.

> preservation of natural features.

> enhancement of natural features where compromised by fragmentation or reduction due to the development.

> stability of the land.

> function and purpose of the development.

> potential for flooding, erosion and other natural events.

> potential for flooding, erosion and other natural events.

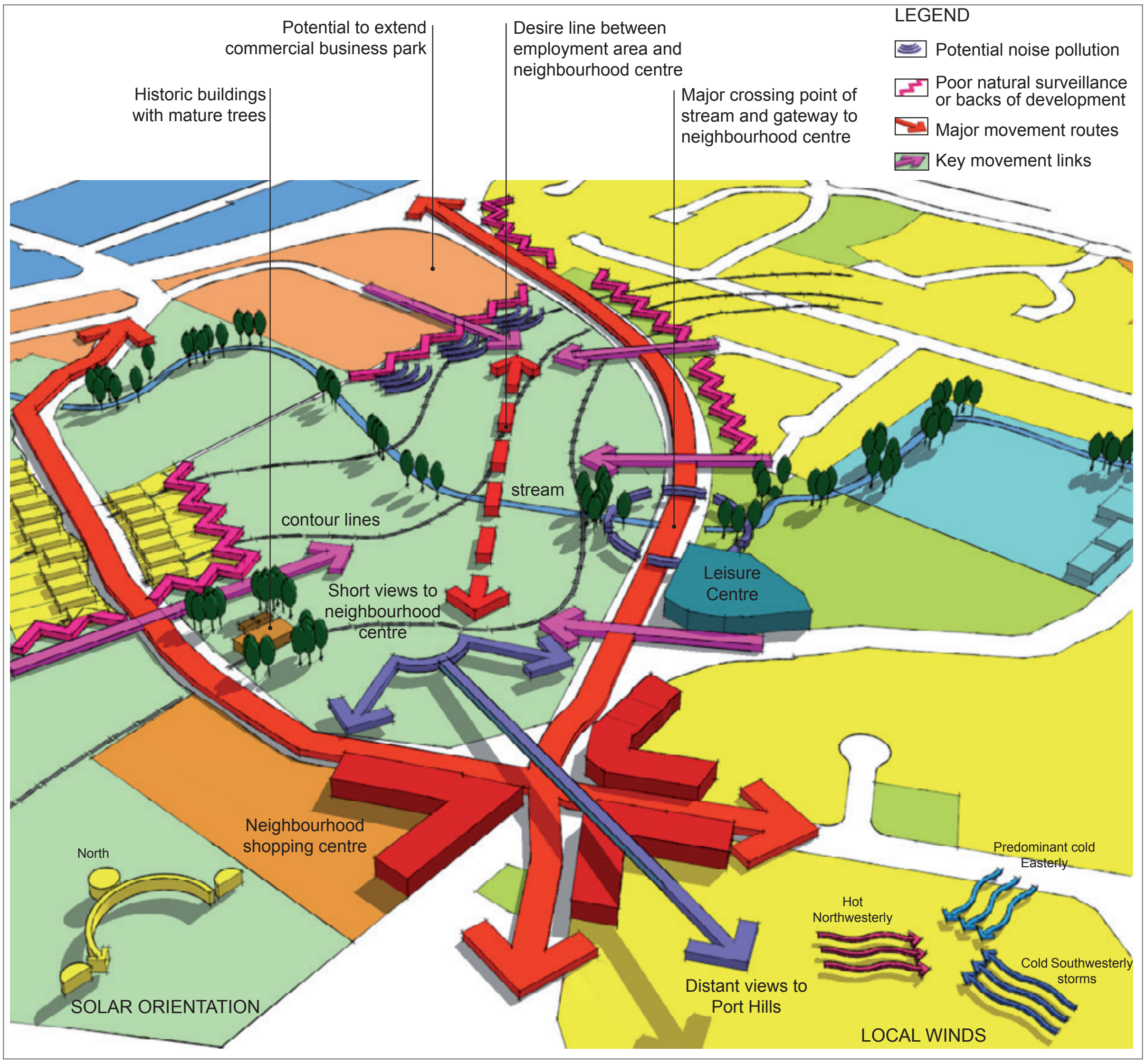

Figure 2 Site analysis

The order of importance of these factors will vary from project to project.

The final choice of landform must represent the most desirable compromise between the development requirements, the preservation of natural features including the existing soil profile, and the natural quality of the landscape. Also refer to clause 4.6.1 – Suitability of landform (Geotechnical Requirements).

2.5.5 Environmental considerations

Planning advice and scoping of potential environmental impacts should be completed during the investigative stage of projects. This ensures that the site and its surrounds are fully understood prior to the commencement of design.

The Council has environmental policies designed to protect and enhance the City's natural environment. It also encourages parties to retain and enhance the natural environment in tandem with development works. When carrying out a design, evaluate its overall impact on the environment for both the construction and operational phases, consistent with legislation, *National Policy Statements, Regional Plans* and the *District Plan*. The *Sustainability Policy* elaborates on these requirements.

An archaeological site is any place in New Zealand that was associated with human activity occurring before 1900 and which may provide evidence relating to the history of New Zealand. Any work on any part of these sites will require an archaeological authority from Heritage New Zealand Pouhere Taonga or a resource consent to alter an historic item.

Wherever possible, avoid environmentally significant areas. Some examples of these areas include:

- stands of native vegetation, bushland, habitats of threatened native species.
- waterways and floodways.
- wetlands, swamps, estuaries, sand dunes, foreshore areas.
- community drinking water supply zones
- archaeological sites, heritage item precincts and cultural sites.
- Department of Conservation scenic reserves and protected species.
- ecologically significant sites or habitats including protected trees.
- Maori relics and significant indigenous sites.
- *Hazardous Activity and Industries List* (HAIL) sites including parks, cemeteries, landfill sites and contaminated land.
- areas of aggressive ground conditions, e.g. acid sulphate soils and aggressive ground waters.

The Wildlife Act 1953 protects most native species. The Department of Conservation can issue permits to translocate or destroy species protected under the Wildlife Act, e.g. lizards on the Port Hills, however mitigation and compensatory conditions may apply. It is preferable to avoid impacts on protected species.

The *National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health* ensures land that is potentially affected by contaminated soil is identified and assessed before work commences. Small scale works on confirmed sites may be permitted, but others require a resource consent.

When it is not possible to avoid environmentally sensitive areas, address the following environmental issues in the design strategy and construction methodology and under an Environmental Management Plan (EMP) which complies with clause 3.8.2- Environmental management:

> The environmental impact of the construction;

> Protection of trees and ecologically significant vegetation;

> Protection of waterways and site restoration;

> The use of low impact methods and design solutions such as trenchless technology, rain gardens, eco-sourced native plants, wetlands and other mitigation methods;

> The impact of construction equipment on the site and surrounding area;

> Mitigation of key environmental risks including erosion, sediment and dust control, spills, wastewater overflows, dewatering and excavation and disposal of material from contaminated sites.

Ensure that the appropriate authorisations are obtained from Council, Canterbury Regional Council, Heritage New Zealand Pouhere Taonga and the Department of Conservation and that the work is carried out in accordance with the Council's requirements.

2.5.6 Road name signs

When the development contains new roads, private ways or access lots that require signage, organise the manufacture and erection of any new nameplates and posts, including roundabout chevron signage. Arrange the relocation of existing signage, where the new work affects its location.

CSS: Part 6 contains the specifications for manufacture and installation and IDS Part 8 defines the locations.

2.5.7 Coastal hazards

Council's flood modelling incorporates the 100 year projection of 1.0m sea level rise in the mapping of Flood Management Areas (FMA) and High Flood Hazard Management Areas (HFHMA). Information on design floor levels is available at www.ccc.govt.nz/services/stormwater-and-drainage/flooding/floor-level-requirements/.

Consider the impact of climate change on coastal areas and the upstream effect on groundwater levels and flooding when developing land or infrastructure.

The *District Plan* does not directly address climate change and its effects on coastal inundation and erosion. Supporting information on coastal hazards, including the *Coastal Hazard Assessment Report Stage Two* is available on the Council's webpage. Further explanation and clarification of the interpretation of this information is available from Council. Refer also to the *Climate Resilience Strategy*.

2.5.8 Infrastructure sustainability

Council has adopted a *Sustainability Policy* to help Christchurch become a net positive city. Consider sustainability at the beginning of a project's lifecycle, particularly for large or flagship projects. Sustainable outcomes include management systems, procurement and purchasing, climate change adaption, energy and carbon, water, materials, discharges to air, land or water, land, waste, ecology, community health, well-being and safety, heritage, stakeholder participation, urban and landscape design, innovation.

The effect of the project on these outcomes can be evaluated using online tools. The Infrastructure Sustainability Council of Australia (ISCA) www.iscouncil.org provides one such tool including the one page rating resource spreadsheet 'IS Scorecard v1.2'.

Where sustainability has been evaluated, provide your results in the Design Report to support design decisions. Refer to clauses 2.3.1 – Resource Management Act, 2.5.5 – Environmental considerations and 2.6 Urban Design and the IDS.

2.6 Urban Design and the Infrastructure Design Standard

A useful definition of urban design is:

*'The art of **making places for people**. Urban design is concerned with the **way places work** as well as how they **look**. It concerns the **connections** between people and places, **movement** and **urban form**, **open space** and **buildings**, and the **process** of creating successful neighbourhoods, towns and cities.*

*Urban design is important in creating **sustainable** developments that support **economic** life and **social** integration.'*

This definition highlights the importance urban design has in creating successful places where people want to live, work and play. Urban design skills and principles are commonly used to coordinate various parts of a development to ensure each design decision is complementary to the next, over a range of scales.

Many of the standards in the IDS could simply be 'ticked off' in a piecemeal way but developers are encouraged to think more holistically and to understand how their development fits into the 'big picture'.

New developments should reinforce the broader strategic objectives for Christchurch, which cover a range of scales and detail. These strategies and plans aim to incrementally shape the future growth of Christchurch in a sustainable way (environmentally, socially and economically). The success of these strategies is largely dependent on how well individual developments contribute to the bigger picture. The strategies include:

> *Urban Development Strategy*
> *Land Use Recovery Plan*
> *Christchurch Central Recovery Plan and Addendums* including *An Accessible City: Transport Chapter, A Liveable City: Residential Chapter* and *South Frame Chapter*
> *Integrated Water Strategy*
> *Climate Resilience Strategy*
> *Safer Christchurch Strategy*

The Council also recognises that some places have their own particular character, which may require a different approach to infrastructure design. For some of these special areas the Council is or has prepared place-based plans and may require new developments in these areas to conform to these plans. Check whether the development falls within one of these areas. Place-based plans include:

> *Streets and Spaces Design Guide*
> *Central City Street Trees & Gardens Masterplan (draft)*
> *A City for People Action Plan*
> *Akaroa Township Public Realm Design Guidelines (draft)*

The Council has a number of non-regulatory guidelines on urban design best practice. These are targeted particularly at public space, such as streets and parks that will be vested with the Council. However, the configuration of public space has a direct influence on what can be achieved within private areas, including the mix of land uses, different residential densities, lot layout and built form. Non-regulatory guidelines include:

> *Suburban Centre Master Plans (Edgeware Village, Ferry Road, Linwood Village, New Brighton Centre, Selwyn Street, Sumner Village, Lyttelton, Main Road and Sydenham)*
> *Sumner Village Centre Design Guidelines*
> *Sydenham Suburban Centre Design and Character Guide*
> *Large Buildings in the Lower Density Living Zones*
> *Building Multi-unit Housing (in Living 3 Zones)*
> *Central City Lanes Design Guide*
> *Health Promotion and Sustainability Through Environmental Design*
> *Exploring New Housing Choices*
> *Creating Safer Communities*

The Council encourages designers and developers to seek further guidance, particularly when considering the relationship between the public and private areas. The Council recommends that developers commission professional consultants to carry out the site design or to peer review proposals.

2.7 Requirements for Design and Construction

2.7.1 Investigation and design

All investigation, calculations, design, supervision and certification of the works, as outlined in the IDS, must be carried out by or under the control of persons who:

- are experienced in the respective fields;
- hold appropriate membership in the respective professional bodies;
- have appropriate professional indemnity insurance.

The provisions of the IDS do not reduce the responsibility of those professionals to exercise their judgement and devise appropriate solutions for the particular circumstances of each development or project.

For projects that will affect strategic routes, consult with Christchurch Transport Operations Centre regarding the construction methodology and temporary traffic management needs. This is also advisable but not mandatory for projects on non-strategic routes.

Strategic routes can be found in the *Christchurch Transport Strategic Plan*.

2.7.2 Construction

All works carried out in any development must be done by persons who:

- have the appropriate experience in the relevant areas;
- have the appropriate equipment;
- are approved for that type of work e.g. authorised drainlayers, authorised water supply installers, Site Traffic Management Supervisors. Refer to www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-contractors/.

All construction must comply with the requirements of the *Construction Standard Specifications*.

Erect Notice Boards, complying with *CSS: Part 1* clause 9.0 – Notice Boards, at all construction sites. Where work is being carried out on behalf of other parties e.g. land development or subdivision, include the developer's name in place of the Christchurch City Council name and logo on the signs.

2.7.3 Quality assurance

All quality aspects of the investigation, design and construction must comply with Part 3: Quality Assurance. If any or all of the certificates or other documents referred to in Part 3: Quality Assurance are not supplied, the Council may refuse to accept the work and refuse to issue the certification of the work pursuant to Section 224(c) of the RMA.

2.8 Survey Requirements

2.8.1 Level datum

The level datum used in Christchurch and Banks Peninsula must be the Christchurch Drainage Datum (CDD), as described in clause 5.4.2 – Information to be provided (Stormwater and Land Drainage). Where a Christchurch City Council benchmark is not available within 1.0 kilometre of the site, use a LINZ level mark. Adjust the LINZ datum (which is in the terms of Lyttelton Datum 1937) by +9.043m to convert it to the CDD Datum. State both the source of the levels (the benchmark) and the datum used on the engineering drawings.

2.8.2 Benchmarks

Establish a permanent benchmark where required by the Council as a condition of subdivision consent or as part of a project brief for capital works. As a general rule, a permanent bench mark will be required when, in the case of a subdivision, there is an extension to the Council's sewer, water, stormwater or roading network resulting in a distance of more than 650m from an existing permanent bench mark.

Benchmarks must be accurate in the vertical plane to two decimal places with an accuracy of ±15mm to the origin of the level.

Obtain a stainless steel washer with the unique benchmark number from the Council. Fix it by Ramset nail to a kerb, drainage structure or to other substantial concrete structure within the legal road or council reserve.

Provide the following documentation:

> a finder diagram (an example is provided in Figure 3), 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 Appendix III – Benchmark Certificate);

> the methodology used e.g. differential levelling, GPS.

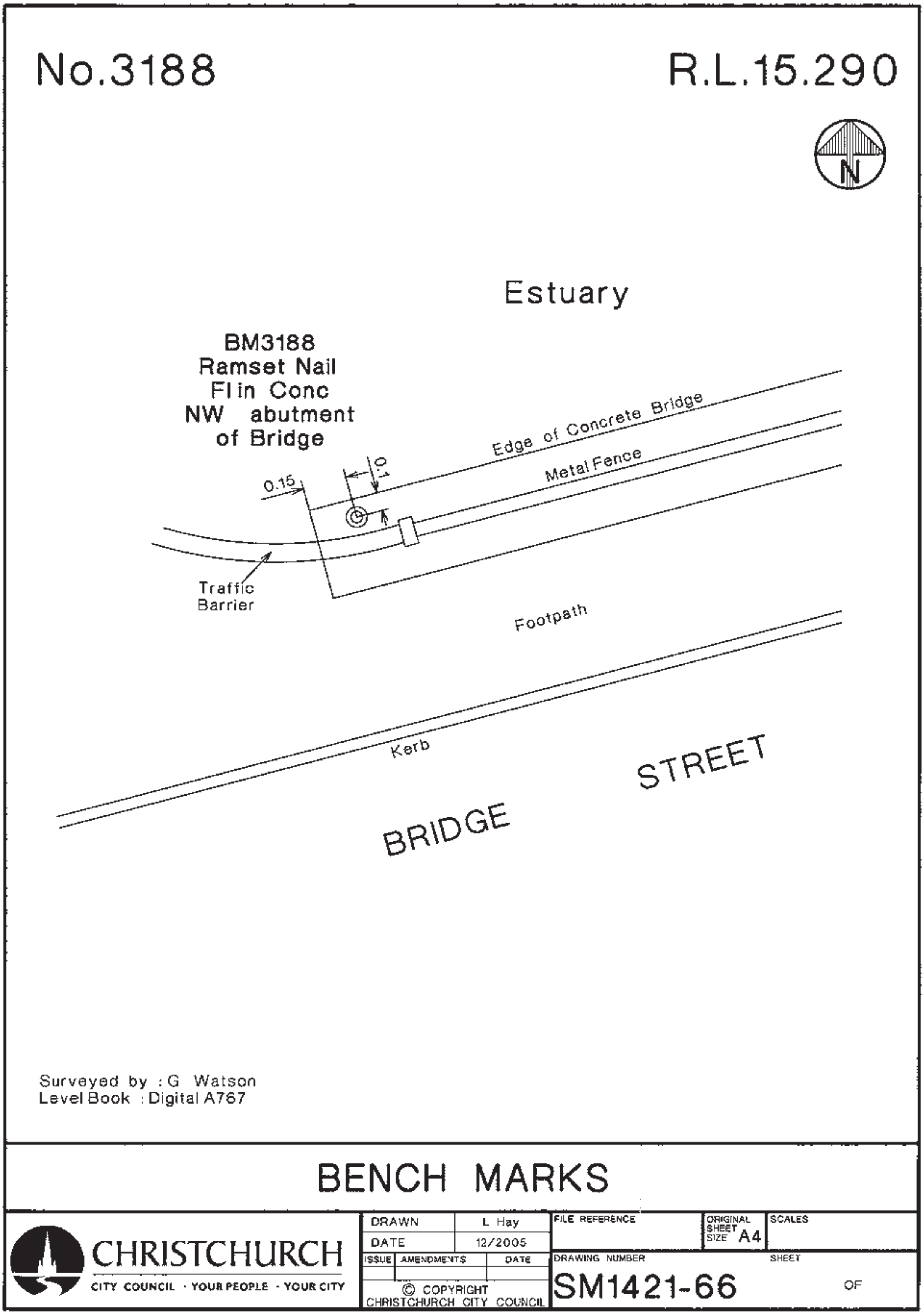

Figure 3 Finder diagram

2.9 Drawings

Engineering drawings must be legible, clear, readable and complete. They must clearly illustrate the proposal and enable both assessment of compliance with the IDS and accurate construction. Produce drawings on ISO - A series format. Follow the draughting requirements attached in Appendix I - Standard Draughting Layout and Format Requirements. *The United States National CAD Standard* provides guidance for electronic draughting requirements.Engineering drawings generally include the following:

> A locality diagram giving the overall layout and location of the works;

> Detailed drawings, longitudinal sections, cross sections and diagrams of the proposed developments and/or works;

> Special details where the standard drawings are not sufficient;

> Benchmarks at a maximum spacing of 650m;

> A north point, preferably pointing above the horizontal (i.e. in the top 180 degrees);

> Standard sheet notes, referring particularly to *CSS*;

> Set out information;

> A service legend, where services are shown on the drawing;

> A planting key or clearly labelled planting, where it is shown on the drawing.

If the project is large, provide a separate landscape drawing. On smaller projects, landscaping details may be shown on the engineering drawings. In both cases, show landscape planting areas on the roading construction drawings, by shading or patterning.

2.9.1 Content of drawings

Show the following information on the drawings:

> The extent of the works showing existing and proposed roads, and the relationship of the works with adjacent works, services and/or property, including adjacent property levels;

> Proposed and existing property boundaries and street numbers;

> Significant existing vegetation to be removed and any special or protected trees, and any areas of heritage significance that may be affected by the works;

> The extent of earthworks, including earthworks on proposed reserves, existing and proposed contours, areas of cut and fill, batter slopes, proposed stockpiles, subsoil drainage, erosion and sediment control measures both temporary and permanent;

> Details and location of existing and proposed stormwater primary and secondary flowpaths;

> The design of proposed roads (and their connections with existing roads), including plans, longitudinal and cross sections, horizontal and vertical geometry and levels, typical cross sections, details of proposed pavement and surfacings, kerbing, berms, footpaths, cycleways, tree planting, road marking and signage and all other proposed street furniture;

> Details and location of existing water, wastewater and stormwater mains and service connections, valves, hydrants, manholes, sumps, bends, tees, thrust blocks, meters and backflow devices;

> The horizontal and vertical alignment and location, including invert levels, physical grades, lengths, sizes, materials, types, minimum cover, cut to invert, position relative to other services of all proposed water, wastewater and stormwater mains and service connections, valves, hydrants, manholes, sumps, bends, tees, thrust blocks, meters and backflow devices, and services that may be reconnected or plugged;

> Details and location of mechanically restrained portions of pipelines, pipeline bridges, pumping stations, reservoirs, intake and outlet structures, headwalls, swales, basins, ponds and the location of surface obstructions, hazards, or other features that may be affected by the works;

> In respect of water mains - chlorination points, pressure reducing valves with upstream and downstream design pressures;

> The street lighting layout showing the location and type of each light, proposed and existing significant road features (e.g. kerbs, property boundaries, planting and traffic management features) and property addresses;

> Details and location of existing and proposed telecommunications, electricity and gas supply, including proposed underground and above-ground junction boxes, transformers and similar equipment;

> The bedding and backfill depths, design compactions and trench restoration details for all underground services;

> Details of proposed landscaping of roads and allotments, and details of proposed reserve development including earthworks, landscaping features, landscaping structures, tree planting, irrigation, hard and soft surface treatment, park furniture and playground equipment. Include details of the ongoing maintenance requirements, using the Riparian Maintenance Guides in Appendix II - Generic Guides for Riparian Maintenance of Part 10: Reserves, Streetscape and Open Spaces where appropriate.

This information may be expanded in the relevant part.

2.9.2 Form of drawings

Provide all drawings in electronic form and as a .pdf. Prepare electronic drawings in Microstation (.dgn), 12Da or AutoCAD format.

All drawings must be legible at A3 size. Streetlighting drawings can be either 1:500 or 1:1000 scale.

2.10 Acceptance of Design

This clause applies to works carried out under subdivision consent.

Include stage boundaries on all plans that are submitted for engineering acceptance where the project is being constructed incrementally.

2.10.1 Documents to be submitted for engineering acceptance

The Council will require a design report to be submitted. Clause 3.3.2 – Design report (Quality Assurance) sets out in detail what is required in a design report.

Submit the design records, incorporating drawings, calculations, specifications, material specifications where not detailed elsewhere, graphical representations and calculations of infrastructure where requested, with the design report. This information should enable the process to be followed easily and should allow for replication of the results.

Include the geotechnical engineer's report on the suitability of the land for subdivision and/or development, including any site investigations.

Each separate Part of the IDS sets out those aspects particular to that Part which must be covered by the design or design report, where relevant.

2.10.2 Cost benefit or life cycle costing

Where required by the Council, carry out a cost benefit or life cycle costing of a proposal. This will typically be for larger or unique projects.

Life cycle costing may be used to consider options within a proposal or a proposal as a whole. In undertaking life cycle costing, consider the initial costs borne by the developer or the Council and the maintenance and replacement costs borne by the future owners and/or the Council. Maintain a reasonable balance between these short-term and long-term costs.

2.10.3 Engineering acceptance

When it is satisfied that the design and design report meets the requirements of the IDS, the Council shall notify the designer that the design and Design Report has been accepted and stamp the plans as accepted. For the purpose of this acceptance, the Council may require amendments to any quality plans, engineering drawings, specifications and/or other documentation and further reports submitted. In considering the design and design report and giving its acceptance, the Council shall act without undue delay.

2.11 Approval of Construction

Work must not commence on site unless and until:

> A resource consent for the work has been issued, except when no such consent is required;

> The Council has given engineering acceptance for works carried out under a subdivision consent;

> The Contractor has received stamped accepted plans;

> The Council has accepted the Contract Quality Plan and Engineer's Review Certificate as detailed in clause 3.3.3 - Contract Quality Plan (Quality Assurance);

> Any other consent required has been granted e.g. NZ Railways Corporation, Department of Conservation, landowner.

2.11.1 Notification of hold or witness points

Hold or witness points form part of the Contract Quality Plan required for each development. The developer or contractor must notify the Council at all 'hold' or 'witness' points and such other times as the Council may determine, for Council's information and to enable audits or witnessing to be carried out.

Give the Council at least one working days notice and adequate access for audits or tests. Audits will be carried out within one working day of notification if possible. The Council will inform the developer of any problems encountered with these audits so they can be addressed at an early stage.

2.11.2 Testing

Any work required to be tested by the contractor or developer in the presence of the Council must be pre-tested and proved satisfactory before test witnessing by the Council is requested.

2.12 Completion of Land Development Works

2.12.1 Defects liability

The defects liability period for all works must be 12 months from the issue of the Practical Completion Certificate. Maintain the works until they are formally taken over by the Council or to a date specified in a bond for completion of uncompleted works. The developer must also remedy defective works, as defined in NZS 3910, over this period.

Establish and maintain landscaping, in accordance with *CSS: Part 7* clause 14.0 - Establishment, over this period or until the landscape establishment bond is released. Establishment includes achieving lawn areas that comply with *CSS: Part 7* clause 13.8 – Acceptance criteria.

2.12.2 Completion documentation

Upon completion of all subdivisional developments, provide completion documentation in accordance with Part 3: Quality Assurance. Additionally, provide evidence that reticulation and plant to be taken over by network utility operators has been installed to their standards and will be taken over, operated and maintained by the network utility operator concerned.

Completion documentation includes, as a minimum:

> completion certificates as per Part 3: Quality Assurance appendices;

> the geotechnical reports, certificates and as-built records required by Part 4: Geotechnical Requirements;

> an up-to-date Environment Canterbury compliance monitoring report which indicates no significant or major non-compliance;

> evidence of a complying post construction safety audit for works on or becoming legal road.

> completion documentation required by Part 11: Lighting;

> as-built records of all infrastructure, where required by the subdivision consent or contract, showing the information required by each Part;

> as-built data, where required by the subdivision consent or contract, for all infrastructure taken over by the Council, in RAMM format;

> project and contract records , e.g. inspection and test plans, non-conformance reports;

> other documentation required by the Council including, but not limited to, operation and maintenance manuals and warranties for stormwater treatment facilities and new facilities involving electrical or mechanical plant; asset valuations for all infrastructure to be taken over by the Council;

When all the conditions of approval that are imposed on a resource consent for subdivision have been met, the Council will issue a Section 224(c) Compliance Certificate to that effect.

2.12.3 Approval of uncompleted work

Where in the opinion of the Council it is appropriate, the Council may approve uncompleted work, subject to satisfactory bonds being arranged.

2.13 Bonds

A bond template is available in Appendix IV – Bond Form.

2.13.1 Uncompleted works bonds

Bonds to cover minor uncompleted works, especially where a subdivision or development has been substantially completed, are recognised as an acceptable procedure and will be permitted at the discretion of the Council, except that acceptance of a bond for uncompleted works shall not be unreasonably withheld. Council may consider bonding the establishment of planting, lawns and associated works as uncompleted works. Refer to clause 10.11 – Establishment (Reserves, Streetscape and open Spaces) for further information.

Bonds must be secured by an appropriate guarantee or must be in cash and lodged with the Council. Where necessary bonds must be executed and registered.

The amount of the bond shall be the estimated value of the uncompleted work plus a margin to cover additional costs estimated to be incurred by the Council in the event of default.

APPENDIX I

STANDARD DRAUGHTING LAYOUT AND FORMAT REQUIREMENTS

Provide electronic drawings to a minimum standard that complies with the *United States National CAD Standard*.

1 Drawing base data (existing topography)

Draw existing features in a lighter line thickness e.g. 0.18mm or 0.25mm. Draw standard draughting symbols un-shaded for existing features e.g. □

2 Drawing proposed work

Draw proposed work in a heavier line thickness e.g. 0.35mm and thicker. Use the same line type, to enable clear differentiation between existing features and proposed work. Draw standard draughting symbols filled in for proposed features e.g. ■

3 Labelling

Draw text at the suggested minimum heights in Table 1.

Table 1 Minimum text heights

Titles and drawing numbers	5mm
Subtitles, headings, view and section designations	3.5mm
General notes, material lists, dimensions	2.5mm
Road name	7mm
Side road	5mm
Existing property levels	1.8mm
Buildings	3.5mm

Note: 1) This table is derived from AS/NZS 1100.101: 1992 Table 4.1.

Differentiate between existing features and proposed features by using different formatting:

> lower case or upper case;

> normal format or bold format;

> 0.25mm pen weight or 0.5mm pen weight.

Use the abbreviations in Table 2.

Table 2 Feature abbreviations

Asphaltic concrete	AC
Edge of seal	EOS
Tangent point	TP
Curve Tangent point	CTP

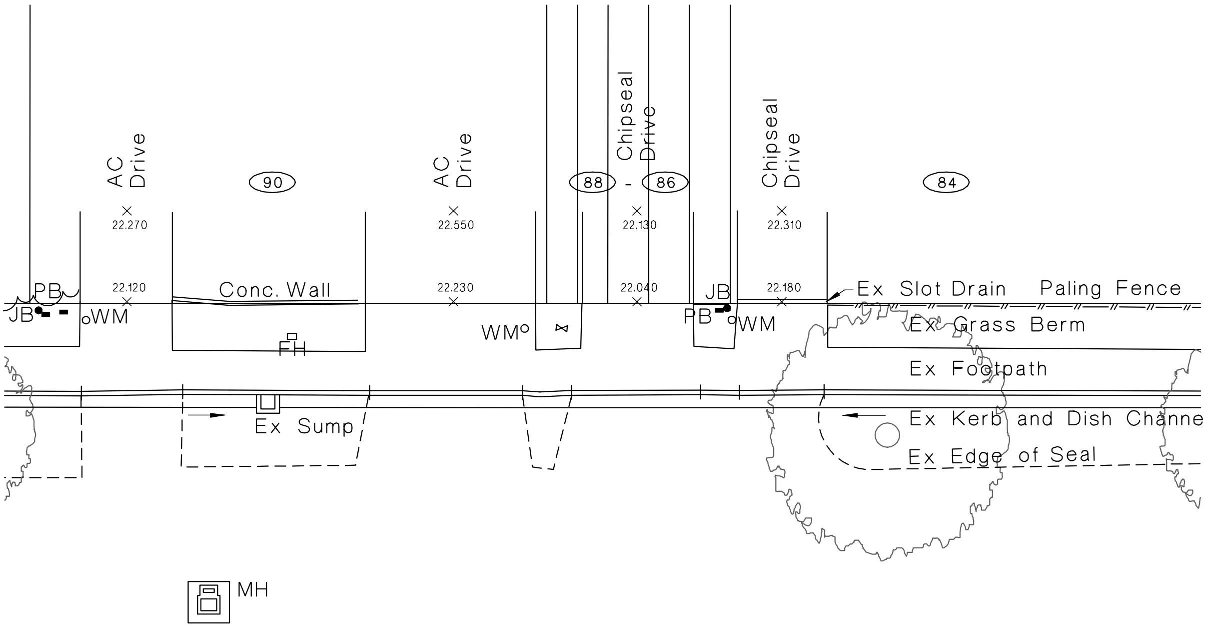

Figure 4 Labelling existing street features (1:200 scale)

Ensure notes do not go through other notes and that leaders do not cross.

Place road names above the north road boundary but not through section boundary lines. Show spot levels on the legal boundary and at least 3.0m inside the abutting private property.

Use standard symbols for trees, lights, service covers and boxes. Typical symbols are shown in the example drawings in section 14 of this appendix. Draw symbols to true scale. Typical abbreviations are shown in Tables 2, 3, 4 and 7.

4 Underground services

Use the line types, colours and RGB values set out in Figure 5. Label all high voltage cables and all fibre optic cables or indicate with a slightly heavier line weight.

SERVICES LEGEND	COLOUR	RGB
SEWER (Gravity)	Red	255,0,0
SEWER (Pressure)	Red	255,0,0
WATER	Blue	50,150,255
STORMWATER	Green	107,255,48
POWER	Orange	255,128,0
TELECOMMUNICATIONS	Purple	128,0,255
GAS	Yellow	194,194,0

Figure 5 Service legend

Label all utility structures or boxes. Label water meters (these include the backflow preventers installed as part of the connection on each side).

Table 3 Service abbreviations

Water meter	WM
Fire hydrant	FH
Power box (above-ground)	PB
Power pole	PP
Sluice valve	SV
Gate valve	GV
Pressure reducing valve	PRV
Backflow preventer	BFP

Note: Label telecommunications boxes, manholes and pillars to suit the development.

5 Drainage

Label all stormwater and sewer pipes with pipe size and flow direction, using similar terminology to that used by the manufacturer to code or classify the pipe e.g. label a 225 diameter stormwater pipe as Ø225 RCRR Class X stormwater or DN225 PVC-U stormwater. Show sewer laterals.

For major pipes 750mm and above, show the outside width of the pipe and manholes, as the manhole lid may not be on the pipe centreline. Show the actual shape of special manholes.

Label all sumps and manholes with the structure identifier e.g. MH with a unique letter and sump abbreviation with a unique number. Structures that are not affected by the work do not require a unique letter or number. Start at one end of the project and number or letter continuously through. Where an existing sump is being modified, draw the proposed sump over it. Label any structures that are being altered in height.

Table 4 Drainage structure abbreviations

Single Sump	SS
Double Sump	DS
Triple Sump	TS
House Drain Sump	HDS
Hillside Sump	HS
Corner Sump	CS
Manhole	MH
Inspection Chamber	IC
Flush Tank	FT
Flush Manhole	FM
Air Gap Separator	AGS

Label new wastewater mains and laterals and stormwater mains and laterals that are being CCTV surveyed using the CPMS number for capital works or the RMA number for subdivisions and new developments as summarised in Table 5.

Table 5 Labelling of new wastewater mains and laterals and stormwater mains

New Asset Type	Labelling
Wastewater main	WW001_CPMSNumber
	WW001_RMANumber[_**]
Wastewater lateral	WWLA001_CPMSNumber
	WWLA001_RMANumber[_**]
Stormwater main	SW001_CPMSNumber
	SW001_RMANumber[_**]
Stormwater lateral	SWLA001_CPMSNumber
	SWLA001_RMANumber[_**]

Notes:

1. Use underscore and no spacing between the characters, 3 digits for the asset number.
2. Remove the backslash (/) in the RMA number, only use the numbers.
3. Characters in brackets are optional to indicate the RMA Stage, written with underscore and a maximum of 2 alpha-numeric characters.
4. Wastewater assets to be named are DN100 mm and larger
5. Stormwater assets to be named are DN225 mm and larger

Refer to Figure 14 for an example of the labelling of new wastewater assets.

6 Landscape

Distinguish existing vegetation from proposed vegetation. Show existing trees, including those to be removed and retained, as well as proposed trees, using the symbols in Figure 6. Accurately show tree locations and, where applicable, use expanded symbol sizes to illustrate the full canopies (driplines) of existing trees that will be retained. Label any protected tree(s).

Figure 6 Landscape draughting symbols

Cross reference all other related designs, including earthworks, underground services, irrigation, and lighting. Show underground services and street light locations on planting plans.

All planting plans must have a plant list. The plant list must include the botanical name, common name, container size and the quantity, and must also include any abbreviations used and planting centres (plant spacings) as detailed in Figure 7.

PLANT LIST

ABBREV.	BOTANICAL NAME	COMMON NAME	SIZE	CNTRS.	QTY
Shrub and Riparian Planting					
Apo sim	*Apodasmia similis*	Oi Oi	2.5L	600mm	30
Art cir	*Arthropodium cirratum*	Renga Renga	2.5L	600mm	24
Car sec	*Carex secta*	Sedge	Rx90	1.2m	5
Fic nod	*Ficinia nodosa*	Knobby club rush	Rx90	600mm	36
Pho coo	*Phormium cookianum*	Mountain flax	2.5L	1.5m	7
Poa cit	*Poa cita*	Silver tussock	Rx90	750mm	28
TREES					
Cor aus	*Cordyline australis*	Cabbage tree	25L	n/a	3
Hoh ang	*Hoheria angustifolia*	Lacebark	25L	n/a	3
Myo lae	*Myoporum laetum*	Ngaio	25L	n/a	5
Pla reg	*Plagianthus regius*	Ribbonwood	25L	n/a	8

Figure 7 Typical plant list

7 Roadlighting

Draw roadlighting as specified in *Specification and Guidelines for Road Lighting Design.*

8 Title blocks

The title block must include the following information:

> A project title, including street address;
> A unique number or identifier, preferably the consent or project number;
> The designer's name, signature and contact details;
> The draughtsperson's name;
> The drawing checker's name;
> The design reviewer's name and signature;
> The stage of work e.g. for acceptance, accepted engineering drawings, construction, as-built;
> The date of preparation and of acceptance;
> The scale or scales used;
> A graphic scale;
> The datum and origin;
> The original sheet size;
> A drawing title e.g. Long-section;
> Sheet numbers, including the number in the set;
> An amendment box, including brief description of amendment and sign off by designer.

The scale for drawings is generally 1:200 but other accepted engineering scales may be used to suit the level of details on the drawings. Scales progress in multiples of 10 e.g. 1:1, 1:2, 1:5 as detailed in Table 5.1, AS/NZS 1100.101.

9 Long-sections

Draw horizontal scales generally to match the plan. Vertical scales may be 1:20 or 1:50, to improve clarity.

Show concrete surround on the pipe long-section. Label structures and vertical curves. Use thicker line weights for proposed work.

10 Cross-sections

Label levels with identifiers e.g. K12.400. Use thicker line weights for proposed work.

Provide a minimum of one fully detailed typical cross-section per sheet.

Show construction depth outlines for roads, paths, grass berms and landscape planting. Label legal boundaries vertically.

11 Road marking drawing

Use the following line types when detailing roadmarking.

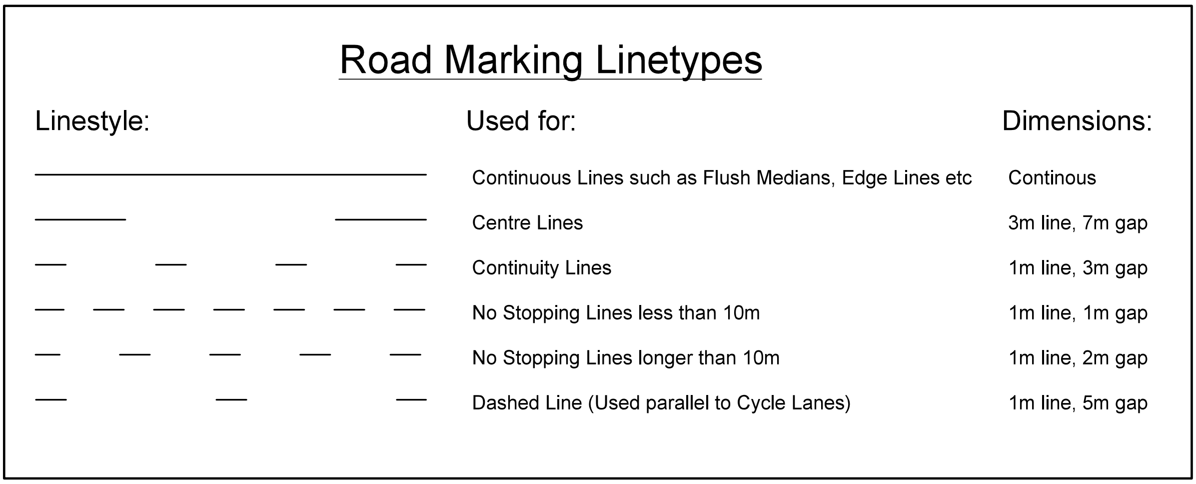

Figure 8 Roadmarking line types

The road marking drawing must show:

- The existing markings to be removed (i.e. sandblasted);
- The new road markings to be installed;
- How the proposed markings mate into the existing markings at the project's extents.

Show roadmarking on a drawing base that is essentially 'as-built' in terms of features such as kerbs and paths. Indicate the type of marker, generally by using the standard symbols and descriptions in Tables 6 and 7..

Table 6 Marker symbols and descriptions

Text Description for drawings		Symbol
RPM	**Reflective Pavement Markers**	
	White Mono RPM	○
	Red Mono RPM	□
	White Bi Direction RPM	⦶
	White/Yellow Bi Direction RPM	⬗
	Yellow Bi Direction RPM	
KTM	**Kerb Top Markers**	
	KTM	●

Note: Specify numbers, spacings and colours for reflective pavement markers and kerb top markers.

Table 7 Sign types and descriptions

Sign	Text Description for drawings
Bridge End Markers (always used in pairs)	BEM
Hazard Marker	HM

12 Locality diagram

Show the road boundaries and street names. Show the limit of the development. Draw the locality diagram true to the map orientation or at the same orientation as the engineering drawing.

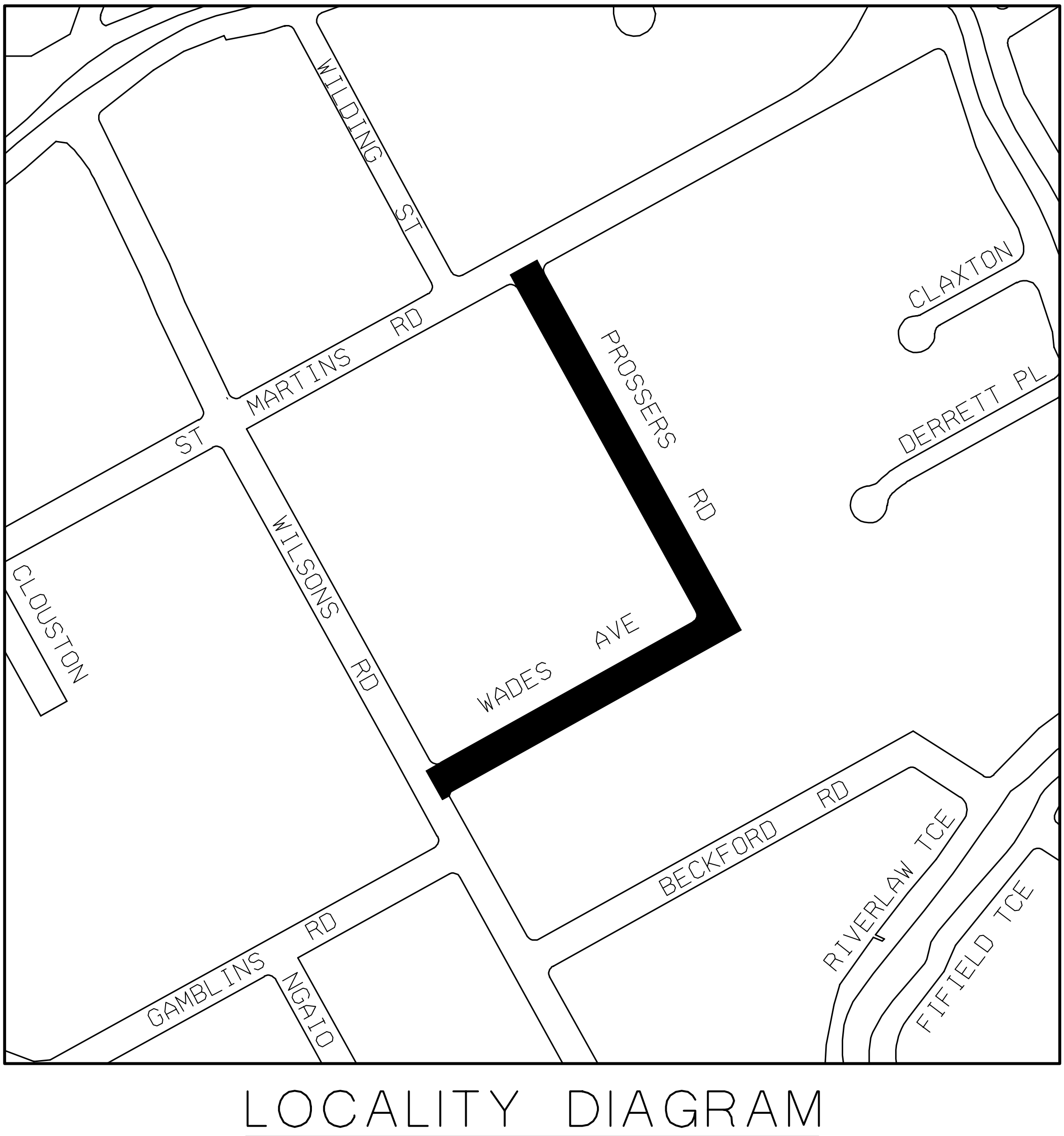

Figure 9 Locality diagram

13 Examples and drawings

Examples of standard drawings follow.

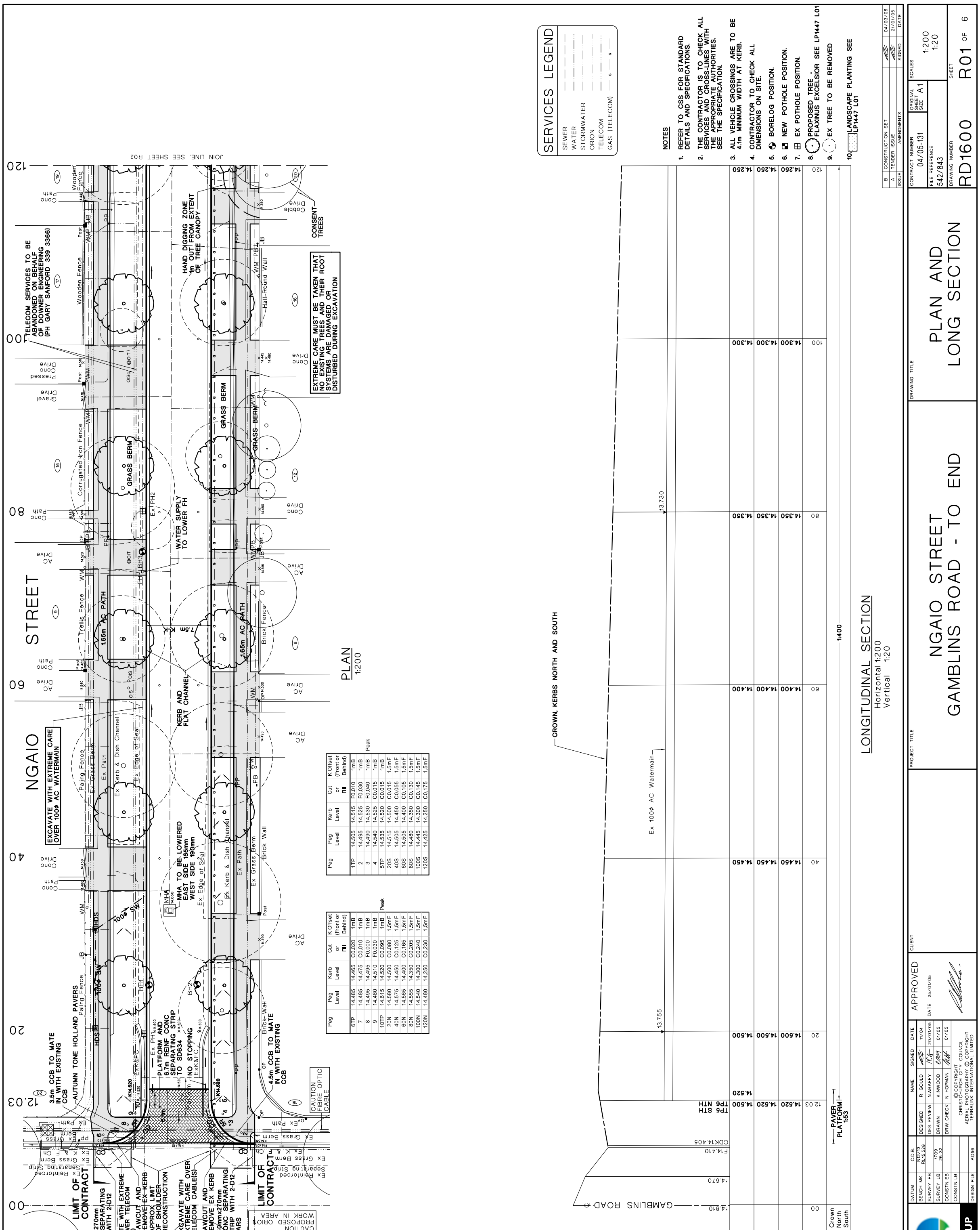

Figure 10 Long-section and paving drawing

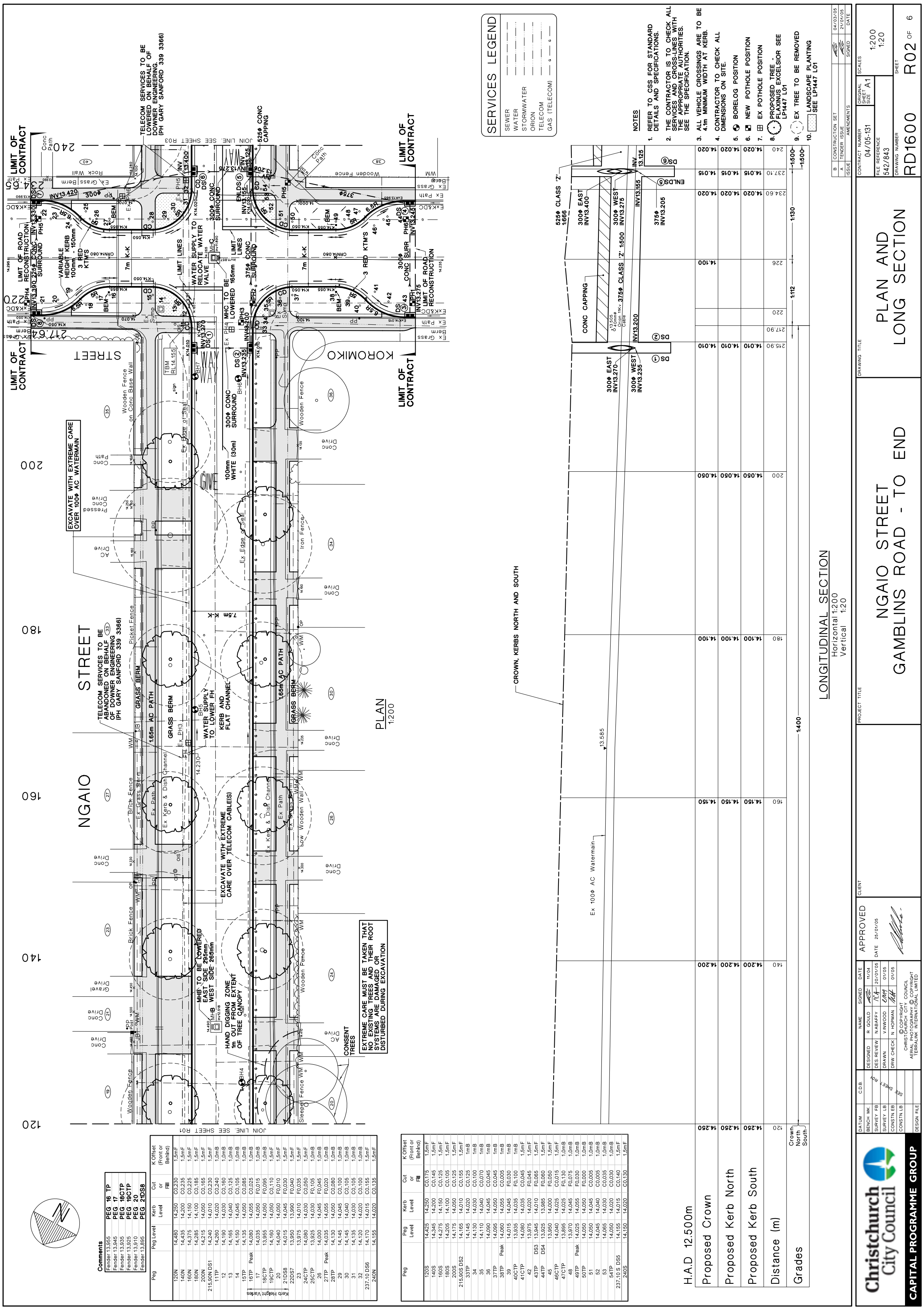

Figure 11 Concrete haunching and kerb setout

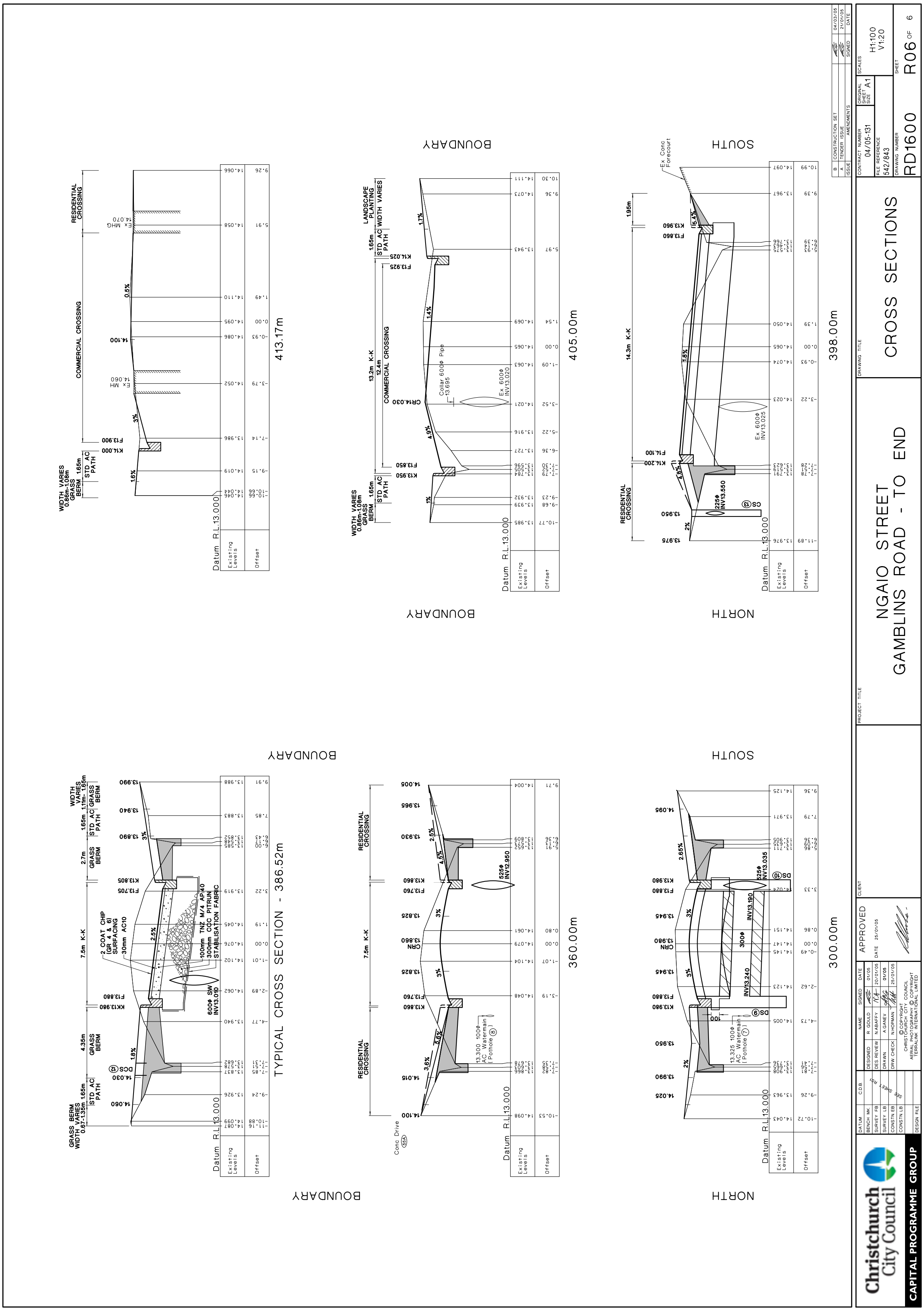

Figure 12 Cross-sections

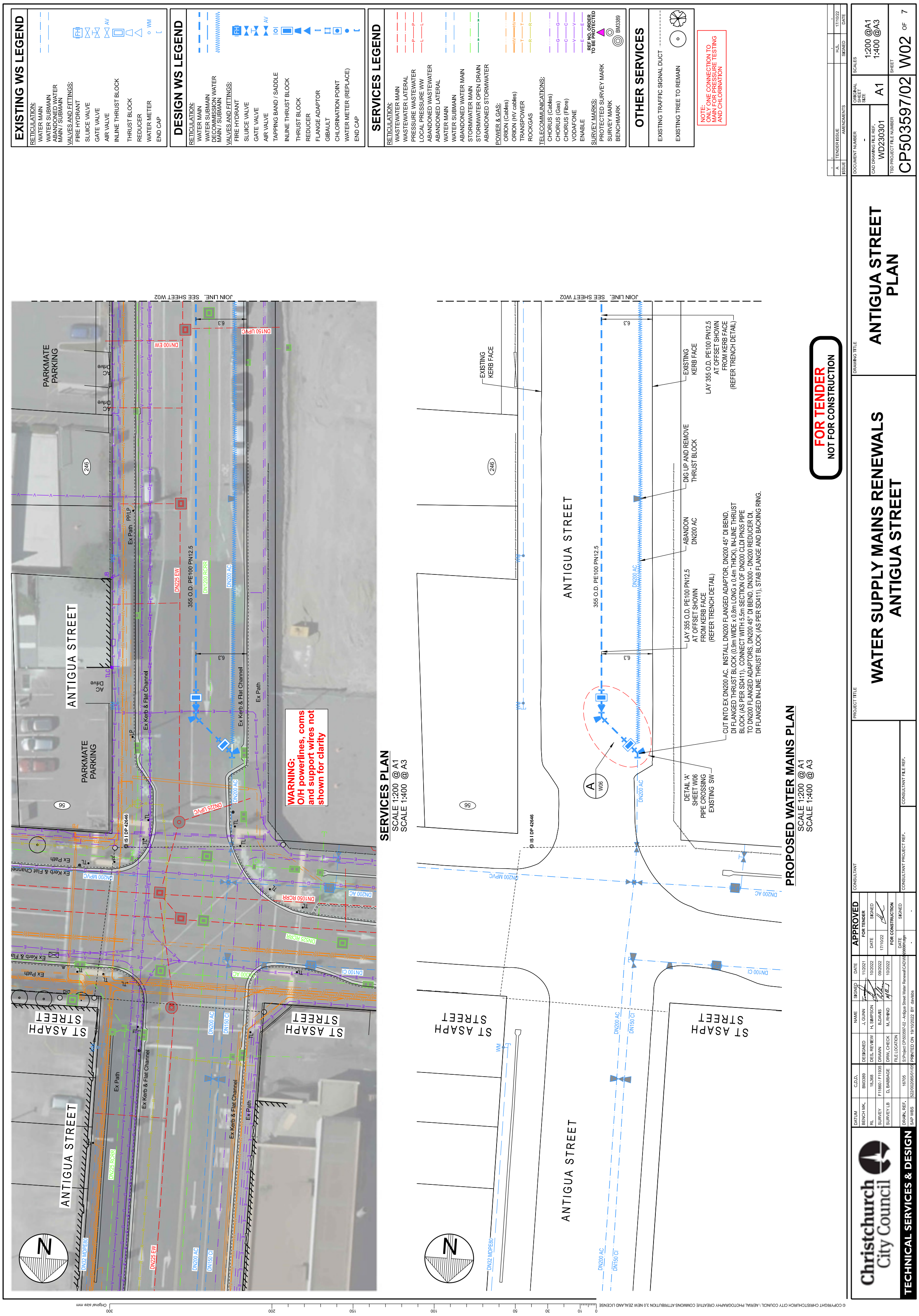

Figure 13 Water supply drawing

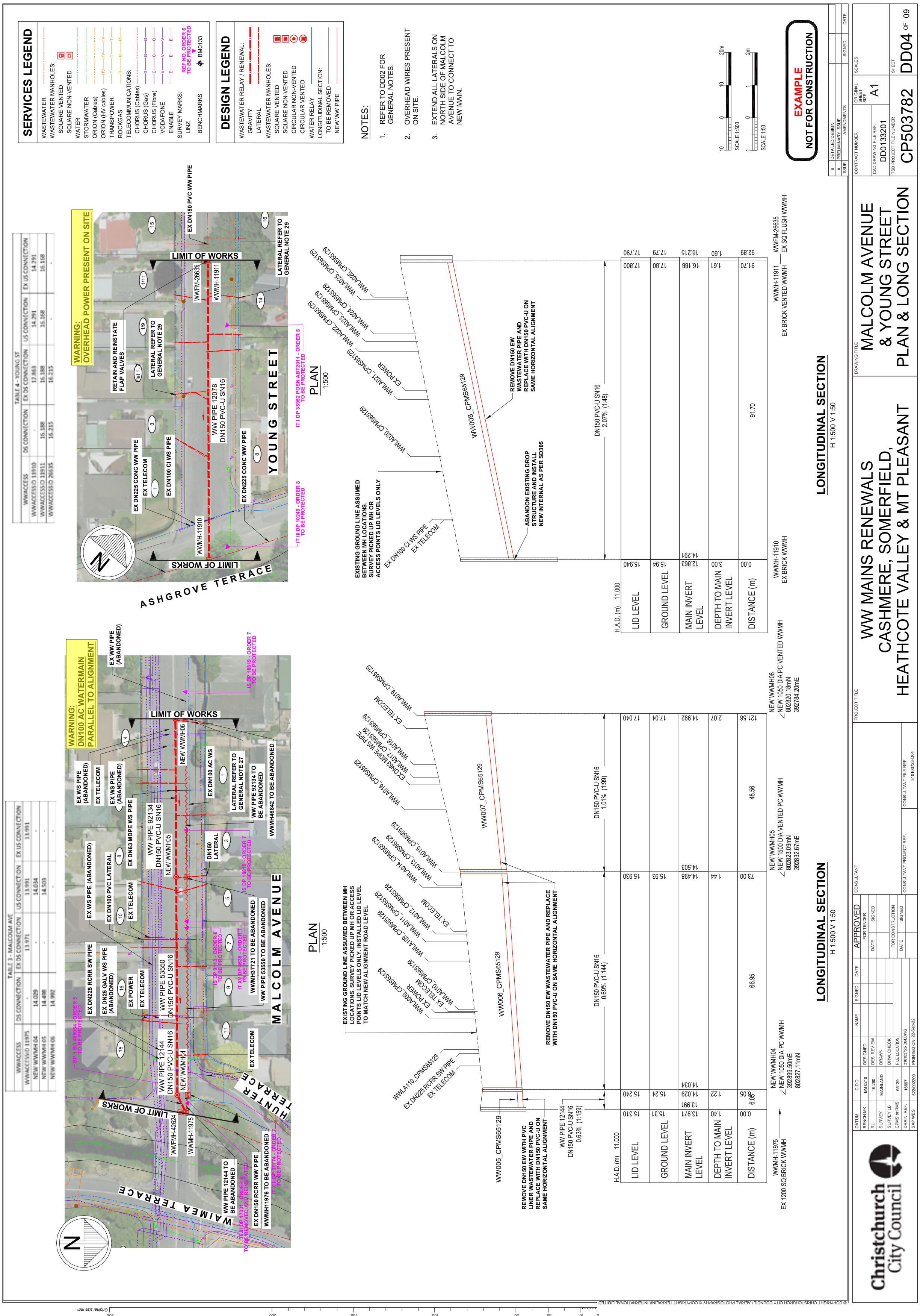

Figure 14 Drainage drawing

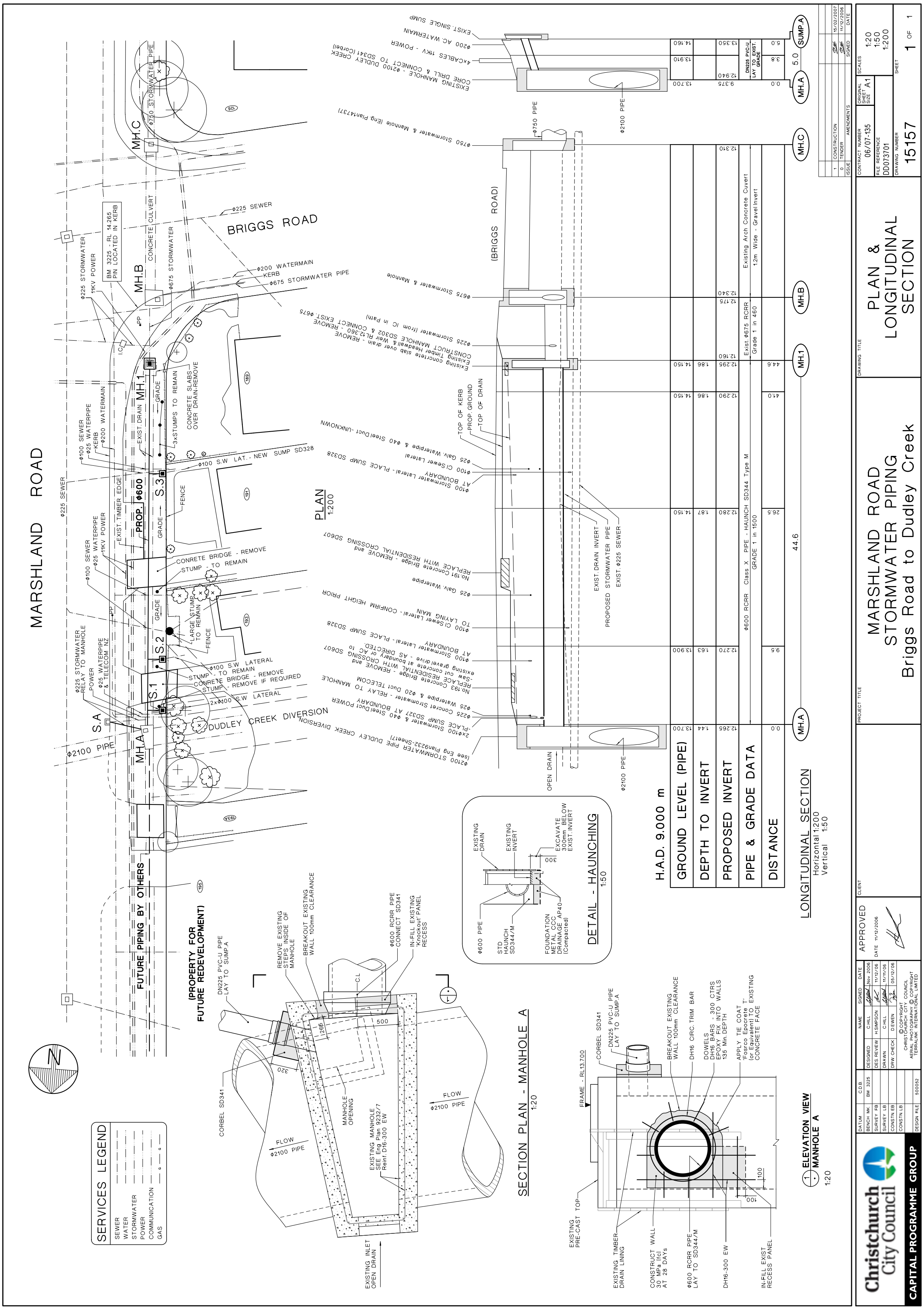

Figure 15 Special drainage details

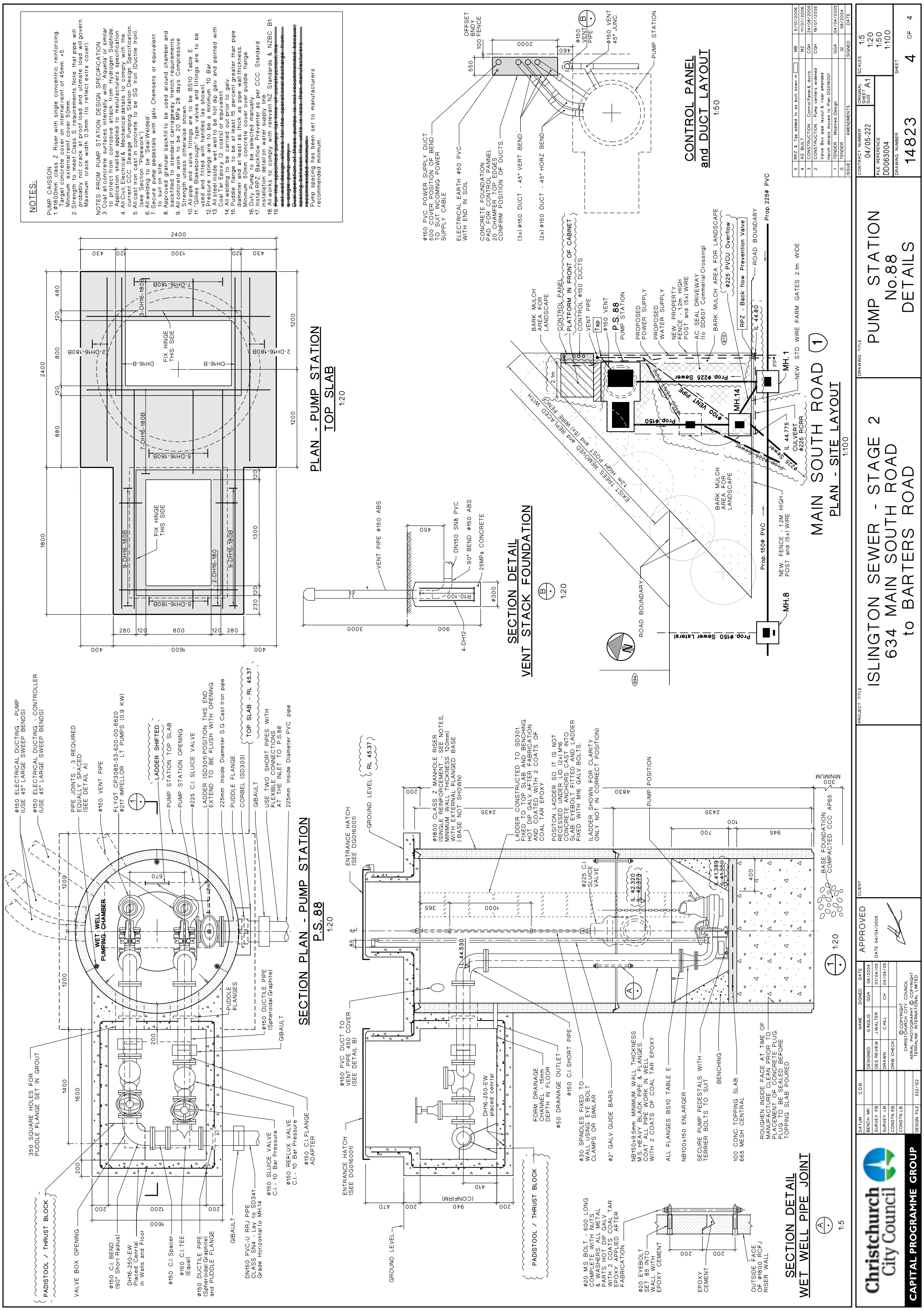

Figure 16 Pump station

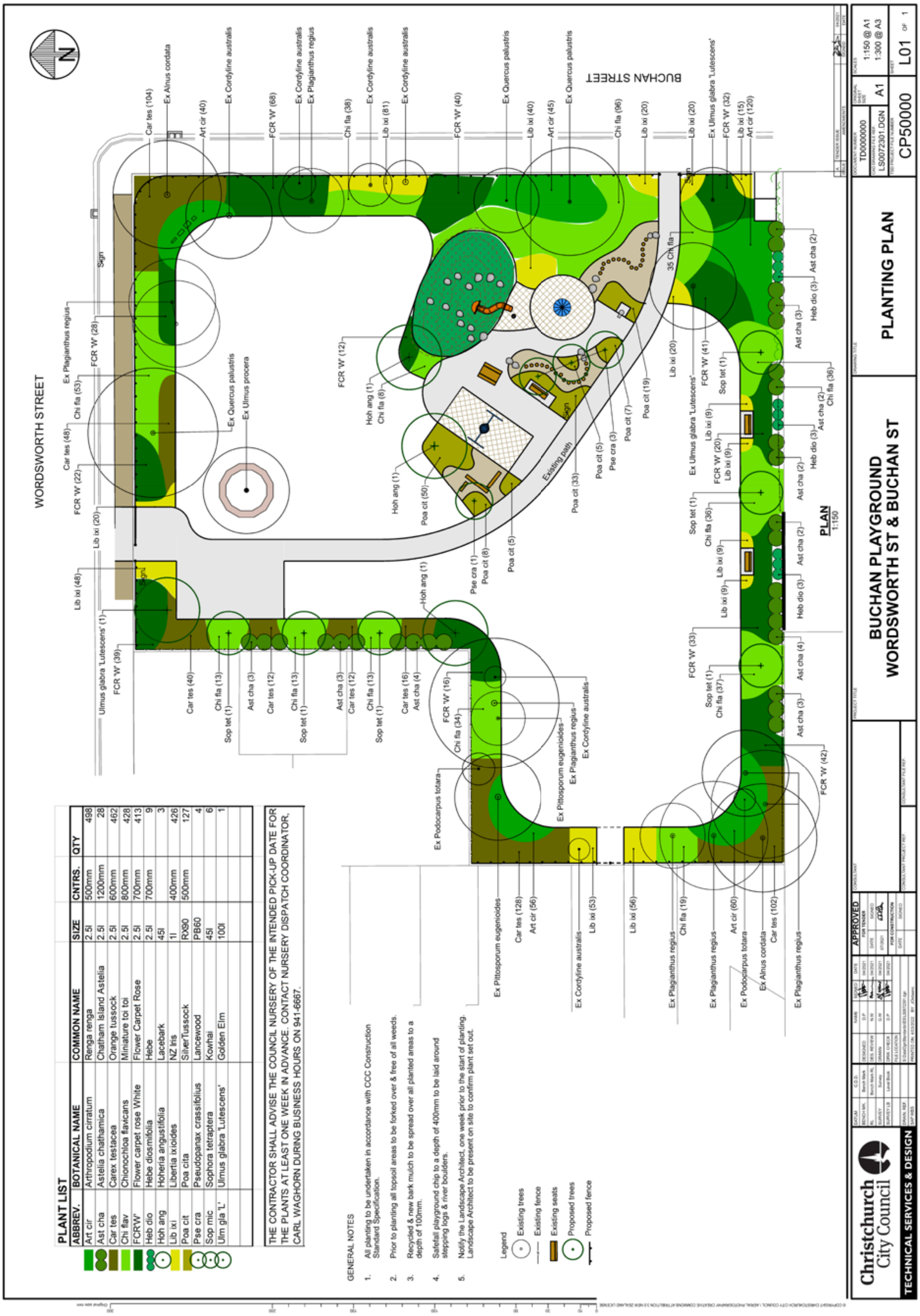

Figure 17 Landscape planting drawing

APPENDIX II

DRAUGHTING CHECKLIST

DRAWING – (LAYOUT)	
Street names and waterways correctly spelt and orientated with correct text size.	☐
Running distances are shown at top of drawing - at right angles to drawing.	☐
Join lines (if any) are shown and labelled.	☐
North point (should be correctly orientated i.e. not pointing down), service legend and standard notes (bottom right hand corner of sheet) shown. Drawing to be labelled with scale.	☐
Leader arrows from notes should not cross one another.	☐
Existing notes and proposed notes do not overlap one another, or the boundary and section lines.	☐
Title block filled out correctly, including sheet numbers.	☐
Any amendment to drawing to be indexed in amendments box as a letter (not number) with small description and date.	☐
Any details or sections to be labelled correctly.	☐
Related drawings cross referenced.	☐
Locality diagram labelled and orientated correctly.	☐
Proposed notes are standard in wording. Benchmark referenced.	☐
DRAWING – (EXISTING FEATURES)	
Existing kerb and channel correctly labelled.	☐
All existing manholes, sumps, fences, grass berms, footpaths, driveways and landscape features are labelled.	☐
Boundaries shown – existing and proposed, including easements.	☐
Property levels or contours are shown over development, at boundary and 3m outside development.	☐
All buildings to be hatched and labelled (e.g. DAIRY).	☐
House numbers shown at correct orientation.	☐
All existing drainage pipes are correctly labelled with flow direction shown.	☐

All existing utilities are correctly labelled.	☐
Existing vegetation, including that to be removed, is clearly shown, in both canopy size and position.	☐
DRAWING – (PROPOSED FEATURES)	
Proposed kerb and channel correctly labelled.	☐
Proposed kerb and flat channel has fender line shown.	☐
All radii on proposed kerb and channel shown.	☐
TP's, CTP's on proposed kerb face have 'tick' shown.	☐
Proposed cutdowns are shown and labelled (particularly at intersections and adjacent to pedestrian islands). Does not apply to standard driveways.	☐
Proposed property/spot levels and contours are 'proposed' weight.	☐
All proposed paths/paving/other hard surfaces are shaded and labelled correctly.	☐
Correct Peg box attached.	☐
Manholes being altered or installed have an allocated letter.	☐
Extent of filling, finished levels shown.	☐
If landscape planting is shown on drawing there must be a landscape planting key.	☐
If there is a separate landscape planting drawing, planting to be patterned and labelled on roading drawing; cross referenced to the landscape planting drawing.	☐
LANDSCAPE DRAWING – (ADDITIONAL TO LAYOUT)	
Proposed features/structures labelled, including furniture/bins/signs/fountains/fencing.	☐
Proposed playground equipment/softfall areas/sports fields/recreational hard surfaces labelled.	☐
Proposed vegetation/plant symbols clearly labelled and/or listed in plant list.	☐
Plant list has correctly spelled botanical names, common names, sizes and quantities.	☐
LONG SECTION (ADDITIONAL TO LAYOUT)	
Proposed kerbs, crowns, edge of seals to be labelled. No existing kerbs, edges of seal, are shown (when required, small sections may be shown for clarity).	☐
Pipe size, class, protection shown, vented manholes labelled.	☐
Longitudinal section to have title below section.	☐

Sump numbers/MH letters correspond to the drawing.	☐
Running distances from easily located point on engineering drawing.	☐
All required grades shown and labelled.	☐
Existing and proposed levels shown, including cuts and fills.	☐
Property boundaries, road intersections, crossing services shown.	☐
Datum, shown to 3 decimal places.	☐
ROAD MARKING DRAWING (ADDITIONAL TO LAYOUT)	
RPM'S and KTM's use the symbols and are correctly labelled.	☐
Correct line types are used for 100 mm WHITE, NO STOPPING, CONTINUITY etc.	☐
Correct line weights used for 'ex lines to be removed'; 'ex lines to remain' and 'proposed markings'.	☐
CROSS SECTIONS (ADDITIONAL TO LAYOUT)	
Every cross section sheet to have at least one typical cross section showing construction in full and labelled correctly with standard notes.	☐
The word chainage should not appear. Cross sections labelled with chainage value only (ie 20.00 m) to be centred under cross section.	☐
Proposed kerb and fender, quarter points, crown, interpath channel, and invert of swales to have levels shown.	☐
Sump numbers/MH letters correspond to the drawing.	☐
Proposed stormwater pipes, sumps and any services which could be disturbed to be shown.	☐
North, south or west and east boundaries to be labelled as such.	☐
Proposed trees and other plantings are shown in relation to underground services, paths and carriageways.	☐
Datum text to be positioned at left hand side of cross section on datum line.	☐

DESIGN CHECK BY: ______________________________ DATE: ____________________

Appendix III

Benchmark Certificate

ISSUED BY: ____

(Surveying firm or suitably qualified surveyor)

TO: ____

(Owner/Developer)

TO BE SUPPLIED TO: ____

(Territorial authority)

IN RESPECT OF: ____

(Description of benchmark)

AT: ____

____

(Address)

On behalf of ____

(Surveying firm)

I, ______________________ a Licensed Cadastral / Registered Professional Surveyor

(Surveyor) (delete one)

hereby certify that the benchmark shown on finder diagram ______________________

has been installed in accordance with the requirements of the Infrastructure Design Standard and good survey practice, using ______________________ methodology.

The surveying firm issuing this statement holds a current policy of professional indemnity insurance of no less than $______________.

(Minimum amount of insurance shall be commensurate with the current amounts recommended by EngNZ, ACENZ, TNZ, INGENIUM.)

______________________ Date: ______________________

(Signature of Surveyor)

______________________ ______________________

(Surveyor firm) (Address)

Appendix IV

Bond Form

Christchurch City Council
Conditions Of Receipt Of Cash Refundable Bond

SUBDIVISION REFERENCE: ______________________________

ADDRESS OF ACTIVITY: ______________________________

THE CHRISTCHURCH CITY COUNCIL hereby acknowledges:

(a) Receipt of the cash refundable bond (Receipt No. ____________)

(b) That such sum is to be held by it as a cash refundable bond for uncompleted subdivisional works on the conditions set out below.

THE OWNER described below for himself his successors and assigns, hereby confirms and ratifies that the conditions set out below are the conditions upon which he has lodged the said sum and hereby covenants to complete the works listed in the schedule by the date specified therein.

CONDITIONS

1. If the Owner completes all the work listed in the Schedule below to the satisfaction of the Council by the date specified, the sum shall be refunded to the Owner in full.
2. If the Owner does not complete all the said work by the said date the Council, on the Owner's behalf, may carry out or cause to be carried out the said work or such parts as shall not be completed and may apply the said sum towards the cost of so doing. Any surplus after completion by the Council shall be refunded to the Owner.
3. The Council shall not however, be obliged to carry out all or any of the said work and if it chooses to do so the carrying out of such work shall be without prejudice to the Council's exercise of any other rights remedies or powers which it may have against the Owner.
4. Bond monies will be refunded once Council costs attending to the outstanding works and confirming compliance have been recovered. An invoice will be raised in due course for these costs.
5. Bond monies are non-interest bearing.

DATED this ______________________________day of ___________________

SCHEDULE

THE OWNER: ____

THE DATE FOR COMPLETION: ____

DESCRIPTION OF WORK: ____

BOND VALUE: ____
(Receipt to Account Code SRB)

SIGNED by the said)
)
in the presence of:) ___________________ ___________________

Director Director/Secretary

Signature of Witness: ____

Full Name of Witness: ____

Occupation of Witness: ____

Address of Witness: ____

Note:

1. If two directors sign, no witness is necessary.
2. If a director and secretary sign, both signatures are to be witnessed.
3. If the director and secretary are not signing together, a separate witness will be necessary for each signature.

Part 3: Quality Assurance

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3.1 Referenced Documents

Planning and Policy

> Health and Safety at Work Act (2015)

Design

- AS/NZS ISO 9000:2016 *Quality management systems - Fundamentals and vocabulary*
- Transit New Zealand *Quality Standard TQS2*: Second Edition, June 2005
- New Zealand Transport Agency *Safety in Design – minimum standard for road projects* www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Zero-harm/Safety-in-design/ZHMS-V02-Minimum-Standard-Safety-in-Design-for-Road-Projects.pdf
- NZS 3910:2013 *Conditions of contract for building and civil engineering construction*
- Engineering New Zealand Practice Note 02 *Peer Review – Reviewing the work of another engineer* www.engineeringnz.org/engineer-tools/engineering-documents/practice-notes-and-guidelines

Construction

- 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/
- Worksafe New Zealand *Underground services – Guide for safety with underground service*s www.worksafe.govt.nz/topic-and-industry/excavation/excavation-safety-gpg/

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).

The terms, and their definitions, used in this standard are consistent with those of NZS ISO 9000 and NZS 3910.

3.1.1 Source document

TQS2 was used a guide in the development of this section of the IDS. That standard was developed by Transit New Zealand as a framework for an acceptable quality management system for the suppliers of physical works on state highways, and came into effect as a mandatory requirement from July 1996.

The use of that standard as a basis for this Part has been with the kind permission of Transit New Zealand.

3.1.2 Guidelines

Notes have been included in Appendix I – Guidelines and further explanation. These are intended to aid in the understanding of this section, expand on the requirements and explain the application of a project quality system in more detail. Read them in tandem with the clauses in this section.

3.2 Introduction

Christchurch City Council aims to achieve well-designed and constructed assets for its ratepayers. Building and maintaining assets, regardless of whether they are created through the subdivision and development of land or the capital works process, is a partnership of developers, designers and contractors. Where quality principles are applied to both design and construction, real benefits result.

Christchurch City Council therefore requires the application of quality assurance for all physical works that result in assets being transferred to the Council. Any designer, contractor or supplier wishing to tender for capital works or any developer exercising a resource consent must implement this part.

Where the assets will be vested through subdivision, designing and constructing assets in accordance with a Project Quality System will be a condition of subdivision consent. The developer must demonstrate compliance by providing and applying the project quality system, to substantiate the release of the subdivision compliance certificate, known as the 224(c) certificate. Similarly a contractor engaging in capital works is required to provide and apply a Contract Quality Plan during the contract period, which provides the supporting structure for the quality system.

This Part provides a framework for a quality management system. It has been developed by a Council internal working party and has been benchmarked against best national practice. The quality management system must ensure that all quality assurance issues relevant to a subdivisional land development or a capital works project are effectively defined, managed and communicated to ensure that all quality requirements are achieved.

3.3 Project Quality System

The project quality system must include documented procedures relating to all management, design and construction activities. This includes the following components:

- Project management, as described in clause 3.4;
- Management of purchasing, as described in clause 3.5;
- Control and inspection of the work, as described in clause 3.6;
- Non-conformance and quality improvement, as described in clause 3.7;
- Health and safety, as described in clause 3.8.1;
- Environmental management, as described in clause 3.8.2.

> The Project Quality System consists of a document trail comprising:

> the Design Report, as described in clause 3.3.2 and illustrated in the example in Appendix II;

> the Contract Quality Plan, as described in clause 3.3.3 and illustrated in the example in Appendix III;

> the Engineer's Report, as described in clause 3.3.4.

These three documents support the certificate trail, which establishes compliance with the Project Quality System. The certificate trail includes:

> the Design Certificate (see Appendix IV) and Design Peer Review Certificate (see Appendix V), which complete the Design Report documentation;

> the Engineer's Review Certificate (see Appendix VI), which completes the Contract Quality Plan;

> the Engineer's Completion Certificate (see Appendix VII) and the Contractor's Completion Certificate (see Appendix VIII), which complete the Engineer's Report;

> the 224(c) Certificate or Practical Completion Certificate.

The issue of the 224(c) Certificate or Practical Completion Certificate is therefore dependent on the application of the Project Quality System and the provision of its related documentation. This interrelationship is set out in figure 1.

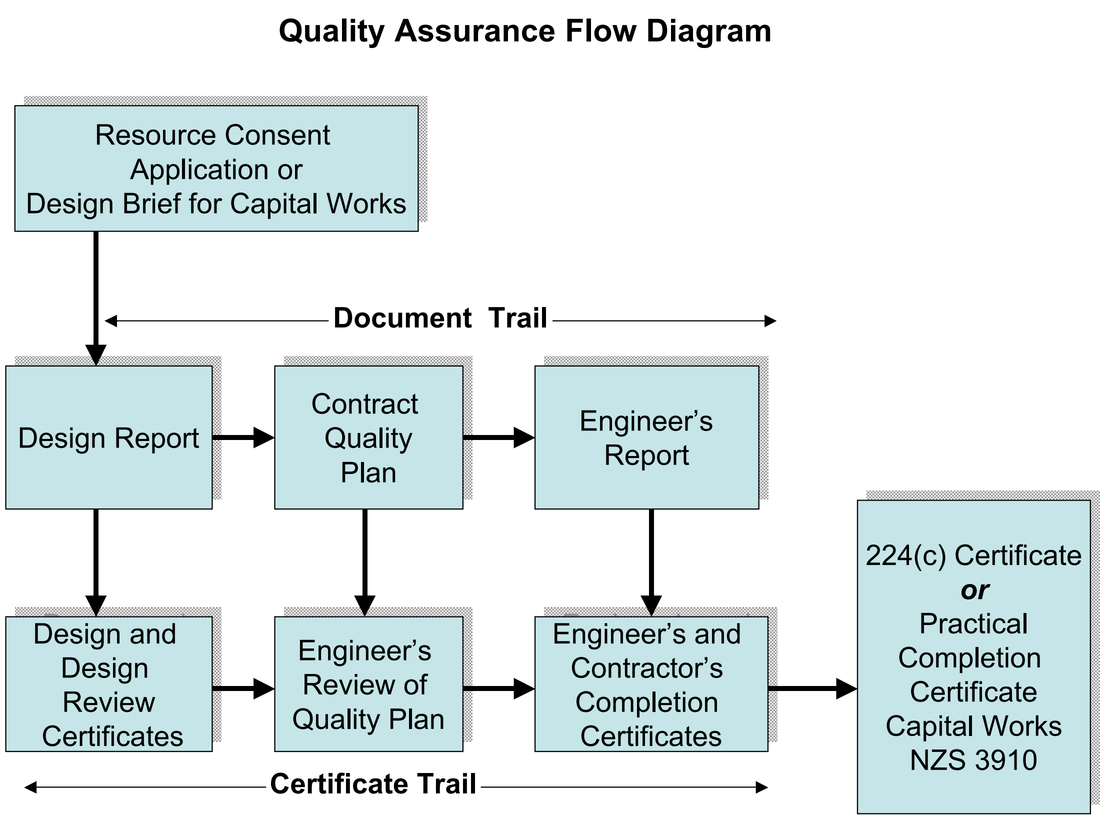

Figure 1 Quality Assurance Flow Diagram

Quality assurance responsibilities and requirements are a combination of relationships across the investigation, design and construction phases. Figure 2 explains those relationships and the point at which they are applicable.

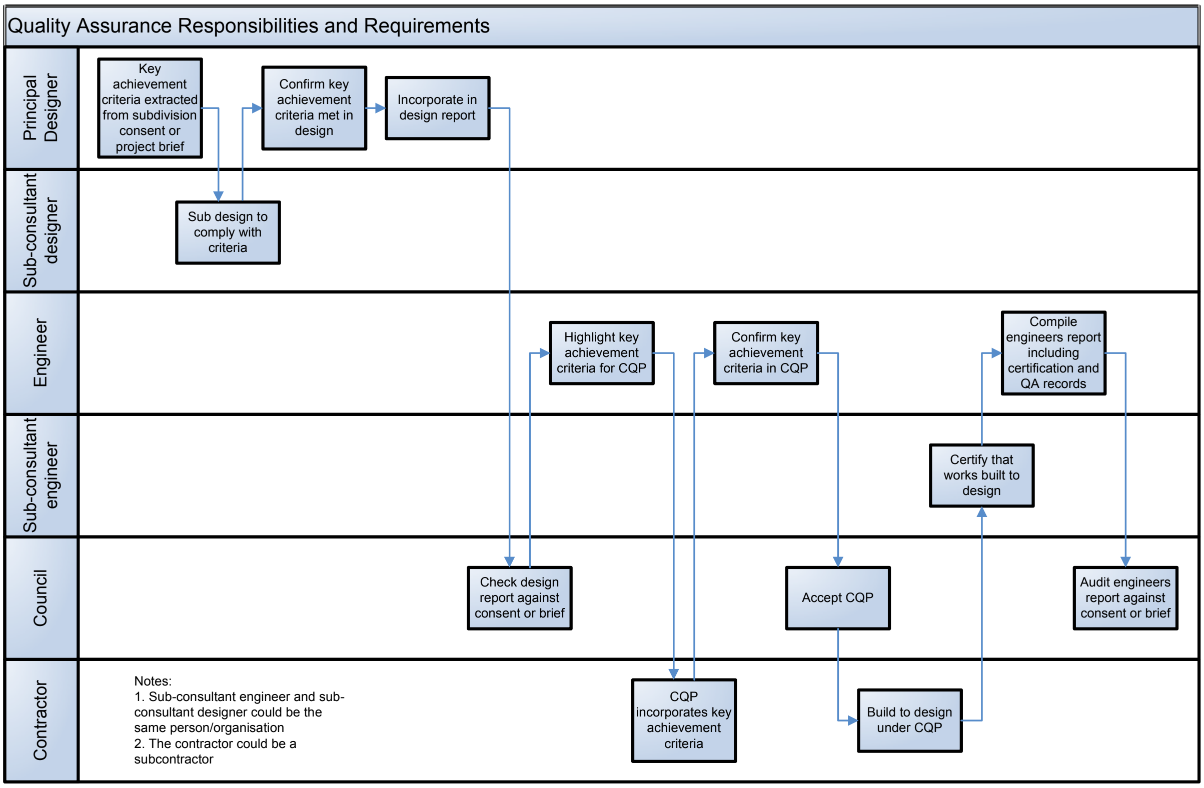

Figure 2 Responsibilities and Requirements Diagram

3.3.1 Key achievement criteria

Key achievement criteria are defined as elements of design or construction that are critical to the quality of the asset. These are typically found in the resource consent or project brief. They may also come out of particular aspects of the design e.g. the designer may require proof of levels on a weir at a particular place in the system to support compliance with a higher level key achievement criteria.

3.3.2 Design Report

Submit a Design Report, where required as a condition of consent in respect to a subdivisional land development or where specified in the project brief. Submit a Design Certificate to the Council along with the Design Report. Engineering acceptance is subject to presentation of this report.

The designer describes how s/he has:

> Identified and addressed the design, management, administrative and legislative requirements specific to the design;

> Planned the work to satisfy those requirements;

> Managed communication with stakeholders and other parties to the design;

> Reviewed/tested the design to ensure compliance with the quality requirements;

> Recorded design activities and maintained records and evidence of compliance.

If required as a condition of consent, peer review the design in accordance with *Peer Review – Reviewing the work of another engineer*. Submit a Design Peer Review Certificate to the Council along with the Design Report.

Where aspects of the design require expertise outside of the field of knowledge of the designer, provide a Design Certificate from a suitably qualified sub-consultant designer to support the submission of the Design Report. Ensure additional information obtained from the sub-consultant designer regarding key achievement criteria or other matters is also incorporated in the Design Report.

3.3.3 Contract Quality Plan

Submit a Contract Quality Plan within the time frame and to the extent specified in the resource consent or contract. Submit an Engineer's Review Certificate to the Council along with the Contract Quality Plan. Where specified as a deliverable in the contract or as a requirement of resource consent, the Contract Quality Plan and Review Certificate must be subject to review and acceptance by the Council, along with any major amendments. Present the Contract Quality Plan and Review Certificate before physical works commence.

The contractor describes how s/he will:

> Identify and address the contract management (including traffic management, technical and environmental issues), administration and legislative requirements specific to the contract as detailed in clause 3.4 – Project Management;

> Plan the work to satisfy those requirements;

> Control (manage) the work, including that undertaken by subcontractors, to comply with requirements;

> Manage communications with stakeholders and other parties to the contract;

> Inspect/test the materials and work to ensure compliance with the quality requirements;

> Address communication and reporting requirements;

> Manage, review and update management plans to ensure they remain relevant to the requirements of the contract and work being undertaken;

> Record contract activities and maintain records as evidence of compliance.

Provide certification upon Practical Completion through submitting a Contractor's Completion Certificate.

Where aspects of the construction require expertise outside of the field of knowledge of the contractor, the contractor must provide a Completion Certificate from a suitably qualified subcontractor to support the submission of the Contractor's Completion Certificate. Ensure additional information obtained from the subcontractor regarding key achievement criteria or other matters is also incorporated in the Contract Quality Plan.

Where aspects of the construction require expertise outside of the field of knowledge of the contractor, the contractor must provide a Completion Certificate from a suitably qualified subcontractor to support the submission of the Contractor's Completion Certificate. Ensure additional information obtained from the subcontractor regarding key achievement criteria or other matters is also incorporated in the Contract Quality Plan.

3.3.4 Engineer's Report

Submit the Engineer's Report upon completion of physical works, where required as a condition of consent in respect to a subdivisional land development or where specified in the project brief.

The engineer describes how s/he has:

> Identified and addressed the quality management requirements specific to the project;

> Inspected, audited and tested the materials and work to ensure compliance with the quality requirements;

> Recorded project activities and maintained auditable records as evidence of compliance, including any non-conformance reports.

Provide certification upon Practical Completion through submitting an Engineer's Completion Certificate. Present the completed audit records with the application for 224(c) certification.

Where aspects of the construction require expertise outside of the field of knowledge of the engineer, provide a Completion Certificate from a suitably qualified sub- consultant engineer to support the submission of the Engineer's Report.

3.4 Project Management

Clearly state the responsibility, authority, necessary qualifications and relationships of the key personnel involved in achieving quality outputs. Include these in the Design Report or Contract Quality Plan.

In the case of capital works contracts for the Council include the responsibilities for safety and environmental management programmes, in accordance with relevant legislative requirements (as set out in clause 3.8 – Safety and Environmental Management).

3.5 Management of Purchasing

3.5.1 Purchasing instructions

Purchase orders that are significant in terms of achieving the project quality requirements must be in writing. They must contain a clear specification of the requirements.

3.5.2 Material supply

Check materials purchased for the project that are significant in terms of achieving the contract quality requirements. Confirm compliance with the specified requirements prior to incorporation in the project. Note the verification of compliance either on the relevant checksheet or some other appropriate record.

3.5.3 Subcontractor quality control

The contractor is responsible for the quality of materials supplied and work performed by its subcontractors. Include appropriate quality assurance procedures in the Contract Quality Plan, to control and monitor subcontractor compliance with the contract and/or Contract Quality Plan. Conduct planned periodic audits of subcontractor activity.

These procedures do not relinquish the responsibility of the main contractor. Ensure that the subcontractor is aware of specific technical and management requirements in the contract, and that these are incorporated in the Contract Quality Plan. Ensure that the subcontractor has appropriate controls in place for the management of any specific construction risks.

3.6 Control and Inspection of the Work

Undertake the work in a planned and controlled manner to ensure that the quality requirements are realised. Demonstrate that the following has been undertaken on all projects:

- Identify the key achievement criteria;
- Plan how these will be realised;
- Control the work in conformance with the project quality system;
- Check, inspect or test the work and verify that it conforms to the specified requirements;
- Record the results as documentary evidence of compliance.

This clause relates to both design and construction works and requires that all the processes involved are properly managed.

3.6.1 Identifying and planning

Systematically identify from the consent the key achievement criteria of the project for each discipline. Identify the key achievement criteria at each stage to satisfy all the requirements of clause 3.6.2 – Checking, inspection, testing and recording. Use these as a basis for developing the Design Report, Contract Quality Plan or Engineer's Report. Include documentation of constraints, assumptions and base data, e.g. site investigations, in these documents.

Apply documented procedures to the extent necessary to ensure that those performing the work fully understand what is required, or where their absence could create a risk to the quality or safety of the work being undertaken.

3.6.2 Checking, inspection, testing and recording

Check, inspect or test against all the identified key achievement criteria to verify compliance during design and construction and on final completion. Specify the methods, specification references, frequency, timing, responsibilities and necessary qualifications for checking, inspection and testing in the Design Report, Contract Quality Plan and Engineer's Report. Measure compliance against quantified acceptance criteria based on the IDS and/or specification requirements. Document the results and retain as part of the quality records.

Clearly indicate any "hold' or "witness points" in the Design Report, Contract Quality Plan or Engineer's Report, where the project requires checking, an inspection and/or approval to proceed (i.e. internally and/or from the Council). Establish systems to record the findings, any remedial action initiated and the final approval to proceed. Treat non-conforming work in accordance with clause 3.7 – Non-Conformance and Quality Improvement.

Where there is a requirement to use third party accredited agencies, include the details of compliance methods in the Design Report, Contract Quality Plan or Engineer's Report.

3.7 Non-Conformance and Quality Improvement

3.7.1 Control of non-conforming work

The designer must have a procedure to ensure that design work that does not conform to the specified requirements is either:

> redesigned to meet the specified requirements; or

> accepted by concession from the Council.

Record all non-conforming work on the relevant design record and/or the relevant design checksheet.

The contractor/engineer must have a procedure to ensure that construction work that does not conform to the specified requirements is either:

> reworked to meet the specified requirements;
> accepted with or without repair by concession from the Council;
> regraded for alternative use;
> rejected and replaced.

Record all non-conforming work on the relevant construction checksheet.

If the construction non-conformance is significant in that it either:

> results in the need for written concession;
> results in delay or interference to the work or to other parties;
> indicates that the fault has occurred due to the use of incorrect work practices and/or failure of materials and could have been prevented;
> occurs sufficiently frequently as to indicate a problem in training or procedures,

produce a Non-Conformance Report (NCR) and send to the Council.

The report and supporting documentation must clearly indicate the action to be taken to rectify the fault, the timeframe and responsibilities. It must be authorised by the designer or engineer. An example of a report is enclosed in Appendix IX – Non-Conformance Report.

In cases involving concessions, the designer or engineer and the Council must approve the proposed rectification (the corrective action) of the non-conforming work in writing and prior to implementation.

3.7.2 Quality improvement

Investigate the cause (as opposed to the symptom) of reported non-conforming work. Record proposals for improving the company's quality system on the Non-Conformance Report, to prevent the recurrence of a specific non-conformance. Send all corrective action proposals to the Council.

Ensure that the proposed corrective action is properly and effectively implemented.

3.8 Safety and Environmental Management

3.8.1 Health and safety

Consider "Safety in Design" and carry out a risk assessment appropriate to the scale of the project. Use these outputs to inform requirements for the project's health and safety system. Refer to *Safety in Design Minimum Standard for Road Projects* and ensure the contractor applies the *Guide for Safety with Underground Services*.

A health and safety programme is mandatory for all contract quality plans submitted as part of a capital works project. It is not a Council requirement of subdivision consents.

Operate a formal health and safety programme, which complies with the statutory requirements of the Health and Safety at Work Act and any subsequent revisions and associated regulations. To the extent practical and permissible by law, health and safety policies and procedures should be integrated into the engineer's and contractor's quality system.

Ensure the system addresses the following as a minimum:

- Hazard identification and assessment of control measures imposed;
- Hazard monitoring and auditing, including frequency;
- Emergency management;
- Hazard monitoring and auditing, including frequency;
- Procedures for training and supervising staff in relation to safety issues; and
- Contact details of key personnel.

3.8.2 Environmental management

Consider environmental management in the design and carry out a risk assessment appropriate to the scale of the project. Use these outputs to inform requirements for the project's environmental management system.

Operate a formal environmental management programme that complies with the statutory requirements of the Resource Management Act, any associated Regulations and any other specific requirements set out in any applicable resource consent. To the extent practical and permissible by law, integrate the programme into the quality system.

Ensure the Environmental Management Plan (EMP) within the environmental management system addresses as a minimum:

> The identification of environmental risks in clause 2.5.5 – Environmental considerations and an assessment of mitigation measures imposed;

> Emergency response and contingency management;

> Procedures for compliance with resource consents and permitted activities;

> Environmental monitoring and auditing, including frequency;

> Corrective action, reporting on solutions and update of the EMP;

> Procedures for training and supervising staff in relation to environmental issues;

> Contact details of key personnel responsible for environmental management and compliance.

The Contract Quality Plan must identify all compliance issues relating to the Resource Management Act, including any conditions contained within the project related resource consents.

APPENDIX I

Guidelines and Further Explanation

Project Quality System (clause 3.3)

The project quality system identifies how the requirements of the project were or will be addressed. These may include quality, safety, environmental, technical and general management requirements. This may be achieved by:

> adopting industry best practices;

> adopting or adapting documents developed for the same or similar activity on previous jobs;

> preparing new documents for those activities which are new or substantially different from anything undertaken previously.

Provide details of how all the identified requirements were or will be planned, controlled (managed), checked or inspected for compliance and the results recorded. Include provision for document control, including review and approval of the quality systems. The identified requirements will include the key achievement criteria but also those routine items which, through being achieved, will provide a quality asset.

For example, if a consent had a condition like "*The surface water management system shall rely on stormwater disposal to ground in accordance with the consent conditions of CRCXXXX.1*", the key requirement (achievement criteria) to ensure this condition was met would be to demonstrate that the design soakage rates for any infiltration system can be achieved on-site.

Each part of the IDS contains examples, for guidance, of records that can be provided to support the project quality system e.g. thrust block design calculations in clause 7.3.2 – Design records (Water Supply).

Design Report (clause 3.3.2)

A Design Report is a document specific to a design, which describes how the design was managed and administered in compliance with the requirements of the IDS and the resource consent or project brief.

Include a list of project personnel, their qualifications and their contact details. List the procedures and design checksheets that were used to effectively manage the design. These procedures should include the necessary qualifications of key personnel as they relate to particular tasks. Highlight exceptional aspects of the project that must be covered by the Contract Quality Plan.

For the example given above, information provided through the project quality system to support the assertion of compliance (which is more substantial as the condition is a key achievement criteria) might include, in the Design Report:

> Methodology to determine the design soakage rate.

> Design checksheet (see guidelines to clause 3.6.2) including the assumptions upon which the design is based (see clause 5.4.3 – Design records (Stormwater) bullets) and their source.

- Calculations leading to the design infiltration.
- Record of key achievement criteria for inclusion in the CQP.
- Design Certificate.
- Designers qualifications relevant to infiltration design.
- Design Peer Review Certificate if required.
- Specific requirements for OMM to preserve ongoing compliance.

Supporting information retained in the project quality system might include:

- Alternatives explored.
- Contractual requirements around the key achievement criteria into the CQP.
- Quick check of the design infiltration, by an alternative method if possible.

An example of a simple proforma Design Report setting out the minimum requirements of the IDS is provided in Appendix II. It is an example only and designers may develop their own format to suit their specific needs.

Contract Quality Plan (clause 3.3.3)

A Contract Quality Plan is a document specific to the project, which describes how the contract works will be managed and administered in compliance with its requirements.

Include, or otherwise reference, the procedures and the checksheets necessary to effectively manage the contract works. These procedures should include the qualifications of key personnel as they relate to key tasks particularly the key achievement criteria e.g. the connection to the Council water reticulation must be undertaken by an authorised water installer. The following is a guideline of the information that should be included in the Contract Quality Plan:

- A statement of policy with respect to the timing and frequency of internal reviews and/or audits of the quality plan during the project.
- A schedule of the contractual quality records to be kept.
- A list of subcontractors.
- Procedures for auditing subcontractor compliance to the quality plan.
- A schedule of inspection and/or testing of materials and/or completed works, clearly indicating ‘hold’ or ‘witness’ points.
- Documented procedures included, or referenced, for all activities.
- Non-conformance & quality improvement procedures included, or referenced.
- Provisions for traffic management and environmental management plans included or referenced.

For the example given above, information provided through the project quality system to support the assertion of compliance (which is more substantial as the condition is a key achievement criteria) might include, in the Contract Quality Plan:

(Pre-construction)

> Engineers Review certificate.
> Inspection and test schedule highlighting the infiltration test requirement.

(Post-construction)

> Contractor's Completion Certificate.
> Inspection and test schedule proving compliance is achieved.

Supporting information retained in the project quality system might include:

> Infiltration test record sheets.

An example of a simple proforma Contract Quality Plan is provided in Appendix III. This sets out the minimum requirements the Contract Quality Plan must achieve for this standard. It is an example only and contractors may develop their own format to suit their specific needs.

Prepare site-specific Erosion and Sediment Control Plans (ESCP) in accordance with clause 4.9 – Erosion, Sediment and Dust Control (Geotechnical Requirements).

As noted above, processes and procedures for the management of subcontractors must be stipulated in the Contract Quality Plan. This is especially important where subcontractors perform a large component of the works (e.g. earthworks).

Engineers Report (clause 3.3.4)

An Engineer's Report is a document specific to a project, which describes how the project was managed and administered in compliance with the IDS, the *Construction Standard Specifications*, the Contract Quality Plan and the resource consent or project brief. It provides background information to the release of the 224(c) certificate.

The following is a guideline of the information that should be included in the Engineer's Report:

> A schedule of the project and contractual quality records that have been kept. A summary of the quality records proving compliance is to be submitted to the Council.
> What procedures were employed for auditing contractor and subcontractor compliance with the quality plans.

For the example given above, information provided through the project quality system to support the assertion of compliance (which is more substantial as the condition is a key achievement criteria) might include, in the Engineers Report:

> Engineers Completion Certificate.

> Non-conformance Reports if generated.

> OMM as it relates to the ongoing achievement of this condition.

> Audit and test schedule proving compliance has been achieved.

Project Management (clause 3.4)

The project management structure need only show the key positions or functions. In many companies an individual can hold more than one position or be responsible for more than one function. The designer and the engineer can be the same person or organisation.

Relate job descriptions to positions and named individuals. They can be quite simple and should only state the principal responsibilities of the position, any necessary qualifications and the reporting lines. Examples of a management structure and job descriptions for a typical subdivision and a small/medium contractor are enclosed in Appendix II – Design Report section 1 and Appendix III – Contract Quality Plan section 3.

Purchasing instructions (clause 3.5.1)

Ensure that purchasing instructions are precise; otherwise there is a significant risk of not getting what is needed. Include, as appropriate:

> the product type, class, and size etc;

> the quality standards;

> the quantities;

> the scope of the work;

> the delivery details;

> the completion dates.

It may not be necessary to fully describe the requirements in every case e.g. when there is a record that the supplier has previously supplied full details or a copy of the specification and that the detail is current. In this instance, it would be sufficient to order by reference to those previously supplied details.

Material supply (clause 3.5.2)

Checking for compliance should preferably be done on receipt of the materials. The verification referred to can be recorded when completing the relevant checksheet (refer to the examples given in Appendices XIII - XVII). Attach any supporting documentation to the checksheet, such as delivery dockets or supplier certificates of compliance, which provide evidence of the type, grade, and class etc of material used.

Keep records of material tests that are traceable to defined sections of the work e.g. seven and 28 day concrete crushing strength test results, basecourse sand equivalent tests ex-supplier.

Identifying and planning (clause 3.6.1)

Each project is unique in that it:

> has technical requirements which may vary in part or full from other projects;

> will have a different scope of work from other projects, which is also likely to alter during the course of the project;

> will be in a different location and therefore will have different external influences from other projects;

> will utilise different resources;

> will have its own programme etc.

The identification of the project requirements is therefore important and must be undertaken in some systematic and documented manner. The project must be planned and managed to suit its unique set of characteristics, either by highlighting the key achievement requirements in the relevant sections of the consent, project brief or contract specification, or in a more formalised manner, by listing the requirements on a form. These key requirements must also be communicated between the various parties to the project.

The procedures should follow a standard format and be user friendly. They will describe how individual work activities are planned, controlled and inspected for compliance with the specification requirements. They will:

> describe how the activity or task will be performed;

> define key task responsibilities and required qualifications;

> describe how key design parameters which directly impact on the effectiveness of the design are communicated;

> indicate the sequence;

> specify the resources to be used;

> be written in precise and easily understandable language.

They should contain as a minimum the information outlined in the example in Appendix XII – Quality System Work Procedure.

Examples of work activities that would be covered by procedures include: surface and groundwater modelling; survey and setout; placement of unbound granular basecourse; stormwater pipework; traffic control. For work activities that are more or less standard, procedures from previous projects may be adopted or adapted.

Checking, inspection, testing and recording (clause 3.6.2)

The documentation requirements associated with checking, inspection, testing and recording need not be complex. The checksheets are useful in that they provide a breakdown of the checks that should be performed and, when completed, serve as a record. They should be developed for each key design and work activity and should contain the quality requirements as reminders.

The design checksheet should:

> include the constraints, assumptions and base data;
> identify the personnel responsible for the design;
> record that the design has been checked and the method used;
> provide for signing-off at the bottom of the sheet after a fully complying “design check”.

The engineer’s checksheet should:

> identify the personnel responsible;
> provide for signing-off at the bottom of the sheet.

Examples of engineer’s checksheets are included in Appendices XIII - XVI.

The construction checksheet should:

> provide a checklist of the items to be inspected;
> include the acceptance criteria;
> identify the personnel responsible for doing the inspection;
> contain space for recording that compliance of the individual items has been attained;
> contain reference to further records generated by non-conformances;
> provide for signing-off at the bottom of the sheet after a fully complying “final inspection”.

Examples of construction checksheets are included in Appendix XVII and XVIII.

An audit or inspection and test schedule should provide a full listing of all audits, inspections and tests of materials and completed works. It should clearly indicate ‘hold’ or ‘witness’ points and include signing off by the contractor, the engineer and the Council where required. A sample engineer’s audit and test schedule is contained in Appendix X and a sample inspection and test schedule is contained in Appendix XI.

Control of non-conforming work (clause 3.7.1)

It is inevitable that, even with excellent practices and controls, some degree of defective workmanship or material will occur. When it does, it is important that it is properly handled to ensure that the defects are rectified in the appropriate way.

A non-conformance should be considered an opportunity for improvement, rather than to apportion blame. By adopting this philosophy, identifying a non-conformance provides an opportunity to learn from the mistake and (more importantly) prevent it happening again.

Note that there is a clear differentiation between what should be considered a "routine construction issue" or a "routine design step" and a non-conformance. Ensure this is understood by and communicated to all staff. A construction issue, such as soft subsoils, is often identified (and reasonably expected) during a project and does not therefore necessitate the raising of a Non-Conformance Report, unless procedures have not been followed. The inability to achieve the minimum grade on a sewer design is a non-conformance and must be reported, as is the inability to achieve a passing Benkelman Beam test or infiltration test.

A non-conformance exists, and therefore a report should be raised, in all instances where a defect in the work or design occurs that indicates that the required standard or key achievement criteria prescribed in the Design Report, Contract Quality Plan or Engineer's Report has not been met, e.g. failure to achieve compaction results, pre-seal inspection etc. For this process to be successful it must be handled in a positive and constructive manner, without unnecessary recrimination.

Any non-conforming work that is subject to follow-on work by other parties must be clearly denoted as such to alert the other parties to its non-conforming status.

Quality improvement (clause 3.7.2)

The objective is to reduce, if not eliminate, the root causes of the recurring inefficiencies and errors which have caused or can cause non-conforming work, i.e. to find a permanent cure for the problem, not just a quick-fix. This provides a formal and disciplined procedure for identifying, investigating and correcting inefficiencies and shortcomings in a company's work practices.

There can be significant benefits to the company from the positive application of quality improvement, through reducing the incidence of non-conforming work and improving efficiency, to reducing costs including those of rework. Common causes of non-conforming work that can be addressed are:

- lack of training.
- lack of resources.
- poor communication / incomplete instructions.
- inadequately defined work practices.
- inadequate supervision.

Environmental management (clause 3.8.2)

Environmental management is an integral part of project management and therefore will be most efficiently operated within the framework of the project's quality system.

Design the environmental management programme in full compliance with the Resource Management Act. Specific activities that may require resource management consents or authorisations include:

> management of stockpile material.

> selection and management of disposal areas.

> the use of chemical sprays and fertiliser.

> noise and dust nuisance.

> prevention of fuel and oil spills including the actions taken if an oil spill occurs.

> control of silt, contaminants and stormwater runoff.

> the alteration of, or taking water from, waterways.

> work around protected trees.

> redirection of groundwater.

> excavation of HAIL sites and accidental discovery of contaminated material.

> discharges of dewatering water, sewage, or contaminants.

> archaeologically and culturally sensitive sites.

> disturbance of wildlife species or habitat.

> excavation over aquifers.

It is a legal requirement to maintain fish passage under the Freshwater Fisheries Regulations.

This is by no means an exhaustive list. There may also be Department of Conservation permits and Heritage New Zealand Pouhere Taonga authorities. Consider (if not contractually required to) developing a formal Environmental Effects Register. Also identify these matters in an assessment of environmental effects, for applications for subdivision consent.

APPENDIX II

Design Report

____

(contract name/subdivision name)

____

(contract /subdivision consent number)

Copy No______________of ______________

Version: ______________________________

Date of Issue: __________________________

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7	Design Check and Review	26
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APPENDICES: *(attach these – as applicable)*

1 - Design Certificate <see example in Appendix IV>
2 - Design Peer Review Certificate <see example in Appendix V>
3 - Non-Conformance Report <see example in Appendix IX>

DESIGN REPORT APPROVALS:

This Design Report has been:

Prepared by: (Designer)	____________________ (Name/Sign/Date)
Approved by: (Principal designer)	____________________ (Name/Sign/Date)
Reviewed by: (Peer Reviewer)	____________________ (Name/Sign/Date)

1 Project Personnel and Design Management

Principal designer:

Name: ______________________________

Address: ______________________________

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

Developer:

Name: ______________________________

Address: ______________________________

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

Sub-consultant designer:

Name: ______________________________

Address: ______________________________

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

Design Peer Review (if undertaken):

Name: ______________________________

Address: ______________________________

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

The following key personnel have been involved in this design:

Name	Position Title	Responsibility

This list should include details of different design specialists, internal reviewers and auditors.

2 Sub-consultant designers

Sub-consultant designers undertook the following design activities:

Activity	Name of Sub-consultant designer

Sub-consultant designers were selected in accordance with company policies and procedures, and were provided with copies of the relevant project briefs and/or resource consents requirements and/or drawings prior to commencement of the work.

Sub-consultant designers were subject to monitoring and their work was subject to periodic internal audit.

3 Full Description of Work

This section contains a full description of the work included in the Design Report. It should include a description of:

> *the existing pre-development site;*
> *the proposed development;*
> *the extent of the assets to be constructed;*
> *all key design and quality requirements, from the Council and the developer e.g. key achievement criteria;*
> *evidence of consultation, if applicable;*
> *the constraints, parameters, assumptions and raw data on which the design is based;*
> *data manipulation methods e.g. computer software, methodology.*

4 Quality Control and Inspection

Procedures and design checksheets were used to control the design and verify compliance with the quality requirements. The following documents were used for this design:

Identifier	Title

The documents can be made available for the Council's review, if requested.

Exceptional aspects of this project to be covered by the Contract Quality Plan include:

____

____

5 Environmental Management

The following Resource Consents, relevant to the design, have been obtained:

____

____

In accordance with the resource consent/s, environmental controls relating to this particular design will be outlined in the Contract Quality Plan.

6 Concessions

If, during the process of design, work is identified which does not conform to the specified requirements and will require a concession from the Council, submit a Non-conformance Report as part of the Design Report. The concession proposed will be discussed and must be approved by the Council prior to execution.

7 Design Check and Review

Undertake internal design reviews, to verify the design outlined and/or referenced in this Design Report, in accordance with "Reviewing the work of another engineer". Include written documentation of this review, by checksheet, calculations carried out by hand or another method to check design calculations, or document here.

Undertake a peer review, to verify the compliance and effectiveness of the design, in accordance with "Reviewing the work of another engineer". Document the review here or include as an Appendix.

This review shall be specific only to those aspects of the works in which the reviewer is competent i.e. more than one reviewer may be required where the development incorporates specialised disciplines.

Record, report and action the review findings.

8 Design Records

The following design records were produced for this design and are appended where noted:

(e.g. engineering drawings, specifications, calculations, material specifications where not detailed elsewhere, photos etc.)

____

____

The following completed checksheets are appended (e.g. safety in design, risk register).

Checksheet No.	Title

APPENDIX III

Contract Quality Plan

____

(contract name/subdivision name)

____

(contract /subdivision consent number)

Copy No_____________of _____________

Version: ____________________________

Date of Issue: _________________________

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APPENDICES: *(attach these – as applicable)*

1 – Construction Programme
2 – Inspection & Test Schedule <see example in Appendix XI>
3 – Site Safety Plan
4 – Traffic Management Plan(s)
5 – Erosion and Sediment Control Plan
6 – Non-Conformance Report – <see example in Appendix IX>
7 – Contractor's Completion Certificate <see example in Appendix VIII>

CONTRACT QUALITY PLAN APPROVALS:

This Contract Quality Plan has been:

Prepared by: ______________________________________
(Name/Sign/Date)

Approved by: ______________________________________
(Engineer) (Name/Sign/Date)

Approved by: ______________________________________
(Contractor) (Name/Sign/Date)

1 Contract Personnel

Contractor:

Name: ____

Address: ____

____

Contact Ph (Mobile): ________________ Contact Ph (A/H): ________________

Telephone: ________________ Fax: ________________

Developer:

Name: ____

Address: ____

____

Contact Ph (Mobile): ________________ Contact Ph (A/H): ________________

Telephone: ________________ Fax: ________________

Project Manager:

Name: ____

Address: ____

____

Contact Ph (Mobile): ________________ Contact Ph (A/H): ________________

Telephone: ________________ Fax: ________________

Engineer:

Name: ____

Address: ____

____

Contact Ph (Mobile): ________________ Contact Ph (A/H): ________________

Telephone: ________________ Fax: ________________

2 Document Control

This Contract Quality Plan (CQP) has a controlled distribution as follows:

Copy No	Issued To	Date	Version No
1	<Contract Manager>		
2	<Site Supervisor>		
3	<All Subcontractors>		
4	<Other>		
5	<Engineer (for review and acceptance)>		
6	Council (for review and acceptance)		

This CQP will be subject to periodic review during the course of the contract. All holders of controlled copies listed above will be issued with updates to this document as and when they occur.

3 Contract Management

The following key personnel have been assigned to this contract:

Name	**Title**

<or insert your organisation chart here>

Key responsibilities and authorities are as follows:

a) Overall responsibility for the management of the contract and principal contact with the developer and the engineer:

________________________________ (Title)

b) Authorised to address and resolve issues of dispute relating to compliance with the quality requirements of the contract and this quality plan and rectification of non-conforming work:

________________________________ (Title)

c) Responsible for and qualified to the required level for the day to day on-site supervision, control and inspection of the works and communicate on such matters with the developer or engineer. Authorised to receive, on behalf of the contractor, any instructions from the developer or engineer (refer NZS 3910 clause 5.2.1):

____

(Title)

d) Responsible for on-site Traffic Control activities, qualified to STMS level:

____

(Title)

e) Responsible for compliance with the requirements of the Resource Management Act (Environmental Management):

____

(Title)

f) Preparation and amendment of this quality plan:

____

(Title)

g) Approval of this quality plan:

____

(Title)

4 Subcontractors

Subcontractors will undertake the following work activities:

Activity	**Name of Subcontractor**

All Subcontractors are required to operate in accordance with this Contract Quality Plan.

5 Quality Control and Inspection

Procedures, construction checksheets and inspection and test schedules will be used to control the work and verify compliance with the quality requirements. The following procedures will be adopted for this contract or will be prepared in advance and be made available on site:

Identifier	Title

These can be made available for the Council's review, if requested.

Compliance checksheets are appended to the various parts of the CSS, which may provide initial guidance on what to consider when compiling construction checksheets.

An example of an inspection and test schedule is contained in Appendix XI. The schedule should indicate the frequency, timing, type of both inspection and/or tests required to be performed on the materials and at certain stages of construction. This schedule would be signed off as the specified activities are completed, and once completed would then serve as a Contract Record (refer clause 3.5.2 – Material supply).

In addition to the inspection and test schedule, the following key 'Hold' and 'Witness' points have been identified by the engineer as requiring inspection and approval by the engineer and/or the Council prior to further construction. They will be documented on the relevant construction checksheet.

Key achievement criteria may suggest some of these points. 'Hold' or 'witness' points could include:

- *Site establishment;*
- *Commencement of works;*
- *Formwork or foundations prior to pouring concrete;*
- *Prepared earthworks and subsoil drainage prior to filling;*
- *Completed earthworks and prepared subgrade prior to topsoil or metalcourses;*
- *Confirmation of thrust block ground conditions and design;*
- *Complying polyethylene pipe weld preconstruction joint tests;*
- *Drainage and water reticulation bends, junctions and inspection points prior to backfilling, to allow as-builting;*
- *Utility reticulation prior to backfilling;*
- *Water and drainage reticulation during testing;*
- *Sterilisation of watermain;*

> *Finished subbase before the placement of basecourse;*

> *Finished basecourse before the commencement of surfacing or paving;*

> *Finished surface prior to roadmarking;*

> *Landscape areas formed and plants on site prior to planting;*

> *Construction safety audit;*

> *Practical Completion inspection;*

> *Defects Liability inspection for planting;*

> *Defects Liability inspection for roading etc.*

6 Environmental Control

The following Resource Consents, relevant to the works undertaken and/or materials used in this contract, have been received:

____

____

These have been reviewed and appropriate controls have been put in place to manage and/or mitigate the risk.

In accordance with contract requirements, <*if applicable*> environmental controls relating to this particular contract and/or the work being undertaken are outlined <*delete as applicable*> further in the attached documentation/in the site-specific Erosion and Sediment Control Plan appended. The compliance and effectiveness of management controls will be subject to periodic review.

7 Non-Conformance

If, during the process of inspection, work is identified which does not conform to the specified site requirements, a Non-Conformance Report will be prepared by the person at 3 b). The rectification proposed will be discussed and agreed with the engineer and will be stated on the NCR.

A proforma Non-Conformance Report is attached.

8 Contract Records

The following records will be produced for this contract:

(e.g. site meeting minutes, construction checksheets, photos, inspection and test schedules, test results, construction programmes, completion documentation, as-built records)

____

____

APPENDIX IV

DESIGN CERTIFICATE

Infrastructure/Land Development

ISSUED BY: ____

(Design firm or suitably qualified design professional)

TO: ____

(Owner/Developer)

TO BE SUPPLIED TO: ____

(Territorial authority)

IN RESPECT OF: ____

(Description of infrastructure/land development)

AT: ____

____

(Address)

____ has been engaged by

(Design firm or suitably qualified design professional)

____

(Owner/Developer)

to provide ____
services in respect of the infrastructure/land development described above. I have the qualifications and experience relevant to this project as set out herein and have designed the subject works.

I ______________________ (Designer) on behalf of ______________________ (Design Firm) confirm that the design is to current good engineering practice, and that it satisfies all relevant resource consent conditions.

The design firm issuing this statement holds a current policy of professional indemnity insurance of no less than $ ______________________ (Minimum amount of insurance shall be commensurate with the current amounts recommended by EngNZ, ACENZ, TNZ, NZTA, INGENIUM.)

Qualifications and experience

____

____

______________________ Date: ______________________

(Signature of designer)

APPENDIX V

DESIGN PEER REVIEW CERTIFICATE

Infrastructure/Land Development

ISSUED BY:____

(Design peer review firm or suitably qualified design peer review professional)

TO: ____ (Owner/Developer)

TO BE SUPPLIED TO: ____ (Territorial authority)

IN RESPECT OF: ____

(Description of infrastructure/land development)

DESIGNED BY: ____ (Design firm/Designer)

________________________ has been engaged by _________________________________

(Design peer review firm or suitably qualified design peer review professional) (Owner/Developer)

to provide design review services in respect of ______________________________ aspects of the above work, which is described in the specification and shown on the drawings

numbered ____________approved by ______________________________ (Territorial authority)

under consent number ________________________ on_________________________ (Date)

As an independent professional, I have reviewed the design assumptions, methods, accuracy and conclusions. I have sighted the conditions of consent to the works and the approved specifications and drawings.

In my professional opinion and based upon reasonable enquiry, this review, information supplied by the designer and the designer's certification (copy attached),

I ____ (Design peer reviewer)

confirm on behalf of ____(Design Firm)

the acceptability of the design and that the design complies with the above consent and current good engineering practice, subject to the findings below if any.

___________________________________ Date:________________________________

(Signature of Design peer reviewer)

____ Member NZIS ACENZ EngNZ

(Professional qualifications)

____

(Address)

Findings ____

____

APPENDIX VI

ENGINEER'S REVIEW CERTIFICATE

Review of Contract Quality Plan

ISSUED BY:____

(Engineering consultancy firm or suitably qualified engineer)

TO: ____

(Owner/Developer)

TO BE SUPPLIED TO: ____

(Territorial authority)

IN RESPECT OF: ____

(Description of infrastructure/land development)

DESIGNED BY: ____

(Design Firm/Designer)

AT:____

(Address)

I ____(Engineer)

on behalf of ______________________________________ (Engineering consultancy firm)

have reviewed the Contract Quality Plan (a copy of which is attached).

I confirm the following have been provided in accordance with IDS Part 3: Quality Assurance:

> Contract personnel and contact details listed

> Quality policy statement enclosed

> Contract management and responsibilities set out

> Subcontractors listed

> Procedures are documented and hold or witness points listed

> Site Safety and Environmental controls detailed

> Non-conformance process detailed

> Contract records listed

________________________________ Date:______________________________

(Signature of engineer)

____ Member NZIS ACENZ EngNZ

(Professional qualifications)

____

(Address)

APPENDIX VII

ENGINEER'S COMPLETION CERTIFICATE

Infrastructure/Land Development

ISSUED BY:________________________________ (Engineering consultancy firm or suitably qualified engineer)

TO: ____ (Owner/Developer)

TO BE SUPPLIED TO: ____ (Territorial authority)

IN RESPECT OF: ____

(Description of infrastructure/land development)

AT: ____

____

(Address)

____ (Engineering consultancy firm or suitably qualified engineer)

has been engaged by ____ (Owner/Developer)

to provide ____ services in respect of the construction of the infrastructure/land development described in the specification and shown on the drawings

numbered ________________ approved by ____ on

(Territorial authority)

____(Date).

I, ____(Engineer)

confirm on behalf of ____ (Engineering consultancy firm)

that I have managed the subject works and that the works, other than those outstanding works listed below if any, have been completed in accordance with current good engineering practice, and that they satisfy all relevant resource consent conditions.

The engineering consultancy firm issuing this statement holds a current policy of professional indemnity insurance of no less than $__________ (Minimum amount of insurance shall be commensurate with the current amounts recommended by EngNZ, ACENZ, TNZ, NZTA, INGENIUM, LPMS.)

____ Date:____________________________________

(Signature of engineer)

____ Member NZIS ACENZ EngNZ

(Professional qualifications)

____

(Address)

Outstanding Works ____

____

APPENDIX VIII

CONTRACTOR'S COMPLETION CERTIFICATE

Infrastructure/Land Development

ISSUED BY: ______________________________ (Contractor)

TO: ______________________________(Owner/Developer)

TO BE SUPPLIED TO: ______________________________ (Territorial authority)

IN RESPECT OF: ______________________________

(Description of infrastructure/land development)

AT: ______________________________

____

(Address)

______________has been contracted by ______________________________

(Contractor) (Owner/Developer)

to carry out and complete certain infrastructure/land development in accordance with a

contract, titled Contract No ______________________________ for

______________________________("the contract").

I ______________ , a duly authorised representative of ______________ ,

(Duly authorised representative) (Contractor)

hereby certify that______________________________ has carried out and completed

(Contractor)

the works, other than those outstanding works listed below if any, in accordance with the relevant resource consent conditions.

______________________________ Date:______________________________

(Signature of authorised representative)

______________________________ ______________________________

(Contractor) (Address)

Outstanding Works

____

____

____

APPENDIX IX

Non-Conformance Report

Contract Name/No: ______________________________ NCR Ref No: __________

1 NON-CONFORMING WORK DETAILS:

(provide precise location, detailed description and sketches as appropriate)

Company responsible for NC ____

Contractor (sign/date) ____

2 PROPOSED CORRECTIVE ACTION

(provide details with sketches)

3 APPROVALS:

3.1 The corrective action is accepted/ not accepted/ accepted subject to attached conditions.

Engineer (sign/date) __________________________________

Council (sign/date) __________________________________

3.2 The corrective action has been completed.

Certified: (sign/date) __________________________________

Reviewed: (sign/date) __________________________________

Approved: (sign/date) __________________________________

APPENDIX X

Engineer’s Audit & Test Schedule

<table>
<tr><th colspan="3">Testing</th><th colspan="2">Inspection</th><th colspan="3">Verification</th></tr>
<tr><th>Phase</th><th>Test / Material Certificate Audit Frequency</th><th>Specification Reference</th><th>Contractor Y/N</th><th>Engineer Y/N</th><th>Hold Point Y/N</th><th>Acceptance Criteria</th><th>Signed / Accepted / Date</th></tr>
<tr><td colspan="8">Note that the below information is an example for selected phases only. Prepare audit and test plans unique to the project, incorporating that project’s quality criteria for infrastructure and materials installed on that project.</td></tr>
<tr><td colspan="8">Materials</td></tr>
<tr><td>TNZ M/4:AP20

TNZ M/4: AP40</td><td>All Suppliers Certificates

All Contractors test results</td><td>TNZ M/4</td><td>Y</td><td>Y</td><td>N</td><td>
<table>
<tr><th rowspan="2">Sieve Size</th><th colspan="2">Percent Passing</th></tr>
<tr><th>AP20</th><th>AP40</th></tr>
<tr><td>37.5mm</td><td></td><td>100</td></tr>
<tr><td>19.0 mm</td><td>100</td><td>66 - 81</td></tr>
<tr><td>9.5 mm</td><td>55 – 75</td><td>43 - 57</td></tr>
<tr><td>4.75 mm</td><td>33 – 55</td><td>28 - 43</td></tr>
<tr><td>2.36 mm</td><td>22 - 42</td><td>19 - 33</td></tr>
<tr><td>1.18 mm</td><td>14 – 31</td><td>12 - 25</td></tr>
<tr><td>0.600 mm</td><td>8 – 23</td><td>7 – 19</td></tr>
<tr><td>0.300 mm</td><td>5 – 16</td><td>3 – 14</td></tr>
<tr><td>0.150 mm</td><td>0 – 12</td><td>0 – 10</td></tr>
<tr><td>0.075 mm</td><td>0 - 8</td><td>0 - 7</td></tr>
</table>
</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">Testing</th><th colspan="2">Inspection</th><th colspan="3">Verification</th></tr>
<tr><th>Phase</th><th>Test / Material Certificate Audit Frequency</th><th>Specification Reference</th><th>Contractor Y/N</th><th>Engineer Y/N</th><th>Hold Point Y/N</th><th>Acceptance Criteria</th><th>Signed / Accepted / Date</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>
<table>
<tr><th rowspan="2">Fraction</th><th colspan="2">Percent within</th></tr>
<tr><th>AP20</th><th>AP40</th></tr>
<tr><td>19mm – 4.75mm</td><td></td><td>28 – 48</td></tr>
<tr><td>9.5mm – 2.36mm</td><td>20 – 46</td><td>14 – 34</td></tr>
<tr><td>4.75mm – 1.18mm</td><td>9 – 34</td><td>7 – 27</td></tr>
<tr><td>2.36mm – 0.600mm</td><td>6 – 26</td><td>6 – 22</td></tr>
<tr><td>1.18mm – 0.30 mm</td><td>3 – 21</td><td>5 – 19</td></tr>
<tr><td>0.600mm – 0.150mm</td><td>2 - 17</td><td>2 - 14</td></tr>
</table>

> CBR under Vibrating hammer test over 80%.
> Less than 10% fines shall pass a 2.36mm sieve after a crushing resistance test with a 130kN load.
> Shall have a quality index above CB from weathering quality index test.
> Shall either have a sand equivalent greater than 40 or the fraction of the aggregate passing a 0.075mm sieve shall have a clay index less than 3 or the fraction of the aggregate passing a 0.425mm sieve shall have a plasticity index less than 5.
> 70% of the aggregate by weight shall have 2 or more broken faces.
</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">Testing</th><th colspan="2">Inspection</th><th colspan="3">Verification</th></tr>
<tr><th>Phase</th><th>Test / Material Certificate Audit Frequency</th><th>Specification Reference</th><th>Contractor Y/N</th><th>Engineer Y/N</th><th>Hold Point Y/N</th><th>Acceptance Criteria</th><th>Signed / Accepted / Date</th></tr>
<tr><td>CCC AP65</td><td>All Suppliers Certificates

All Contractors test results</td><td>CSS Part 1: 31.2</td><td>Y</td><td>Y</td><td>N</td><td><table><tr><th>Sieve Size</th><th>Percent Passing</th></tr><tr><td>65.0 mm</td><td>100</td></tr><tr><td>37.5 mm</td><td>60 - 90</td></tr><tr><td>19.0 mm</td><td>45 - 65</td></tr><tr><td>9.5 mm</td><td>30 - 50</td></tr><tr><td>4.75 mm</td><td>20 - 40</td></tr><tr><td>2.36 mm</td><td>10 - 28</td></tr><tr><td>1.18 mm</td><td>7 - 22</td></tr><tr><td>0.600 mm</td><td>5 - 16</td></tr><tr><td>0.300 mm</td><td>4 - 12</td></tr><tr><td>0.150 mm</td><td>3 - 8</td></tr><tr><td>0.075 mm</td><td>3 - 6</td></tr></table>
> CCC AP65 shall be free of organic matter.
> Less than 10% fines shall pass a 2.36mm sieve after a crushing resistance test with a 130kN load.
> CCC AP65 shall either have a sand equivalent greater than 25 or the fraction of the aggregate passing a 0.075mm sieve shall have a clay index less than 3 or the fraction of the aggregate passing a 0.425mm sieve shall have a plasticity index less than 5.</td><td></td></tr>
<tr><td>Premix concrete for kerb and channel</td><td>All Suppliers certificates</td><td>CSS Part 6: 4.3</td><td>Y</td><td>Y</td><td>N</td><td>Concrete (Normal) strength 20 MPa at 28 days, slump 75mm, nominal maximum aggregate 19mm, water content under 170 kg/m³</td><td></td></tr>
</table>

Testing			Inspection		Verification		
Phase	Test / Material Certificate Audit Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Acceptance Criteria	Signed / Accepted / Date
100 dia uPVC Kerb entry	All Suppliers certificates	AS/NZS 1260: 2009	Y	Y	N	SN10, factory moulded	
100 dia uPVC SN10 pipe	All Suppliers certificates	AS/NZS 1260: 2009	Y	Y	N	SN10, 100mm uPVC	
First class topsoil	All Suppliers Certificates All Contractors test results	CSS Part 1: 34.1	Y	Y	N	> Under 5% solid detritus, under 10% stone, both under 30mm diameter. > Under 25% clay, organic matter 7-20% > Loose friable, well aerated, lightly processed > pH 5.5-7.5	
Medium grade bark mulch	All Suppliers Certificates All Contractors test results	CSS Part 1: 35.2	Y	Y	N	> Under 25% wood chips, under 1% inorganic component, 100% between 11-40mm.	
Construction							
Subgrade strength	Penetrometer test at 50 metre intervals, all Contractors test results	CSS Part 6: 11.6.4	Y	Y	Y	CBR greater than 7	
Kerb and channel stringline	Check height and location of string line at every peg on day poured	CSS Part 6: 4.4	Y	Y	Y	String 100mm behind kerb location and at design level	
Subbasecourse density	Nuclear Densometer test every 25 metres All Contractors test results	CSS Part 6: 4.2	Y	Y	Y	Minimum 2100 kg/m^3 , 95% of readings exceeding 2150 kg/m^3	
Subbasecourse level	Measure depth from string line every 50 metres and at all grade changes and TPs.	CSS Part 6: 4.2	Y	Y	N	Finished levels within -25mm & +5mm of design.	

Testing			Inspection		Verification		
Phase	Test / Material Certificate Audit Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Acceptance Criteria	Signed / Accepted / Date
Concrete placement	All Contractors test results	CSS Part 6: 4.3	Y	Y	N	Slump 75mm	
Kerb level	Check level of kerb every 50 metres and at all grade changes and TPs	CSS Part 6: 4.4	Y	Y	N	Finished level +/- 5mm of design	
Kerb alignment and location	Check alignment and location every 50 metres and at all TPs	CSS Part 6: 4.4	Y	Y	N	Location +/- 10mm of design, max 5mm deviation, cumulative visible gaps 10mm over 3m straightedge	
Tree pit excavation	Check dimensions, subgrade condition in 1/5th tree pits	CSS Part 2: 8.4, Part 7: 6.6	Y	Y	Y	Minimum 1000mm deep, 750mm wide, subgrade loosened for 150mm all around	
Tree pit construction	Check finished level of filling, mulch area in 1/5th tree pits	CSS Part 2: 9.5.4, Part 7: 6.6	Y	Y	N	Finished surface +0mm, -0mm design Mulch extends 150mm outside tree stakes	
Trench excavation	Check dimensions of each fifth trench	CSS Pt 3: 8.7	Y	Y	N	Minimum 850mm to invert in drives, 750mm to invert in untrafficked areas without protection	
Pipe laying	Check fall to outlet of each fifth pipe	CSS Pt 3: 8.7	Y	Y	N	Invert level of pipe below property gully level	
Pipe haunching	Check depth of haunching of each fifth pipe	CSS Pt 3: SD 344/2	Y	Y	Y	150mm above and below pipe	
Trench backfill compaction	Clegg test each 1/5th trench. All Contractors test results	CSS Part 4: 13.3	Y	Y	N	Backfill exceeds Clegg Impact value of 35 in the commercial crossing, 25 in other areas.	

APPENDIX XI

Inspection & Test Schedule

Testing			Inspection		Verification		
Material / Construction Phase	Test(s) / Material Certificate(s) Required Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Contract Records	Signed / Completed / Date
Note that the below information is an example for selected phases only. Prepare inspection and test plans unique to the project, incorporating that project's quality criteria for infrastructure and materials installed on that project.							
Materials – Kerb and channel							
CCC AP65	One sieve analysis/500m³	CSS Part 1: 31.2	Y	Y	N	Suppliers certificate Gradings	
Premix concrete for kerb and channel	Suppliers certificate/truck	CSS Part 6: 4.3	Y	Y	N	Suppliers certificate	
100 dia uPVC SN10 kerb entry	Suppliers certificate/delivery	www.ccc.govt.nz/webapps/approvedmaterials/frmAPRDetails.asp?APR_ID=58&ProductName=PVC	Y	Y	N	Suppliers Certificate	
Construction – Kerb and channel							
Subgrade strength	Penetrometer test at 50 metre intervals under kerb and channel	CSS Part 6: 11.6.4	Y	Y	Y	Metalcourse design checksheet	
Kerb and channel stringline	Check height and location of string line at every peg on each day string line used	CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Subbasecourse density	Nuclear Densometer test every 10 metres	CSS Part 6: 4.2	Y	Y	Y	Kerb and channel construction checksheet	

Testing			Inspection		Verification		
Material / Construction Phase	Test(s) / Material Certificate(s) Required Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Contract Records	Signed / Completed / Date
Subbasecourse level	Measure depth from string line every 20 metres and at all grade changes and TPs	CSS Part 6: 4.2	Y	Y	N	Kerb and channel construction checksheet	
Concrete placement	Slump test where mix appears dry	CSS Part 6: 4.3	Y	Y	N	Kerb and channel construction checksheet	
Kerb level	Check level of kerb every 20 metres and at all grade changes and TPs	CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Kerb profile	Check profile at all hand boxed sections immediately after pour	CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Kerb alignment and location	Check alignment and location every 20 metres and at all TPs	CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Stormwater outlets	Check outlets at invert after placement	CSS Part 6: 4.5	Y	N	N	Kerb and channel construction checksheet	
Materials – Tree pit							
First class topsoil	One sieve analysis, nutrient content and soil pH test/50m^3	CSS Part 1: 34.1	Y	Y	N	Test results Suppliers certificate	
Bark mulch	One sieve analysis/50m^3	CSS Part 1: 35.2	Y	Y	N	Gradings Suppliers certificate	
Construction – Tree pit							
Tree pit excavation	Check dimensions, subgrade condition of each pit	CSS Part 2: 8.4, CSS Part 7: 6.6	Y	Y	Y	Landscape construction checksheet	
Tree pit construction	Check finished level of filling, mulch area of each pit	CSS Part 2: 9.5.4 CSS Part 7: 6.6	Y	N	N	Landscape construction checksheet	

Testing			Inspection		Verification		
Material / Construction Phase	Test(s) / Material Certificate(s) Required Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Contract Records	Signed / Completed / Date
Materials – Property stormwater pipes							
100 dia uPVC SN10 pipe	Suppliers certificate/delivery	www.ccc.govt.nz/webapps/approvedmaterials/frmAPRDetails.asp?APR_ID=58&ProductName=PVC	Y	Y	N	Suppliers Certificate	
TNZ M/4: AP20	One sieve analysis/50m³	TNZ M/4	Y	Y	N	Suppliers certificate Gradings	
Construction – Property stormwater pipes							
Trench excavation	Check dimensions once for each property	CSS Part 3: 8.7	Y	N	N	Property stormwater checksheet	
Pipe laying	Check fall to outlet for each line	CSS Part 3: 11.2	Y	N	N	Property stormwater checksheet	
Pipe jointing	Check each line doesn't leak	NZS 7643	Y	N	N	Property stormwater checksheet	
Pipe haunching	Check depth once for each property	CSS Part 3: SD 344/2	Y	Y	Y	Property stormwater checksheet	
Trench backfill compaction	Clegg test every 10 metres of trench, on all layers.	CSS Part 3: 15.4	Y	N	N	Property stormwater checksheet	
Property stormwaters	Check all properties connected	CSS Part 6: 4.5	Y	N	N	Property stormwater checksheet	

APPENDIX XII

QUALITY SYSTEM WORK PROCEDURE

Control & Inspection of Pipe Subsoil Drain Construction

1. Scope of this procedure

   Subsoil drain construction other than perforated corrugated plastic pipe.

2. Responsibility & Actions

   The site supervisor shall be an authorised drainlayer, where the pipe is laid in the legal road or shall be vested. Where the pipe is to be laid under a building consent, the site supervisor shall be a registered drainlayer.

   The site supervisor shall be responsible for progressively inspecting the work to ensure it complies with the requirements.

   The results of the inspection shall be recorded on the Pipe Subsoil Drain Construction Checksheet for defined sections of drain.

   Inspection shall record the following:

   (a) Pipe type and diameter.
   (b) Trench width and depth.
   (c) Bedding and filter material and depth.
   (d) Measured grade.
   (e) Joint details.
   (f) Backfilling.
   (g) Connections.

APPENDIX XIII

ENGINEER'S H&S EXAMPLE CHECKSHEET

Health and Safety Management Plan

CONTRACTOR:____ DATE: ___________________

PROJECT DESCRIPTION: ________________________________

The following should be documented:	Requirement Met? Yes	No
1. Project Description:		
> Brief description of the scope of the work or services	☐	☐
> Summary of major activities and types of work	☐	☐
> Specialist tasks or procedures are documented and reference to safe work procedures and training documented	☐	☐
> Areas of project requiring special consideration are documented and procedural requirements are referenced: e.g. presence of public, traffic management, notifiable work, restricted work	☐	☐
2. Contractor's Health and Safety Structure and System:		
> Names and positions of personnel with specific health and safety responsibilities are documented	☐	☐
> Position and name of the senior person who will liaise with the Engineer on health and safety issues is documented	☐	☐
> Name and position of the on-site supervisor is documented	☐	☐
3. Contractor's Induction and Safety Training		
> Outline of the contractor's induction procedures for employees and subcontractors	☐	☐
> Register of personnel completing the induction programme	☐	☐
> Details of employee health and safety training relevant to the project.	☐	☐
> Copies of relevant certificates attached e.g. Code of Practice for Temporary Traffic Control, Cable Location, Confined Spaces	☐	☐
> Register of persons holding authorisations, permits, competency certificates, licenses etc required for the project	☐	☐

The following should be documented:	Requirement Met? Yes	No
4. Safe Work Practices and Procedures		
> List of company safe work procedures relevant to the project	☐	☐
> Copies of safe work procedures, permits or notifiable work notices	☐	☐
> Details of project operations subject to work permits	☐	☐
> Work permit procedure documented	☐	☐
> Distribution list of people (including subcontractors) issued with safe work procedures	☐	☐
5. Noise		
> Control measures and standards are documented with clear procedures on how to achieve the control	☐	☐
6. Hazard Management		
> All hazards (existing and potential) associated with the project are documented on the hazard register form	☐	☐
> The hierarchy of controls has been considered (i.e. eliminate, isolate or minimise)	☐	☐
> Control measures are documented with clear procedures on how to achieve the control	☐	☐
> Evidence of employee and subcontractor training on control measures is included	☐	☐
7. Workplace Health and Safety Inspections		
> Inspection team documented	☐	☐
> Frequency and type of inspection defined	☐	☐
> Checklists to be used are included	☐	☐
> Procedure for actioning inspection findings included	☐	☐
> Hazard reporting procedures documented and form included	☐	☐
> Specific areas targeted for inspections documented	☐	☐
8. Emergency Procedures		
> Overall emergency plan and structure for the project	☐	☐
> Register of emergency equipment and locations	☐	☐
> Register of current qualified first-aiders	☐	☐
> Arrangements/coordination with other worksite occupants in event of emergency	☐	☐

The following should be documented:	Requirement Met? Yes	No
9. Accident Reporting, Recording and Investigation		
> Details of accident recording, reporting and investigation system and procedures	☐	☐
> Details of how accidents will be notified to OSH and Engineer	☐	☐
> Details of how accident statistics are to be compiled (major projects)	☐	☐
10. Health and Safety Performance Monitoring (Major Projects)		
> Details of how health and safety performance statistics associated with the project are reviewed	☐	☐
> Details of how monthly health and safety performance reports will be compiled for review by Engineer	☐	☐
> Nature of health and safety performance information presented to employees on a regular basis	☐	☐
> Outline of auditing programme to evaluate the effectiveness of the Health and Safety Management Plan	☐	☐

11. Health and Safety Management Plan Review

This Health and Safety Management Plan has been:

Reviewed by: ______________________________

(Name/Position/Sign)

Approved by: ______________________________

(Sign/Date)

Contractor notified: ______________________________

(Date)

Reviewed by: ______________________________

(Council) (Name/Position/Sign)

APPENDIX XIV

Engineer's Gravity Pipe Test Checksheet

Contractor:______________________________ Asset (sewer/sw):__________

Project Title ______________________________

Site And Pipeline Information

Overall length (m)______________________________ Location __________

Pipe material and class ______________________________ __________

Nominal diameter (mm)______________________________ __________

Pressure Test Standards (to CSS: Part 3)

Contract document reference ______________________________

		Select test method (delete inapplicable)	
Type of test	**Visual inspection**	**Air test**	**Hydrostatic test**
Reference	clause 14.2.3	clause 14.2.5	clause 14.2.4
Performance measure	No leaks or defects visible	Pressure drop less than 2kPa (0.2m) over test period	Water level does not drop over test period[1]

TEST CRITERIA ***(provide before testing)***				**TEST RESULTS**		
Section tested	**Length (m)**	**Test pressure[2] (m)**	**Test period[3] (min)**	**Test Date**	**Pressure achieved (m) or loss (ml)**	**Pass/ fail**

Note:

1) See Hydrostatic test table for allowable losses under 3.0m test head on reverse of sheet
2) Determine hydrostatic test pressure using CSS: Part 3 clause 14.2.4. Test pressure for both types is a minimum of 3.0m.
3) Obtain air test period from table in CSS: Part 3 clause 14.2.5 (reproduced on reverse of sheet). Hydrostatic test period is 5 mins.

Engineer ____ Signature ________________________

Contractor Rep __________________________________ Signature ________________________

Council Rep _____________________________________ Signature ________________________

Date plan accepted ______________________________________

Date and time pipe test witnessed ___________________________ Retest required yes/no

NCR reference ____ Pipeline accepted yes/no

1. Hydrostatic Testing

Allowable losses (ml) over a 5 minute test period

Conditions: Concrete pipe, where 30kPa hydrostatic test is required.

	Length of test section (m)							
Pipe diameter (mm)	5	10	15	20	30	40	50	100
225	28	56	84	113	169	225	281	563
300	38	75	113	150	225	300	375	750
375	47	94	141	188	281	375	469	938
450	56	113	169	225	338	450	563	1125
525	66	131	197	263	394	525	656	1313
600	75	150	225	300	450	600	750	1500

2. Air Testing

Length of air test required (min:sec)

Conditions: Maximum permissible loss in a concrete or ceramic pipe is 2kPa or 0.3 PSI.

	Length of test section (m)									
Pipe diameter (mm)	10	20	30	40	50	60	70	80	90	100
150	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00
200	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00
225	2:00	2:00	2:00	2:00	2:00	2:00	2:10	2:10	2:10	2:10
250	2:00	2:00	2:00	2:00	2:20	2:30	2:40	2:40	2:40	2:40
300	2:00	2:00	2:00	2:20	3:00	3:00	3:00	3:00	3:00	3:00
375	2:00	2:00	2:40	3:40	3:40	3:40	3:40	3:40	3:40	3:40
450	2:00	2:30	3:50	4:20	4:20	4:20	4:20	4:20	4:20	4:20

APPENDIX XV

Engineer's Concrete Pressure Pipe Test Checksheet

Contractor: ____ Asset (sewer/water): _________

Project Title ____

Site And Pipeline Information

Overall length (m) ____ Location ___________________

Pipe material and class ______________________ Test water disposed of to _____________________

Nominal diameter (mm) ______________________

Pressure Test Standards (To CSS: Part 3)

Contract document reference _________________________________

Type of test	*Select test method (delete inapplicable)* Working pressure water test	Max operating pressure water test
Reference	clause 14.3.1	clause 14.3.1
Performance measure	No pressure loss	Measured loss mm/hr not to exceed 0.3 x length m x dia mm
Test period	3 hrs	5 mins

Thrust Blocks

Block identifier	Bearing capacity (kPa) Assumed	Site verified	Redesign required	New design details
Add rows as necessary				

TEST CRITERIA *(provide before testing)*			TEST RESULTS		
Section tested	**Length (m)**	**Specified test pressure or allowable loss**	**Test Date**	**Pressure achieved (m) or measured loss (mm/hr)**	**Pass / fail**
Add rows as necessary					

Engineer ______________________________ Signature ______________________

Contractor Rep ______________________________ Signature ______________________

Council Rep ______________________________ Signature ______________________

Date plan accepted ______________________________

Date and time pipe test witnessed ______________________ Retest required yes/no

NCR reference ______________________________ Pipeline accepted yes/no

APPENDIX XVI

Engineer's Pressure Pipe Test Checksheet

Contractor:____ Asset (sewer/water): ________

Project title____

Site and Pipeline Information

Overall length (m)____________________________________ Location ________________

Pipe material and class __________________ Test water disposed of to __________________

Nominal Diameter (mm) __________________

Pressure Test Standards

Contract document reference ___________________________

	Select test method (delete inapplicable)	
Type of test	**Pressure rebound method**	**Constant pressure method**
Material	PE $\leq$ DN315	DI, GRP, PVC, steel
Reference	clause 6.3.4.4	clause 6.3.4.1
Performance measure	Pressure rises or remains static	Make up water Q $\leq$ 0.14LDH1
Test pressure (m)	1.25 x max operating pressure but less than 1.25 x rated pressure	

Thrust Blocks

Block identifier	Bearing capacity (kPa) Assumed	Site verified	Redesign required	New design details
Add rows as necessary				

Constant Pressure Method *Remove redundant test method*

TEST CRITERIA *(provide before testing)*			TEST RESULTS		
Section tested	**Q (l/hr)**[1]	**Specified test pressure (m)**	**Test Date**	**Makeup water used (l/hr)**	**Pass / fail**

Pressure Rebound Method *Remove redundant test method*

TEST CRITERIA *(provide before testing)*		TEST RESULTS				
Section tested	**Specified test pressure (m)**	**Test Date**	**P_{60}[2]**	**ΔV[2]**	**Pressure plot[2]**	**Pass / fail**

Notes

1) Provide details of this calculation.

2) Provide time/pressure readings and graphed results to confirm test details, as detailed in NZS 2566.2.

Engineer ______________________________ Signature ____________________

Contractor Rep ______________________________ Signature ____________________

Council Rep ______________________________ Signature ____________________

Date plan accepted ______________________________

Date and time pipe test witnessed ____________________ Retest required yes/no

NCR reference ______________________________ Pipeline accepted yes/no

APPENDIX XVII

CONSTRUCTION CHECKSHEET

Activity – Pipe Subsoil Drain Construction

Contract/Job: ______________________________ Date: ______________

Drain Location: ____

Task	Acceptance Criteria/ Test Frequency	Task/Completion Signature/ Comment
1. Drawings and specifications checked for requirements		
2. Pipe material > type class > diameter		
3. Filter material > specification > grading		
4. Trench > alignment check > grade (normal min 1:100) > width > depth		
5. Bedding > min depth 75mm > sockets not bearing	Yes/No	
6. Pipe laying > sockets uphill > joints clean, invert flush > joints as detailed > rings required > isolated from surface water		
7. Backfill material > specification > grading		
8. Backfill placement > layer depth > compaction		
9. Connections > as per design > location		

Arising NCR: ____

All tasks defined above have been satisfactorily completed to the standards required:

Contractor: ______________________________________ (Sign/Date)

APPENDIX XVIII

CONSTRUCTION CHECKSHEET

Activity – Basecourse Stringing

Contract/Job: ______________________________ Date: ______________

Road Location: ____

Refer to diagram on back of this sheet for measuring diagram

Ch.	L	C	R

Ch.	L	C	R

APPENDIX XIX

PUMP STATION OUTSTANDING WORK/DEFECT LIST

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**

Part 4: Geotechnical Requirements

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4.1 Referenced Documents

Planning and Policy

> The *Christchurch District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan

> Resource Management Act (1991) Section 106

> Building Act (2004) Section 36

> Chartered Professional Engineers Act of New Zealand (2002)

> Christchurch City Council *Water Supply, Wastewater and Stormwater Bylaw* (2014) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/water-supply-wastewater-and-stormwater-bylaw-2014/

> Christchurch *Residential Red Zone Technical Zone Categories* (description and map) www.ccc.govt.nz/consents-and-licences/land-and-zoning/technical-categories-map#10

> Ministry of Business, Innovation and Employment *Repairing and rebuilding houses affected by the Canterbury earthquakes* and updates www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/

> Ministry of Business, Innovation and Employment *Building in toe slump areas of mass movement in the Port Hills (Class II and Class III)* and FAQs www.building.govt.nz/building-code-compliance/canterbury-rebuild/

> Cubrinovski et al, *Liquefaction Impacts on Pipe Networks. Short Term Recovery Project No. 6,* Natural Hazards Research Platform, December 2011 University of Canterbury

> GNS CR2012-311: Canterbury Earthquakes 2010/11 Port Hills Slope Stability: *Pilot study for assessing life-safety risk from rockfalls (boulder rolls)*

> GNS CR2012-57: Canterbury Earthquakes 2010/11 Port Hills Slope Stability: *Pilot study for assessing life-safety risk from cliff collapse*

> GNS CR2012-124: Port Hills Slope Stability: *Life-safety risk from cliff collapse in the Port Hills*

> GNS Science Stage 1 Report - Mass Movement www.ccc.govt.nz/assets/Documents/Environment/Land/CR2012-317Stage1.pdf

Design

> Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō Ngā Arawai Rēpo* (WWDG) (2003) www.ccc.govt.nz/environment/water/policy-and-strategy/waterways-wetlands-and-drainage-guide

> Christchurch City Council *Pumping Station O&M Manual Template Draft* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/pumping-station-design-specification

> 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

- NZS 1170 *Structural Design Actions Set*
- NZS 4431:1989 *Code of practice for earthfill for residential purposes*
- NZS 3604:2011 *Timber-framed buildings*
- NZS 4404:2010 *Land development and subdivision infrastructure*
- BS EN 1997 *Eurocode 7 - Geotechnical Design*
- New Zealand Transport Agency *Bridge Manual* www.nzta.govt.nz/resources/bridge-manual/bridge-manual.html
- Canterbury Regional Council *Erosion and sediment control guidelines* 2007 esccanterbury.co.nz/
- Auckland Regional Council Technical Publication 10, *Stormwater treatment devices: design guideline manual* (2003) www.aucklandcity.govt.nz/council/documents/technicalpublications/TP10%20Stormwater%20management%20devices%20design%20guideline%20manual%202003.pdf
- Ministry for the Environment *Hazardous Activities and Industries List (HAIL)* www.mfe.govt.nz/land/risks-contaminated-land/my-land-contaminated/hazardous-activities-and-industries-list-hail
- Ministry for the Environment *Contaminated Land Management Guidelines No. 1 – Reporting on Contaminated Sites in New Zealand* (2011) www.mfe.govt.nz/publications/hazardous/contaminated-land-mgmt-guidelines/index.html
- Ministry of Business, Innovation and Employment *Rockfall: Design considerations for passive protection structures*. www.building.govt.nz/building-code-compliance/b-stability/b1-structure/
- New Zealand Geotechnical Society *Geotechnical Issues in Land Development*, Proceedings of NZ Geotechnical Society Symposium, Hamilton (1996)
- New Zealand Geotechnical Society Geotechnical Earthquake Engineering Practice Module 3 – *Guideline for the identification, assessment and mitigation of liquefaction hazards* www.building.govt.nz/building-code-compliance/b-stability/b1-structure/geotechnical-guidance
- New Zealand Geotechnical Society *Field Description of Soil and Rock* (December 2005) fl-nzgs-media.s3.amazonaws.com/uploads/2016/06/Field-guide-sheet-description-of-soil-and-rock-2005.pdf
- Landcare Research Report LC0203/111 *Soil Conservation Guidelines for the* Port Hills (May 2003)
- Australian Geomechanics Society Practice Note 2007 (and commentary) *Landslide Risk Management*, Australian Geomechanics Volume 42 No 1 (March 2007) www.australiangeomechanics.org
- Engineering NZ Practice Notes & Guidelines www.engineeringnz.org/resources/practice-notes-and-guidelines
- European Organisation for Technical Approvals *ETAG 27 – Falling Rock Protection Kits*
- Transport Research Board. *Landslides: Investigation and Mitigation*, Special Report No. 247 National Academy of Sciences. 1996
- Transport Research Board. *Rockfalls: Characterisation and control*. National academy of sciences, 2013.
- Lambert S, Nicot F. *Rockfall engineering*. Wiley, July 2011
- Volkwein A et al. *Interdisciplinary workshop on rockfall protection*. Switzerland 2008.

> Ministry of Business, Innovation and Employment. Rockfall: Design considerations for passive protection structures. Oct 2016 www.building.govt.nz/assets/Uploads/building-code-compliance/b-stability/b1-structure/rockfall-design-consideration/rockfall-design-passive-protection-structures.pdf

Construction

> 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

> Engineering NZ *Construction Monitoring Services* www.engineeringnz.org/documents/112/Construction_Monitoring_Services.pdf

> Ministry of Business, Innovation and Employment *Part D – Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury Region (Dec 2012)* www.building.govt.nz/assets/Uploads/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses/canterbury-guidance-part-d.pdf

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).

4.1.1 Source documents

This Part of the IDS is based on Part 2 of NZS 4404:2010, by agreement, and with the consent of Standards New Zealand.

4.2 INTRODUCTION

This part of the IDS draws attention to the need for the assessment of land suitability and includes:

> site and ground investigations;

> surface and subsurface drainage and erosion control;

> liquefaction (including lateral spreading);

> contaminated sites;

> foundation stability;

> slope stability (including the design of rockfall protection structures); and

> control of earthworks.

The *District Plan* sets out planning rules, which may include the provision of geotechnical and natural hazards requirements.

Such assessment assures a suitable platform for the construction of buildings, roads and other structures, as well as the minimisation or mitigation of any adverse environmental effects arising from such works. It should also include an early assessment of the site's soils and their potential to provide for on-site stormwater systems (e.g. detention basins, infiltration basins).

This part is not a geotechnical standard but sets out some, though not necessarily all, of the matters to be considered in planning and constructing a land development or geotechnical hazard management project. The Canterbury Earthquake Sequence, which started with the Darfield earthquake in 2010 and continues to date, has increased our scientific and geotechnical understanding of how Christchurch ground conditions react to earthquake shaking. In-depth knowledge has also been gained in understanding how natural hazards pose risks. Apply the knowledge gained to how we use land, through utilising the series of Ministry of Business, Innovation and Employment (MBIE) best practice guidelines.

4.2.1 Relevant standards

NZS 4431 applies to the construction of earthfills for residential development, including residential roading. It does not, however, deal with historic fill that has not been placed in accordance with any Standard. It does not cover natural slopes, banks, batters or reinforced earth rockfall protection barriers.

There is no Standard for earthfill for other than residential developments. Clause 4.8.3 - Compaction standards for fill material sets out the requirements in these situations.

MBIE has published a series of technical guidance documents (Parts A - D) on *Repairing and Rebuilding Houses Affected by the Canterbury Earthquakes*. They have also provided guidance documents on *Building in Port Hills' Toe Slump Areas of Mass Movement (Classes II and III)* and *Rockfall: Design Considerations for Passive Protection Structures*.

4.2.2 Statute and District Plan requirements

Where there is a requirement for an assessment of land stability to meet the provisions of the Resource Management Act and the Building Act, this is the responsibility of the Geoprofessional. The Council relies on that assessment when granting the resource consent. The Geoprofessional determines the methods used and investigations undertaken.

Special requirements apply when the land is subject to erosion, avulsion, alluvium, falling debris, subsidence, inundation or slippage. In such situations, refer to section 106 of the Resource Management Act or section 74 of the Building Act.

Specific Council requirements include:

- No earthworks are permitted for work within Christchurch City unless it complies with the provisions of the *District Plan, clause 6.6 – Waterway body setbacks and clause 9.4 significant trees and other trees*.
- On a subdivision that has been granted resource consent no earthworks can begin prior to final engineering acceptance, unless written permission from the Council is given, detailing conditions that must be adhered to.
- The requirements for areas subject to slope instability are defined in the *District Plan*, which recognises Slope Instability Management Areas for rockfall, cliff collapse and mass movement.

4.3 Quality Assurance Requirements and Records

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

4.3.1 The Geoprofessional

The Geoprofessional must be suitably experienced. Their experience must be to a level to permit an appropriate grade of membership in the relevant professional body. The Geoprofessional may be a suitably experienced civil or geotechnical engineer, engineering or environmental geologist or a hydrologist. Refer to clause 2.7.1 – Investigation and design (General Requirements) for further information.

The Geoprofessional must possess both suitable insurance policies and relevant experience.

4.3.2 Requirement for a Geoprofessional

Engage a Geoprofessional to provide geotechnical, soil contaminant and geohydrological expertise where the following issues exist:

> the lack of, or limitations of, relevant Standards.

> the construction of earthworks associated with any development requires initial planning and design, to ensure that fill, banks, embankments and slopes remain stable and that fill material is placed in such a way that it can support the future loads imposed on it.

> the assessment of ground for building foundations, roads, etc. requires specialist expertise e.g. weak ground may require special design.

> the wide range of soil and rock types, physical conditions and environmental factors existing in different areas make it impossible to lay down precise requirements for land stability assessment or earthworks.

> the preliminary evaluation in clause 4.4 – Preliminary site evaluation raises doubt about the stability, or suitability, of the land for the proposed development.

> other geotechnical hazards are identified.

> the Council requires Geoprofessional expertise to assess the project.

4.3.3 Responsibilities of the Geoprofessional

The Geoprofessional will carry out the following functions:

> Undertake a site assessment and any preliminary site evaluation required, including investigations of sub-surface conditions and identifying geotechnical, natural and environmental hazards affecting the land, before the detailed planning of any development. Consider hazards located outside but which may pose a risk to the site. These matters must be included with the Geotechnical Assessment Report in any assessment of environmental effects (AEE) associated with any consent application;

- Before work commences, be involved in the design or review of the drawings and specifications defining any earthworks, rockfall hazard mitigation or other construction work, and submit a written report to the Council on the foundation recommendations, natural hazard risk and slope stability aspects of the project with the application for engineering acceptance, including any required Producer Statements;
- Determine the earthwork requirements, where no standard for earthworks is applicable to the project, to conform to the IDS and to the subdivision or resource consent conditions (if any) that apply to the proposed development;
- Before work commences, and during construction, determine the extent of further services required (including investigation and geological work);
- Before and during construction, determine the methods and frequency of construction control tests to be carried out, determine the reliability of the testing, and evaluate the significance of the test results and field inspection reports in assessing the quality of the finished work;
- During construction, undertake inspections at intervals consistent with the extent and complexity of the geotechnical issues associated with the project;
- On completion, submit a written report to the Council attesting to the compliance of the earthworks and/or the rockfall hazard mitigation with the specifications and to the suitability of the development for its proposed use. If NZS 4431 is applicable, the reporting requirements of that Standard must be used as a minimum requirement. Otherwise, provide the required Producer Statements as detailed in clause 4.8.4 – Rockfall hazard mitigation construction.

4.3.4 Geotechnical Assessment Report

The Geotechnical Assessment Report is presented with the resource or building consent application. The report shall include, as applicable:

- Details of and the results of site inspections, evaluations and field investigations.
- Documentation of rock and soil types, distribution and properties.
- A liquefaction and lateral spread assessment.
- An assessment of rockfall, cliff collapse and landslide (mass movement) hazards, including those resulting from seismic activity.
- An assessment of the slope stability confirming the location and appropriateness of building sites.
- An assessment of ground bearing capacity.
- Recommendations for measures to avoid, remedy or mitigate any geotechnical hazards on the land subject to the application. These shall be in accordance with the provisions of Section 106 of the Resource Management Act 1991 where they are supporting a resource consent application.

> A statement of professional opinion as set out in Appendix I – Statement of Professional Opinion on the Suitability of Land for Subdivision.

Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region provide guidance on the extent of the assessment required in areas prone to liquefaction.

4.3.5 Design Report

Detail the key achievement criteria and assumptions in the Design Report, such as the chosen factors of safety, for the geotechnical aspects of the engineering design.

Wherever building sites on natural ground have soil strengths less than 100 kPa, or exhibit other specific characteristics that may require specific foundation design, note them in the report, along with any recommendations for strengthened or piled foundations for residential buildings or other works.

Provide the following design records, as appropriate, to support the Design Report:

> the site inspection and evaluation

> the foundation aspects of the project including proposed mitigation measures

> the consideration of slope stability including displacements, rockfall and/or cliff collapse hazards

> the extent of further Geoprofessional inputs required (including investigation and geological work)

> the methods and frequency of construction control tests to be carried out

> the extent of further construction monitoring by the Geoprofessional to confirm design assumptions

4.3.6 Geotechnical Completion Report

For all developments where a Geoprofessional is engaged, the Geoprofessional must submit a Geotechnical Completion Report, accompanied by a statement of professional opinion as set out in Appendix II – Statement of Professional Opinion on the Suitability of Land for Building Construction. The report must, as applicable:

> Identify any specific design requirements that necessitate the design of the development to deviate from the relevant New Zealand standard.

> Describe the extent of inspection, the results of testing and include all geotechnical reports prepared for the development.

> Indicate the degree of compliance of the development with the design or standards set.

> Include documentation on both the testing of the soils for compaction and for soil strength and type, clearly showing the areas to which the tests relate.

> Include areas where compaction complied with the required Standards, any areas requiring re-testing and areas which did not comply with the Standards.

> Include documentation of rock types, distribution and properties (if rock is present on the site).

> Detail the rockfall protection works undertaken and any ongoing maintenance requirements necessary to protect the site in perpetuity. Note that this may only be completed by an Approved Geoprofessional.

For simple developments where there are no earthworks, the Geotechnical Completion Report will consist of the Geotechnical Assessment Report. For large or more complex developments where there may have been several stages of geotechnical reporting, include all relevant geotechnical information in the Geotechnical Completion Report.

4.3.7 As-Built records

Prepare as-built records and maintenance manuals, which comply with Part 12: As-Builts. Present the as-built records in conjunction with the Geotechnical Completion Report and tabulated results.

4.4 Preliminary Site Evaluation

Consider the total surroundings of the site, without being influenced by details of land tenure, territorial or other boundary considerations.

Locate and review any historic geotechnical investigations or reports (including subsurface investigations) that may help to identify the key geotechnical issues for the site.

In simple cases, a visual appraisal may be sufficient. In other cases, depending on the nature of the project, its locality, the scale of development proposed and individual site characteristics, consider the following matters before preparing a proposal for development.

4.4.1 Existing landforms

Study the general nature and shape of the ground and take particular note of:

> the geological nature and distribution of soils and rock

> existing and proposed surface and subsurface drainage conditions and the likely effects on groundwater and on surface runoff

> the previous history of rockfalls in the area

> the previous history of ground movements in similar soils in the area

> where earthworks are involved, the performance of comparable cuts and fills (if any) in adjacent areas

> air photography and other sources of information that should be reviewed and incorporated into any slope stability assessment

> trees, other significant vegetation and other features to be protected and retained (e.g. natural landforms, ecological protection areas)

4.4.2 Surface and subsurface drainage

Identify the existing natural surface and subsurface drainage pattern of any area, and locate any natural springs or seepage. Wherever any natural surface or subsurface drainage paths may be interfered with or altered by earthworks, assess the wider implications e.g. the impact on springs in nearby waterways. Sealing areas to preserve these drainage paths may be preferable to providing alternative drainage paths. Consider also the stormwater needs of the site and erosion and sedimentation control during development.

4.4.3 Slope stability

When assessing the stability of slopes and earthfills, refer to criteria applicable to land development in New Zealand that is published or recommended by the New Zealand Geotechnical Society, including *Geotechnical Issues in Land Development*.

Some natural slopes exist in a state of marginal stability and natural triggers like an earthquake or rainfall event may trigger failure. In addition, relatively minor works such as trenching, excavation for streets or building platforms, removal of scrub and vegetation, or the erection of buildings, can lead to failure. Look for signs of instability, such as cracked or hummocky surfaces, crescent-shaped depressions, crooked fences, trees or power poles leaning uphill or downhill, uneven surfaces, swamps or wet ground in elevated positions, plants such as rushes growing down a slope and water seeping from the ground.

When considering development on or near the Port Hills and Banks Peninsula, refer to GNS Science Stage 1 Report - Mass Movement www.ccc.govt.nz/assets/Documents/Environment/Land/CR2012-317Stage1.pdf when considering developments in the *District Plan* Mass Movement Hazard Management Areas 2 and 3.

Engage a Geoprofessional to assess the slope stability risk for any proposed development and evaluate possible protective structures within Rockfall, Cliff Collapse, Mass Movement and the Remainder of the Port Hills and Banks Peninsula Slope Instability Management Areas.

Incorporate the special requirements that are needed for Port Hill developments in dispersive loess soils. Refer to the *Assessment of slope stability at building sites, WWDG* and *Soil Conservation Guidelines for the Port Hills* for further guidance.

4.4.4 Rockfall and cliff collapse hazards

In some circumstances, a potential hazard from rockfall or cliff collapse may exist on a proposed development site or above an existing structure. In most cases the rockfall source will be beyond the site boundaries, sometimes at a considerable distance. Engage a Geoprofessional to assess the risk for any proposed development and evaluate possible protective structures within the Slope Instability Management Areas as defined in the *District Plan*.

The GNS reports *Pilot study for assessing life-safety risk from rockfalls (boulder rolls)* and *Pilot study for assessing life-safety risk from cliff collapse* contain information on rockfall and cliff collapse hazards on the Port Hills under seismic conditions. Note that whilst there may be a benefit to using the GNS methodology to compile an Annual Individual Fatality Risk (AIFR) to aid in decision making, this risk metric is not necessarily a requirement of building consents.

An overview of potential mitigation measures for rockfall is included in and refer to MBIE rockfall section 3 Ministry of Business Innovation and Employment. *Rockfall: Design considerations for passive protection structures.*

Adhere closely to *Rockfall: Design Considerations for Passive Protection Structures*.

Provide, as a minimum:

> details of source areas of rockfall or cliff collapse

> a full geological description of potential hazard sources

> an assessment of likely run-out distances and the level of damage that a rockfall or cliff collapse may induce

> an assessment of the likely kinetic energy of boulders at the site

> an assessment of the feasibility and/or suitability of possible mitigation measures

4.4.5 Foundation stability

Study the general topography of the site and its surroundings for indications of areas that have previously been built up; either as a result of natural ground movement or by the deliberate placing of fill material. Unless such fill has been placed and compacted under proper control, long-term differential settlement could occur, causing damage to superimposed structures, roads, services or other structures.

Test those areas of natural ground on planned subdivisions or developments that are not proposed to be filled or excavated, for soil strength and type.

4.4.6 Unsuitable historic fill

Council records may (or may not) indicate that a site has been filled with unsuitable, uncontrolled or contaminated material. Discuss any remediation proposals for such fillings with the Council at an early stage of the investigation.

4.4.7 Contaminated sites

Sites known to be, or subsequently found to be, contaminated as a result of previous activities may require the services of a specialist environmental scientist for a site evaluation. *Hazardous Activities and Industries List (HAIL)* provides further detail.

Ascertain, at an early stage, the extent of any contamination and gain a reasonably accurate picture of any constraints on earthworks, including excavated material disposal. Refer to *Contaminated Land Management Guidelines* for information on reporting requirements.

4.4.8 Local conditions

Consider the range of soil types which exist within Christchurch and Banks Peninsula e.g. expansive soils, volcanic soils, dispersive soils, soft alluvial sediments and compressible soils. Note the presence of loess and loess colluvium as these soils have specific slope instability characteristics. The Council and Canterbury Regional Council (Environment Canterbury) may have information on the soil types of particular areas.

4.4.9 Liquefaction

Liquefaction is the loss of strength of a liquefied soil and can result in any of the following types of damage: ground surface disruption including surface cracking, dislocation, ground distortion and slumping; permanent deformations such as large settlements and lateral spreads; and sand boils. Use the MBIE Module 3 *Guideline for the identification, assessment and mitigation of liquefaction hazards* (https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/module-3-identify-liquefaction-hazards/) when determining areas at risk of liquefaction.

Appendix IV - Liquefaction Vulnerability Overview Map indicates areas where underground reticulation could be affected by liquefaction. For detailed liquefaction information see Canterbury Maps, "Vulnerability to Liquefaction" (https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer/). The full Tonkin & Taylor report on which the map is based can be downloaded from www.ccc.govt.nz/environment/land/liquefaction.

The "Vulnerability to Liquefaction" map has been prepared using the liquefaction vulnerability categories described in the latest National liquefaction guidance, "Planning and engineering guidance for potentially liquefaction-prone land" (www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land/).

For the purposes of liquefaction vulnerability mapping, the former MBIE Residential Zone "Technical Categories" have been replaced with the new liquefaction vulnerability categories mapped in Appendix IV and at (https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer/).

The original Technical Categories maps are included under the "Other Maps" tab ("MBIE Technical Categories" layer) at https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer/.

Lateral spread due to liquefaction

When reporting on subdivision developments on land prone to liquefaction, use MBIE Guidance *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury Region* (www.building.govt.nz/assets/Uploads/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses/canterbury-guidance-part-d.pdf). *Part D* refers to the original Technical Categories.

4.4.10 Peer review

If the risk to the land is assessed as being medium to very high, obtain a peer review of the geotechnical assessment for the proposed development before development. An independent geoprofessional must carry this out. *Peer Review: Reviewing the work of another Engineer* provides guidance on this process. Refer to clause 3.3.2 – Design report (Quality Assurance) for further information.

Consider using the following to aid in the risk assessment:

> Landslide Risk Management (AGS, 2007)

> Pilot study for assessing life-safety risk from rockfalls (boulder rolls)

> Pilot study for assessing life-safety risk from cliff collapse

The Resource Consent Application must make reference to, and give an evaluation of, these matters.

4.5 Ground Investigations

Make sufficient borings, probings or open cuts to:

> classify the soil strata by field and visual methods.

> evaluate the likely extent and variation in depths of the principal soil types.

> establish the natural long-term seasonal groundwater levels.

> characterise the natural ground water environment.

Obtain an indication of the seasonal variation in groundwater levels from a review of historical data held by the Council or Canterbury Regional Council, or by an extended period of monitoring. At least one year's readings may be required wherever groundwater levels are critical, or could have a long-term effect on the development.

4.5.1 Geotechnical data

In addition to the general assessment of the suitability of the site for its intended use (buildings, roads), obtain sufficient geotechnical (rock or soil) test data to characterise the ground data for areas that are intended to:

> form in-situ bases for fills

> yield material for construction of fills

> be exposed as permanent batters

- remain as permanent slopes or cut areas
- be used for stormwater disposal to ground

Special consideration of erosion potential is required wherever excavation and filling is made in Port Hill's loess soils, because of their highly dispersive properties.

The *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* provide guidance on the extent and type of investigation required in land prone to liquefaction.

For consistency in the reporting of soils to the Council, use the *Field Description of Soil and Rock*.

4.5.2 Further investigation

The geotechnical information thus obtained forms the basis for:

- further sampling and testing which may be required on representative soil or rock types
- relating subsequent soil or rock test properties to relevant strata over the site
- assessment of, or calculations for, slope stability
- assessment of, or calculations for, foundations suitable for the finished site
- assessment of, or calculations for, road pavements

Determine the test data that is appropriate for different areas.

4.5.3 Special soil types

Wherever special soil types are known to exist in a locality or are identified, advise on appropriate measures for incorporation of these soils into a development. Where the presence of coal tar contamination has been identified, detail the proposed on-site treatment.

Special soil types include, but are not limited to:

- soils with high shrinkage and expansion
- compressible soils
- volcanic soils
- soils subject to liquefaction
- soils prone to dispersion (e.g. loess)
- marine or estuarine soils

Contact the Council for information on hazard rating and on special soil types in the locality additional to those referenced above, if unfamiliar with the area.

4.5.4 Rockfall engineering data

Assess potential rockfall block sizes from mapping of the source area and boulder distribution on the slope. Evaluate block size distribution in relation to the distance from the source to assess gravity sorting and fragmentation effects. Assess all this information in relation to the block size information in the Council GIS database to arrive at the best estimate for the site-specific boulders.

Rockfall/boulder data is available from the Council on request: email IDS@ccc.govt.nz with 'Request for Port Hills Data' in the subject line. These requests require the Geoprofessional to sign a disclaimer document before data will be released.

Other special requirements for investigations for rockfall engineering may include:

> Basic rock material properties (e.g., uniaxial compressive strength, point load strength, Schmidt hammer rebound value)

> Detailed topographical sections along potential rockfall trajectories

> Assessment of slope characteristics affecting rockfall behaviour (restitution coefficients, roughness, vegetation etc)

> Previous rockfall history in this area e.g. size and distribution of boulders on the slope

4.6 Planning and Design

4.6.1 Suitability of landform

The choice of a suitable landform is dependent on many factors that may be specific to a particular site. Refer to clause 2.5.4 – Balancing landform choices (General Requirements) for these factors.

Avoid unnecessary earthworks, aim to protect original soils and drainage patterns and to minimise disturbance, compaction, earthworks and the importation of topsoil, although earthworks may be justified in the following circumstances:

> to minimise the risk of property damage through ground movement in the form of rockfall, debris slides, slips, subsidence, creep, erosion or settlement.

> to minimise the risk of property damage through flooding, surface water run-off or groundwater modification.

> to lessen tunnel gully erosion within Port Hill developments.

> to develop a more desirable roading pattern with improved accessibility to and within the

Tunnel gully exposed by earthworks

site, and to create a better sense of orientation and identity for the area as a whole.

> to increase the efficiency of overall land use, including the quality of individual sites and amenity areas around buildings, the economics of providing engineering services and the standard of roading and on-site vehicular access.

> to create, where needed, suitably graded areas for playing fields and other community facilities.

> to enhance the general environmental character of the area by softening the landscape or by artificially creating or emphasizing landforms of visual significance, particularly on flat sites or on areas devoid of landscape features.

Note that some Port Hill developments require soil conservation measures such as plantings and revegetation of areas liable to tunnel gully erosion, sheet erosion, slips and existing stream bank/bed erosion. Refer to the *Soil Conservation Guidelines for the Port Hills*, for guidance on erosion prone areas and measures to prevent or control erosion. Refer to clause 10.9.8 - Revegetation, restoration and connection of habitats (Reserves, Streetscape and Open Spaces) for an explanation of revegetation.

4.6.2 Seismic considerations

Consider the seismic effects on earthfills, foundations, major or critical infrastructure, slopes, rockfall sources and liquefiable ground, and take these into account in the design and construction of any development. These effects could include liquefaction, lateral spread, rockfall, cliff collapse and slippage.

Preliminary estimations of importance levels for major infrastructure required by *Structural Design Actions*, from which exceedance probabilities for seismic events are determined, may be obtained from the following documents:

> *Bridge Manual*

> *Sewage Pumping Station Design Specification*

> *Water Supply Wells, Pumping Station and Reservoir Design Specification*.

For liquefaction information see Appendix IV – Canterbury Maps, "Vulnerability to Liquefaction" https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer. Select the liquefaction "Vulnerability Map" tab, which follows the most recent liquefaction guidance. The full Tonkin & Taylor report on which the map is based can be downloaded from www.ccc.govt.nz/environment/land/liquefaction.

The "Vulnerability to Liquefaction" map has been prepared using the liquefaction vulnerability categories described in the latest National liquefaction guidance, "Planning and engineering guidance for potentially liquefaction-prone land" (www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land/) .

For the purposes of assessing areas where infrastructure could be affected by liquefaction, the former Residential Zone "Technical Categories" have been replaced with the new liquefaction vulnerability categories mapped in Appendix IV and at https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer.

4.6.3 Peat

Ensure the geotechnical design in peat or organic compressible material areas will achieve the infrastructure design life required by all other parts of the IDS. Preserve the flow of groundwater through the peat at pre-development levels.

Special care is required in any development over peat areas to:

> maintain uninterrupted groundwater flow;

> preserve existing natural groundwater levels to avoid area wide settlement;

> avoid settlement of any surface works or structures;

> ensure the continued operation of infrastructural services and service connections to buildings throughout their design life.

4.6.4 Debris slides

Confirm that any proposed building platform is unlikely to be affected by debris slides. Refer to *WWDG Part B* clause 20.4.5 for further information.

Debris slide in Orton Bradley Park

4.6.5 Reducing waste

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

> Design to reduce waste during construction e.g. minimise earthworks, reuse excavated material elsewhere.

> Use materials with a high recycled content e.g. recycled concrete subbase. Proposed recycled materials will need approval from the Council to ensure that environmental contamination does not occur.

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

4.7 Rockfall Hazard Mitigation

All mitigation measures must be designed by a suitably experienced Geoprofessional and will require both building and resource consents. Design of mitigation measures to consider assessment of bounce height and kinetic energy for the likely rock sizes as assessed in clause 4.4.4 – Rockfall and cliff collapse. Calibrate bounce height and kinetic energy with previous rockfall behaviour at the specific site or similar locations.

Rockfall mitigation measures could include any combination of (refer MBIE 2016, *Rockfall: Design considerations for passive protection structures*):

- Avoidance
    - move facility/structure away from hazard
    - build tunnel or viaduct
- Stabilisation
    - remove hazardous material by scaling/drilling/blasting
    - reinforce slope with bolting/shotcrete/buttressing/meshing/cabling/lagging
    - improve drainage
- Protection
    - catch area or bench
    - rigid barrier (earthen bund/berm or structural wall
    - flexible/dynamic barrier (rockfall net fences, etc.)
    - attenuator systems
    - rock Sheds
- Non engineered solutions
    - warning signs
    - monitoring/early warning systems
    - establishment and retention of an effective vegetation barrier (not a suitable short term solution and may be best used in combination with other measures).

Any rockfall protection system shall:

- be accessible for inspection, rock removal and repair without compromising the safety of downhill property or life;
- not be compromised where gates or accessways are provided;
- be and remain effective over their design life.

Ensure the design addresses erosion potential and the impact on any natural surface and subsurface flow.

4.7.1 In-situ anchorage

In-situ anchorage solutions such as grouted steel ground anchors, rock bolts, cables, mesh, nets and drape systems may be used for protective works in rock source areas.

Design above-ground structures and easily replaced components (such as posts and mesh but excluding components such as ground anchors or rock bolts) with a design life of no less than 15 years.

Include the design loads and the manufacturer's testing certificates for the properties of the supplied materials, to support the design life in the design report.

Design anchorage solutions and foundation systems for dynamic rockfall barriers to the following codes of practice:

- *Eurocode 7 - Geotechnical Design*
- Anchor requirements of the *Bridge Manual*

4.7.2 Designer requirements

The designer of the protection system's foundations including ground anchors shall be a suitably qualified Geoprofessional, who shall provide a Producer Statement PS1 - Design, as set out in Appendix V - Producer Statement PS1 – Design.

The design shall be reviewed by a Geoprofessional, who shall provide a Producer Statement PS2a – Design Review, as set out in Appendix VI - Producer Statement PS2a – Design Review.

Design amendments shall also be reviewed by the Geoprofessional, who shall provide a Producer Statement PS2b – Design Review Amendment, as set out in Appendix VII - Producer Statement PS2a – Design Review Amendment.

4.8 Construction

4.8.1 Underrunners and springs

In hill catchments, underrunners are often encountered. Where practicable and considered necessary, intercept these and bring them to the surface, with a free outfall into the stormwater system wherever possible. If possible, locate the source and redirect or eliminate the underrunner.

4.8.2 Control testing

A testing laboratory, or a competent person under the control of the Geoprofessional, must carry out the construction control testing. The testing laboratory must have recognised registration or quality assurance qualifications.

4.8.3 Compaction standards for fill material

The standard of compaction and method of determination is as set out in NZS 4431, except where NZS 4431 is not applicable. For example, reinforced earth embankment barriers, industrial and commercial developments often have specialised requirements for fill materials and compaction. Specify the fill and compaction standards, procedures and methods of determination for the development in these cases. Use NZS 4431 as a basis where appropriate.

4.8.4 Rockfall hazard mitigation construction

The contractor shall verify the construction complies with the manufacturer's requirements and with the design by providing a Completion Certificate complying with Part 3: Quality Assurance, Appendix VIII.

The designer (the Approved Geoprofessional who designed the mitigation) shall review the construction and provide a Producer Statement PS4 – Construction Review, as set out in Appendix VII - Producer Statement PS4 – Construction Review. The minimum construction monitoring requirement shall be *Construction Monitoring Services Level CM4*.

4.9 Erosion, Sediment and Dust Control

4.9.1 Minimisation of effects

Design and construct earthworks to minimise soil erosion and sediment discharge. Where necessary, make permanent provision to control erosion and sediment discharge from the area of the earthworks.

At the planning and design phase, consider the generation of dust during and after the earthworks operation. If necessary, incorporate specific measures to control dust.

Requirements for erosion, sediment and dust control will be set in the resource consent conditions for the project. Refer to these conditions and take into account in the early stages of planning a project. Refer also to the requirements of *CSS: Part 1*.

4.9.2 Site-specific erosion and sediment control plan requirements

For all developments where erosion could result in contaminants in sediments entering the groundwater, surface waters or the Council's stormwater system, provide a site-specific Erosion and Sediment Control Plan (ESCP) to the Council at least four weeks before any works start on site. Note that, even where the Council has accepted an ESCP, the developer remains entirely responsible for all adverse effects associated with the site development.

Develop the ESCP to eliminate or reduce the following issues:

- ecological damage to waterways;
- channel infilling;

- disturbed or uncompacted surfaces and potential sediment yield;
- contaminated runoff;
- sediment discharges from dewatering;
- potential contamination from bituminous materials.

The ESCP must include the following assessment factors:

- a description of the pre-development surface water runoff regime;
- the development area (hectares);
- the catchment area passing through the site (hectares) marked on drawing;
- a plan of the development area, identifying discharge points to waterways or pipelines;
- calculated flow rates, and velocities through from the site (dry weather, two-year flood and typical water levels);
- a site plan showing the proposed earthwork strategy;
- the earthworks engineering drawings;
- a statement on how the exposed soil surface will be minimised;
- a statement (with sketches as appropriate) on how sediment runoff will be trapped and disposed of;
- a statement on potential tracking of soils on and off site by machinery;
- a statement on other contaminants and how they will be controlled;
- a statement on how ground water will be treated and discharged (if required).

The ESCP must comply with the standards:

- as specified by Canterbury Regional Council e.g. *Erosion and sediment control guidelines*;
- *Water Supply, Wastewater and Stormwater Bylaw*;
- *Soil Conservation Guidelines for the Port Hills*,

4.9.3 Protection measures

Take the following protection measures, unless incompatible with Canterbury Regional Council resource consent conditions:

- Construct stabilised construction entrances and detail proposed remedial works to mitigate contaminants moving off site e.g. mud on streets or silt in existing sumps in streets.
- Construct sediment traps and retention ponds where necessary. These should be cleaned out, as required, to ensure that adequate sediment storage is maintained.
- Use temporary barriers, or silt fences using silt control geotextiles, to reduce flow velocities and to trap sediment.

> Leave sections of natural ground unstripped to act as grass (or other vegetation) filters for run-off from adjacent areas.

> Construct temporary drains at the top and toe of steep slopes to intercept surface run-off and to lead drainage away to a stable watercourse or piped stormwater system.

> Slope benches in batter faces back and grade (both longitudinally and transversely), to reduce spillage of stormwater over the batter wherever surface water could cause erosion of batters, or internal instability through infiltration into the soil.

> Prevent surface water from discharging over batter faces by constructing open interceptor drains in permanent materials formed to intercept surface run-off and discharge via stable channels or pipes, preferably into stable watercourses or piped stormwater systems.

> Grade the surfaces of fills and cuts to prevent ponding.

> Shape and compact the upper surface of intermediate fills with rubber-tyred or smooth-wheeled plant when rain is impending or when the site is to be left unattended, to minimise water infiltration.

> Topsoil and grass the completed battered surfaces of fills to reduce run-off velocities.

> Re-topsoil and grass (or hydroseed) all earthwork areas as soon as possible after completion of the earthworks and drainage works.

> Use planting, environmental matting, hydroseeding, drainage channels or similar measures at an early stage in the earthworks construction phase as a permanent control of erosion and sediment discharge.

> To control dust or encourage early vegetation growth, water the site frequently during construction.

> Establish the permanent surface at an early stage of the construction phase.

Possible treatment methods are provided in the *Stormwater treatment devices: design guideline manual*.

Earthworks for developments on hillside land are not to be undertaken between 1 May and 31 August in any year, without the express written permission of the Council. This may be in the form of either conditions of subdivision, building or resource consent.

Ensure a satisfactory grass strike is obtained on all completed earthworks surfaces as soon as practicable. The intention is to provide early vegetative cover, particularly before the onset of winter, to minimise erosion and sedimentation. Suitable irrigation methods may be required to assist grass growth in the summer months.

Prevent water from stormwater systems flowing into a fill or into natural ground near the toe or sides of a fill. Do not construct stormwater or wastewater soakage systems in a fill, which could impair the fill's stability. Take into account the effect of utility services laid within the fill.

APPENDIX I

Statement of Professional Opinion on the Suitability of Land for Subdivision

ISSUED BY: ____

(Geotechnical engineering firm or suitably qualified Geoprofessional)

TO: ____

(Territorial authority)

TO BE SUPPLIED TO: ____

(Owner/Developer)

IN RESPECT OF: ____

(Description of infrastructure/land development)

AT: ____

____

(Address)

I ____ on behalf of

(Geoprofessional)

____

(Geotechnical engineering firm)

hereby confirm:

1. I am a suitably qualified and experienced Geoprofessional employed by ____________________ and the geotechnical firm named above was retained by the owner/developer as the Geoprofessional on the above proposed development.

2. The geotechnical assessment report, dated ______________ has been carried out in accordance with the Ministry of Business, Innovation and Employment *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* and the Christchurch City Council *Infrastructure Design Standard – Part 4: Geotechnical Requirements* and includes:

(i) Details of and the results of my/the site investigations.

(ii) A liquefaction and lateral spread assessment.

(iii) An assessment of rockfall and slippage, including hazards resulting from seismic activity.

(iv) An assessment of the slope stability and ground bearing capacity confirming the location and appropriateness of building sites.

(v) Recommendations proposing measures to avoid, remedy or mitigate any potential hazards on the land subject to the application, in accordance with the provisions of Section 106 of the Resource Management Act 1991.

3. In my professional opinion, not to be construed as a guarantee, I consider that Council is justified in granting consent incorporating the following conditions:

(i) ____

(ii) ____

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building. It is limited to those items referred to in clause 2 only.

5. This statement shall be read in conjunction with the geotechnical report referred to in clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. Liability under this statement accrues to the geotechnical firm only and no liability shall accrue to the individual completing this statement.

7. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than $__________________

(Minimum amount of insurance shall be commensurate with the current amounts recommended by ENGINEERING NEW ZEALAND, ACENZ, NZTA, INGENIUM.)

____________________________________ Date:________________________________

(Signature of engineer, for and on behalf of ____________________________________)

Qualifications and experience

____

____

This form is to accompany Form 9 – Resource Management Act 1991 (Application for a Resource Consent (Subdivision))

APPENDIX II

Statement of Professional Opinion on the Suitability of Land for Building Construction

ISSUED BY: ____

(Geotechnical engineering firm or suitably qualified engineer)

TO: ____

(Owner/Developer)

TO BE SUPPLIED TO: ____

(Territorial authority)

IN RESPECT OF: ____

(Description of infrastructure/land development)

AT: ____

____

(Address)

I ____ on behalf of

(Geoprofessional)

____

(Geotechnical engineering firm)

hereby confirm:

1. 1. I am a suitably qualified and experienced Geoprofessional and was retained by the owner/developer as the Geoprofessional on the above development.

2. The extent of my inspections during construction, and the results of all tests carried

out are as described in my/the geotechnical completion report, dated ________________

3. In my professional opinion, not to be construed as a guarantee, I consider that *(delete as appropriate)*:

(a) the earthfills shown on the attached Plan No ________________ have been

placed in compliance with the requirements of the________________Council and my/the specification.

(b) the completed works give due regard to land slope and foundation stability considerations.

(c) the original ground not affected by filling is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

(i) ____

(ii) ____

(d) the filled ground is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

(i) ____

(ii) ____

(e)The original ground not affected by filling and the filled ground are suitable for the construction of a development/subdivision and are not subject to erosion, subsidence or slippage provided that:

(i) ____

(ii) ____

NOTE: The sub-clauses in Clause 3 may be deleted or added to as appropriate.

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.

5. This statement shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. Liability under this statement accrues to the geotechnical firm only and no liability shall accrue to the individual completing this statement.

7. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than $__________________

(Minimum amount of insurance shall be commensurate with the current amounts recommended by ENGINEERING NEW ZEALAND , ACENZ, NZTA, INGENIUM.)

____ Date:_______________________________________

(Signature of engineer)

Qualifications and experience

____

____

APPENDIX III

Soil Log

Project:		Project No:	Bore ID:
Client:			
Bore Depth:	Ground Level:	Recorded by:	Date:
Location:	WaterTableDepth:		

Elevation	Depth	Symbol	Material Description Soil Type + Colour + Strength + Moisture + Grading + Organics	Scala Penetrometer (mm/blow) 0 10 20 30 40 50 60 70 80 90 100	Depth
	0.0				0.0
	0.1				0.1
	0.2				0.2
	0.3				0.3
	0.4				0.4
	0.5				0.5
	0.6				0.6
	0.7				0.7
	0.8				0.8
	0.9				0.9
	1.0				1.0
	1.1				1.1
	1.2				1.2
	1.3				1.3
	1.4				1.4
	1.5				1.5
	1.6				1.6
	1.7				1.7
	1.8				1.8
	1.9				1.9
	2.0				2.0
	2.1				2.1
	2.2				2.2
	2.3				2.3
	2.4				2.4
	2.5				2.5
	2.6				2.6
	2.7				2.7
	2.8				2.8
	2.9				2.9
	3.0				3.0

Locality Diagram		Other Comments:

Soil Descriptions

Examples: Sandy GRAVEL, with some clay
Clayey SILT, with trace of peat, light grey, firm, moist

SOIL TYPE

Lesser Fraction	
20-50% volume	
Soil Type Term	
Coarse	gravelly
Medium	gravelly
Fine	gravelly
Coarse	sandy
Medium	sandy
Fine	sandy
Silty	
Clayey	
Peaty	

Dominant Fraction			
> 50% volume			
Soil Type term		**Particle size (mm)**	**Graphic Symbol**
BOULDERS		> 200	
COBBLES		60 - 200	
COARSE	GRAVEL	20 - 60	
MEDIUM	GRAVEL	6 - 20	
FINE	GRAVEL	2 - 6	
COARSE	SAND	0.6 - 2.0	
MEDIUM	SAND	0.2 - 0.6	
FINE	SAND	0.06 - 0.2	
SILT		0.002 - 0.06	
CLAY		< 0.002	
PEAT		N/A	

Minor Fraction		
12 - 20%	5 - 12%	< 5%
with some	**with minor**	**with trace**
boulders		
cobbles		
coarse		gravel
medium		gravel
fine		gravel
coarse		sand
medium		sand
fine		sand
silt		
clay		
peat		

COLOUR

Adjective1	***Adjective2***	***Main Colour***
light	pinkish	pink
dark	reddish	red
	yellowish	yellow
	brownish	brown
	olive	olive
	greenish	green
	bluish	blue
	greyish	white
		grey
		black

STRENGTH

Cohesive Soil Consistency

Consistency	***Undrained Shear Strength (kPa)***	***Characteristic***
very soft	< 12	Easily exudes between fingers
soft	12 - 25	Easily moulded by fingers
firm	25 - 50	Can be moulded with fingers with some effort
stiff	50 - 100	Impossible to mould with fingers, but will change shape with heel pressure
very stiff	100 - 200	As for stiff, but considerable heel pressure is required
hard	200 - 500	Brittle, very tough

Non Cohesive Soil Density

Density	***Characteristic***
very loose	Very easy to excavate by hand
loose	Easy to excavate by hand
medium dense	Between loose and dense
dense	Very difficult to excavate by hand
very dense	Particles bound together

MOISTURE

Moisture	***Description***
dry	Cohesive soils usually hard or powdery Granular soils run freely through hands
moist	Some moisture present – usually darkens the colour
wet	Strong squeezing in the hand will drive some water out
saturated	Squeezing will drive water out

SAND/GRAVEL GRADING

well graded
poorly graded

ORGANIC CONTENT

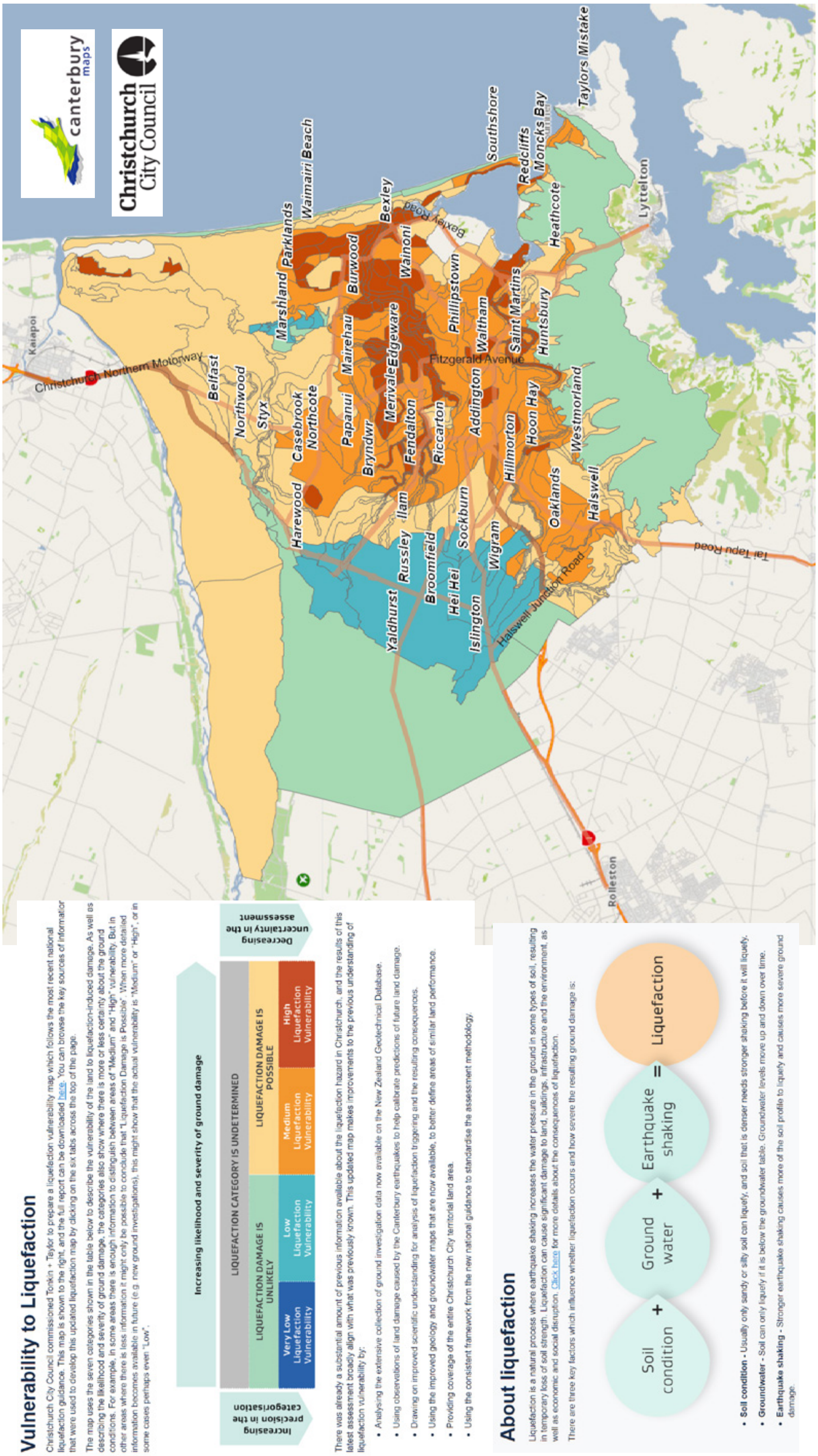
Adjective	***Organic Type***
trace	fibrous
little	wood pieces
some	root fibres
and	vegetation

For full descriptions see: *Field Description of Soil and Rock*, NZ Geotechnical Society, Dec 2005

APPENDIX IV

Liquefaction Vulnerability

Based on the "Vulnerability Map" tab at https://apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer



APPENDIX V

Producer Statement PS1 – Design

This Producer Statement is for the design of support or protection devices for the rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

DESIGNED BY: ____

(Approved Geoprofessional)

ISSUED BY: ____

(Design Firm)

TO: ____

(Purchaser)

OWNERS: ____

(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

Appointed Peer Reviewer ____

(Approved Geoprofessional and signatory to a Producer Statement PS2- Peer Review)

Description of Work ____

____

(Describe the work covered by this Producer Statement in detail)

At ____ (Address)

Lot Number ________________ **DP**________________ **C/T Number**________________

Description of Design Services Undertaken ____

____

Inputs to the Design ____

(Standards and codes used)

____

(Rockfall Energy used and its derivation/supply)

____

(other)

Design Life ______________________ **Expected Service Life** _____________________

(To take account of the environmental setting)

Name any Proprietary System ____

Test Level for Proprietary System Used ______________________ **Certificate Number** _______________

(Current test level certificate)

The works covered by this Producer Statement are **described** in calculations titled

____

All details are given on drawings **titled** ____

I ____

(the designer)

being a Chartered Civil Engineer under the Chartered Engineers Act of New Zealand and a Geoprofessional (see note 2) **believe** on reasonable grounds the works designed by me, if constructed according to the details shown on the drawings, in the specification and any other accompanying documents will perform to the design intent as set down by the Christchurch City Council in a consent to construct. The work covered by this Statement will be observed as it is constructed according to:

CM4 ◯ CM5 ◯ Other_______________

This statement is endorsed by ____

(Director and/share holder)

of ____

(Design Firm)

and the employer of the Designer.

I/we are member(s) of ACENZ **YES** ◯ **NO** ◯ , hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Designer ____ (Signature)

____ (Date)

Signed on behalf of the Design Firm ____ (Signature)

____ (Date)

Notes And Requirements For Ps1 - Design

1. This Producer Statement shall provide the Christchurch City Council with reasonable grounds to issue a consent for construction of the work without the need for duplicate and independent design checking.

2. PS1 - Design is required from a Geoprofessional, as defined in clause 4.3.1 – The Geoprofessional.

3. The Designer shall have signing authority delegated by the Design Firm. By signing the PS1 – Design the Designer warrants that she/he has:

   a. delegated authority from a Director of the Design Firm to undertake the design and develop the construction details;

   b. a directory role in the gathering of site data, establishing the design inputs overseeing the design process, checking the outputs from design, arranging and signing off internal verification, developing the work specification, overseeing the drawing of details and shall be fully satisfied that the documents accompanying the PS1 – Design are completed and relevant to the stabilisation of rockfall or protection of life and/or property from rockfall or boulder roll.

4. The Designer shall employ a suitably qualified Geoprofessional to independently review the design and to provide a Producer Statement PS2a – Design Review. The costs associated with the design review shall be borne in full by the Design Firm. Issues of disputed design shall be resolved by the Designer and Design Reviewer to enable the PS1 – Design to be signed unconditionally. Council will not accept a PS1 with conditions.

5. The PI Insurance minimum stated on the PS1 shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design firm to the Statement.

6. In the case where a Design Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain “run-on” insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.

APPENDIX VI

Producer Statement PS2a – Peer Review

This Producer Statement is for the peer review of the design of the support or protection devices for the rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

APPOINTED PEER REVIEWER: ____

(Approved Geoprofessional named on the Producer Statement PS1 - Design)

ISSUED BY: ____

(Peer Reviewer Firm)

TO: ____

(Designer)

OF: ____

(Design Firm)

OWNERS: ____

(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

Description of Work ____

____

(Describe the work covered by this Producer Statement in detail)

At ____ (Address)

Lot Number ________________ **DP**________________ **C/T Number**________________

I ____ (Peer Reviewer) have been engaged

by ____ (Design Firm)

to review all of the work included by the design calculations, specification and drawings

Calculations titled ________________ dated ________________

Specification titled ________________ dated ________________

Drawings titled ________________ dated ________________

Drawing numbers ________________ Revision numbers ________________

I ____

(the Peer Reviewer)

being a suitably qualified Geoprofessional (see note 2) **have** reviewed the design and construction documents supplied by the Designer and agree all matters of difference between the Designer and myself are satisfactorily resolved.

I believe on reasonable grounds the design work reviewed by me, if constructed according to the details shown on the drawings, in the specification and any other accompanying documents will perform to the design intent determined by the Designer as set down by the Christchurch City Council in the consent to construct.

I have sighted the signed Producer Statement PS1 and confirm that the Statement is complete and correct.

This statement is endorsed by ____

(Director and/share holder)

of ____

(Peer Reviewer Firm)

and the employer of the Peer Reviewer.

I/we are member(s) of ACENZ **YES** ◯ **NO** ◯, hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Peer Reviewer ____ (Signature)

____ (Date)

Signed on behalf of the Peer Reviewer Firm ____________________________________ (Signature)

____ (Date)

Notes And Requirements For PS2a – Peer Review

1. This Producer Statement shall provide the Christchurch City Council reasonable grounds to issue consent for construction of the work. It shall be based on an independent review of the design covered by PS1 – Design.

2. PS2a - Peer Review is required from the Peer Reviewer who shall be a Geoprofessional, as defined in clause 4.3.1 – The Geoprofessional.

3. The Peer Reviewer shall be a person and not a Firm and shall have signing authority delegated to him/her from a Director of the Peer Reviewer's Firm to undertake the review and sign the PS2a.

4. The Peer Reviewer is engaged by the Design Firm to undertake a review of the documents representing the design work. Christchurch City Council is not responsible in any part for the commercial arrangements between the Design Firm and the Peer Reviewer.

5. From time to time differences of opinion will arise between the Peer Reviewer and Designer of the work. Both parties are expected to work together to resolve any difference so that the PS1 and PS2 Statements are submitted to Christchurch City Council without conditions.

6. The PI Insurance minimum stated on the PS2a shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design Reviewer Firm to the Statement.

7. In the case where a Peer Reviewer Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain "run-on" insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.

APPENDIX VII

Producer Statement PS2b – Peer Review Amendment

This Producer Statement is a variation to PS2a to cover variation to the design content arising out of construction of rockfall support or protection devices for rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

APPOINTED PEER REVIEWER: ______________________________

(Approved Geoprofessional named on the Producer Statement PS1 - Design)

ISSUED BY: ______________________________

(Peer Reviewer Firm)

TO: ______________________________

(Designer)

OF: ______________________________

(Design Firm)

OWNERS: ______________________________

(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

The amendment to the work ______________________________

____

(Describe the work covered by this Producer Statement in detail)

At ______________________________ (Address)

Lot Number ______________ **DP**______________ **C/T Number**______________

I ______________________________ (Peer Reviewer) have been engaged

by ______________________________ (Design Firm)
to review the work as it is constructed including the design calculations, specification and drawings

VARIATION TO DESIGN CONTENT

> Variation No__________ Description______________________Date____________

> Variation No__________ Description______________________Date____________

> Variation No__________ Description______________________Date____________

> Variation No__________ Description______________________Date____________

I ____

(the Peer Reviewer)

being a suitably qualified Geoprofessional (see note 2) have reviewed the amendments to the design reviewed under PS2a and viewed the variations at the place of construction.

I believe on reasonable grounds the amendments to the design work reviewed by me, as constructed, will perform to the design intent determined by the Designer as set down by the Christchurch City Council in the consent to construct.

I have sighted the signed Producer Statement PS1 and PS4 and confirm that the Statements are complete and correct.

This statement is endorsed by ____

(Director and/share holder)

of ____

(Peer Reviewer Firm)

and the employer of the Peer Reviewer.

I/we are member(s) of ACENZ **YES** ◯ **NO** ◯, hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Peer Reviewer ____ (Signature)

____ (Date)

Signed on behalf of the Peer Reviewer Firm ____ (Signature)

____ (Date)

Notes And Requirements For PS2b – Design Review

1. This Producer Statement shall show the Christchurch City Council that variation to the content of the design work which arises out of its construction does not alter the design intent and the basis of the design review. It shall be based on an independent check of the variation to the design covered by the PS2a – Peer Review.

2. PS2b - Peer Review Amendment is required from the Peer Reviewer and signatory to the PS2a, who shall be a Geoprofessional, as defined in clause 4.3.1 – The Geoprofessional.

3. The Peer Amendment Reviewer shall be a person and not a Firm and shall have signing authority delegated to him/her from a Director of the Peer Reviewer's Firm to undertake the review and sign the PS2b.

4. The Peer Amendment Reviewer is engaged by the Design Firm to undertake a review of the documents representing the design work. Christchurch City Council is not responsible in any part for the commercial arrangements between the Design Firm and the Peer Amendment Reviewer.

5. The PI Insurance minimum stated on the PS2b shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design Amendment Reviewer Firm to the Statement.

6. In the case where a Peer Amendment Reviewer Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain "run-on" insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.

APPENDIX VIII

Producer Statement PS4 – Construction Review

This Producer Statement is for the construction compliance of design for support or protection devices for the rockfall and boulder roll hazards on and near to the Port Hills, Christchurch. It applies to construction consented by the Christchurch City Council under the Building Act 2004 and its amendments.

ISSUED BY: ____

(Design Firm)

TO: ____

(Purchaser)

OWNERS: ____

(Registered owners shown on the Certificate of Title. Individuals, trusts, Trustees, Company Directors)

Consenting Authority – Christchurch City Council

Description of Work ____

____

(Describe the work covered by this Producer Statement in detail)

At ____ (Address)

Lot Number ________________ **DP**________________ **C/T Number**________________

Designed by ____ *(Designer)*

Construction observations made by ____

Qualifications of Construction Observer NZCE ◯ REA ◯ TENZ ◯ CPEng ◯ Other ◯

Construction observations to CM4 ◯ CM5 ◯ Other________________

(Categories given by ENGINEERING NEW ZEALAND)

Description of construction observations ____

____

Authorised variations to design details that are covered by PS1 and PS2a for construction

____

(attach all documentation to vary content of construction)

Endorsement of variation to vary content of construction by the Design Reviewer Producer Statement PS2b is attached YES ◯ NO ◯

(Include copies of the communication with the Design Reviewer)

I ____ (the designer)

being a Chartered Civil Engineer under the Chartered Engineers Act of New Zealand and a Geoprofessional (see note 2) **have** monitored the construction of the work and **believe** on reasonable grounds the works are constructed according to my design.

I am satisfied that variation to the work as detailed made at time of construction has not altered its expected performance and durability.

I confirm that the conditions of Consent issued by Christchurch City Council are satisfied in full by the construction.

This statement is endorsed by ____

(Director and/share holder)

of ____

(Design Firm)

and the employer of the Designer and Construction Observer.

I/we are member(s) of ACENZ **YES** ◯ **NO** ◯ , hold Professional Indemnity insurance of no less than $5,000,000.00 and accept that liability under this statement accrues to the Design Firm only.

Signed by the Designer ____ (Signature)

____ (Date)

Signed on behalf of the Design Firm ____ (Signature)

____ (Date)

Notes And Requirements For PS4 – Construction Review

1. This Producer Statement shall provide the Christchurch City Council with assurance that the work as designed and amended at time of construction has been built according to the documents to which PS1, PS2a and PS2b apply and any conditions of consent to construct.

2. PS4 – Construction Review is required from a suitably qualified Geoprofessional, as defined in clause 4.3.1 – The Geoprofessional.

3. The Designer shall be a person and not a Firm and shall have signing authority delegated to him/her from a Director of the Design Firm to undertake the Construction Review and sign the PS4.

4. The Designer shall establish the frequency for inspections and shall adopt CM4 and CM5 as specified by the consent to construct. The day-to-day inspections of construction can be undertaken by other professional or sub-professional engineers who are under the direct supervision of the Designer.

5. The PI Insurance minimum stated on the PS4 shall be current at the time of submission to Christchurch City Council. A certificate of currency shall be appended by the Design Firm to the Statement.

6. In the case where a Design Firm ceases to trade within 10 years of the construction of the designed work, the Director(s) shall maintain "run-on" insurance to the full value of $5,000,000 for the balance of time to 10 years from completion of construction.

Part 5: Stormwater and Land Drainage

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5.1 Referenced Documents

Planning and Policy

- The *Christchurch City District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- Resource Management Act (RMA) (1991)
- Building Act (2004)
- New Zealand Building Code (1992)
- Canterbury Regional Council *Canterbury Land and Water Regional Plan* www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-land-and-water-regional-plan
- Christchurch City Council *Water Supply and Wastewater Bylaw* (2014) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/water-supply-and-wastewater-bylaw-2022
- Christchurch City Council *Waterways and Wetlands Natural Asset Management Strategy 1999* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies
- Christchurch City Council *Integrated Water Strategy* www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Strategies/Integrated-water-strategy.pdf

Design

- Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō Ngā Arawai Rēpo (WWDG)* (2003) Part A and B www.ccc.govt.nz/environment/water/policy-and-strategy/waterways-wetlands-and-drainage-guide
- Christchurch City Council *Streamside Planting Guide* www.ccc.govt.nz/environment/water/waterways/waterway-restoration/
- Christchurch City Council leaflet *Stormwater Tanks on Private Property* www.ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/stormwater-and-your-property/
- Christchurch City Council *Small Site Stormwater Attenuation* www.ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/stormwater-and-your-property/
- Christchurch City Council *Rain Garden Design, Construction and Maintenance Manual* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/waterways-wetlands-and-drainage-design/
- Canterbury Regional Council *Erosion and sediment control guidelines* 2007 www.esccanterbury.co.nz/
- NZS 4404:2010 *Land development and subdivision infrastructure*
- *New Zealand Fish Passage Guidelines* www.niwa.co.nz/freshwater-and-estuaries/research-projects/new-zealand-fish-passage-guidelines
- New Zealand Transport Agency *Bridge Manual* (2013)
- McKerchar and Pearson, *Flood Frequency In New Zealand*, 1989

Construction

- 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

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).

5.1.1 Source documents

This Part of the IDS is based on Part 4 of NZS 4404:2010, by agreement, and with the consent of Standards New Zealand.

5.2 Introduction

This Part of the IDS covers the design and construction requirements of stormwater and land drainage works for land development and subdivision, including capital works projects.

5.2.1 Philosophy

The Christchurch City Council is taking a values-based approach to management of the natural and physical resources that make up Christchurch's system of waterways, wetlands and drainage. This includes not only the natural waterway system but also the built network. By understanding the natural processes operating in land and water we are much more able to bring to life values that are important to the community while addressing drainage issues associated with individual developments. Values that have been specifically identified are ecology, landscape, recreation, heritage, culture and drainage.

The emphasis on each value at a particular site will be dependent on the objectives of the project. The process toward understanding these values, how they can be reflected and enhanced in new developments, and an appreciation of ongoing management requirements, is outlined in the *Waterways, Wetlands and Drainage Guide (WWDG) Part A*. Design and management for the six values is a requirement of the *Waterways and Wetlands Natural Asset Management Strategy*.

5.2.2 Objectives

Stormwater run-off is the chief driver of water quality in urban catchments, and stormwater management is crucial to reducing flood events. The *Integrated Water Strategy* establishes that the objectives of a stormwater drainage system include: to regulate the storm surface run-off rate of flow and volume (quantity); to control groundwater levels; and to protect the quality of both, to the extent that agreed levels of service are maintained and any adverse effects on the environment are not more than minor. To satisfy the latter, remedial or mitigation works will often need to be incorporated within the stormwater drainage system (see *WWDG Part B* clause 2.2). Potential adverse effects include flood damage, surface and channel erosion and sedimentation, water pollution, loss of bio-diversity and damage to aquatic ecosystems.

Well designed and maintained alternative systems that replicate the pre-development hydrological regime can not only mitigate adverse environmental effects but also enhance amenity and ecological values

5.2.3 Four purposes

The stormwater drainage system serves four purposes: the conveyance of storm surface run-off with minimal flood damage; control of water quality; protection of bio-diversity and ecological function; groundwater control and protection. Consider all four aspects in the engineering design and endeavour to achieve them with minimal adverse effects on the environment.

Opportunities exist for the stormwater drainage design to integrate with the natural drainage system. On and off-site treatment and attenuation, grassed swales, natural or artificial waterways, ponds and wetlands, for example, may in certain circumstances be not only part of the stormwater drainage system, but a required solution (depending on urban priorities) especially if a low impact on receiving waters downstream is critical. Low Impact Urban Design & Development (LIUDD) is one means of achieving these four purposes along with other sustainability objectives.

5.3 Consent and Compliance Issues

Christchurch City Council holds a number of network discharge consents throughout its territory which it may use to authorise the discharge of stormwater from third party developments into its network. Compliance with relevant consent conditions may require on-site stormwater mitigation (treatment and/or attenuation/ disposal). If Council does not authorise the stormwater discharge under one of its global consents, separate authorisation from Canterbury Regional Council (Ecan) may be required unless the activity meets the permitted activity threshold of Rules 5.95 or 5.96 in the *Canterbury Land and Water Regional Plan*. Both a land use consent (Council) and a discharge consent (ECan) are generally required for subdivisions and capital works projects and when significant water quantity and quality issues need to be addressed.

Consult with Council prior to consent application. If separate Ecan consent is required, it is good practice for Council and Ecan to process subdivision and water-related resource consents simultaneously and deal with land and water issues at a joint hearing pursuant to section 102 of the RMA.

Typical conditions will reflect the Council’s network stormwater consent and stormwater management plans including:

- An erosion and sediment control plan is required for all activities involving land disturbance.
- Sediment generated by the activity must be contained within the work site.
- Sumps collecting runoff from new hardstand areas must be fitted with submerged or trapped outlets
- Site management and spill procedures are required for sites where the occupier engages in hazardous activities.

Additional conditions may include:

- An assessment of water quantity effects, and provision of on-site stormwater storage or network upgrade may be required.
- No discharge onto or into land where the average site slope exceeds 5 degrees.
- First flush treatment is required for stormwater runoff from new hardstand areas in excess of 150 m^2 where usage could generate contaminants exceeding normal residential levels.
- Treatment may be required for stormwater runoff from buildings with uncoated metal roofs.

Requirements in the *Water Supply and Wastewater Bylaw and the Integrated Water Strategy* must be met (see also *WWDG Part B* chapter 17).

5.3.1 Legislation

The Resource Management Act (RMA) is the principal statute that controls land development, including stormwater drainage aspects.

5.3.2 Consent from the Canterbury Regional Council

Other activities often associated with stormwater drainage works which must be authorised by Ecan include: the diversion of natural water during construction work; the permanent diversion of natural water as a consequence of the development; activities in the bed or on the banks of a natural waterway; damming waterways; permanent or construction related dewatering.

5.3.3 Exercising consents

Discharge and temporary water consents and land use consents required during construction must be applied for by, and exercised in the name of, the developer.

Other discharge and water permits required for works that are to be transferred to the Council upon completion, must be applied for by, and exercised in the name of the developer. Discuss with the Council any application involving consents intended to transfer to the Council. The Council must approve these prior to application as it will not accept the transfer of a consent unless it has previously approved the conditions of that consent.

5.4 Quality Assurance Requirements and Records

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

5.4.1 The designer

The designer of all stormwater reticulation systems that are to be taken over by Christchurch City Council and the person undertaking the catchment analysis must be suitably experienced. Their 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.

5.4.2 Information to be provided

The level datum used must be the Christchurch Drainage Datum.

This is the reference plane used for drainage purposes in Christchurch. Levels above this plane are stated in metres as 'reduced level' or R.L. The Christchurch Drainage Board established this datum in 1878 at 50 feet below the floor of the Cathedral. Refer to *WWDG Part B* Appendix 1 and clause 2.8.1 – Level datum (General Requirements) for further information.

Specific information to be provided with any concept drawings or Resource Consent plans must include:

> the location of any natural waterways, springs, bores, wells or wetlands within the site or in close proximity to a boundary. The location in plan and level of the water's edge and shoulder of the banks must be indicated;

> the location of existing drainage pathways;

> representative pre-existing and post development cross-sections through any natural waterways or wetlands, including the areas immediately adjacent to the proposed development;

> catchment boundaries defined by surface levels (where the location of the catchment boundary is uncertain, the developer must define the boundary by survey);

> summaries of hydrological and hydraulic modelling as required by the *WWDG* (see *WWDG Part B* chapters 21 and 22), including design parameters and assumptions;

> estimates of catchment imperviousness and the basis for its derivation;

> the proposed proximity of buildings to the water's edge and/or shoulder of the banks;

> clear identification of the extent of any existing and post-development river or coastal floodplains on or in close proximity to the site and overland flow paths within the site;

> secondary flow paths;
> identification of any natural or artificially created basins;
> the impact of any proposed filling or excavation on existing surface drainage pathways;
> existing services and easements;
> details of any contaminated ground or historical filling;
> trees, other significant vegetation and other features to be protected and retained (e.g. natural landforms, ecological protection areas);
> details of any investigations such as ground water levels, profiles, infiltration testing and effects on the environment and geological or water quality assessments.

5.4.3 Design records

Provide the following information to support the Design Report:

> details and calculations that demonstrate that levels of service required by the *WWDG Part B* chapter 20 will be maintained;
> detailed calculations and drawings where applying to build within a flood plain, which determine the floodplain boundaries and levels relative to building floor levels (see *WWDG Part B* chapter 20 and the Building Act);
> details and calculations that clearly indicate any impact on adjacent areas or catchments that the proposed works may have;
> draft versions of operations and maintenance manuals for any water quantity or quality control structures (refer also to clause 5.7.4 - Operations and maintenance manual);
> landscape and planting drawings complying to Part 2: General Requirements – Appendix I Standard Draughting Layout and Format Requirements.

Design checklists, to aid this process, are available in *WWDG Part B* clauses 6.10 and 19.2.

Provide the following additional information for detention basins and swales:

> the design return period;
> the design rate of discharge at each discharge point;
> the design water level;
> the design volume, where there is a storage function.

5.4.4 Construction records

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

- Environment Canterbury compliance monitoring reports;
- all performance test results;
- CCTV records;
- material specification compliance test results;
- compaction test results;
- subgrade test results;
- infiltration test results.

Provide the Council with a certificate for each pipeline 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-Builts, including manufacturer, diameter, type, class, jointing and contractor who laid the pipe.

5.5 Catchment Management Planning

Carry out stormwater planning on a coordinated and comprehensive catchment-wide basis. Although this is primarily the responsibility of the Council, consider catchment-wide issues at the concept design stage and comply with the catchment management plan, if one exists.

The implications of future upstream development on the site, and the cumulative effects of land development on water quality and flooding downstream, are important considerations. The larger the scale of the development the more significant the catchment management planning issues are likely to be.

Discuss any catchment management planning issues with the Council at an early stage (see also *WWDG Part B* chapters 2, 5, 7 to 12 and 20).

5.5.1 Effects of land use on receiving waters

Impervious surfaces and piped stormwater drainage systems associated with urban development have a major effect on catchment hydrology. Faster run-off of polluted storm flows, reduction in base flows and accelerated channel erosion and depositions alter the hydrology and adversely affect the quality of receiving waters. This in turn reduces the diversity of the aquatic biological community.

The effects of rural development on receiving waters are generally less significant where riparian margins are protected. The modification to stream hydrology is generally minor. However, any reduction in riparian vegetation increases sediment loads and nutrient concentrations are likely to reduce aquatic biodiversity.

Consult with Ecan at an early stage to identify likely adverse effects of land use on receiving waters (see also *WWDG Part B* chapter 2).

5.5.2 Catchments and off-site effects

All drainage systems, including waterways, must provide for the collection and controlled disposal of surface and ground water from within the land being developed, together with run-off from upstream catchments. In designing downstream facilities, consider the upstream catchment to be fully developed and comply with any Catchment Management Plan. Consult the Council about mechanisms for assigning costs associated with off-site effects.

Ground water is a precious resource. Carry out development in a way that avoids adverse effects on ground water quality and levels. Refer to clause 4.5 - Ground Investigations (Geotechnical Requirements) and *WWDG Part B* clause 5.3.1.

For all land development works (including projects involving changes in land use or coverage), include an evaluation of stormwater run-off changes on upstream and downstream properties. This evaluation will generally be required at the resource consent stage.

Development must not increase upstream flood levels, unless any increase is negligible and can be shown to have no detrimental effects.

Investigate downstream impacts including changes in flow peaks and patterns, flood water levels, contamination levels, erosion or silting effects, and effects on the existing stormwater drainage system. Where such impacts are considered detrimental, mitigation measures (e.g. peak flow attenuation, velocity control, contamination reduction facilities) on or around the development site, or the upgrading of downstream stormwater disposal systems at the developer's expense, will be required.

Consider the impact of climate change on coastal areas and the upstream effect on groundwater levels and flooding when designing stormwater basins and infrastructure. Refer to clause 2.5.7 - Coastal Hazards for further information.

5.6 Drainage System Design

Stormwater drainage is the total system protecting people, land, infrastructure and improvements against flooding. It consists of a primary drainage system of pipes and waterways and detention areas and a secondary system consisting of open channels, controlled flood plains, natural ponding areas and flow paths. These are utilised in conjunction with the setting of building levels to ensure that buildings remain free of inundation up to the minimum protection standard. Protection standards are set by the RMA, the *District Plan* and the Building Act and are discussed in *WWDG Part B* chapter 20.

The primary system must cater for the more frequent rainfall events including the 20% AEP storm. The secondary system must convey over-design events without inundation hazard to house floors and building platforms at least to the 2% AEP storm, including occasions when there are blockages in the primary drainage system.

Consider the following aspects and include in the design, where appropriate:

> The Six Values (refer to clause 5.6.1 – Integrated stormwater systems to achieve the six values);

> size (or sizes) of the surface water drainage pipework throughout the proposed reticulation system;

> details relating to the protection of trees, other significant vegetation, natural habitats and other features to be protected and retained;

> selection of appropriate pipeline material type(s) and class;

> mains layout and alignment including: route selection, topographical and environmental aspects, easements, foundation aspects, clearances and shared trenching requirements, provision for future system expansion;

> hydraulic adequacy including acceptable flow velocities and other requirements where applicable to satisfy *WWDG Part B* chapter 22;

> property service connection locations and sizes;

> seismic design - all structures must be designed with adequate flexibility and special provisions to minimise risk of damage during earthquake. Provide specially designed flexible joints at all junctions between rigid structures (e.g. reservoirs, pump stations, bridges, buildings, manholes) and natural or made ground;

> geotechnical investigations - take into account any geotechnical requirements determined under Part 4: Geotechnical Requirements;

> major reticulation and its potential for significant traffic disruption. Discuss at an early stage with Council.

5.6.1 Integrated stormwater systems to achieve the Six Values

Integrated stormwater systems are both the optimum and preferred method of stormwater treatment. When these systems are being considered, discuss their use with the Council at an early stage. Refer to *WWDG Part B* chapters 5 to 12 for more information on this topic.

Well-designed and well-maintained integrated systems, which replicate the pre-development hydrological regime, can not only mitigate adverse environmental effects, but also enhance local amenity, water quality and ecological values. These systems are designed in accordance with the waterway's six values (refer *WWDG Part A* Table 1.1):

> Ecology - Includes ecological processes and inter-relationships between plants, birds, fish and insects.

> Landscape - The special character of sites, aesthetic quality, and sense of place to people and communities.

> Recreation - Active and passive recreation, play and facilities associated with recreational activities.

> Heritage - Sites and activities of both human (e.g. structures) and natural (e.g. landforms) significance.

> Culture - The values of Maori and European, as well as wider community aspirations and involvement.

> Drainage - Groundwater and surface water inter-relationships, flows, flooding and stormwater.

5.6.2 Secondary flow paths

Shape lots generally so that they fall towards roadways, which may be used as secondary flow paths. Secondary flow velocities must be sub-critical except where it is unavoidable on hillsides. On hillsides, convey secondary flows safely and as directly as possible into permanent open waterways.

Where secondary flow paths cannot, with good design, be kept on roads, they should be kept on public land such as accessways, parks, and reserves. Secondary flow paths over private land are the least desirable option and will require protection by legal easements.

Design secondary flow paths so that erosion or land instability caused by the secondary flows will not occur. Where necessary, incorporate special measures to protect the land against such events.

In most circumstances, limit ponding or secondary flow on roads in height and velocity such that the carriageway is passable.

The secondary flow path sizing and location must be supported by adequate analysis, taking into account extreme events, to show:

> that it is of adequate capacity to cope with the anticipated flow;

> that it discharges to a location that does not detrimentally affect others and can safely dissipate via a controlled disposal system as the storm peak passes.

Consider the secondary flow path under conditions of total inlet blockage at critical culverts and other critical structures.

Avoid shaping roads to create basins with piped outlets. Where basins are created a higher level of service for the primary system may be required. The desirable standard for ponding or secondary flow on roads is that they are passable to light vehicles in the 2% AEP (annual exceedance probability) event and to 4WD vehicles in a more extreme event.

5.6.3 Location and design of basins and swales

Ponding basins are being used throughout the city as stormwater treatment and detention devices to improve water quality and to mitigate increased stormwater flows. These structures are important landscape features in public open space. Carefully consider their location, design, construction, and ongoing maintenance requirements during the early stages of planning.

From a landscape perspective, these types of basins are often very specifically designed and managed in order to optimise their primary functions (e.g. stormwater storage capacity, soil infiltration). Design solutions should build on the features of the local landscape, features associated with the proposed development and the wider planning context. As the Council will generally take on the responsibility for these structures, it needs to have input into the design of these structures from the outset.

Co-locate basins with public open space having a similar appearance and maintenance approach (i.e. road reserves and recreation reserves with a garden approach to maintenance). Basins should not be located in areas that are being managed primarily for their ecological values (such as esplanade reserves). The management approach for ecological areas aims to support natural processes through encouraging natural regeneration with limited maintenance that focuses predominantly on managing for weed species.

Where there is co-location of stormwater features with reserves, open space or streetscapes the requirements of clause 10.5.4 – Local purpose (utility) reserves (Reserves, Streetscape and Open Spaces) must also be met.

Design and construct swales and basins so that they replicate natural landforms. Avoid regular shapes, 'bathtubs' and even slopes: instead create organic, undulating landforms with sinuous inverts and mid-slope terraces. Avoid slopes that have a gradient steeper than one-in-four. Round off all tops and toes of slopes to blend imperceptibly with adjoining landforms. For safety reasons, ensure open sightlines from surrounding public and private land. Provide sufficient areas of land to achieve this land shaping and to enable public access, as well as to provide for stormwater capacity.

Refer to *WWDG Part B* chapter 6 for specific design criteria regarding the design of basins and stormwater treatment systems. Note that underdrain systems (*WWDG Part B* figure 6-14) should not have topsoil detailed over the soakage media as this impedes filtration.

Council encourages preserving and adding life-containing materials such as humus in the soils of soakage basins. Soil structure and permeability can be maintained and improved by soil biological communities.

5.6.4 Design standards for new developments

Design all new surface water and land drainage systems to design storms in accordance with *WWDG Part B* chapters 20 and 21.

For the protection of buildings, design and build the stormwater system of water pathways and ponding areas so that every new building platform is at less than 2% annual exceedance probability (AEP) risk of flooding. Include a minimum freeboard height above computed flood levels as shown in Figure 1, complying with Table 1. Any relevant building floor protection specified in the City Plan or Banks Peninsula District Plan must also apply. Both the building platform and the floor level can be individually placed higher than these minimum levels, so long as their heights comply with the requirements of the Building Code.

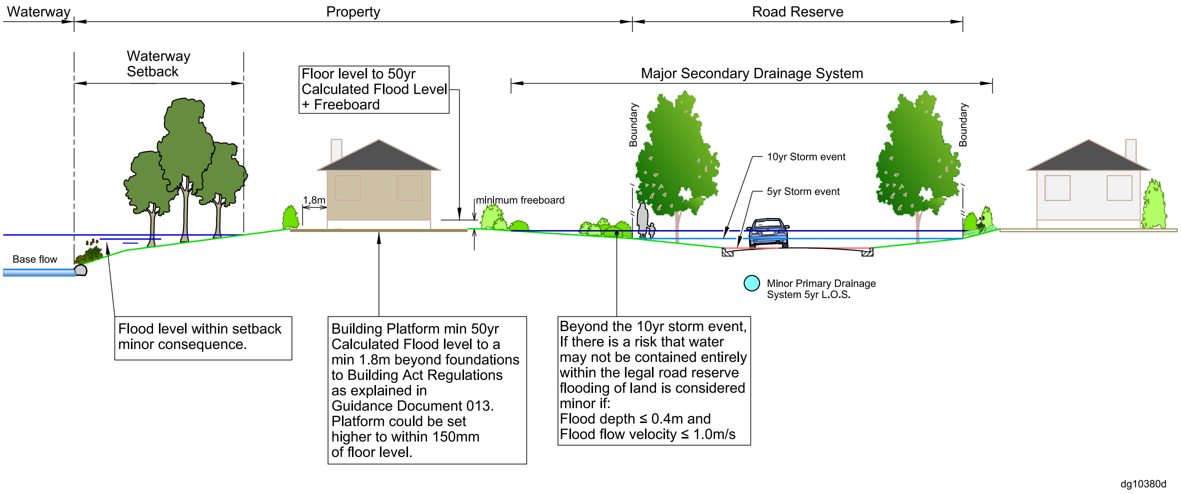

Figure 1 Minimum floor levels

Table 1 Minimum freeboard

Building type	Minimum freeboard height (m)
Habitable building floors	0.4
Commercial and industrial buildings	0.3
Habitable building platforms	0.25

Note:

1) Freeboard is the provision for flood level design estimate imprecision, construction tolerances and natural phenomena (e.g. waves, debris, aggradations, channel transition and bend effects) not explicitly included in the calculations.
2) Discuss commercial and industrial developments with special circumstances with the Council.
3) In circumstances where ponded water on roads will exceed 100mm a greater freeboard may be required.

Discuss protection standards in tidal areas with the Ecan and the Council at an early stage. Storm surge and tsunami hazards, climate change and sea level rise must be considered, and a precautionary design approach is recommended.

5.6.5 Bridges and culverts

Design all bridges and culverts to enhance the visual qualities of the site. Bridges must have an attractive appearance. Refer to the *Bridge Manual* and *WWDG Part B* chapter 13 for waterway design at bridges and culverts.

5.6.6 Protection of road subgrade

The potential risk of carriageway damage from a saturated sub-base is a design issue. Early discussion with the Council is needed when the maximum level of detained water in any ponding area is higher than 200mm below any carriageway or right of way within a horizontal distance of 80 metres. Provide evidence that the road subgrade will not be compromised. Special pavement or pond design may be necessary.

5.6.7 Outfall water levels

The Council will provide the start water level at the point of connection to the public stormwater system or at some point downstream where design water levels are known, as a subdivision consent parameter.

When a tributary drain or a waterway flows into a much larger drain or a much larger waterway, the peak flows generally do not coincide. Check both the situation where the tributary has reached peak flow but the receiving waterway has not and where the receiving waterway is at peak flow but the tributary has passed it. Take the worst case as the design case (refer to *WWDG Part B* clause 22.5.2).

5.6.8 Alternative technologies

Alternative technologies will be considered on a case by case basis. These may include bio-retention devices (rain gardens and stormwater tree pits) or proprietary in-line filtration devices.

5.6.9 Stormwater pumping

Permanent stormwater pumping will only be permitted under exceptional circumstances. Refer to *WWDG Part B* clause 13.6 pages 13-15.

5.6.10 Liquefaction

Liquefaction Vullnerability categories are shown on the Vulnerability Map tab of apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer. Clauses 4.4.9 – Liquefaction and 4.6.2 – Seismic considerations (Geotechnical Requirements) provide further detail on the application of these maps when designing piped infrastructure.

5.7 Waterway Design

Design waterways in accordance with *WWDG Part B* chapters 7 to 13 inclusive. Maintain fish and invertebrate passage, unless otherwise authorised by the Council or by the ECan. Refer to *WWDG Part B* clauses 2.2 and 13.2.3.

Provide access along at least one side of any waterway for maintenance, taking into account the “reach” of cleaning machinery. Vegetate berms and banks and lay at slopes that are stable, not prone to scour in flood flows and maintainable.

5.7.1 Constructed waterways

Design constructed waterways to meet the aesthetic and amenity criteria of the Council (see *WWDG Part B* chapters 7 to 9, 11 and 12). These waterways must form part of a surface water management system.

Protect constructed waterways, which will be maintained by the Council, by easement where they will not be placed in public ownership.

5.7.2 Natural waterways

Restore the natural character and enhance amenity values of highly modified natural waterways wherever possible.

Where it is possible, avoid the piping or filling in of natural waterways. Where the activity is unavoidable, a resource consent from the Council and the Ecan will be required for this activity.

Provide for drainage, landscape, ecology, heritage, recreation and cultural values when enhancing these waterways. Refer to *WWDG Part A* for an understanding of the principles underpinning these values and *WWDG Part B* Chapters 7 to 9, 11 and 12 for information about specific criteria. For information about riparian planting refer also to the *Streamside Planting Guide*.

Create Local Purpose (Esplanade) Reserves around significant natural waterways.

5.7.3 Hill watercourses

All hill watercourses that will receive stormwater discharges from development must be stabilised with permanent materials. Permanent materials include suitably bedded and stabilised rock lined channels and pipes. Vegetation is not a permanent material.

This requirement may be waived where the development consists of a small number of residential properties whose hard surface runoff is attenuated though a suitably sized rain tank and distribution system and that discharges at least 5 metres inside the boundary of each property, such that overland flow will not be increased over the natural rate of runoff.

5.7.4 Operations and maintenance manual

Provide an Operations and Maintenance Manual in accordance with *WWDG Part B* clause 19.2 for any water quantity and/or quality control structures or formed features such as ponds. The manual must describe the design objectives of the structure, describe all the major features, identify all the relevant references to the *WWDG* and identify key design criteria (including any conditions attached to the relevant resource or other consents).

A separate section must explain operations such as the recommended means of sediment removal and disposal, and identify on-going management and maintenance requirements such as landscape establishment, vegetation control and nuisance control. Amend Appendix II - Generic Guides for Riparian Maintenance (Reserves, Streetscape and Open Spaces), to show the required maintenance regime for all plantings. Clause 10.11 – Establishment (Reserves, Streetscape and Open Spaces) expands on these requirements.

Submit the manual for engineering acceptance as part of the Design Report.

5.7.5 Fencing

The *Water Supply and Wastewater Bylaw* requires consent for the erection of a fence across a waterway. Fences must not significantly impede flood flows up to the minimum protection standards (Refer *WWDG Part B* clause 13.9).

5.8 Stormwater Disposal

5.8.1 Approved outfall

The discharge for a development must be authorised by Ecan. This can be achieved by conforming to the Stormwater Management Plan or complying with the conditions of the discharge consent held by council.

The outfall for a development must be either the public stormwater drainage system or an approved alternative stormwater disposal system.

A suitable outfall and if required a dissipating structure must be constructed at the outlet to ensure no erosion occurs in the immediate vicinity of the waterway. No obstruction which will impede the natural flow may be placed in the channel.

When designing outfalls, in addition to *WWDG Part B* clause 14.7 - Pipe outfall structures, consider:

- the surrounding land use now and in the future;
- maintenance of the outfall including its potential for siltation;
- geotechnical constraints including the site's bearing capacity, potential groundwater movement and seismic effects;
- fish passage;
- backflow prevention;
- structural design where vertical heights are over 1.5m.

CSS: Part 3 contains acceptable outfall details.

5.8.2 Discharge to ground

Surface water infiltration systems may be used for developments in rural areas or for developments in urban areas, if connection to the public system is not feasible and ground conditions are suitable for soakage (Refer to *WWDG Part B* 6.5). Carry out a geotechnical assessment when considering the large-scale use of infiltration systems.

A discharge consent may be required from Ecan for discharge to soakage.

Design and locate infiltration systems to allow easy access for maintenance. Refer to the Council's webpage *Small Site Stormwater Attenuation* for further information.

5.8.3 Stormwater tanks

Stormwater tanks on private properties can regulate stormwater discharge from connected impervious areas such as roofs, hardstand areas and driveways. The Council may recommend or require a stormwater tank when:

> the public stormwater system downstream has no capacity for a new connection and it is uneconomic to upgrade it;

> direct discharge to a hill gully or slope is likely to cause erosion.

Refer to the Council's webpage *Small Site Stormwater Attenuation* for further information.

The Council may approve a request from a private property owner to install a stormwater tank for water conservation or other reasons.

Refer to the Council's leaflet *Stormwater Tanks on Private Properties* for further guidance, including installation guidelines.

5.9 Reticulation Layout

5.9.1 Topographical considerations

In steep terrain, the location of pipes is governed by topography. Gravity pipelines operating against natural fall create a need for deep installations, which can be very expensive. They can also create basins with piped outlets.

The pipe layout must conform to natural fall as far as possible. Where basins are created, provide a fail-safe outlet. At basins a higher level of service for the downstream primary system may be required.

5.9.2 Location and alignment of stormwater pipelines

Locate stormwater pipeline mains within the legal road (but not under the crown of the carriageway unless the wastewater sewer is located elsewhere) or within other public land. Allow for access for construction or future maintenance.

Position pipes as follows:

> within the road formation (refer *WWDG Part B* clause 14.2.1).

> within public land with the approval the Council.

> within drainage reserves.

> within private property (if unavoidable) adjacent to, and if possible parallel to, boundaries, with a minimum offset to the pipe centreline of one metre.

Make crossings of roads, railway lines, creeks, drains and underground services at right angles, as far as practicable.

Allow for possible future building plans when locating proposed pipes and avoid maintenance structures within the property. This may include specifying physical protection of the pipe within or adjacent to the normal building areas or any engineering features (existing or likely) on the site e.g. retaining walls.

5.9.3 Clearances from other services or structures

Clause 9.5.3 – Typical services layout and clearances (Utilities) summarises clearances for utility services. Confirm these clearances with the network utility operators, before deciding on any utility layout or trench detail.

Locate pipes that are adjacent to existing buildings and structures clear of the "zone of influence" of the building foundations. If this is not possible, undertake a specific design covering the following:

> protection of the pipeline;

> long term maintenance access for the pipeline;

> protection of the existing structure or building.

Specify the protection on the engineering drawings.

5.9.4 Curved pipelines

The straight-line pipe is usually preferred as it is easier and cheaper to set out, construct, locate and maintain in the future.

Curved pipes must be to the manufacturer's design and construction standards and be used only where approved by the Council.

5.9.5 Building over pipelines

The *Water Supply and Wastewater Bylaw* defines the Council's requirements and protection for the drainage works.

5.9.6 Easements

Easements are required for constructed waterways and in those instances when there are secondary flow paths through private property. Provide easements for public pipelines and public subsoil drains through private property or where private pipelines serving one property cross another.

Equation 1 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 operation and maintenance.

5.10 Reticulation Detailing

5.10.1 Pipeline connections

Make pipeline connections in accordance with *CSS: Part 3*.

Design the stormwater drainage system as a separate system (i.e. with no inter-connections whatsoever with the wastewater system).

5.10.2 Minimum pipe sizes

The minimum diameter Council stormwater pipe within the carriageway is 225mm.

5.10.3 Minimum cover

Where the minimum cover complying with the manufacturer's specifications is not achieved, pipelines must be adequately protected from external loadings.

5.10.4 Gradients and acceptable flow velocities

Refer to *WWDG Part B* clause 14.2.4.

5.10.5 Structures

Design inlets and outlets in accordance with *WWDG Part B* clauses 14.6 and 14.7. Install debris grills where blockage is a potential problem. Provide for operational requirements.

Consider the effects of inlet and tailwater controls when designing culverts, as set out in *WWDG Part B* clause 22.9.

Take backflow effects into account in design. Consider outlet design and water level conditions in the design of discharges to existing stormwater systems and waterways and incorporate backflow prevention if necessary.

Where pipes discharge onto land or into a waterway outlet, if required design structures to dissipate energy and minimise erosion or land instability. Ensure velocities are non-scouring at the point of discharge. Acceptable outlet velocities will depend on soil conditions, but should not exceed:

> 0.5m/s where the substrate is cohesive; or

> velocities given in *WWDG Part B* Clause 22.7 Table 22-5.

5.10.6 Manholes and sumps

Provide manholes and sumps in accordance with *WWDG Part B* clause 14.4 and 14.5 and *CSS: Part 3*.

Council prefers the use of wavy sump grates as detailed in *CSS: Part 3* SD 301/5 where they meet the requirements of that site. In addition to the single sumps in *WWDG Part B* clause 22.10.2 - Sump capacity, the capacity per standard or cycle safe wavy grating unit, allowing for partial blockage of the sump grating, is:

Table 2 Grate capacity (l/s)

	Inline	Valley
Cycle safe sump unit	15	40
Wavy sump unit	20	40

Do not locate sumps in kerb crossings. Where sumps are located in this position; consider the relocation of either the sump or crossing; detail the installation of a cycle safe wavy sump top or; detail a corner sump top and provide additional drainage capacity elsewhere if necessary. Balance the means of providing sufficient inlet capacity against cyclist safety perceptions when selecting and locating sump grates, to ensure all uses of the roadway are optimized.

Where the manhole is likely to experience differing movement from the pipeline under seismic loading, replace the yield joints with flexible joints e.g. *CSS: Part 3* SD 341/4. These may mitigate the potential for damage by allowing some longitudinal movement at the structure.

Consult the Council before embarking on any part of the system design where the velocity is such that the flow will not progress smoothly through the manhole into the discharge pipe.

Check the effects of turbulence or hydraulic grade on pressure within manholes. Where pressures may expel manhole covers, assess options to maintain public safety e.g. by installing safety grates or fixing down the manhole cover. No feature should impede flow through a manhole. The flow deviation angle between the inlet and outlet pipes must not be greater than 90 degrees, as shown in Figure 1 in clause 6.6.1 – Location and spacing (Wastewater). If circumstances necessitate such a feature, widen the cross section of the manhole to counteract any potential head loss. The design must be accepted by the Council.

Secure manholes against uplift in accordance with *WWDG Part B* clause 14.4.

Where a special manhole cannot be constructed with a standard riser the lid must:

> meet the *WWDG Part B* clause 14.4 requirements for structural design, as confirmed by a Design Certificate;

> have minimum concrete strength and cover of 40 MPa and 50mm respectively;

> conform to the geometric requirements of SD 302 or SD 303, whichever is relevant.

5.10.7 Subsoil drains

Design subsoil drains, which are installed to control groundwater levels, in accordance with *WWDG Part B* clause 5.3.1.

Refer to manufacturer's literature for information on pipe materials, filter fabrics, bedding and filter design.

5.10.8 Pipelines in permeable ground

Where a buried pipeline is likely to encounter an underground source of water, ensure that the groundwater in the water bearing layers will not be diverted to a new exit point through the backfill. Specify backfill material with the same permeability as the surrounding ground and detail water migration barriers at any change of ground permeability.

5.10.9 Steep gradients

Provide adequate anchorage for the pipes, through designing thrust or anchor blocks or by utilising restrained pipe systems.

Specify water stops on all pipelines with gradients steeper than 1:3. Where 'firm mix' is used for haunching water stops are not required. *WWDG Part B* clause 14.2.3 details the design criteria to consider before installing concrete water stops, additional to those relating to permeable ground. Specify water stops constructed to comply with *CSS: Part 3* SD 347.

5.10.10 Pipe ducts

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. Pipe ducts shall be required for any pipes crossing the alignment of a newly constructed NZTA expressway or motorway. Installation of additional pipe ducts shall be required for future proofing purposes for any pipeline anticipated to be required with 50 years.

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 or steel. Pipe class strengths shall be designed to meet maximum anticipated loading and asset life of the greater of 100 years or 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 steel. Corrosion protection design is required for steel ducting.

Duct size shall allow for minimum annulus spacing of 50 mm between the duct and appropriate flange connector or coupler fitting for the pipeline or 20% greater than the diameter of the appropriate flange connector or coupler fitting, whichever is greater. This also applies to ducts installed under railways. For design purposes, assume the duct size meets minimum compliant ID standards and flanges or couplers meet maximum OD dimensional standards. When gravity pipelines are to be inserted into the duct, duct sizing may need to be increased to allow for pipeline design grades to be achieved. Centraliser and casing spacing systems are required and shall be specified in the design drawings. Detail how the duct, in the case of a future proof duct, or duct annulus will be sealed to prevent ground or surface water ingress. Grouting or installation of any flowable fill within the annulus is strictly prohibited since the ducts shall be designed and constructed to allow easy installation and extraction of the pipe.

The grade the duct needs to be designed and laid to take into consideration grade requirements of the pipe installed in the duct and whether the pipeline is gravity or pressurised. Design such that no high points are created. If high points are unavoidable, an air valve is required for pressurised pipelines.

Duct positioning shall allow for adequate space and staging area for the removal of the entirety of the pipeline length from flange to flange or coupler to coupler or combination thereof from the duct.

SDR11 PE100 pipe material shall be installed within the duct for all pressure pipe applications to allow for pipe de-rating due to risk of scratching or gauging the pipe during installation. Alternative material/wall thickness options for gravity pipe installations will be considered/approved by CCC on a case by case basis. Detail flange connection and fitting details at each end.

5.11 Connection to the Public System

5.11.1 Individual lots and developments

The connection of individual lots and developments to the public system must meet the following requirements:

- Connection must be by gravity flow via laterals to mains or waterways, or to a roadside kerb or swale or rain tanks, or (in certain situations) on-site detention tanks;
- Provide all new urban lots with individual service laterals located at least one metre from the top of the vehicle crossing cutdown;
- Each connection must be capable of serving the entire building area of the lot (unless approval is obtained from the Council to do otherwise);

> Provide stormwater connections at such depth at the boundary of urban lots that a drain is able to be extended from the connection, at grades and cover complying with the Building Act, to the farthest point on the lot;
> The minimum diameter of connections must be:
  - 100mm for residential lots.
  - 150mm for commercial/industrial lots.
  - 150mm for connections serving three or more dwellings or premises (unless otherwise approved by the Council);
> Where the public system is outside the lot to be served, extend a connection pipeline a minimum of 0.6m into the net site area of the lot;
> Connection to features such as vegetated swales, soakpits, or soakage basins is acceptable provided the system is authorised by the Ecan and adverse effects and potential nuisances are addressed;
> Seal all connections to pipelines or manholes by removable caps at the upstream end, until such time as they are required.

5.11.2 Connection of lateral pipelines to mains

Connections of laterals to mains must be in accordance with *CSS: Part 3*.

5.12 Means of Compliance

5.12.1 Surface water

Surface water hydrology must be in accordance with *WWDG Part B* chapter 21.

5.12.2 Estimation of surface water run-off – peak flow rate

Estimation of the peak flow rate for localised urban catchments must be in accordance with *WWDG Part B* (**December 2011 update**) chapters 21, 22 and Appendix 10.

For the Banks Peninsula area, a recognised alternative flood estimation method supported by good hydrological information may be presented for consideration.

5.12.3 Estimation of surface water run-off – volume

Estimation of the peak flow rate must be in accordance with *WWDG Part B* (**December 2011 update**) chapters 21, 22 and Appendix 10.

5.12.4 Sizing of the stormwater drainage system

Drainage system hydraulics must be in accordance with *WWDG Part B* chapters 20 and 22.

5.12.5 Soakage systems

Design of the soakage systems must be in accordance with *WWDG Part B* chapter 6.

5.12.6 Pipe flow

Determine pipe diameters, flows and gradients from *WWDG Part B* Appendix 11.

For pipes not flowing full use Manning's equation adopting 'n' values from *WWDG Part B* Table 22-1. Determine part full pipe flow relationships from *WWDG Part B* Appendix 9.

5.12.7 Energy loss through structures

Refer to *WWDG Part B* chapter 22 for guidance on energy loss through structures.

5.12.8 Determination of water surface profiles

Design stormwater drainage systems in accordance with *WWDG Part B* clauses 14.6 and 22.10, by calculating or computer modelling backwater profiles from the specified outfall water level set by the Council as stated in clause 5.6.7 - Outfall water levels. On steep gradients, both inlet control and hydraulic grade line analysis must be used, and the more severe relevant condition adopted for design purposes. For pipe networks at manholes and other nodes, water levels computed at design flow must not exceed finished ground level while allowing existing and future connections to function satisfactorily.

An example of stormwater system analysis including a backwater calculation is provided in *WWDG Part B* Appendix 5.

Stormwater pipelines generally operate in a surcharged condition at full design flow. Pipe diameters chosen on the basis of pipe flow graphs, such as *WWDG Part B* Appendix 9 (which uses pipeline gradient rather than hydraulic gradient), are likely to be conservative in parts affected by free outfall conditions.

5.12.9 Stormwater quality

Design for surface water runoff quality in accordance with the Stomwater Management Plan for the catchment. Provide macro-pollutant traps, basins and wetlands to *WWDG Part B* chapter 6 in greenfield or large brownfield developments.

Design rain gardens to treat stormwater in small urban areas that are being redeveloped. Where the above treatment options are not practicable or where installing large trees, design stormwater tree pits. Refer to the *Rain Garden Design, Construction and Maintenance Manual*.

All these treatment options require a consent to discharge stormwater to ground.

Refer to clause 5.3 - Consent and compliance issues.

Ensure the design considers the ongoing maintenance requirements and costs. Specify verification through testing and commissioning that the constructed option achieves design infiltration rates, treatment levels and volumes specified.

The designer may propose alternative design elements with supporting evidence from recognised authorities.

5.12.10 Fish Passage

Waterways and stormwater systems to be designed in accordance with New Zealand Fish Passage Guidelines. Appendix G of guidelines has minimum standards.

5.13 Construction

Construction must be carried out in accordance with *CSS: Part 3*.

Wherever works are installed within existing legal roads, the developer must 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.

5.13.1 Reducing waste

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

- Plan to reduce waste during site clearance 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 waste by selecting materials with minimal installation wastage.
- 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.

5.13.2 Materials

All materials must comply with those listed on the Council's web page for approved materials at www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list. Use Appendix III- Wastewater Material Selection Table of Part 6: Wastewater Drainage as a guide when specifying materials.

Proposed pipes and concrete structures that are likely to lie within the blue zones shown on Plan No. RG005102 R01 *Aggressive Groundwater Map* (refer to Appendix IV - Aggressive Groundwater Map of Part 6: Wastewater Drainage) will need additional protection such as an external plastic wrapping membrane.

5.13.3 Bedding, haunching and backfill

Design bedding, haunching and backfill to conform to clause 6.14 – Haunching and Backfill (Wastewater Drainage) including clauses 6.14.2 – Difficult Ground Conditions and clause 6.14.3 – Scour. Bedding and haunching materials must comply with *CSS: Part 3* and the pipe manufacturer's specifications.

Where works will produce redundant in-ground piping or manholes, specify treatment of the potential void as detailed in clause 6.14.4 – Redundant infrastructure (Wastewater Drainage).

Specify wrapping of the joints in all concrete rubber ring jointed pipes with a geotextile that complies with TNZ F/7 strength class C. Wrapping of joints is not required in 'hillside' trenches backfilled with lime stabilised material. Select a geotextile that will prevent the infiltration of backfill or natural material into the stormwater system where pipes break under seismic loading.

Haunching for plastic pipes shall be wrapped with a geotextile that complies with TNZ F/7 strength class C when the pipe is in a location with high liquefaction vulnerability. Consider wrapping where the proposed pipeline extends into a medium liquefaction vulnerability area. Use engineering judgment where the site is in a location where liquefaction damage is possible or where the liquefaction category is undetermined. Wrapping may improve the longitudinal strength of the pipeline, reducing the likelihood of a earthquake causing potential alterations in grade. Liquefaction vulnerability categories are shown on the Vulnerability Map tab of apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer.

Specify backfill materials individually. The material used must be capable of achieving the backfill compaction requirements set out in *CSS: Part 1* clause 32.0 - Backfilling and clause 5.10.8 - Pipelines in permeable ground.

5.14 As-Built Information

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

Part 6: Wastewater Drainage

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6.1 Referenced Documents

Planning and Policy

- The *Christchurch District Plan*
  www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- 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

Design

- *Christchurch City Council Odour and Corrosion Management Design Guide*
- Christchurch City Council *Sewage Pumping Station Design Specification*
  www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/sewage-pumping-station-design-specification
- Christchurch City Council *Subdivision Bulletin 27 - Wastewater Capacity Certificates*
  www.ccc.govt.nz/consents-and-licences/news-and-information/
- New Zealand Building Code *Compliance Document G13 Foul Water*
  www.building.govt.nz/building-code-compliance/g-services-and-facilities/g13-foul-water
- New Zealand Transport Agency *Bridge Manual* (2013)
  www.nzta.govt.nz/resources/bridge-manual/bridge-manual.html
- Water Services Association of Australia *Pressure Sewerage Code of Australia* WSA 07-2007
- Water Services Association of Australia *Vacuum Sewerage Code of Australia* WSA 06-2008
- AS/NZS 2566.1:1998 *Buried flexible pipelines - Structural design*
- AS/NZS 3725:2007 *Design for installation of buried concrete* pipes
- AS/NZS 5065:2005 *Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications*
- AS/NZS 4131:2010 *Polyethylene (PE) compounds for pressure pipes and fittings*
- AS 3996:2006 *Access covers and grates*
- PIPA POP010A *Polyethylene Pressure Pipes Design for Dynamic Stresses* May 2010
  www.pipa.com.au/index.php/technical/pop-guidelines
- PIPA POP101 *PVC Pressure Pipes Design for Dynamic Stresses* Feb 2009
  www.pipa.com.au/index.php/technical/pop-guidelines

> Australasian Society for Trenchless Technology *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking* www.astt.com.au/guidelines

> Lauchlan, C., Forty, J. and May, R., *Flow resistance of wastewater pumping mains,* Proceedings of the Institution of Civil Engineers 158 (WM2), (2005)

> Water Industry Specification 4-34-04 *Specification for renovation of gravity sewers by lining with cured-in-place pipe* March 1995
www.water.org.uk/technical-guidance/water-standards/wiss-and-igns/

Construction

> 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 *Level 2 functional description template* (TRIM 09/367127)

> Christchurch City Council *Pumping Station O&M Manual Template Draft*
www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/pumping-station-design-specification

> Christchurch City Council *CWW Tagging Convention*
www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/pumping-station-design-specification

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).

Contact Council for access to those Council reference documents available only through TRIM.

6.2 Introduction

6.2.1 History of the city's wastewater system

Christchurch City's wastewater system differs from most other cities in New Zealand in that, due to the terrain, the early design decisions made extensive use of flatter than normal sewer grades. Further decisions to limit sewer depths in the rapidly expanding network, in the 1920's, resulted in a large number of pumping stations in the system.

The standard of specification and supervision of construction has always had a high priority, meaning that, on average, the system is in good condition despite its age.

Because of the flat grades, traditional maintenance methods involved regular flushing and cleaning of pipelines with water supplied from shallow wells. Mains-supplied water is now used for flushing and consequently the cost and conservation of water is important.

Banks Peninsula presently has seven public sewerage schemes, to which approximately 3,600 properties are connected - Akaroa, Diamond Harbour, Duvauchelle, Governors Bay, Lyttelton, Tikao Bay and Wainui. There are also approximately 600 properties that have connections but are currently unconnected.

The remaining properties on Banks Peninsula dispose of their wastewater by other means - generally from their own on-site wastewater treatment systems.

6.2.2 Changes in design philosophy

Since the Christchurch Drainage Board Design Manual was last revised in 1986, there has been a move towards self-flushing methods.

The application of the 'simplified sewerage design' method, which is based on 'tractive force' theory, provides a more robust method of ensuring self-cleansing velocities are achieved. Tractive force theory is modelled on the migration of sediment in small increments along a pipeline as pulses of turbulent flow pass.

Although the series of earthquakes from September 2010 highlighted the potential for longitudinal settlement under seismic loading, no additional grade allowance is being required as tractive force theory provides steeper grades than those that were previously constructed and found to be workable, albeit with more frequent cleaning.

Clauses 4.4.9 – Liquefaction and 4.6.2 – Seismic considerations (Geotechnical Requirements) provide further detail of Liquefaction Vulnerability Areas and their application when designing piped infrastructure. Use engineering judgement where proposed infrastructure traverses the boundaries of areas or where it is located in areas where liquefaction damage is possible or undefined. The Liquefaction Vulnerability is shown on the Vulnerability Map tab of apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer.

The IDS does not eliminate provision for flushing but encourages greater use of self-flushing grades, particularly at the head of catchments. Some relaxation of the degree of flushing elsewhere in the system is offered in return.

Pumping station designs now use submersible type pumps and are generally standardised, particularly for subdivisions.

6.2.3 Water Supply and Wastewater Bylaw

The *Water Supply and Wastewater Bylaw* defines the Council's requirements and protection for the drainage works.

6.2.4 New developments

Gravity reticulation, with conventional pumped systems where necessary, remains the preferred method of reticulation for most developments but consider alternative technologies for new developments on the perimeter of the older system. Council will also consider pressure sewer systems (PSS) where there are downstream capacity constraints or the site has significant construction issues.

In areas where gravity reticulation systems are not achievable due to grades or long distances, common pressure main or PSS systems, including small privately operated and municipal systems, are an option subject to the Council's approval. Each lot must have an individual wastewater pump connected to a common pressure main system.

Standard plans (subject to charge) and specifications for submersible pumping stations are available from the Council.

Odour treatment design is included in this Part of the IDS. Odour treatment are required at the terminal of all rising mains likely to generate.

6.2.5 Design lifetime

All wastewater reticulation systems are expected to last for an asset life of at least 100 years with appropriate maintenance. Design the systems accordingly, to minimise life cycle costs for the whole period. Maintenance in design and future serviceability must be considered to ensure future feasibility of repair and maintenance methodology and costs. Unlined concrete manholes and pipes should only be used where the average airflow concentration of H_2S is less than <0.1ppm and the peak airflow concentration is less than 1ppm.

6.2.6 Alternative technology

Consider alternative technologies in areas of high liquefaction vulnerability as defined on the Vulnerability Map tab of apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer. Examples of such technologies are PSS and vacuum systems. In addition to Table 1, areas suitable for implementing PSS are defined in the Outline Development Plan (ODP) in the District Plan. These technologies may also be appropriate in particular circumstances in other areas of the city and Banks Peninsula.

The Council will only consider vacuum technologies complying with clause 6.10 – Vacuum sewers on a case-by-case basis, where other methods are inappropriate.

Table 1 LR zone versus reticulation system

System	High liquefaction vulnerability areas	Very low, low and medium liquefaction vulnerability areas
Gravity	Possible option but need to discuss with Council	yes
PSS	Possible option but need to discuss with Council	no
Vacuum	Possible option but need to discuss with Council	no
Max depth for gravity	3.5m	Lesser of 5.0m or 3.0m below WT
Wrap plastic pipe haunching	yes	not required

6.3 Quality Assurance Requirements and Records

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

6.3.1 The designer

The designer of all wastewater systems that are to be taken over by Christchurch City Council must be suitably experienced. Their 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.

6.3.2 Design records

Provide the following information to support the Design Report:

- all options considered and the reason for choosing the submitted design;
- hydraulic calculations, preferably presented in an electronic form;
- all assumptions used as a basis for calculations, including pipe friction factors;
- a valid wastewater capacity certificate as described in *Subdivision Bulletin 27 - Wastewater Capacity Certificates;*
- design checklists or process records;
- design flow rates;
- system review documentation as detailed in clause 6.4.9 – System review;
- thrust block design calculations, including soil bearing capacity;

> trenchless technology details, where appropriate;
> calculations carried out for the surge analysis of pressure pipes where appropriate.

6.3.3 Construction records

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

> performance test results;
> material specification compliance test results;
> compaction test results;
> subgrade test results;
> confirmation of thrust block ground conditions and design;
> CCTV records;
> site photographs.

Provide the Council with a certificate for each pipeline 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-Builts including manufacturer, diameter, type, class, jointing and contractor who laid the pipe.

6.3.4 Approved materials

All materials must comply with those listed on the Council's web page for approved materials at www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list and with the material specifications in the *Sewage Pumping Station Design Specification*..

6.3.5 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 3* clause 14.0 – 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 the *Sewage Pumping Station Design Specification*.

6.4 Sanitary Sewer Design Flows

Sanitary sewer flows vary with the time of day, the weather and the extent and type of development within the catchment. Design systems to carry maximum flows without surcharging.

The maximum wastewater flow is given by:

Equation 1 Maximum flow

MF = P/A x SPF x ASF

where MF = Maximum flow occurring during wet weather (l/s)

P/A = Dry weather diurnal peak to average ratio (clause 6.4.1)

SPF = Storm Peak Factor including infiltration (clause 6.4.2)

ASF = Average Sewage Flow (clause 6.4.3 or 6.4.5)

Design pipelines with sufficient capacity to cater for all existing and predicted development within the area to be served. Make allowance for all areas of subdivided or unsubdivided land that are capable of future development.

When calculating the unit ASF, the net area used includes roads but excludes reserves.

All diameters are nominal bore, unless otherwise noted. PE only is specified by a nominal outside diameter (OD).

6.4.1 Peak to average ratios

Use a peak/average ratio (P/A) of 1.8 for wastewater reticulation design.

6.4.2 Dilution from infiltration and inflow

Infiltration is the entry of subsurface water into the pipeline through cracks and leaks in the pipeline. Inflow is the direct entry of surface water to the pipeline from low gully traps, downpipe discharges and illegal stormwater connections. Infiltration and inflow together account for approximately one third of Christchurch's annual wastewater flow.

For new developments, apply a storm peak factor (SPF) of 2.78 to the peak wastewater flow to allow for infiltration and storm inflow. When determining the minimum (self-cleansing) flow for the tractive force calculation, use a SPF of 1.0.

Infiltration and Inflow (I & I) can be reduced when designing greenfield pressure sewer systems. Nominate a SPF for pressure sewer system design in (both greenfield and) developed areas and explain the supporting rationale in the design report.

6.4.3 Average residential wastewater flows

Residential flows are derived from a water use of 220 litres per person per day. The unit average wastewater flow is given by:

Equation 2 Unit ASF

$$\text{Unit ASF} = \text{persons/hectare x litres/person/day}$$

And

Equation 3 ASF

$$\text{ASF} = \text{unit ASF x area}$$

Further examples of unit ASF values for different residential zones, and corresponding maximum flows per hectare, are shown in Table 2.

Table 2 Unit ASF values

Zoning	Minimum net density (households/ ha)	Unit ASF (l/s/ha)	MF (l/s/ha)
Residential New Neighbourhood (RNN)	15	0.10	0.51
Residential Suburban (RS)	15	0.10	0.51
Residential Suburban Density Transition (RSDT)	22.5	0.15	0.77
Residential Medium Density (RMD)	30	0.21	1.03
Central City Residential (CCR)	300	2.00	10.0
Central City Mixed Use (CCMU)		2.00	10.0
Residential Hills (RH)	9	0.062	0.31
Residential Large Lot (RLL) (flat land)	6	0.041	0.21
Residential Large Lot (RLL) (Port Hills)	4	0.027	0.14
Residential Small Settlement (RSS)	8	0.055	0.28
Residential Banks Peninsula (RBP)	15	0.10	0.51

Note:
1) If there is any scope for further infill development, increase the net density to allow for this.
2) For mixed density developments or zonings not covered by Table 2, detail in the Design Report how the design flows, based on Table 2 values, were determined.

6.4.4 Maximum flows for new developments

Calculate the maximum flow for new developments using Equation 1.

For example, at an assumed residential population density (RNN) of 15 households per hectare, with a corresponding unit ASF of 0.10 l/s/ha (from Table 2) and a development area of 1 hectare, calculate the maximum flow as follows:

Equation 4 Maximum flow calculation example based on area

$$
\begin{aligned}
MF &= \textit{P/A ratio} \times \textit{SPF} \times \textit{ASF} \\
&= 1.8 \times 2.78 \times (0.10\ \ell/s/ha \times 1\ ha) \\
&= 0.451\ \ell/s
\end{aligned}
$$

Where the actual number of lots is known, use Equation 5. If there is any scope for further infill development, increase the number of lots to allow for this.

E.g. For a residential subdivision of 200 lots:

Equation 5 Maximum flow calculation example based on number of lots

$$
\begin{aligned}
ASF &= \text{number of lots} \times 220\ \ell/\text{person/day} \times 2.7\ \text{persons/lot} \\
&= 200\ \text{lots} \times 220\ \ell/\text{person/day} \times 2.7\ \text{persons/lot} \\
&= 118{,}800\ \ell/\text{day} \\
&= 1.38\ \ell/s
\end{aligned}
$$

$$
\begin{aligned}
MF &= 1.8 \times 2.78 \times 1.38\ \ell/s \\
&= 6.88\ \ell/s
\end{aligned}
$$

6.4.5 Average commercial and industrial wastewater flows

Wastewater flow from commercial developments is derived from a water use of 1 litre per second per 1,000 of population (where this is known). Unless other figures are available, use the values in Table 3.

Table 3 Commercial and industrial unit ASF values

Zoning	Unit ASF (l/s/ha)	Unit MF (l/s/ha)
Commercial Local (CL)	0.09	0.45
Commercial Core (COR)	0.15	0.75
Central City Business (CCB)	2.00	10.0
Central City Mixed Use (CCMU)	2.00	10.0
Industrial General (IG) - suburban	0.15	0.75
Industrial General (IG) - inner city	0.38	1.90
Industrial Heavy (IH)	0.38	1.90
Industrial Park (IP)	0.09	0.45

Note:

1) Where the type of commercial or industrial zoning is not known, assume IH.

2) For zonings not covered by Table 3, detail in the Design Report how the design flows, based on the Table 3 values, were determined.

3) The gross area of malls was used in calculating ASF values.

For known industries, base design flows on available water supply and known peak flows. Ensure that the design flow allows for potential wet industries, using Table 3.

Use Equation 1 for industrial areas greater than 15 hectares.

When assessing whether a wet industry can be reasonably accommodated in an area that is reticulated but not fully developed, leave sufficient flow capacity in the pipeline to serve remaining developing areas at a unit ASF of 0.15 l/s/ha (provided that no other wet industries are being planned).

6.4.6 Total design flows for existing developments

Base the design of major renewal and relief sewers (greater than 375 ID) serving older catchments on actual catchment performance. As the performance, which is derived from flow monitoring, is not always available, discuss larger reticulation requirements with Council.

6.4.7 Size of private sewer drains

The minimum size of private gravity sewer drains must be 100mm diameter.

For major industrial users, determine the size of the lateral using the maximum flow requirements and the available grade.

6.4.8 PSS design flows

For residential designs, MF is not used as the storage chamber and pump dampen the peak flows. Determine the design flow and either a probability assessment of the maximum number of pumps operating at any time or through dynamic modelling, using the ASF defined in clause 6.4.3 - Average residential wastewater flows or clause 6.4.5 - Average commercial or industrial wastewater flows.

6.4.9 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:

- pipe and fittings materials are suitable for the particular application and environment;
- pipe and fittings materials are approved materials;
- pipe class is suitable for the pipeline application (including operating temperature, surge and fatigue where applicable);
- seismic design - all infrastructure is designed with adequate flexibility and special provisions to minimise the risk of damage during an earthquake, and with consideration for the cost and time to repair any potential damage. Provide specially designed flexible joints at all junctions between rigid structures (e.g. pump stations, bridges, buildings, manholes) and natural or made ground;
- layout and alignment meets the Council's requirements;
- maximum operating pressure will not be exceeded anywhere in the pressure pipe system;
- capacity is provided for future adjacent development.

6.5 Gravity Pipelines

Design pipes to withstand all loads, including hydrostatic and earth pressure and traffic, in accordance with *Buried flexible pipelines - Structural design and Design for installation of buried concrete pipes*. Design pipes exposed to traffic to HN-HO-72 axle loading only, as described in clause 3.2.2 of the *Bridge Manual*.

6.5.1 Alignment

Lay gravity pipelines in straight lines and at a constant gradient between access points such as manholes and inspection chambers. Discuss major reticulation and its potential for significant traffic disruption at an early stage with Council.

Lay wastewater pipes in the centre of the road in general, with a minimum vertical cover of 1.2m. This makes the sewer equidistant from the properties it serves, and, being at a relatively high point on the road surface, vented manholes are less subject to surface floodwater entry. Refer to clause 6.14 – Haunching and Backfill for further information regarding depths of pipes.

In curved roads, straight lengths of wastewater pipelines must clear kerbs by 2.0m and manholes should be on the centreline. To minimise manhole numbers, they may be sited between the quarter point and the centreline.

The preferred solution for wastewater reticulation is to avoid easements over private property.

Equation 6 Easement width

The easement width is the greater of:

- 2 x (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 operation and maintenance.

6.5.2 Temporary ends

Extend wastewater sewers to the upstream boundary of new developments, to allow for connection of any future upstream catchments. Terminate the main at an access point.

6.5.3 Minimum gradients

Design minimum gradients to maintain self cleansing flows, using the 'simplified sewerage design' method, which is based on 'tractive force' theory and uses the following parameters:

Minimum tractive force, τ	1 N/m^2
Minimum proportional depth of flow, d/D	0.2
Maximum proportional depth of flow, d/D (84% pipe–full capacity)	0.7
Manning's roughness (n)	0.013

Calculate the minimum (self cleansing) flow using Equation 7 but the minimum flow value should not be less than 1.5 l/s. It is important not to overestimate this value as the smaller the flow, the steeper the necessary gradient. If the flow is overestimated, the gradient chosen could be too flat to self-cleanse. 1.5 l/s has been chosen to represent the discharge from a single water closet or similar fitting.

Equation 7 Minimum self cleansing flow

SCF = P/A x ASF

where SCF = minimum self cleansing flow (l/s)

P/A = Dry weather diurnal peak to average ratio (clause 6.4.2)

and ASF = Average sewage flow (clause 6.4.3 or 6.4.5)

Determine the minimum pipe gradient that meets the tractive force and proportional depth requirements for the minimum self cleansing flow from either Equation 8 or by using Appendix I – Tractive Force Design Charts. Use hydraulic models for pipes over 300mm diameter as the charts are not applicable at these larger diameters.

Equation 8 Minimum pipe gradient

$$i_{min} = 5.64 \times 10^{-3} \times SCF^{-0.461}$$

where i_{min} = minimum gradient in m/m and SCF = minimum self cleansing flow (l/s)

An example calculation is illustrated in Appendix II – Determination of Minimum Gradient and Hydraulic Design Example.

Consider detailing flush tanks where their use may reduce the need for a pump station. Present a non-conformance report in this instance.

6.5.4 Hydraulic design

Gravity pipelines maintained by the Council must have a minimum diameter of 150mm for residential and 175mm for industrial or commercial applications. 175mm diameter incorporates an allowance for future 'wet' industries, normally 8 l/s.

Determine the minimum pipe diameter that meets the tractive force and proportional depth requirements for the maximum flow using either Equation 9 or Appendix I – Tractive Force Design Charts. An example calculation is illustrated in Appendix II – Determination of Minimum Gradient and Hydraulic Design Example.

Equation 9 Minimum pipe diameter

$$D_{min} = 24.35 \times \left[\frac{MF}{i_{min}^{1/2}}\right]^{3/8}$$

D_{min} = minimum pipe diameter in mm

Size pipelines to cater for future flows from the upstream catchment, when fully developed.

6.5.5 Deep pipelines

Limit the maximum pipe depth in High Liquefaction Vulnerability areas to 3.5m to invert. Limit the maximum depth in Very Low, Low or Medium Liquefaction Vulnerability areas to the shallower of 5.0m to invert or 3.0m below the watertable. Liquefaction Vulnerability is shown on the Vulnerability Map tab of apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer. Pipelines with cover exceeding 4.0m in depth require structural design.

6.5.6 Inverted siphons on sanitary sewers

Inverted siphons are sometimes necessary when passing major obstacles such as rivers and large drains. Problems associated with inverted siphons derive primarily from an accumulation of solids when velocities are reduced during low flow. Accumulated solids can give rise to odour problems, make the wastewater more septic, and restrict peak flows. Remember that the water seal blocks airflows and can affect the ventilation pattern.

Size the pipes to give peak daily velocities as per Section 6.5.3 Hydraulic design and Section 6.8.2 Velocity. If flows are expected to increase significantly with time or there are significant differences in dry and wet weather flow scenarios, install two different sized pipes, giving three possible modes of operation. These modes of operation may be used progressively in steps, as flows build up over time, by the removal of plugs or via weirs. Design the plugs to be easily removable and provide details in the Design Report. Also, consider network redundancy, maintenance in design and future serviceability. This may trigger the requirement for duplicate pipelines.

Provide an O&M manual for all siphons.

To improve the transmission of solids, the maximum pipeline slopes must be 45° and 22.5° on the downward and upward legs respectively, with manholes placed to make cleaning easier. Because bedding conditions are often difficult, concrete-lined steel pipes and bends of cast iron are commonly used. Differential settlements are likely to occur between the manhole and the siphon piping so give special attention to the joints in these areas.

It may be necessary to surround piping with concrete under waterways that are dredged from time to time. It may also be necessary to provide isolation valves to help flush siphons.

Do not install siphons on any lateral.

6.5.7 Collector sewers

Design collector sewers where the sewer main is deeper than 2.5m and laterals would discharge to the sewer main. Detail the collector sewers to collect from individual property laterals and discharge into the sewer main at manholes. The sewer main then effectively acts as a trunk sewer.

Design collector sewers parallel to the sewer main and preferably directly over and falling in the same direction as the sewer main. Design grades as detailed in clause 6.5.3 – Minimum gradients, but ensure depths provide service to all properties. Where levels will constrain constructing a single grade, it is acceptable to fall the collector sewer against the sewer main grade as shown in Figure 1.

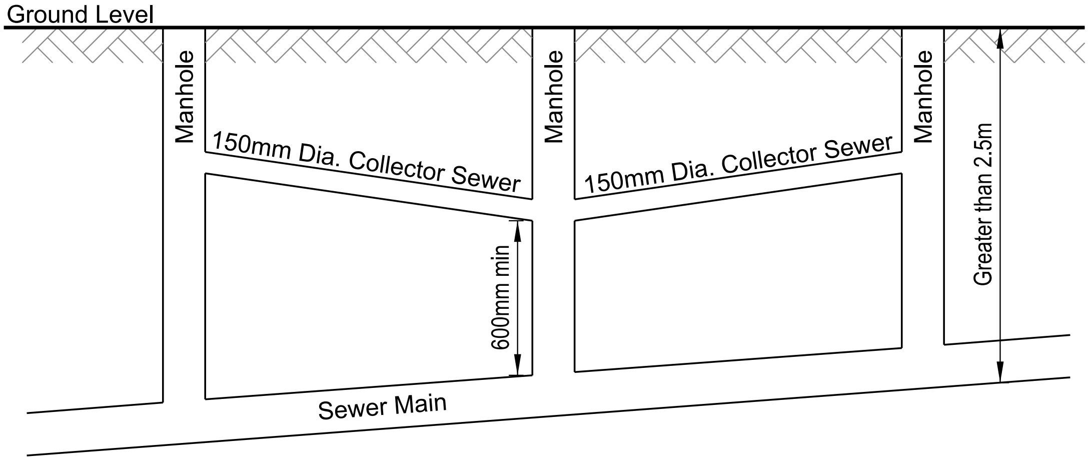


Figure 1 Collector sewer

Detail drop manholes on the collector sewer outlet only when the invert is 1.0m or more above the sewer main soffit. Detail flexible joints, to clause 6.6.3 – Structural design, on the collector sewer.

6.6 Manholes

Check the effects of turbulence or hydraulic grade on pressure within manholes. Where pressures may expel manhole covers, assess options to maintain public safety e.g. by installing safety grates or fixing down the manhole cover.

Consider plastic manholes where concrete manhole corrosion due to the presence of H_2S is likely e.g. immediately downstream from pressure sewer outfalls. Design manholes to clause 6.6.3 - Structural Design including mitigation of flotation or liquefaction related movement. Design the manhole cover's support structure to disperse traffic loads as required by the manhole's load bearing capacity and provide a producer statement confirming this design. Detail robust flexible connections that provide the equivalent design life to the adjacent infrastructure. Similarly, consider plastic inspection chambers where corrosion is an issue and provide equivalent details to those discussed above. Constraints on depth within the *CSS: Part 3* will also apply.

6.6.1 Location and spacing

Manholes should, preferably, be positioned on roadways or where there is vehicle access. The flow deviation angle between the inlet and outlet pipes must not be greater than 90 degrees, as shown in Figure 2. Ensure the distance between incoming pipes in the manhole complies with *CSS: Part 3* SD 303.

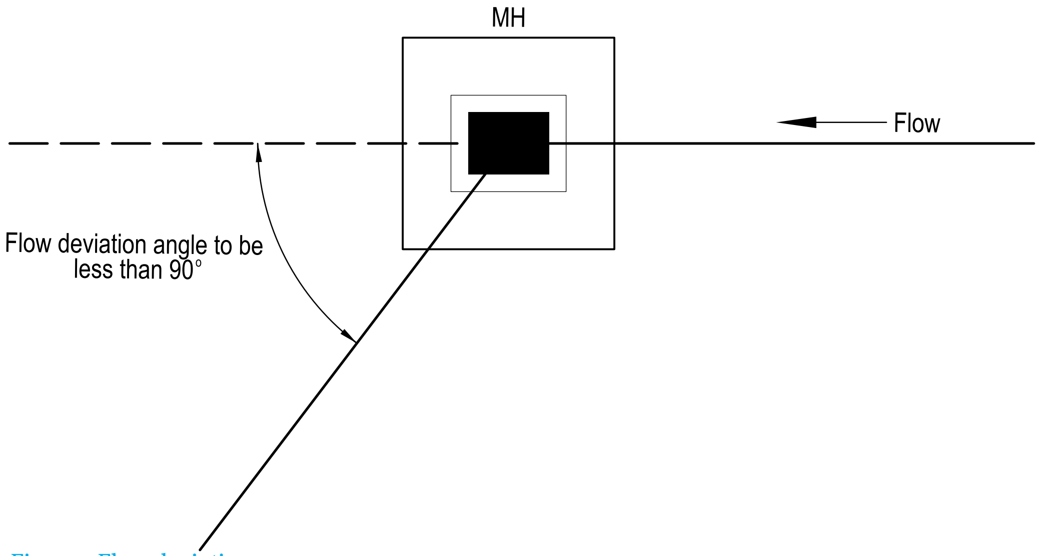


Figure 2 Flow deviation

Table 4 specifies the range of maximum spacings.

Table 4 Spacing for manholes

Diameter in mm	Maximum spacing (m)
150 – 225	100
300 – 900	120
1050 – 1500	150
1600 and above	180

6.6.2 Vented manholes

Vented manholes are designed to serve as intakes for fresh air, which passes through the sewers and laterals to the main vents on individual houses, disposing of corrosive and foul air in a way that causes minimal offence. However, occasional temperature inversions cause the air to flow in reverse and inlet vents should also be located so that any foul air coming from them causes minimal offence.

Use vented manholes on each alternate manhole cover and place them where there is minimal turbulence, to avoid undue odours. Avoid features such as angles, junctions and summit manholes, and rising main outlets.

To avoid surface water entry and the associated gorging of pipelines, site vented manholes away from areas where ponding of stormwater is likely to occur. If this is not possible, install vent stacks on the road boundary. Show on the wastewater engineering drawings the extent of flooding at which secondary flow paths are activated, to verify that vented manholes will not be affected. Likewise, avoid road intersections because gravel and grit entry is greater at these locations.

Special consideration must be given to large trunk sewers (larger than 450 mm ID) as these may be inadequately vented by house connections. To ensure that air movement adequately serves all parts of a sewer, it may be necessary to use special air inlets, special vent stacks and/or a forced draught with designed circulation, possibly in conjunction with odour control (Refer to clause 6.11 –Odour Treatment). Note that siphons cut off all airflow, unless special air ducting is incorporated.

6.6.3 Structural design

Design structures to withstand all loads, including hydrostatic and earth pressure and traffic, in accordance with the *Bridge Manual*. Design structures exposed to traffic to HN-HO-72 loading.

Manholes must comply with *CSS: Part 3* SD 302, 303 or 304, or with other Council approved designs. Provide yield joints between manholes and pipes in accordance with *CSS: Part 3* SD 341. Where the structure is likely to experience differing movement from the pipeline under seismic loading, replace the yield joints with flexible joints e.g. *CSS: Part 3* SD 341/4. These may mitigate against the potential for damage by allowing some longitudinal movement at the structure.

A specific design is required for larger pipes, especially where changes of direction are involved. The design must incorporate a standard manhole opening and be able to withstand a heavy traffic loading HN-HO-72.

Check all chambers for flotation, including under seismic conditions. The factor of safety against floating should be at least 1.2 excluding skin friction in the completed condition, with an empty camber and saturated ground. Counter increased forces resulting from greater depths and spans by thicker walls, counterweighting or reinforcing.

Unreinforced vertical concrete panels, provided for future connections in manholes or other underground structures, which are subject to soil and traffic loading should be specifically designed. Alternatively, in the case of a square panel, ensure that the length of the side does not exceed seven times the panel thickness.

Consider the foundation conditions as part of the design. If there is a possibility of soft ground, carry out ground investigations and a full foundation design.

6.6.4 Drop structures in manholes

Drop manholes are a potential source of blockages. Lay pipelines as steeply as possible to avoid any need for a drop.

When a wastewater pipe must enter a manhole with its invert level more than 200mm higher than the soffit of the outlet pipe, provide a drop manhole as detailed in *CSS: Part 3* SD 305. Clause 6.5.7 - Collector sewers modifies these requirements on collector sewers.

6.6.5 Fall through manholes

The minimum fall in the invert of angled wastewater manholes is set out in Table 5.

Table 5 Minimum fall in manhole

Angle of deviation	Minimum fall (mm)
60° - 90°	20
30° - 60°	10
0° - 30°	5

When there is an increase in the pipe size at a wastewater manhole, the soffit of an inlet pipe must not be lower than the soffit of the outlet pipe.

6.7 Wastewater Pumping Stations

Refer to the *Sewage Pumping Station Design Specification* for all details relating to public pumping stations. All Council pump stations or pump stations to be vested to Council require odour treatment in accordance with Christchurch City Council Odour and Corrosion Management Design Guideline to remove odours and corrosive gases. Acceptable odour treatment units typically include bark or mixed media biofilters, two-stage bioscrubber / activated carbon treatment unit or single-stage activated carbon treatment units. All activated carbon units are required to contain a fan and heater. It is up to Council's discretion to determine acceptance of a proposed odour treatment unit for a specific site upon receipt of a design and options evaluation report showing life-cycle costs.

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 or processing plants that differ from standard, submit full level 2 functional descriptions before coding, using the *Level 2 functional description template*.

6.8 Pressure Pipelines

Rising main design is affected by the performance of the downstream pumping station. Carry out the design of these components together to provide an integrated and efficient system.

Minimise the time fluids spend in a rising main. Design rising mains to prevent wastewater from becoming septic. Maintain velocities high enough to transport solids and prevent solids accumulation. These objectives can be achieved by minimising the length and diameter of the pipe.

Rising mains and PSS pipelines will also need to withstand static and friction heads of long duration, together with short duration water hammer pressures. Once pipe diameters are selected, match pipe class selection to pump, flow and surge characteristics. Allow for fatigue (cyclic dynamic stresses) from a large number of stress cycles over a 100-year lifecycle when selecting the pipe pressure class.

Water hammer and surges can arise from a number of different operations, e.g. the sudden starting or stopping of a pump or closure of a non-return valve. Water hammer can be critical in pumping systems, especially in large diameter rising mains and high static head systems. For details on designing for surge and fatigue see the *Sewage Pump Station Design Specification*, *Polyethylene Pressure Pipes Design for Dynamic Stresses* and *PVC Pressure Pipes Design for Dynamic Stresses*.

Consider soft closing, non-return valves for installations in high head situations.

Submit the design for rising mains, including levels and layout, with the Design Report. Submit a detailed hydraulic surge and fatigue analysis report, including all assumptions and all calculations. Where the rising main is over 100m long or greater than 150mm diameter, model the main's performance.

Consider seismic effects, temperature differentials and the Poisson's effect in flexible pipes. Design end restraints to compensate for this where necessary. Design for lateral spread in high liquefaction vulnerability areas e.g. by drilling pipelines under rivers or designing flexibility at connections to bridges. Design for traffic loads, where the minimum covers in clause 7.9.5 – Cover over pipes are not achieved.

Implement maintenance in design to mitigate operational and maintenance issues and to improve resilience during the design life of the pipeline system. Maintenance in design considerations include:

> Failure of any mechanical surge protection measures, and protection of assets from damage during these situations;

> Future serviceability for example by including adequate drain points;

> Provision of network redundancy, especially for pipelines with difficult access, pipelines installed under rivers or pipelines where maintenance access will result in public disruption including heavily trafficked roads, motorways and expressways. This may trigger the requirement for installation of duplicate pipelines or an emergency backup pipeline; and

> Material selection, joint restraint and/or flexible expansion joints to increase the resilience of critical assets.

Rising mains are normally constructed from polyethylene pipe.

6.8.1 Maximum operating pressure

Design the components of a pressure pipeline to withstand a maximum operating pressure that is no less than any of the following:

Equation 10 Maximum operating pressure

Maximum operating pressure is greater of:

> 400 kPa
> $1.5(H_s + H_f)$
> pump shut off head
> positive surge pressures

where H_s = static head
H_f = friction head

Ensure that external loads on the pipeline are included in all load cases, especially when pressure testing large diameter pipes. Provide a factor of safety of at least 2.0 against buckling under negative or external pressures.

For flexible pipes, such as glass reinforced plastic (GRP), PVC or polyethylene, the fatigue effects may define the pressure rating, which must be the greater of the maximum operating pressure calculated above, the minimum pressure rating in Table 6 or the equivalent operating pressure. To calculate the equivalent operating pressure (P_{eo}) for polyethylene use the methodology described in *Polyethylene Pressure Pipes Design for Dynamic Stresses*. For PVC, use the methodology described in *PVC Pressure Pipes Design for Dynamic Stresses* to confirm the pipe class.

Table 6 Minimum pressure ratings for flexible pipes

Material type	Pressure rating (kPa)
PVC-U	900
PE 80	800
PE 100	800
GRP	800
Concrete lined steel	800
DI	800

6.8.2 Velocity

The rising main velocity should be no less than 0.6m/s. Where lower velocities are unavoidable or where sediment or slime build-up may be an issue, introduce a daily scouring cycle. Maintain this cycle at a velocity that achieves the below target tractive shear stress for a duration sufficient to clear the line:

> For scouring of sediment the minimum tractive shear stress shall be 3 Pa.

> For the stripping of slime growth the minimum tractive shear stress shall be greater than 4 Pa.

Calculate the tractive shear stress using Equation 11.

Equation 11 Tractive shear stress

$$\textit{Tractive shear stress} = (Pa)\ \tau = \frac{f \gamma V^2}{8g}$$

where f = friction factor

γ = fluid density (N/m³)

V = flow velocity (m/s)

The friction factor ‘f’ should be determined from the Colebrook-White Equation 12.

Equation 12 Colebrook-White equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left\{\frac{k_s}{3.71D} + \frac{2.51}{Re\sqrt{f}}\right\}$$

where k_s = hydraulic roughness (m)

D = pipe diameter (m)

Re = Reynolds number (VD/v)

v = kinematic viscosity 1.11×10^{-6} m²/s at 15°C

The hydraulic roughness ‘ks’ may be calculated directly from Equation 13, as detailed in *Flow resistance of wastewater pumping mains*.

Equation 13 Hydraulic roughness

$$k_s\,(mm) = \alpha\, V^{-2.34}$$

where α = scaling coefficient

V = flow velocity (m/s)

Table 7 α values correspond to typical pipe sliming states which cover the range in Wallingford (2006) but with sliming state descriptions adapted to suit Christchurch design conditions. If a rising main is well managed with regular flushing, during normal operation the value α will typically fall into the range between good and poor and the hydraulic roughness k_s will vary accordingly.

Table 7 Values of the coefficient α for various sliming states

New	Good	Average	Poor	Neglected
0.06	0.15	0.6	1.5	6.0

Alternatively, the roughness value k_s is available in Table 8.

Table 8 Hydraulic Roughness (k_s) for various sliming states

Mean velocity	Sliming state versus k_s (mm)				
	New	Good	Average	Poor	Neglected
0.5m/s	0.30	0.60	3.0	6.0	30.0
0.75m/s	0.15	0.30	1.5	3.0	15.0
1.0m/s	0.06	0.15	0.6	1.5	6.0
1.5m/s	0.03	0.06	0.3	0.6	3.0
2.0m/s	0.015	0.03	0.15	0.3	1.5

Note: These k_s values are 'standardised' and so vary slightly from values calculated using Equation 13.

6.8.3 Gradients

Consider air movement through the system. Ideally rising mains should rise from the pumping station to termination. Surcharge all lengths sufficiently to keep the pipe full and prevent sudden discharges of foul air at pump start. Avoid creating summits since they trap air, reducing capacity, and allow the build up of sulphides, which convert to droplets of sulphuric acid and may cause pipe corrosion.

If a summit is unavoidable, provide automatic air release valves with drains to a sanitary sewer. Design the air valves specifically for wastewater operation. Mount air valves vertically above the pipeline to which the air valve is connected. (Fat or solids will block the connecting pipe if the valves are mounted to one side of the vented pipeline.) Fit an isolating gate valve between the air valve and the vented pipeline and mount the valves in a concrete valve chamber. The chamber must be large enough to allow easy access for maintenance staff to operate the isolating valves or remove all valves from the chamber. Specify that air valves on mains of 300mm diameter and less be installed on branches with the same diameter as the main.

Gradients are less important for temporary rising mains but consider creating vertical sections to provide pump starting head and pipeline charging. Wherever there are undulations in the line, consider installing air release valves.

6.8.4 Location and depth

Locate pressure sewer systems as recommended in clause 9.5.3 – Typical services layout and clearances.

Specify cover to pressure sewer system pipes complying with the requirements in clause 7.9.5 – Cover over pipes.

6.8.5 Valves

Consider detailing sluice and scour valves, particularly at troughs in the gradient. Consider isolation valves on long lengths of pressure pipe, particularly where there is insufficient capacity to store flows.

Sluice valves are defined in clause 7.10.1 – Sluice valves.

Label air valves with 10mm Helvetica text as specified in *CWW Tagging Convention* using a 200 x 70mm label on W/B/W traffolyte.

6.8.6 Thrust blocks

Specify thrust blocks to withstand the maximum operating pressure and the test pressure. Confirm the bearing capacity of the in-situ soil and the thrust block design and record as detailed in the Contract Quality Plan prior to installation.

Design and detail thrust blocks individually for any of the following situations, as the thrust block detailed in *CSS: Part 3* SD 346 is not appropriate:

- The test pressure or maximum operating pressure is greater than 390 kPa.
- The allowable ground bearing capacity is less than 50 kPa.

6.9 Pressure Sewer Systems

Generally use the *Pressure Sewerage Code of Australia* for the detailed design of pressure sewerage systems except as amended as follows.

Design the pressure sewer system (PSS) with sufficient capacity to cater for all existing and predicted development within the area to be served. Make allowance for all areas of subdivided or unsubdivided land that are capable of future development. In brownfield areas, the capacity of the existing downstream pressure sewer main may constraint the ability to add extra connections. Discuss reticulation requirements with Council.

Design PSS to allow for individual pumps and storage chambers located within each property and to these criteria:

> Total dynamic head of 45 - 55 metres

> Maximum in-network retention time of 4 hours (based on the weighted average of the accumulated retention time in each zone against the total number of connections)

> Provide emergency storage equivalent to 24 hours of average sewage flow (ASF) in the pump unit and storage chamber

> The minimal pipe length and diameter appropriate, to reduce detention times.

Construct PSS pipelines from polyethylene pipe.

6.9.1 Cleansing velocity

Verify that the design velocity in Table 9 is achieved in all PSS pipelines.

Table 9 Minimum cleansing velocity

Pipe size (DN)	Velocity (m/s)	Full pipe flow (l/s)
40	1.00	0.80
50	1.03	1.29
63	1.06	2.17
75	1.08	3.16
90	1.11	4.65
110	1.13	7.03
140	1.16	11.84

Note: Pipe assumed to be in a 'good' state, with a scaling coefficient $\alpha = 0.15$.

6.9.2 Air valves

For PSS, design out the need for air valves except at significant high points.

Design the PSS air valve to include the minimum head required to seal the air valve and so remove the requirement for drainage. Detail any air valves as specified in clause 6.8.3 - Gradients.

6.9.3 Location and Depth

Locate PSS as recommended in clause 9.5.3 – Typical services layout and clearances. Minimise road crossings through designing PSS submains where practical.

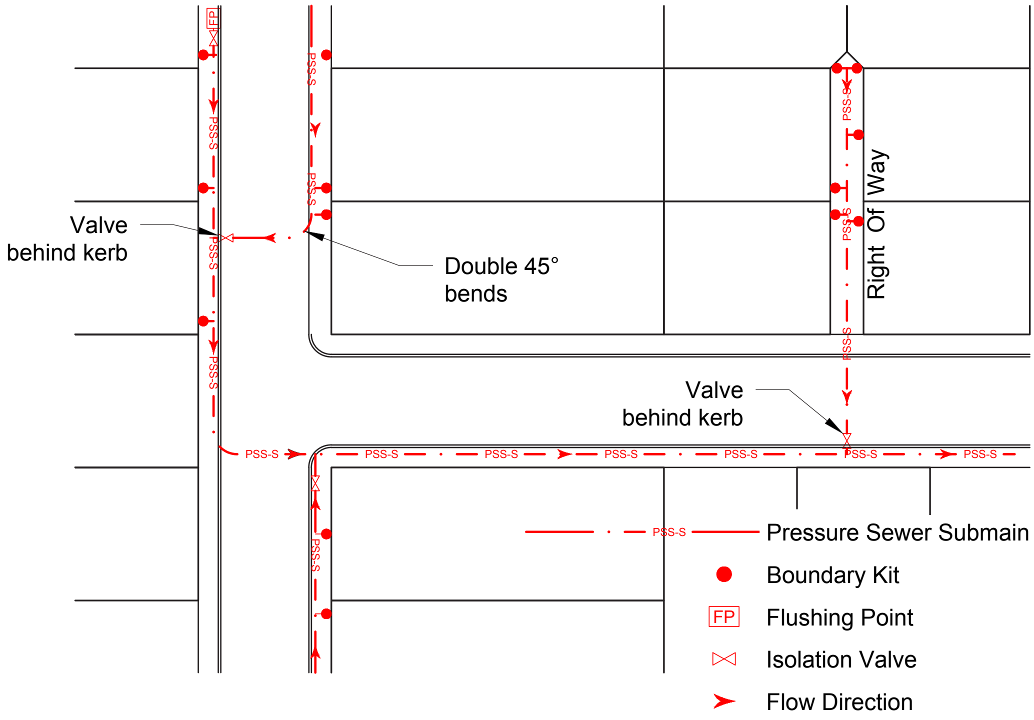


Figure 3 Typical PSS Layout - Submains only

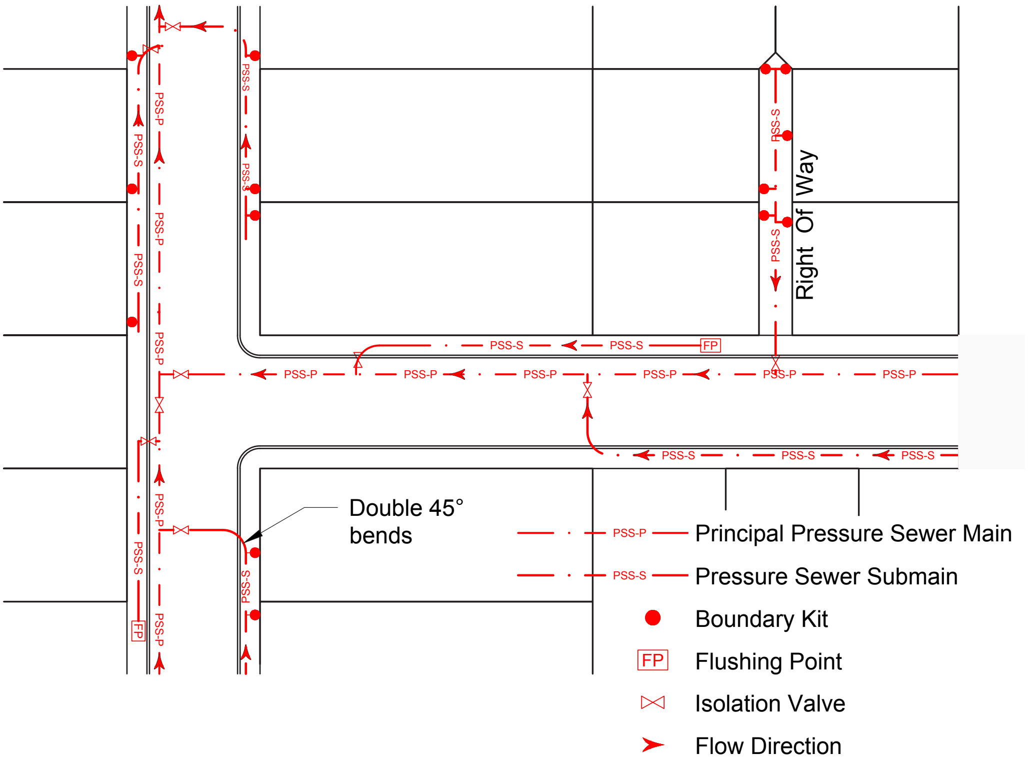


Figure 4 Typical PSS Layout - Mains and Submains

Pressure sewer mains 90mm OD and above are classed as principal mains. Lay principal mains within the carriageway, offset between 1.2 – 1.5m from the kerb face. Locate principal sewer mains on the opposite side of the carriageway from the watermain.

Show the PSS profile including the pressure sewer main depth on the design drawings. Provide a longsection of any main on the hill where the outfall is below the rest of the designed reticulation, showing air egress or ingress. Also provide a longsection where any grade deflection exceeds 250mm in total. Show the flow direction on the design plans.

Pressure sewer mains 90mm OD and above and crossovers in legal road should have a minimum cover of 750mm and a maximum cover of 1.1m. Pressure sewer submains and laterals shall have a minimum cover of 600mm where likely to be crossed by vehicles and 450mm elsewhere.

Provide mechanical protection, in the form of a 1m x 1m concrete protection slab compliant with SD342 Type E, where pressure sewer reticulation crosses under principal water mains (150mm diameter and above). This is to mitigate cross contamination of the water supply network in the event the services are damaged.

Specify bending radii greater than 100 x OD of the pipe where the pipe may be tapped on the bend or radii greater than 75 x OD otherwise.

6.9.4 Isolation valves

Detail isolation valves:

> on both upstream legs of any three way branch.

> on the pressure main just downstream of the last house serviced by the pressure sewer system.

> sufficient to allow isolation of any section of the network containing a maximum of 20 properties.

6.9.5 Detailing

The supply, installation and commissioning, by an authorised installer, of an approved PSS will be at the expense of the property owner under a building consent. Where the subdivision or building consent requires the installation of a PSS, all components of the residential PSS will vest with Council except the lateral between the house and the storage chamber. Where the subdivision or building consent requires the installation of a PSS in commercial or industrial areas, Council will only own the network up to and including the boundary kit.

Connections between new houses and pump chambers must be carried out by an authorised drainlayer.

Locate all PSS boundary kits within the service strip. For reticulation in a right of way, install a pressure sewer submain and locate the boundary kits within the right of way adjacent to each property. Detail an isolation valve behind the kerb. An easement shall be provided over the submain.

To minimise head losses on the pressure sewer lateral, detail multiple 45° bends or shallower instead of 90° deflections.

Detail a 50mm diameter flushing point on mains under DN160mm. Detail 75mm diameter flushing points on all mains DN160 and above. Locate flushing points offset from the main i.e. in the berm.

Laterals shall only connect to submains. Submains are defined as pipes below DN 90mm. Pipes DN90 and greater shall be classed as principal mains; and located in the carriageway on the opposite side to the principal watermains, on an alignment of 1.0m off the kerb.

6.10 Vacuum Sewers

The Council will only consider vacuum technologies on a case-by-case basis where other methods are inappropriate. Design vacuum sewerage systems using the *Vacuum Sewerage Code (WSA 06)*, amended as follows.

Use the following guidelines for the detailed design of vacuum systems:

> Water Environment Federation *Alternative Sewer Systems*, MOP FD-12 (2008)

> BS EN 1091:1997 *Vacuum sewerage systems outside buildings*

> *Airvac Design Manual 2012*.

Contact Council to determine whether existing vacuum sewer systems have the capacity to service additional connections. Specify hardware and fittings consistent with adjacent vacuum system infrastructure, to minimise operational requirements.

6.10.1 Location and depth

Locate vacuum collection chambers in non-trafficable areas of the legal road, and provide clearances between vacuum mains and other utility services, as specified in clause 9.5.3 – Typical services layout and clearances.

6.10.2 Hydraulic design

Ignore the requirement for vacuum generation rates *in WSA 06* clause 5.1 – General. Design sewer discharge pump starts that conform to the *Sewage Pump Station Design Specification*.

Design flows in accordance with clause 6.4 – Sanitary sewer design flows. The definitions and abbreviations in table 9 of *WSA 06* equate to the following:

Table 10 Definitions WSA to IDS

WSA 06 definition	IDS definition
'Design Flow'	Maximum Flow (MF) to IDS clause 6.4
Q_{max} or Maximum Sewage Flow	Maximum Flow (MF) to IDS clause 6.4
Q_a or Average Daily Flow	Average Sewage Flow (ASF) to IDS clause 6.4.3

In addition to the requirements of clause 6.4 - Sanitary Sewer Design Flows, allow for potential future connections from infill. Provide the flow estimations at every node and branch in tabular form in the Design Report, to permit design review and asset recording and to inform the design of future connections.

Consider larger mains up to 315mm diameter where large zones necessitate a single main. The recommended maximum liquid flow for a 315mm PE main is 29.3 l/s.

WSA-06 Table 5.3 gives maximum allowable design flows for different diameter PE80 polyethylene pipes. Note that the 90mm bore given is incorrect - this should be 76.7mm, not 93.3mm. The recommended maximum liquid flow given is correct. This table may be applied to PE100 flows as the SDR remains at 13.6 and the internal bore is the same.

6.10.3 Controls and telemetry system

Provide wireless telemetry monitoring of each vacuum collection chamber. Ensure that infrastructure is located to facilitate monitoring.

6.10.4 Vacuum sewer design

Detail minimum covers for vacuum mains of 750mm and a maximum depth to invert of 1800mm. Detail a minimum cover for vacuum laterals of 600mm. Consider special cover requirements when renewing or laying new pipes in streets with a high crown and dish channels (refer to IDS clause 7.9.5 – Cover over pipes).

Specify polyethylene pipe and materials complying with clause 6.13.1 – Approved materials including post-formed polyethylene bends that don't exceed 45°. Detail jointing of PE pipes and fittings with diameters less than 125mm OD using only electrofusion couplers.

Locate division valves upstream of every branch connection on both the trunk and the branch main. Consider operational issues when locating division valves. Couple valves with a thrust restrained dismantling joint to allow straightforward removal and replacement. Provide at least one maintenance riser for each vacuum main connecting to the vacuum station.

Specify gravity lateral sewers from the collection chamber to each property boundary complying with *CSS: Part 3*, with a minimum diameter of 150mm. Where detailing bends of up to 90 degrees, ensure materials and installation comply with clause 6.13.1 – Approved materials and *CSS: Part 3*.

Design systems to negate the requirement for air admittance devices. Install air admittance devices only where specified by the interface valve supplier.

6.10.5 Collection chambers

Design economical layouts that limit the number of properties connected to each collection chamber to four. Provide confirmation of the valve supplier's approval to support the non-conformance in the Design Report when proposing connecting more than four properties to a chamber.

Ensure that the MF to a standard collection chamber containing a single vacuum interface valve doesn't exceed 0.19 l/s. Where single point flows with MF in excess of 0.19 l/s are to be intercepted with a vacuum system e.g. from schools or other public or commercial facilities, use an interceptor chamber (also known as a buffer tank) containing one or more interface valves.

Allow no more than 25% of the total MF to the entire vacuum system and no more than 50% of the total MF to any single vacuum sewer to enter via interceptor chambers. The MF limits for interceptor chambers are 0.95 l/s for a single valve chamber and 1.9 l/s for a dual valve chamber. The use of three or more valves is possible in single or multiple interceptor chambers; however approval must be sought from the interface valve supplier and be recorded as a non-conformance in the Design Report.

Avoid detailing an interceptor chamber to intercept flows from existing gravity reticulation and pump station discharges as this reduces system reliability. Where a pumped flow is to be intercepted, take the MF to the collection chamber as the maximum capacity of the pump rather than the calculated gravity flow from the connections to the pumping station. The allowable MF to the collection chamber must still be within the limits specified above.

Specify an internal breather for the vacuum collection chamber sump and valve controllers that is capable of supplying air to the controller should the chamber be inundated with liquid. If there is no internal breather, install the breather pipe intake in a vent stack, located against the boundary to minimise the likelihood of vehicular or malicious damage. Locate the vent intake a minimum of 500mm above ground level.

Provide 400 litres storage volume in the collection chamber sump. Provide a storage volume equal to 12 hours of the total ASF from all connections, using the volume in each collection chamber sump and the gravity lateral sewers. Ensure that the storage at every chamber complies with the storage time requirement by providing additional volume if necessary or seek Council acceptance through a non-conformance report for a reduction in the storage time where it is not feasible.

Locate valves within 400mm of the surface. Specify watertight collection chamber access covers complying with clause 6.13.1 – Approved materials.

6.10.6 Commissioning, operation and maintenance

Provide a commissioning plan and a draft Operation and Maintenance Manual (OMM) with the Design Report. Include in the draft OMM a list of compatible replacement parts to be held by the Council's maintenance contractor.

6.11 Odour Treatment

All Council pump stations or pump stations to be vested to Christchurch City require odour treatment to remove odourous and corrosive gases.

Situations where odourous gases are most prevalent include anaerobic conditions, increasing hydraulic residence times, discharges from rising mains, discharges from pressure sewer systems, air valves, industrial and certain commercial discharges and turbulent flow conditions.

Refer to the *Odour and Corrosion Management Design Guide*.

6.12 Laterals

Limit the use of manholes on the public sewer main by installing direct connections that comply with *CSS: Part 3* SD 363. Where a manhole is not installed, specify an inspection point at the road boundary. On laterals over 50m in length, provide a trafficable inspection chamber over the junction of the last two laterals.

6.12.1 Sanitary junctions and laterals

Gradients are subject to BIA Regulations but the minimum gradient for a 100mm diameter pipe in roads is 1 in 80. Do not install siphons on any lateral without Council approval.

Each front lot must be provided with a separate lateral connection. Lay laterals at least 0.6m clear from property side boundaries, to terminate 0.6m inside the net site area of the lot. Haunch laterals, laid as part of a development, in accordance with this Part of the IDS. All materials used must be Council-approved.

Wherever possible, position each junction opposite the centre of each lot frontage, unless the position of the sanitary fittings is known and indicated otherwise.

Do not lay junctions on sewer mains deeper than 2.5m. Where junctions could be deeper than 2.5m, or where they are shallower and in areas with difficult ground conditions, design collector sewers parallel to the sewer main as detailed in clause 6.5.7 – Collector sewers. Where collector sewers are not detailed and the depth to soffit of the main sewer is more than 2.5m, risers may be used, subject to the requirements of other services and land levels. All other junctions must be side junctions.

Form all junctions with a Y or riser junction so that the side flow enters the main at 45°, to reduce deposition of solids.

Avoid lateral connections to manholes at the top of a line where minimum gradients are involved.

In accordance with the Water Supply & Wastewater Bylaw 2022, all existing private drainage to be re-used for infill development, including laterals serving existing dwellings, must be CCTV'd to confirm that they are free from defects.

6.12.2 Cover

Design the lateral grade and invert level to serve the lot adequately. If there could be conflict with other services, it may be necessary to lower the lateral.

The minimum level for a gully trap is calculated by starting from the soffit level of the main at the connection point. Add the minimum cover to the lateral and the elevation increase of the lateral to this soffit level. The minimum cover is set in the BIA regulations. The elevation increase over the lateral length is calculated assuming the lateral is laid at a gradient of 1 in 80 from the main to the gully trap.

Gully traps must be at least 1.0m above the soffit level of the sewer main. If the gully is lower than the crown of the road, ensure that the gully does not become an overflow for the sewer main in the event of a system blockage. Consider installing backflow prevention devices in places where this cannot be achieved.

On sewer renewal work, when a lateral is identified for renewal and runs close to trees as defined in *CSS: Part 1* clause 19.4 – Protection of Existing Trees, either reroute the lateral around the tree by repositioning the junction on the main, or use pipe bursting or similar techniques to relay the lateral in its present position. Specify jointing in accordance with *CSS: Part 3*, clause 11.1 – Laterals in Close Proximity to Trees.

6.12.3 Common drains

Read the following notes in addition to the BIA regulations.

New sewer mains installed in private property as part of a development and that serve only that development will be private common drains, unless Council specifies through a consent condition that they must be vested. If the developer considers a sewer main in private property should be vested, request this at the time of applying for subdivision consent.

Size the private common main using discharge units as specified in *Compliance Document G13 Foul Water*.

In developments serviced by sewer mains located at the rear of the lots (typically hill developments) extend the sewer main to the boundary of the last lot.

Haunch and backfill laterals laid at the time of development, including those in rights of way, in accordance with *CSS: Part 3* SD 344.

Provide Y junctions and laterals extending clear of the right of way for all lots. All laterals must finish 0.6m inside the net site area of the lot.

6.13 Material Selection

Use Appendix III - Wastewater Material Selection as a guide when specifying materials. Specify polyethylene materials for all wastewater mains where they cross waterways or which may experience lateral spread under seismic loading. Consider specifying polyethylene materials for wastewater mains installed adjacent to waterways, only where the grade is sufficient and constructability to comply with CSS tolerances is deemed acceptable.

6.13.1 Approved materials

A schedule of materials approved for use on the Council's infrastructure is on the Christchurch City Council web page at: www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list.

6.13.2 Reducing waste

When designing the development, renewal or new asset, 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 waste by selecting materials with minimal installation wastage.

> 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/.

6.13.3 Corrosion prevention

Corrosion can be caused by hydrogen sulphide, aggressive groundwater, saltwater attack, carbon dioxide or oxygen rich environments.

Design to minimise corrosion through:

> selecting materials which will resist corrosion;

> designing in an allowance for corrosion over the 100-year life-cycle of the asset;

> providing protective coatings;

> using the measures suggested in clause 6.13.4 - Aggressive groundwater.

Bolts and fittings must be hot dip galvanised and incorporate zinc anodic protection. All metal components must be protected from corrosion with a petrolatum impregnated tape system, applied in strict accordance with the manufacturer's specifications. Do not use stainless steel where it may fail as a result of crevice corrosion caused by cyclic stress in the presence of sulphides and chlorides.

6.13.4 Aggressive groundwater

Appendix IV - Aggressive Groundwater Map shows the areas that the Council have found to be subject to aggressive groundwater. Before specifying concrete pipes within 1km of these known areas, test the groundwater to check whether concrete piping is appropriate.

Regard groundwater as aggressive to ordinary Portland cement if any of the following criteria are met:

> over 35ppm calcium carbonate ($CaCO_3$) alkalinity and over 90ppm aggressive carbon dioxide (CO_2).

> under 35ppm calcium carbonate ($CaCO_3$) alkalinity and over 40ppm aggressive carbon dioxide (CO_2).
> pH less than six.
> sulphate greater than 1,000mg/l.

Measures to counter aggressive groundwater include:

> laying concrete pipes in concrete haunching.
> wrapping pipes with polyethylene film.
> providing a sacrificial layer of concrete.
> increasing cover to reinforcing.
> using special cements.
> coating pipes with bitumen, epoxy, or similar, before installation.
> use of alternative highly resistant pipe materials.

6.13.5 Sewers in commercial or industrial zones

Concrete pipes may be used only with approval from the Council and may require an internal sacrificial layers up to 25mm thick. This layer should not be taken into account in strength calculations. Using additives that promote chemical resistance, installing internal linings or specifying a pipe supplied with an internal lining system may be an alternative.

6.13.6 Gravity sewers immediately downstream of pressure pipelines

PVC, PE and concrete pipes are suitable for use in gravity sewer pipelines. Do not specify concrete pipes where it is likely that, in the future, a rising main will discharge to the top end of a gravity system because of the risk of attack from hydrogen sulphide.

Where a new rising main or PSS will discharge to an existing gravity system, mitigate against H2S corrosion and odorous gases by:

> detailing corrosion protection treatment or plastic structures for the receiving manhole and all additional manholes or structures within 400m.
> designing for velocities below 1.5 ml/s at the discharge point.
> reducing turbulence through detailing a minimum four metres length of gravity flow between the discharge chamber and the existing gravity sewer system and ensuring the flow enters the existing system at its invert.

Provide odour control at the receiving manhole where the fully developed system's maximum retention time exceeds 4 hours.

6.13.7 Steep gradients

Where gradients are steeper than 1 in 3 over lengths greater than 3.0m or where velocities are higher than 4.0m/s, and when flows are continuous or frequent, site-specific enigneering design specifying wear-resistant pipe is required (see Appendix III-Wastewater Material Selection Table). This requirement may extend past the termination of the steep grade. Sacrificial layers can be used in special concrete pipes, or in in-situ structures.

Avoid lateral junctions on these sections of pipeline. Take care to provide adequate anchorage for the pipes, through designing thrust or anchor blocks or by utilising restrained pipe systems.

6.14 Haunching And Backfill

Consider the whole trench, including the pipe, the in-situ material, the haunching and the backfill as a structural element. Design it to withstand all internal and external loads.

Specify wrapping of the joints in all rubber ringed jointed concrete pipes with a geotextile that complies with TNZ F/7 strength class C. Select a geotextile that will prevent the infiltration of backfill or natural material into the wastewater system where pipes break under seismic loading. Wrapping of joints is not required for pipes laid on ‘hillsides’, as defined in clause 6.14.3 – Scour.

Haunching for plastic pipes shall be wrapped with a geotextile that complies with TNZ F/7 strength class C when the pipe is in a location with high liquefaction vulnerability. Consider wrapping where the proposed pipeline extends into a medium liquefaction vulnerability area. Use engineering judgment where the site is in a location where liquefaction damage is possible or where the liquefaction category is undetermined. Wrapping may improve the longitudinal strength of the pipeline, reducing the likelihood of a earthquake causing potential alterations in grade. Liquefaction vulnerability categories are shown on the Vulnerability Map tab of apps.canterburymaps.govt.nz/ChristchurchLiquefactionViewer.

Use the manufacturer’s material specifications, design charts or computer models to design bedding and haunching, unless these provide a lesser standard than would be achieved through applying the requirements of *CSS: Part 3*. Provide details in the Design Report.

Specify backfill materials individually. The material used must be capable of achieving the backfill compaction requirements set out in *CSS: Part 1* clause 32 - Backfilling.

Earth loads on deep pipelines can significantly increase when pipes are not laid in narrow trenches e.g. embankments. However, where there is a danger of the surrounding soils or backfill migrating into the haunching or foundation metal, protect the haunching and foundation metals with an approved geotextile.

6.14.1 Pressure pipes

Haunch pressure pipelines as detailed in *CSS: Part 3* and design thrust blocks as detailed in clause 6.8.5 - Thrust blocks. In the case of upward thrust, reliance must be placed on the dead weight of the thrust block. Special design may be warranted where there are high heads, large pipes or unusual ground conditions.

6.14.2 Difficult ground conditions

Consider the ground conditions as part of the design. If there is a possibility of soft ground, carry out ground investigations.

Replacing highly compressible soils (such as peat) with imported granular fill material can cause settlement of both the pipeline and trench surface, because of the substantial increase in weight of the imported material. Refer to clause 4.6.3 – Peat (Geotechnical Requirements) for further information.

Haunching and backfill in these areas may need to be wrapped in filter cloth to stop the sides of the trench pushing out into the softer ground. Wherever the allowable ground bearing strength is less than 50 kPa, design structural support of the pipe and any structures.

Consider using a soft beam under the pipe haunching for support or using a flexible foundation raft. Retain joint flexibility. Difficult bedding conditions may warrant the use of piling, in which case smaller pipes may require some form of reinforced concrete strengthening to take bending between piles.

6.14.3 Scour

'Hillsides' are defined as any location where either the pipe gradient or surface slope directly upstream or downstream is steeper than 1 in 20. 'Hillsides' may have large variations in groundwater levels. These variations can cause sufficient water movement within the trench for bedding scour to develop.

Fill any under-runner voids encountered during the work with either 'foam concrete' or 'stiff flowable mix' as defined in *CSS: Part 1*. This treatment must be carried out under the direction of the engineer.

Haunching and backfill materials for hillside areas include lime stabilised backfill (CCC Stabilised AP40 + 40kg/m3 Hydrated Lime) or 'firm mix' (CCC Stabilised AP20 + 60kg/m3 Hydrated Lime) as defined in *CSS: Part 1*.

Use lime stabilised SAP40 for backfilling all carriageways, and lime stabilised SAP20 in all areas outside carriageways where loess is not suitable. Wrapping of joints is not required in 'hillside' trenches backfilled with lime stabilised material.

Specify water stops at 5m spacing on all pipelines with gradients steeper than 1 in 3. Where 'firm mix' is used for haunching, water stops are not required. Construction must comply with *CSS: Part 3* SD 347.

6.14.4 Abandoned Infrastructure

Where work will produce abandoned in-ground piping, treat the potential void by either removing or by filling the pipe as detailed below:

- Treat abandoned pipes below new pipes where the new pipe is within the zone of influence of the abandoned pipe, as illustrated in Figure 5.
- Treat all pipes on the hillside.
- Where treating abandoned AC pipes, fill them and leave them in the ground to avoid contamination issues. 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.
- For all other pipes that are outside the zone of influence illustrated in Figure 5, only detail sealing of the ends of the abandoned pipes with concrete or grout, including the lateral junctions.

CSS: Part 3 clause 5.3 – Abandoned Infrastructure, specifies treatment methods for abandoned manholes.

Flowable fill with a minimum strength of 1.5 MPa is the suggested material for filling abandoned pipes. Require confirmation through the Contract Quality Plan that the void has been filled. This may be through the provision of a methodology or other means.

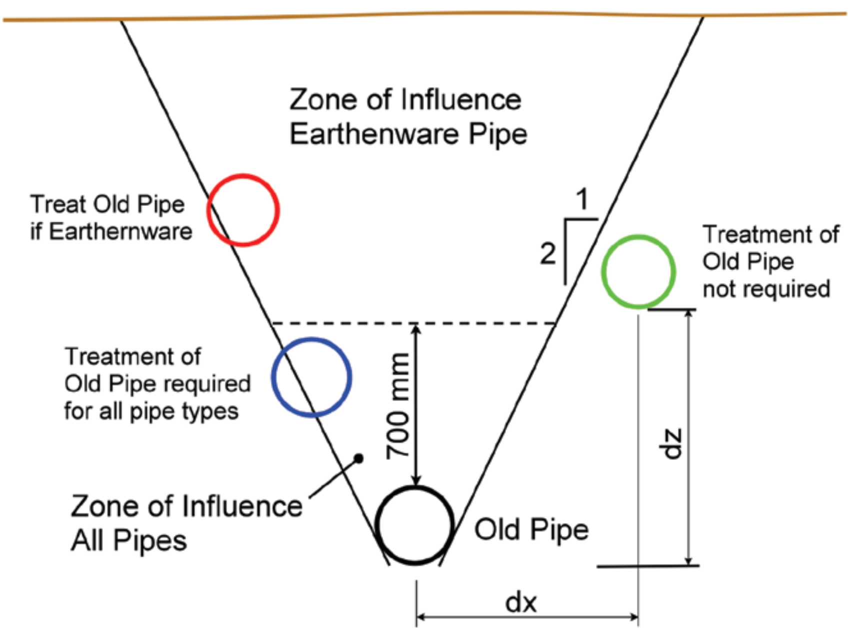


Figure 5 Pipe zone of influence

The zone of influence extends to the ground surface for obsolete earthenware pipes but is limited to 700mm above the soffit of the obsolete pipe otherwise.

A pipe is within the zone of influence if the centreline separation distance (d_x) is less than the minimum given by:

Equation 14 Separation distance

$$d_{xmin} = 0.5d_z + 0.3\ dia_{old} + 0.8\ dia_{new}$$

where d_z is the difference in invert level between the new and obsolete pipes.

CSS: Part 3 clause 5.3 – Redundant and Abandoned Infrastructure specifies treatment methods for redundant manholes.

Where the design manhole invert is being adjusted to a higher pipe level, detail that the manhole invert be filled and re-benched to the requirements of *CSS: Part 3* clause 12.11.6 – New pipe invert in existing manhole.

6.15 Clearances and Asset Protection

Part 9: Utilities summarises clearances for utility services. Confirm these clearances with the network utility operators before deciding on any utility layout or trench detail. Maintain the clearances unless the utility operator grants approval otherwise.

No structures or trees shall be placed within the Maintenance Access Corridor of wastewater assets. 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 buried 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 manhole), the Maintenance Access Corridor is one metre off the asset's border in all directions.

6.16 Trenchless Technology

When working in high volume roads, public areas, adjacent to trees or through private property, consider using trenchless technologies.

Thorough surveys and site investigations, which minimise the risk of encountering unforeseen problems during the work, are essential for the success of trenchless construction. Ensure that the method used complies with the pipe manufacturer's specifications.

Options available include the following:

> Pipe bursting;
> Pipe or manhole relining;
> Horizontal directional drilling (HDD);
> Auger boring/Guided boring;
> Pipe ramming;
> Slip lining;
> Microtunnelling;
> On-line replacement (pipe reaming or pipe eating).

The Council may approve other technologies on a case-by-case basis as they are considered or developed. When proposing a new trenchless technology, submit a full specification to the Council that covers the design and installation process.

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 and depth will be tracked and as-built records provided over the whole length, including joint locations;
> reticulation details including structural pipe design, jointing details, 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 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 trenchless contractor's details, including experience with method, pipe diameter and expected ground conditions, to Council for acceptance.

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

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

> Determination of design slurry pressure rates, methods to prevent fracking and auditing against these during directional drilling.

> Calculations and methodology to ensure installed allowable pipe buckling stress is not exceeded during grouting.

> Relaxation period for polyethylene pipe post installation.

6.16.1 Pipe bursting

Pipe bursting is suitable for replacing sewers that are constructed of brittle pipe material, such as unreinforced concrete and vitrified clay. Generally, this method is not suitable for replacing reinforced pipes. Pipe bursting is not permitted for replacement of asbestos cement (AC) pipes.

Pipe bursting should not be used unless the sewer being replaced has sufficient grade to comply with clause 6.5.3 – Minimum gradients, with an allowance for grade variations as the burst line will maintain the existing grade. Pipe bursting is not suitable when existing pipelines contain dip defects. Provide CCTV records of both the existing pipeline before bursting and the new pipeline after bursting, to confirm the adequacy of the final grades.

Obtain accurate information about the original construction material and the condition of the existing pipeline, including whether there have been any localised repairs, and whether sections of the pipeline have been surrounded or haunched in concrete. Take special care when the existing pipe has been concrete haunched, as this will tend to raise the invert level of the new pipeline and cause operational problems. Shallow pipes or firm foundations can also disturb the ground above the burst pipe.

Replace the entire pipe from manhole to manhole. The number and frequency of lateral connections may influence the economic viability of this technique.

Grouting of the annulus, especially on the hills, is an essential part of this technique. Where special techniques are required, ensure these are approved **before** the work commences.

6.16.2 Cured in Place Pipe (CIPP) Lining

Lining systems can be considered for renovating gravity wastewater mains when standard trenching installation is deemed unfeasible. Before undertaking lining, check the structural integrity of the host pipe and make good any infiltration points. Ensure that the hydraulic capacity, after lining, is sufficient for projected future peak flows. Council will not accept lining of 100 mm diameter wastewater mains or laterals.

The liner must produce a durable, close fit with a smooth internal surface. The liners must have a minimum design life of 50 years, and be resistant to all chemicals normally found in sewers in the catchment area. The manufacturer must submit guarantees to this effect to the Council.

The design of the liner, including the required wall thickness under different loading conditions, must comply with the manufacturer's recommendations and specifications. Submit a specification to the Council that details liner system design and installation methodology for Council acceptance.

As the host pipe is blocked during the liner installation process and any curing requirements, adequate flow diversion procedures and detailed methodology is required. Repair any structural, lateral junction or grade issues by open dig prior to liner installation.

The opening of connections must be carried out remotely from within the lined sewer. Prepare accurate location records by detailed surveys prior to liner installation. Additional grouting of junctions may be required after opening.

6.16.3 Horizontal directional drilling and auger or guided boring

Restrict sewer installation using boring or directional drilling to instances where their construction tolerances are acceptable. Installing gravity reticulation using directional drilling is not generally appropriate. Consider possible ground heave over shallow pipes.

Take into account the space requirements for the following:

- drill pits, including working space;
- drill rigs, including access paths for drill rigs;
- drill angle (the drill rig may need to be placed some distance away from the sewer starting point, depending on the angle);
- placement of an appropriate length of the joined sewer on the ground for pulling through the preformed hole;
- erosion and sediment control.

Surface-launched drilling machines require larger construction and manoeuvring spaces compared to pit-launched drilling machines. Consult specialist contractors before selecting this technique.

6.16.4 Slip lining

It is essential to carefully consider the effect that the work will have on the system operation **before** using a slip-lining technique, especially in relation to finished invert levels and capacity.

Carefully inspect and prepare the host pipe prior to the installation of the new pipe. Use a sizing pig at the investigation stage, to confirm clearances.

Replace the entire pipe from manhole to manhole. Reconnect lateral connections to the new sewer as set out in *CSS: Part 3*, clause 7.3 – Thermoplastic Jointing of Polyethylene Pipe by Electrofusion Welding. The number and frequency of lateral connections may influence the economic viability of this technique.

Carry out grouting of any annulus after installing the new pipeline and gain approval for the technique to be used **before** the pipe is installed. Ensure that grouting doesn't cause buckling or flotation of the internal pipe.

Slip lining of 150mm diameter sewers is not permitted.

6.17 Pipe Ducts

Pipe ducts are required for any 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.

> Gravity pipelines through ducts shall maintain grade, either by duct installation on a matching grade or increasing the duct diameter to allow for the grade.

> 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.

6.18 On-Site Wastewater Treatment Systems

In rural residential areas, where ground conditions and terrain are suitable, wastewater disposal may be catered for using on-site septic tanks or wastewater treatment systems.

The *Natural Resources Regional Plan (NRRP)* contains policies and rules relating to the discharge of wastewater effluent.

If compliance with the *NRRP* rules is not achieved, a resource consent is required from Canterbury Regional Council (Environment Canterbury). Contact Canterbury Regional Council for information on their requirements.

In all instances, obtain a Building Consent from the Christchurch City Council to install, modify or renew an on-site wastewater treatment and distribution system.

6.19 Authorised Installers

Only Christchurch City Council Authorised Drainlayers are permitted to install pipework that will be vested into the Council and any pipework that is located within legal roads. A full list of authorised drainlayers and conditions of approval may be found on the Council webpage www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-contractors/authorised-drainlayers.

Construction of the wastewater system must not start until acceptance 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 work must comply with requirements as set out in *CSS: Part 1* for this type of work.

6.20 As-Built Information

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

APPENDIX I

Tractive Force Design Charts

Chart 1 Tractive force design chart (grade as %)

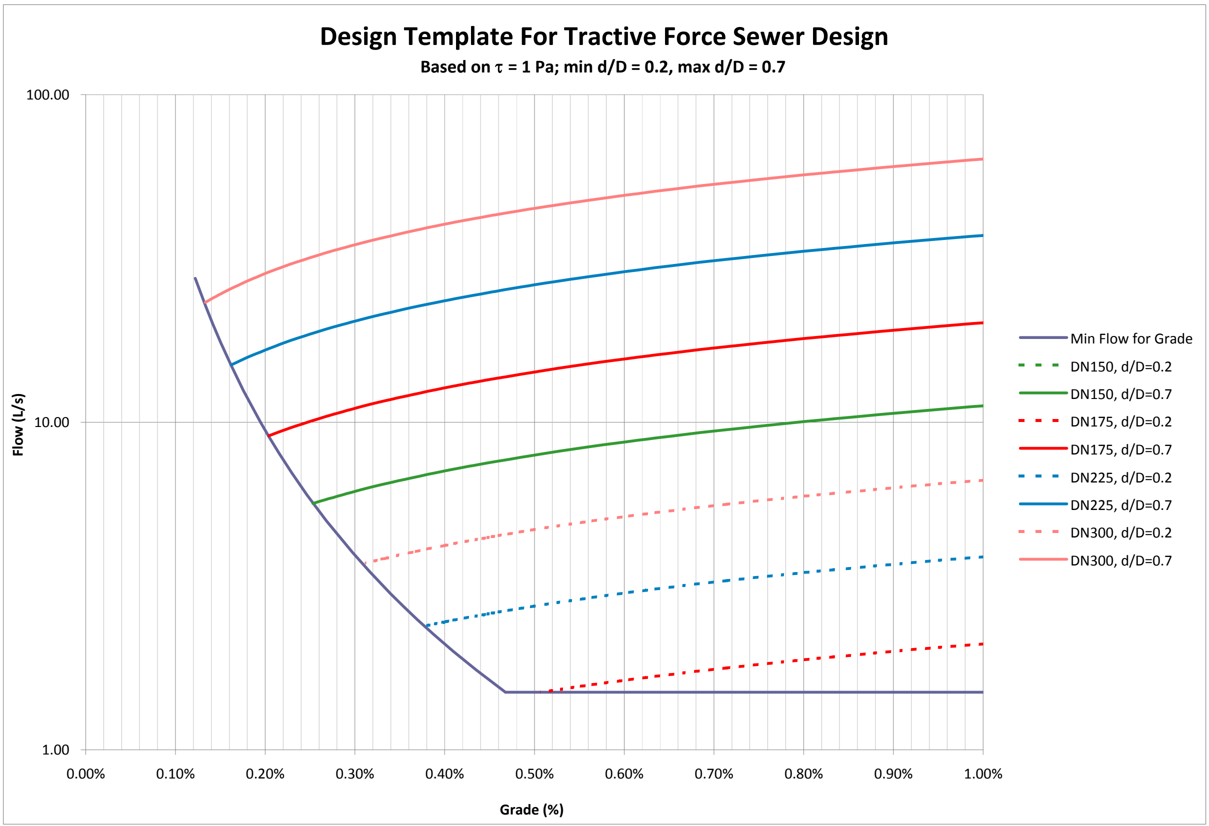
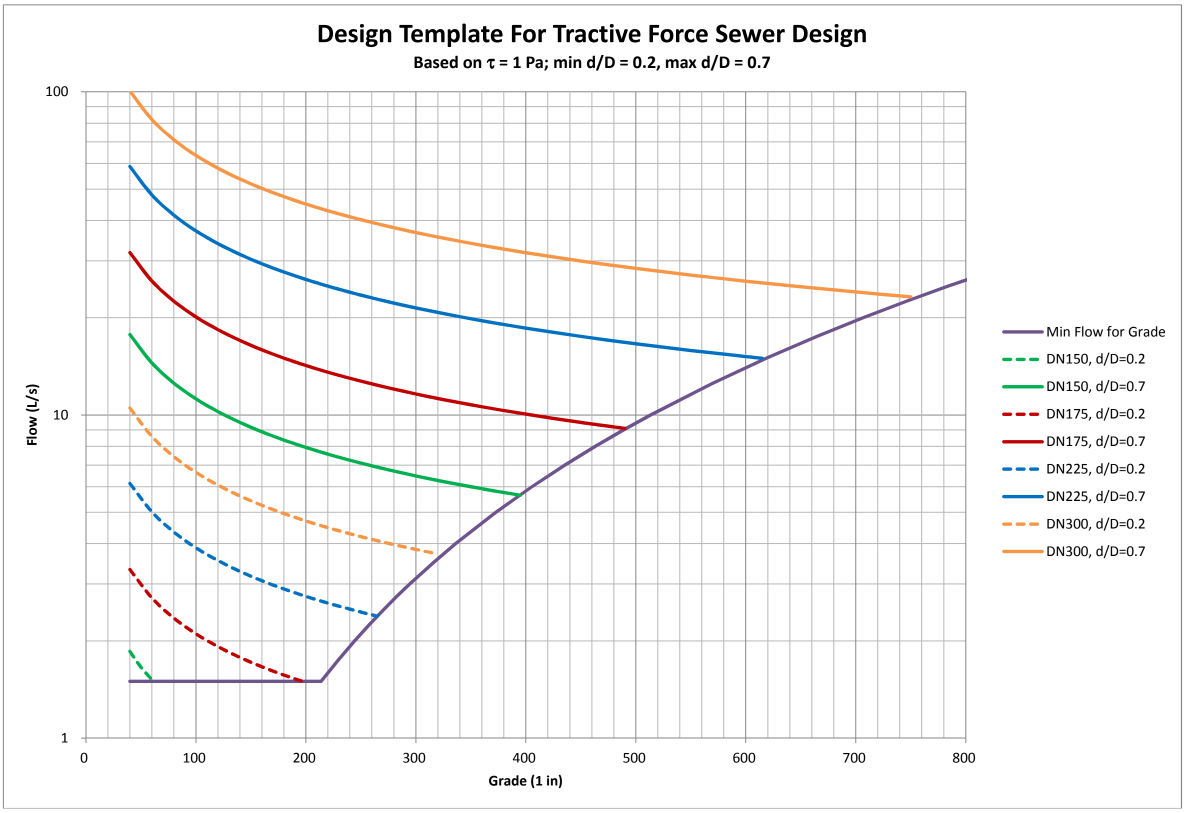


Chart 2 Tractive force design chart (grade as ratio)



APPENDIX II

Determination Of Minimum Gradient And Hydraulic Design Example

An area of 5.0 hectare is zoned L3, with a corresponding unit ASF of 0.25 l/s/ha. The minimum SCF from Equation 14 is:

Equation 15 Self cleansing flow example

$$\begin{aligned} SCF &= P/A\ ratio \times SPF \times ASF \\ &= 1.8 \times 1.0 \times (0.25\ \ell/s/ha \times 5\ ha) \\ &= 2.25\ \ell/s \end{aligned}$$

Drawing the minimum SCF on the Tractive Force Design Chart, the horizontal line intersects the minimum grade line at an approximate grade of 0.39% or 1 in 260.

Chart 3 Tractive force design chart example (grade as %)

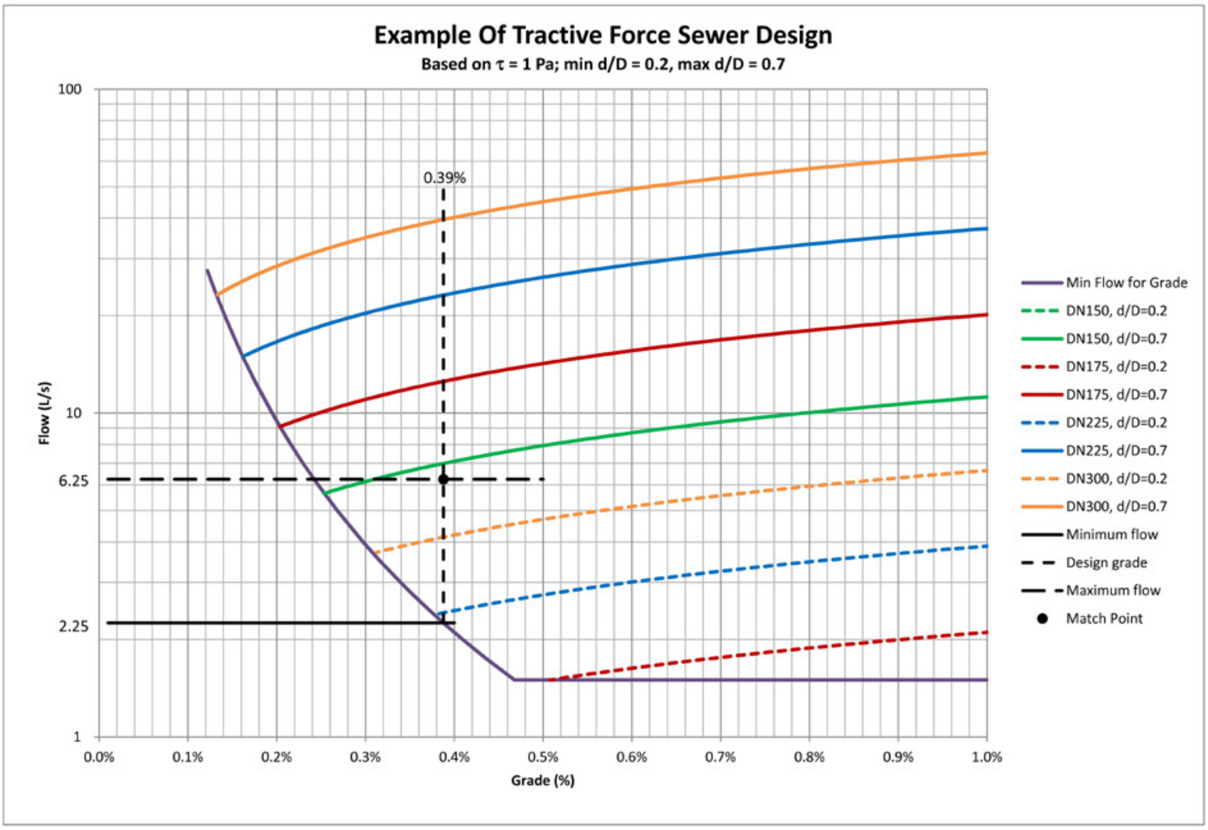
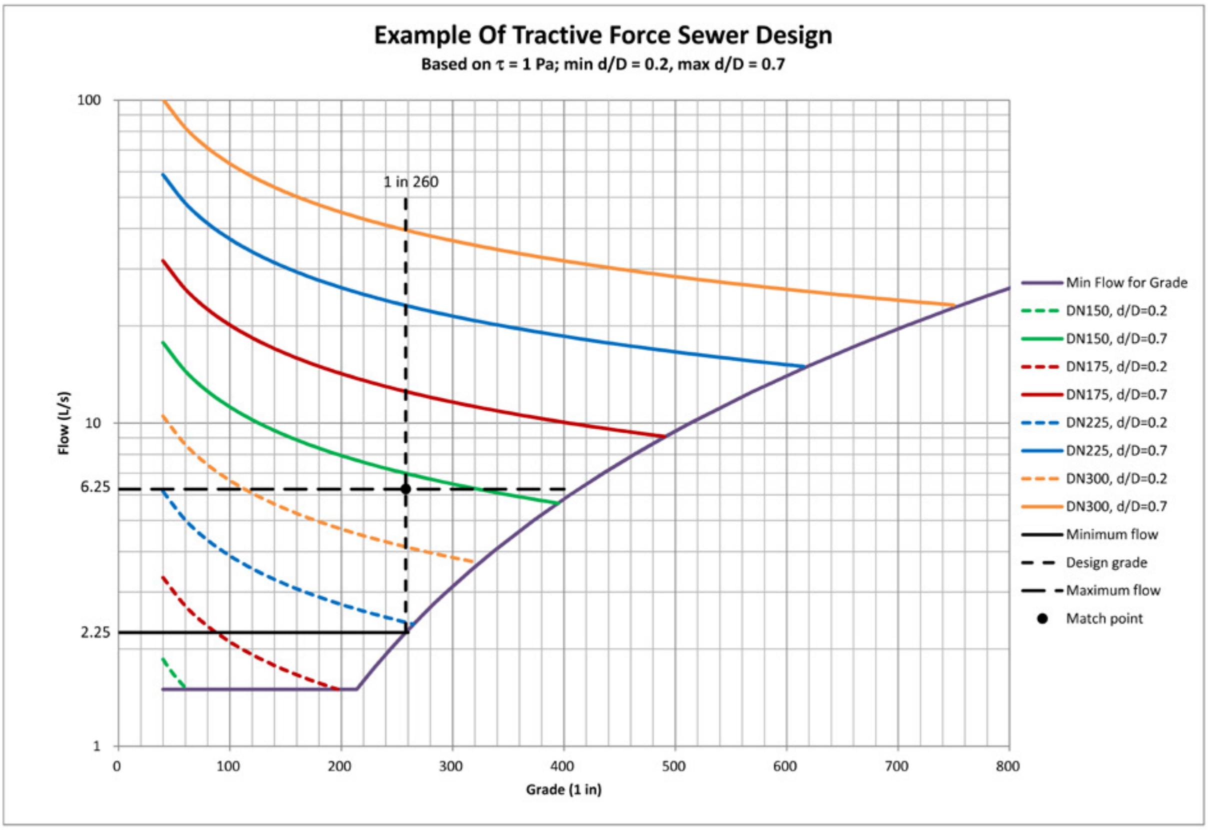


Chart 4 Tractive force design chart example (grade as ratio)



Calculate the maximum flow:

Equation 16 Maximum flow calculation example

$$MF = P/A\ ratio \times SPF \times ASF$$
$$= 1.8 \times 2.78 \times (0.25\ \ell/s/ha \times 5\ ha)$$
$$= 6.25\ \ell//s$$

Drawing a horizontal line at this value on the chart, the line intersects the vertical line representing the grade of 0.39% or 1 in 260 at a point just below the line representing the maximum capacity of a DN150 pipe.

The corresponding pipe size will be 150mm.

APPENDIX III

Wastewater Material Selection Table

Property	CLS	DI	GRP	Single Wall MDPE100	Single Wall PPRRJ	Twin Wall MDPE100/ PP	PVC-U	RCRRJ
Approved for Gravity Wastewater	Specials Only	Specials Only	Project Specific	Project Specific	Laterals Only	Project Specific	Yes	Yes
Approved for Pressure Wastewater	Specials Only	Yes	Project Specific	Yes	No	No	Yes	No
Approved for LPSS Wastewater	No	No	No	Yes	No	No	No	No
Approved for Vacuum Wastewater	No	No	No	Yes	No	No	No	No
Suitable for Trenchless Installation	No	No	No	Yes	No	No	No	Specific Design
Provides a Restrained System	Specific Design	Specific Design	No	Yes	No	No	No	No
Suitable for Aggressive Groundwater	No	Specific Design	Yes	Yes	Yes	Yes	Yes	No
Suitable for Anaerobic Conditions	No	Specific Design	Yes	Yes	Yes	Yes	Yes	No
Suitable for Tidal Zones	No	Specific Design	Yes	Yes	Yes	Yes	Yes	No
Suitable for Above Ground Applications	Specific Design	Specific Design	No	No	No	No	No	Yes
Suitable for High Liquefaction Vulnerability Areas	Specific Design	Specific Design	No	Yes	No	No	No	No
Fatigue Resistant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Approved for Internal Diameters > 600	Specific Design	Specific Design	Specific Design	Specific Design	No	Specific Design	Specific Design	Specific Design
Wear Resistant (scouring veolcities > 4 m/s)	No	Specific Design	Yes	Yes	Yes	Yes	Yes	Specific Design
Suitable for Industrial Zones	No	Specific Design	Yes	Yes	Yes	Yes	Yes	Specific Design
H2S Resistant	No	Specific Design	Yes	Yes	Yes	Yes	Yes	Specific Design

Pipe materials other than those listed are not approved for use on the wastewater network.

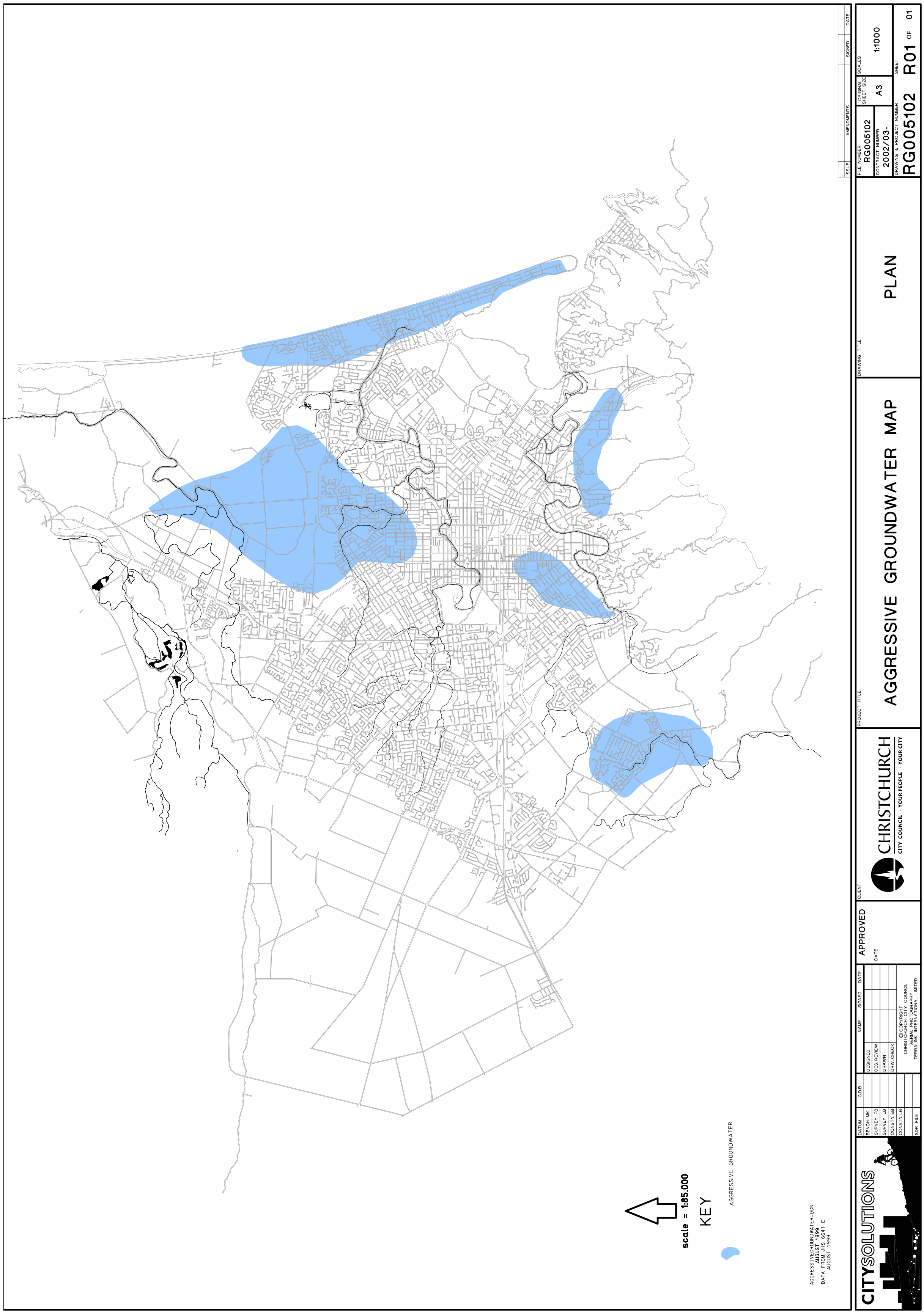
Project Specific means that project specific approval is required. An options assessment proving benefits of the material may be required.

Specific Design means the material requires a site specific design to meet the requirements for use in the application or installation method. Specific designs may focus on jointing methods, coating materials, lining materials and/or installation methods. Specific designs require Council review and approval.

Specials Only means the material is not approved for widespread use but may be used for short lengths to address site specific constraints.

APPENDIX IV

Aggressive Groundwater Map



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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.

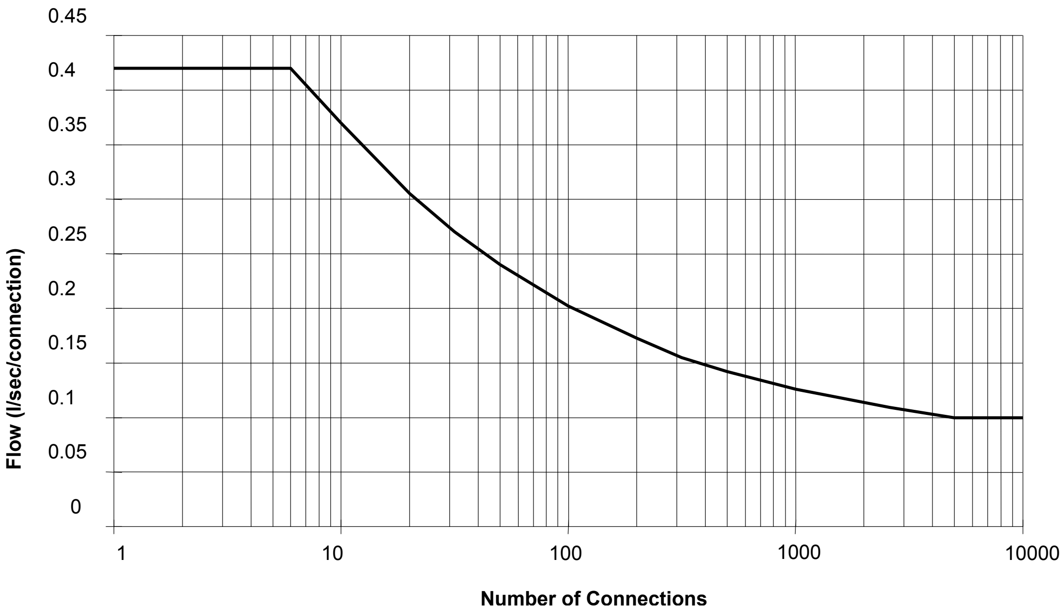


Chart 1 Peak residential design flow rates

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

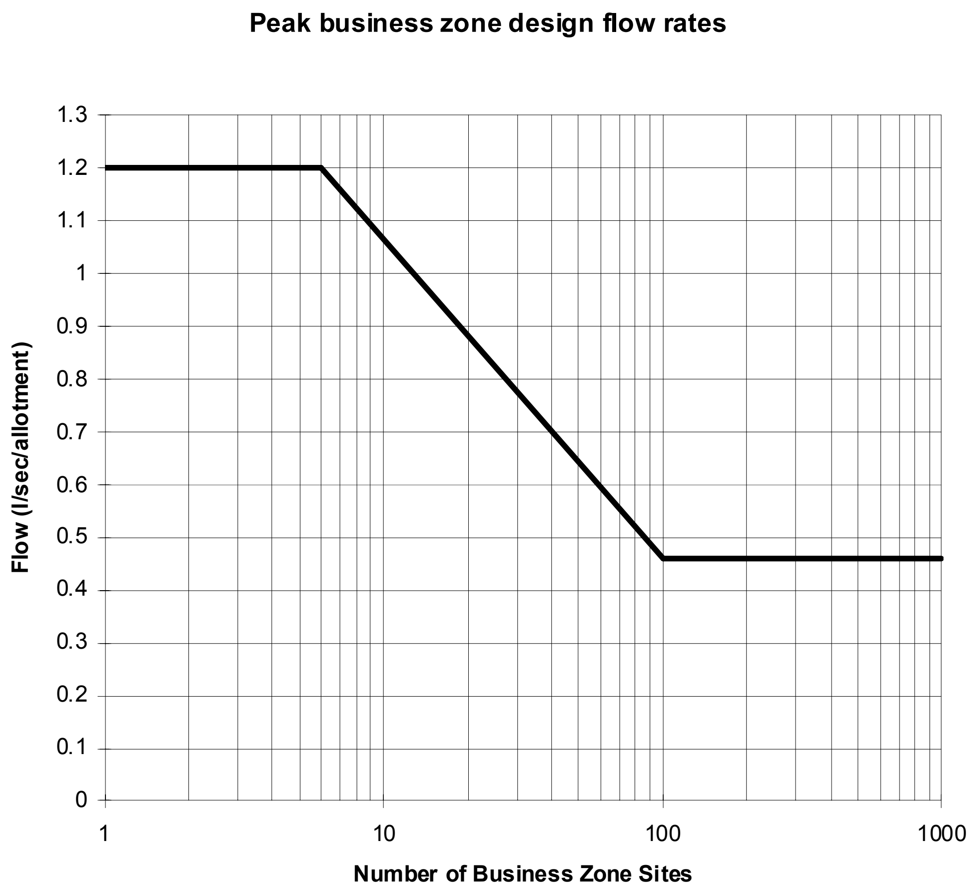


Chart 2 Peak business zone design flow rates

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

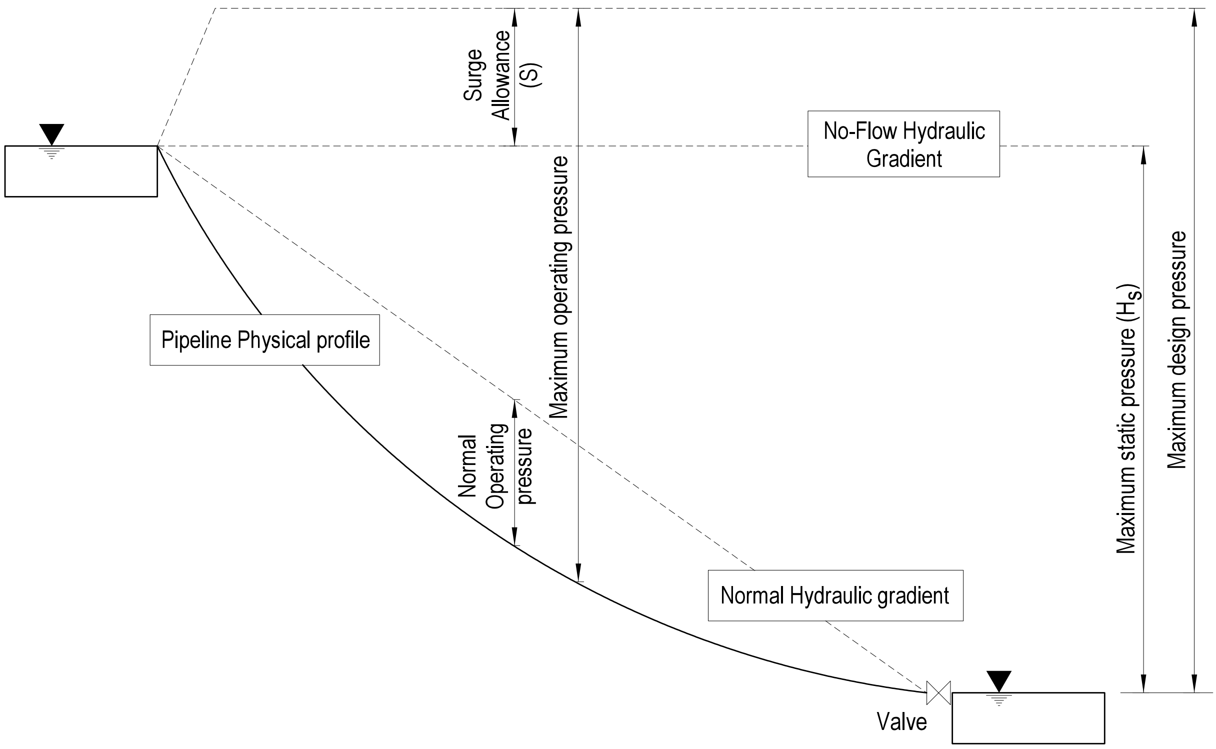
Maximum Operating Pressure (m) = Hs + S - E

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.



CONCEPTUAL HYDRAULIC OPERATION OF A PIPELINE

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.

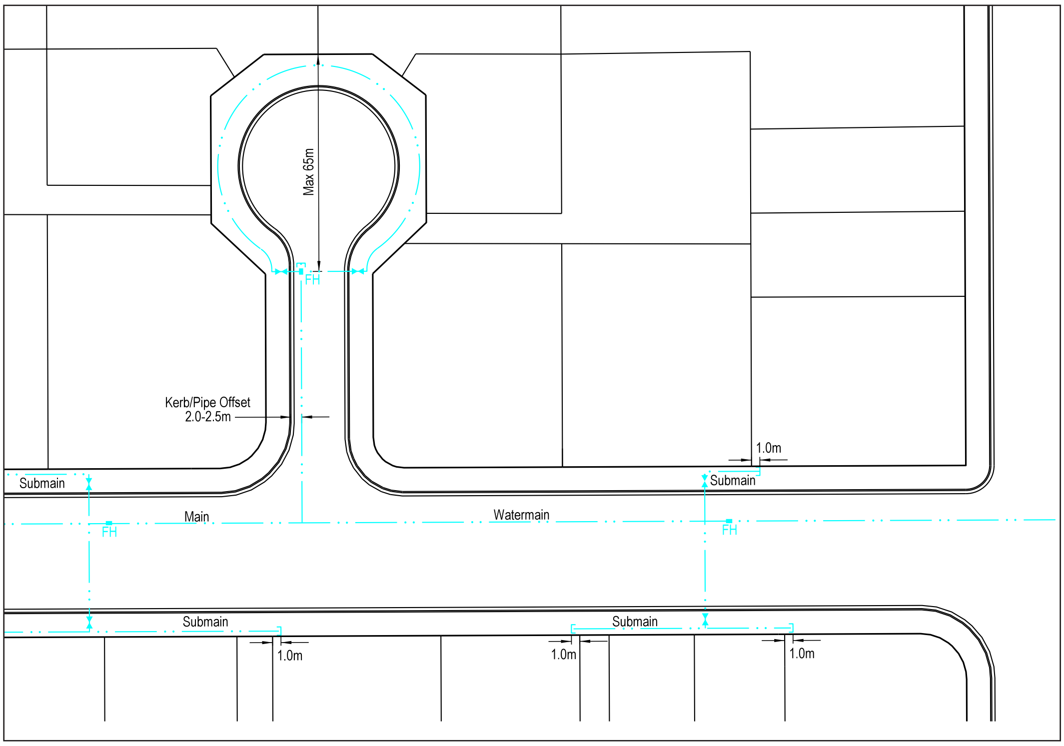


Figure 2 Submain layout

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.

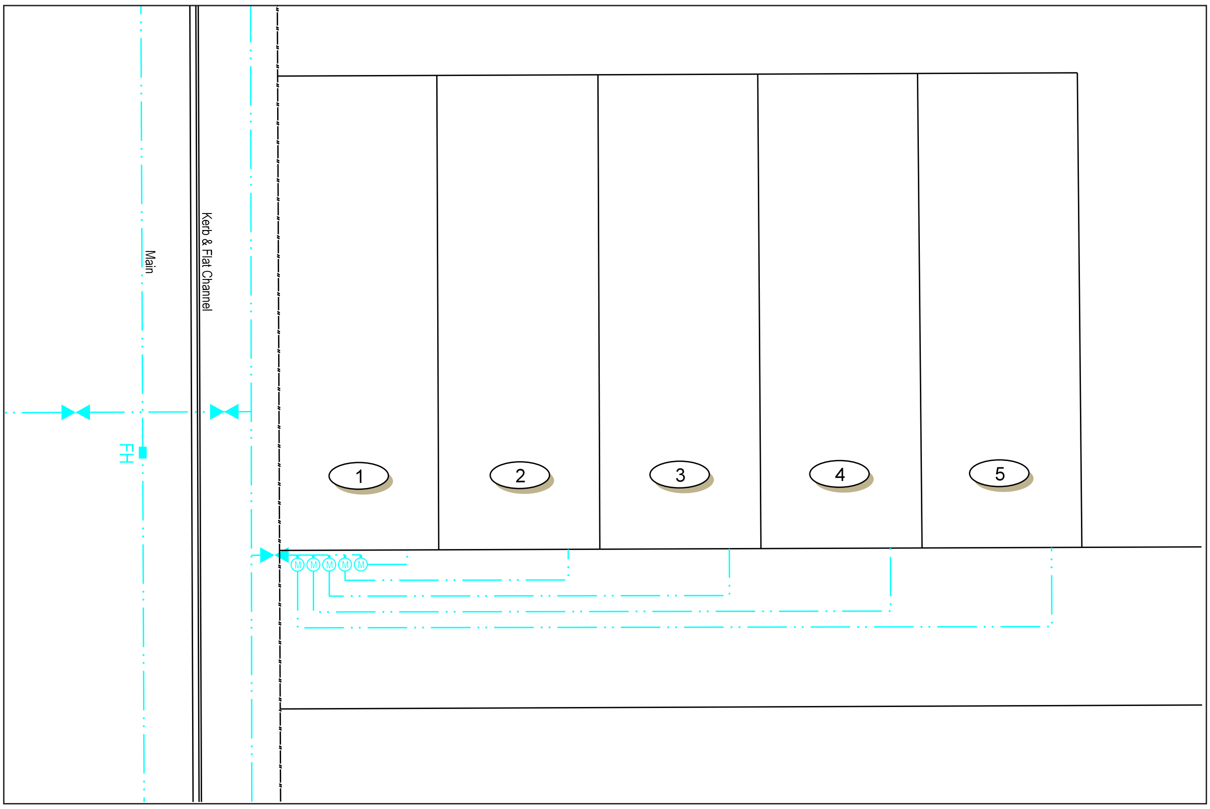


Figure 3 Multiple meters at boundary

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

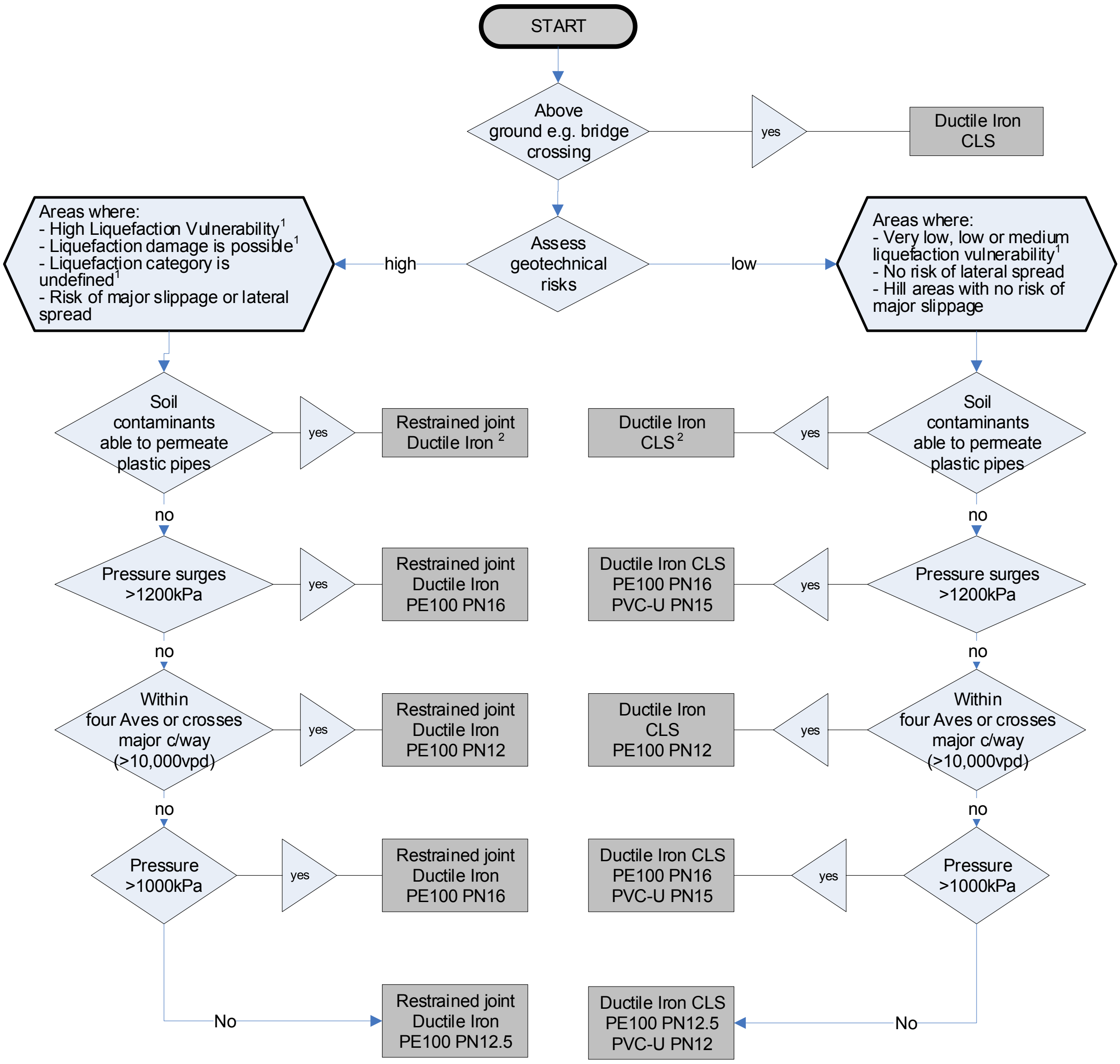
Number of connections	Length in Metres									
	25	50	75	100	150	200	250	300	350	500
2	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50
6	50	50	50	50	50	50	63	63	63	63
8		50	50	50	50	63	63	63	63	63
11			50	50	63	63	63	63		
15			63	63	63	63				
25				63						

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

Part 8: Roading

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8.1 Referenced Documents

Planning and Policy

> The *Christchurch District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan

> Land Transport Act (1998)

> Traffic Regulations (1976)

> Christchurch City Council *Speed Limits Bylaw* (2010) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/

> Christchurch City Council *Traffic and Parking Bylaw* (2008) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/

> Christchurch City Council *Public Places Bylaw* (2008) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/

> Christchurch City Council *Equity and Access for People with Disabilities Policy* (2001)www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/community-policies/

> Christchurch City Council *Policy on Structures on Roads* 2010www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/streets-roads-and-pavements-policies/

> Christchurch City Council *Footpath Berm Policy* (1999) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/streets-roads-and-pavements-policies/

> Christchurch City Council *Waste Management Bylaw 2009 (Terms and Conditions)* www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Bylaws/Waste-Management-Bylaw-2009-Terms-and-Conditions.pdf

> Christchurch City Council *Bus Stop Location Policy* (1999)www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/transport-policies/

> Christchurch City Council *Intersection & Pedestrian Crossing Design for People with Disabilities Policy* (2016)www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/streets-roads-and-pavements-policies/

> Christchurch City Council *Parking - Kerbside Parking Limit Lines Policy* (2010) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/streets-roads-and-pavements-policies/

> Christchurch City Council *Christchurch Transport Strategic Plan* (2012) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies/transport-strategic-plan-2012/

> Christchurch City Council *Christchurch Central Parking Plan* (2015) www.ccc.govt.nz/assets/Documents/Transport/Improvements-planning/CentralParkingPlan2015.pdf

> Christchurch City Council *An Accessible City:* Transport Chapter of the Christchurch Central Recovery Plan (2013) www.ccc.govt.nz/transport/road-improvement-projects/aactransportprojects/

> Christchurch City Council/ Canterbury Regional Council *Metro Strategy* (2010) www.ecan.govt.nz/

your-region/living-here/transport/public-transport-services/greater-christchurch-metro/

> Canterbury Regional Council *Canterbury Regional Public Transport Plan* (2014) www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-transport-plans/

> Land Transport NZ *Traffic Control Devices 2004 Rule* www.nzta.govt.nz/resources/rules/traffic-control-devices-index.html

> Land Transport NZ *Setting of Speed Limits 2017 Rule* www.nzta.govt.nz/resources/rules/setting-of-speed-limits-2017/

> New Zealand Transport Agency *Planning Policy Manual – for integrated planning and development of state highways* 2007 www.nzta.govt.nz/resources/planning-policy-manual/

> New Zealand Asset Management Support *New Zealand Infrastructure Asset Valuation and Depreciation Guidelines* (2006) www.ipwea.org/newzealand/bookshop/nzpubs/nzbookshop/2016-iavdg-nz

Design

> National Guidelines for Crime Prevention through Environmental Design in New Zealand www.mfe.govt.nz/publications/towns-and-cities/national-guidelines-crime-prevention-through-environmental-design-new

> Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō NgāArawai Rēpo (WWDG)* (2003) www.ccc.govt.nz/environment/water/water-policy-and-strategy/waterways-wetlands-and-drainage-guide/

> Christchurch City Council *Christchurch City Bus Stop Guidelines* (Feb 2009)

> Christchurch City Council *Guidelines of Transport and City Streets Unit for the Marking of Cycle Lanes on Urban Roads* (April 2006)

> Christchurch City Council *Regional Special Conditions (for Traffic Signals)* www.ccc.govt.nz/assets/Documents/Consents-and-Licences/construction-requirements/Traffic-Signals-design-requirements/Regional-Special-Conditions.pdf

> Christchurch Central *Streets and Spaces Design Guide* resources.ccc.govt.nz/assets/the-rebuild/StreetsAndSpacesDesignGuideJune2015.pdf

> Christchurch City Council *Christchurch Cycle Design Guidelines* Part A (2013) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies/transport-strategic-plan-2012

> Christchurch City Council *Major Cycleway Design Guide* Part B

> All New Zealand Transport Agency (NZTA) guidelines and the RTS series (including *Pedestrian Planning and Design Guide, Road Safety Audit Procedures for Projects, Cycling Network Guidance – Planning and Design, Guidelines for the Implementation of Traffic Controls at Cross Roads RTS 1, Guidelines for Street Name Signs RTS 2, Guidelines for Flush Medians RTS 4, Guidelines for Rural Road Marking and Delineation RTS 5, Guidelines for Safe Kerbline Protection RTS 8, Road Signs and Markings for Railway Level Crossings RTS 10, Guidelines for Facilities for Blind and Vision-Impaired Pedestrians RTS 14, Guidelines for Urban-Rural Thresholds RTS 15*)

> All New Zealand Transport Agency (NZTA) manuals and TNZ standards (including T/10 *Skid*

Resistance Investigation and Treatment Selection and the *Bridge Manual*)

- NZ Supplement to *Guide to Traffic Engineering Practice, Part 14: Bicycles*
- Austroads *Guide to Traffic Management Set* (including *Part 6: Intersections, Interchanges and Crossings, Part 8: Local Area Traffic Management*
- Austroads *Guide to Pavement Technology Set* and the New Zealand Supplements
- Austroads *Guide to Road Safety Set* (including *Part 6: Road Safety Audit, Part 8: Treatment of Crash Locations, Part 9: Roadside Hazard Management*)
- Austroads *Guides to Road Design Set* (including *Part 3: Geometric Design, Part 4: Intersections and Crossings, Part 4B: Roundabouts, Part 6: Roadside Design, Part 6A: Pedestrian and Cyclist Paths*
- NZS 4121:2001 *Design for Access and Mobility: Buildings and Associated Facilities*
- NZS 4404:2010 *Land development and subdivision infrastructure*
- AS 2890.5:1993 *Parking facilities - On-street parking*
- AS/NZS 1158 Set *Lighting for roads and public spaces - series*
- New Zealand *Code of Practice for Electrical Safe Distances* NZECP 34:2001
- NZUAG *The National Code of Practice for Utilities' Access to the Transport Corridors* nzuag.katipo.co.nz/wp-content/uploads/2018/02/NZUAG-Code.pdf
- New Zealand Heavy Haulage Association Road Design Specifications for Over Dimensions Loads. www.hha.org.nz/assets/Resources/NZHHA-Roading-Design-Spec-For-OD-Loads-Version-8.pdf

Construction

- 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/
- All New Zealand Transport Agency (NZTA) manuals and specifications
- Road Safety Manufacturers Association *Compliance Standard for Traffic Signs* 2010
- NZS 8603:2005 *Design and application of outdoor recreation symbols*

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).

8.2 Introduction

This Part sets out Council's requirements for designing streets, and other access linkages, that not only function well but are also appropriate and safe environments.

This Part is **not** intended to be a detailed design guide or to replace the need for traffic and pavement engineering expertise in some areas of the design process.

8.2.1 Legal requirements

All traffic control devices, as defined in the Land Transport Act, on roads and rights of way, must comply with the:

> Land Transport Act;
> Traffic Regulations;
> *Traffic Control Devices 2004 Rule;*
> *Traffic and Parking Bylaw*.

8.3 Creating Good Urban Infrastructure

To create good urban structure, acquire a good understanding of the urban design principles which underlie the layout of blocks, streets and open spaces in new developments and the inter-relationship between them. While the focus is on new public spaces, also consider the three dimensional character of the spaces which are formed by buildings on private areas within the blocks. The relationship between public and private areas is an essential part of creating places for people.

Access to, and within, areas to be developed includes more than the road network that provides formal access to properties. It also includes public transport routes and green linkages that provide access for pedestrians and cyclists to use areas such as reserves and waterways.

The road network and associated linkages need to be highly connected, to reflect the desire lines and destinations within the area and also in surrounding neighbourhoods. This encourages people to walk or cycle where practicable, rather than using their car, particularly for shorter local trips. Figure 1 illustrates this interconnectedness. When this can be achieved, it results in energy savings and creates a safer and more pleasant neighbourhood.

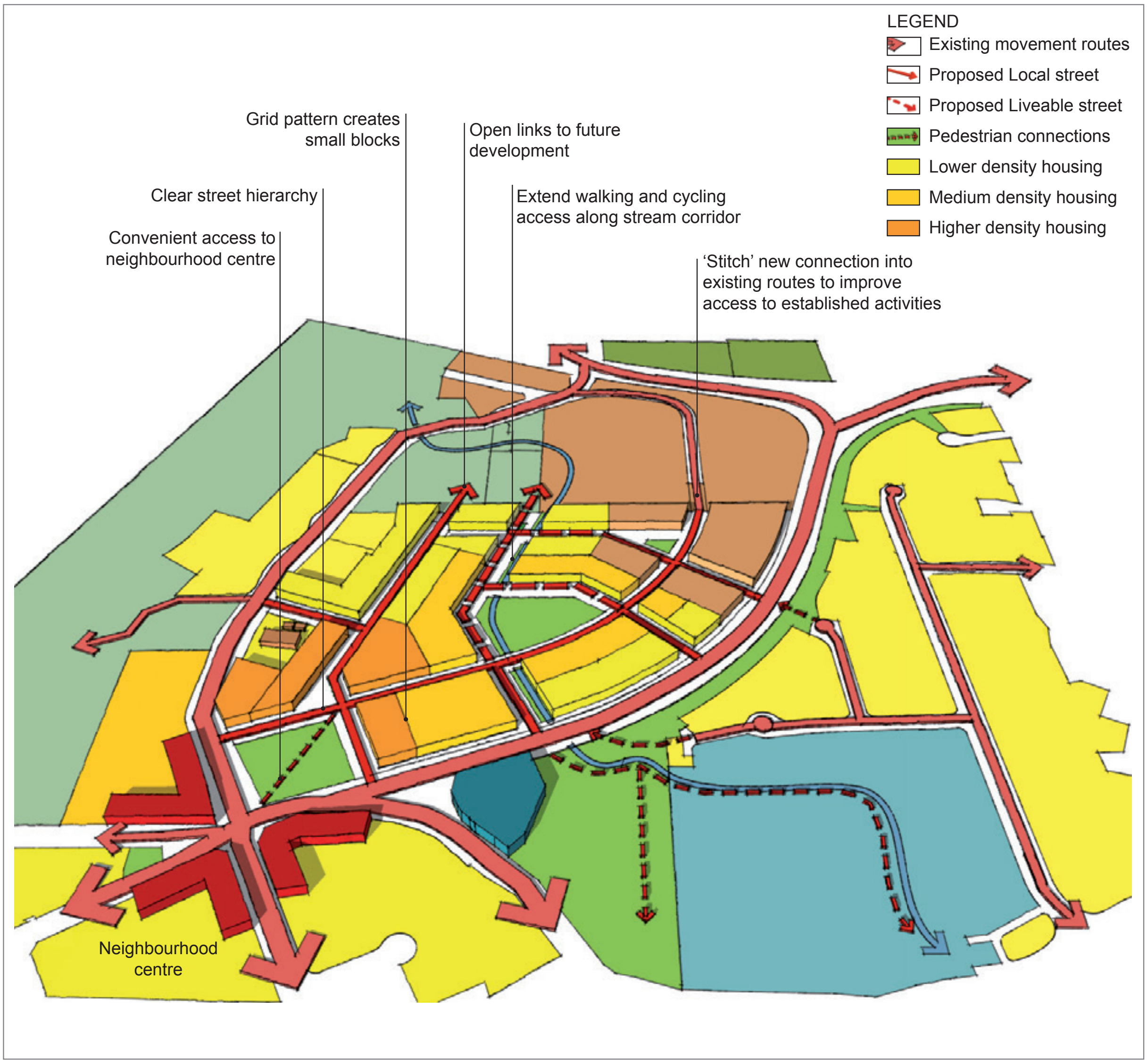


Figure 1 Streets and linkages arranged in an informal grid

Streets can serve a wide range of functions, whilst providing valuable and unique areas of community space (see Figure 2). Use the design process to challenge the assumption that motor vehicles have "automatic" priority (particularly on local roads) and consider all the demands and functions of the street space, in order to achieve a better balance for all those who use it.

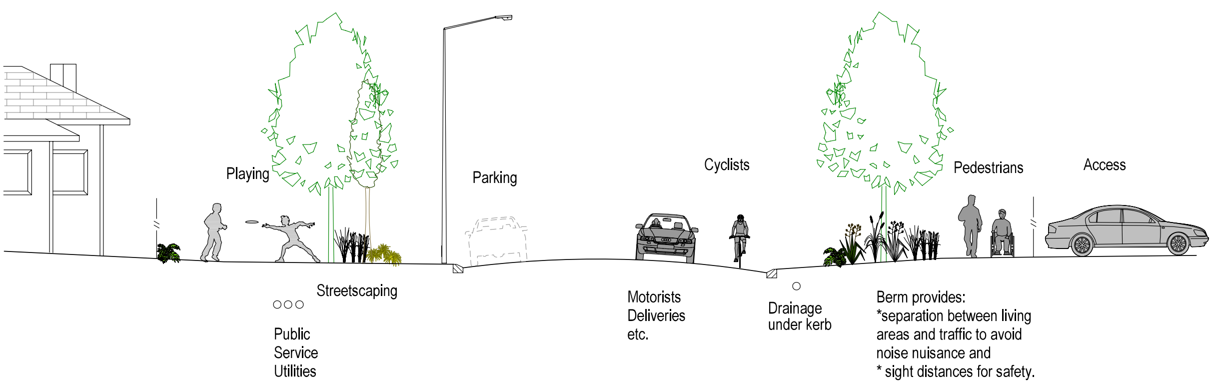


Figure 2 Street functions

The Council encourages innovative design, for access and roading, which satisfies the following objectives:

> safe – the layout must be safe for pedestrians, cyclists, public transport and motorists;

> secure – the design of the roads and other linkages must not compromise the personal security of the users;

> energy efficient – the layout should minimise the number and length of vehicle trips and promote alternatives to motor vehicle use;

> linked – the layout of a development should be extended on a hierarchical network basis for all modes. It should promote walking and cycling, particularly for short trips to local facilities, and should provide direct access to public transport routes. Linkages to existing areas of development must also be provided;

> suitable traffic speeds – the road design must encourage traffic speeds that are appropriate for the road classification and context;

> comprehensible – the road layout must be easy to read and follow, for both residents and visitors;

> accessible - the road design should incorporate footpaths and kerb cutdowns that provide easy access for all;

> enhances environment – the road design should incorporate carriageway and residential stormwater quality improvements or design features as part of the grass berm design e.g. encouraging sheet flow over grass berms, swales protected from traffic use;

> attractive – the design of the street landscaping, trees and other features can add significantly to the amenity, environment and character of the area.

Where the above objectives may be achieved through other mechanisms, the Council may reconsider applying the requirements of this Part of the IDS to a development.

Be familiar with the following documents when considering the design of the development:

> *Christchurch Transport Strategic Plan*

> *Metro Strategy*

> *Pedestrian Strategy*

> *Road Safety Strategy*

> *Christchurch Central Streets and Spaces Design Guide*

> NZS 4121 *Design for Access and Mobility: Buildings and Associated Facilities*

> AS/NZS 1158 Set *Lighting for roads and public spaces - series*

> In accordance with all other parts of the IDS

8.4 Quality Assurance Requirements and Records

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

8.4.1 Design records

Provide the following information, to support the Design Report:

> a clear description of the purpose of the work;

> the scope of the work e.g. legal requirements for road elements such as the provision of appropriate transport facilities, suitable access to the existing transport network;

> transport infrastructure and services issues (e.g. vehicle, cycle, public transport, pedestrian);

> traffic-loading, traffic modelling and volume data and projections used and calculations;

> geometric data;

> geotechnical data, including site assessments, subgrade information and CBR's;

> pavement design methodologies used and corresponding metalcourse calculations;

> surface treatment information;

> road drainage control and edge treatment;

> hydraulic data (e.g. road level, flood level);

> slope stability (during construction and permanent) and retention details;

> utility service conflicts and programmed work issues;

> traffic safety audits;

> streetscape and amenity features.

8.4.2 Safety audit

Safety auditing is an important component in the design of all facilities on legal road. Safety audits provide a check that the proposed design is safe for all users. Safety audits should be integrated throughout the design of new transport facilities.

Provide an independent safety audit at the concept or subdivision consent stage, and for any Variations, which also considers the development's potential to generate high trip volumes requiring specific changes to the road infrastructure.

Provide an independent safety audit with the Design Report i.e. at the engineering acceptance stage for subdivisional works.

An independent safety audit of the constructed asset must also be undertaken and submitted as part of the as-built record. The 224 Certificate will not be issued until safety audit requirements have been addressed.

Carry out safety audits in accordance with *Road Safety Audit Procedures for Projects* and *Guide to Road Safety Part 6: Road Safety Audit*. Use the *Guide to Road Safety, Part 8: Treatment of Crash Locations*, for safe design practices.

8.4.3 Construction records

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

- material specification compliance test results;
- subgrade test results and corresponding recalculations of metalcourse depths;
- compaction test results;
- Benkelman Beam test results;
- as-built levels of the top of kerb, manhole covers and the road centreline;
- surface profile test results for roads and rights of way greater than 100m in length i.e. NAASRA/International Roughness Index;
- surface texture test results;
- concrete or asphalt core test results. Copies of concrete test results are not required for retaining walls;
- construction records and test results for retaining wall components;
- post-construction safety audit.

Provide details in a form complying with the requirements of Part 12: As-Builts.

8.5 Off Road Linkages

Off road linkage (Brooker reserve)

Linkages for pedestrians and cyclists must create an attractive, friendly, connected, safe and accessible environment. These linkages must ensure that people can move about the community freely in areas where there are no road linkages (e.g. at the end of cul-de-sacs) and provide direct pedestrian access to bus stops. Use green linkages between cul-de-sacs, through public reserves or adjacent to waterways, or other natural features. For durability it should be considered that linkages that will be used for access or traversed by maintenance vehicles should be constructed to the CSS SD607 commercial crossing detail.

Design the paths so that they are suitable for pedestrians, cyclists, skate-boarders, skaters, prams and people with disabilities. Motorised wheelchairs require 1.2m clear width.

The overall width of the linkage needs to be adequate for the path and appropriate landscaping. Historically, minimal width linkages of 2.5 to 3.0m had been provided with little or no landscaping. These are unattractive to use and in some cases have been closed due to perceived security problems associated with them. Therefore, providing wide, open and well-lit areas is extremely important to provide a secure and useable linkage.

The minimum clear width of formed paths in legal road is 1.5m for pedestrian-only paths and 2.2m (but a desirable width of 2.5m) for paths shared by pedestrians and cyclists. The formed width should be widened wherever a lot of people are expected to use the facility, as illustrated in Figure 3. Clause 10.8 – Pedestrian and Cycle Paths or Tracks (Reserves, Streetscape and Open Spaces) details requirements for paths in reserves. The Council must pass shared paths by resolution.

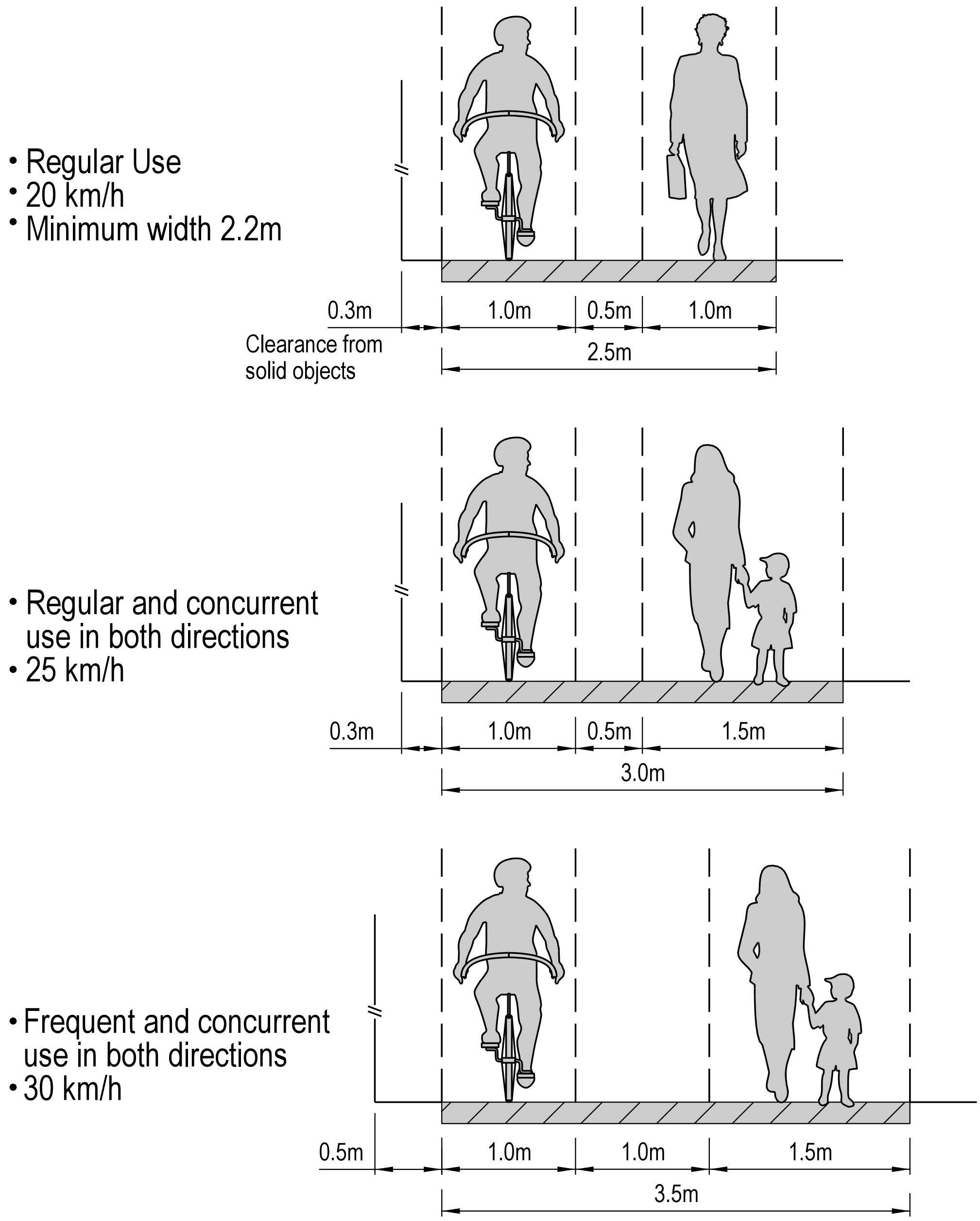


Figure 3 Pedestrian/shared path widths

Seal the path and landscape the remaining land in a manner that does not compromise the security of people using the facility. Part 10: Reserves, Streetscape and Open Spaces provides landscaping guidelines.

Use the following guidelines for the detailed design of off-road paths:

> *Christchurch Cycle Design Guidelines (Part A) and Major Cycleway Design Guide (Part B)*

> *Crime Prevention Through Environmental Design*

> *Guide to Road Design, Part 6A: Pedestrian and Cyclist Paths*

> the New Zealand Supplement to the *Guide to Traffic Engineering Practice, Part 14: Bicycles*

> AS/NZS 1158 Set *Lighting for roads and public spaces - series*

8.6 Cycle Facilities

Make provision for on-street and off-street cycle facilities, as required by the *District Plan* and indicated in the *Christchurch Transport Strategic Plan*, to facilitate an alternative to the car for short to medium length trips. Consider installing cycle parking facilities near bus stops, to ease the transfer between transport modes.

For local urban roads, cycle facilities may be provided through wide kerbside lanes. Ensure cycle 'Give Way' signs and any supplementary signs are located in a position which doesn't impede pedestrians.

Wherever off-road pedestrian and cycle paths are required, design them to the widths specified in Figure 3. *Christchurch Cycle Design Guidelines, Part 6A: Pedestrian and Cyclist Paths*, Part 10: Reserves, Streetscape and Open Spaces and Part 11: Lighting provide further information on off-road facilities.

The cycleway types (major, local and recreational) are defined in clause 1.2 of *Christchurch Cycle Design Guidelines*. Design major cycleways to the requirements in the *Major Cycleway Design Guide*. Design local and recreational cycle facilities to the requirements of the *Christchurch Cycle Design Guidelines*. Refer also to *Cycling Network Guidance – Planning and Design*, the *Guide to Road Design, Part 4: Intersections and Crossings* or *Part 6A: Pedestrian and Cyclist Paths*. Mark the roadmarking in accordance with *CSS: Part 6*.

8.7 Public Transport

Existing and planned or potential public transport routes and stops shall be shown on plans.

8.7.1 Bus routes

Consider the specific needs for public transport at an early stage of the design process to ensure that:

> roads can cater for the manoeuvring requirements of public transport vehicles (including turning around or U-turns at a terminus);

> termini of routes are identified;

> routes are efficient and easily accessible by public transport vehicles;

> proposed routes form a coherent new bus route or an extension to an existing route.

The provision of bus routes in new development areas must be discussed with Canterbury Regional Council (Environment Canterbury) staff. Refer to Environment Canterbury's *Regional Public Transport Plan* for further information.

Wherever there is an existing bus route which can service the area (as defined in the previous sentence), there should be easy and direct access to it for pedestrians. Wherever cul-de-sacs are used to provide access to properties, these should be extended where appropriate to provide direct pedestrian linkages to bus routes. Higher density housing and community facilities, such as schools, parks, shops or retirement villages, should be located close to existing or potential future bus routes to enhance access to the services and encourage use of sustainable transport.

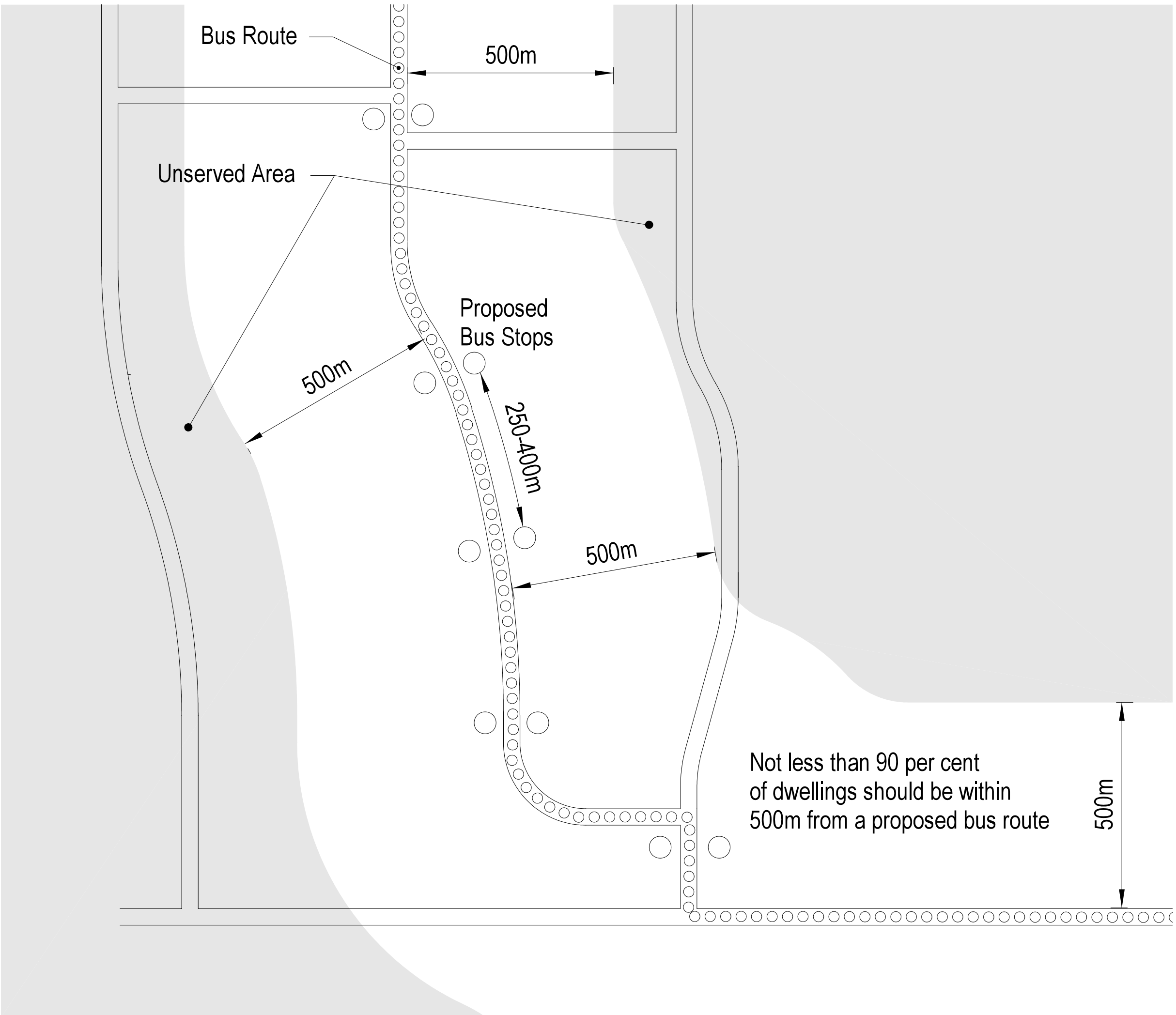


Figure 4 Example of bus routing

Wherever the bus route travels through a development, now or in the future, design the relevant roads to ensure that the bus can travel and manoeuvre along the proposed route easily, without obstructions and, ideally, without delaying other traffic.

Bus routes are generally along collector or arterial roads. Routes need to be as direct as possible to reduce travel times and should avoid or minimise complicated turning manoeuvres at intersections. In particular, avoid right turns when accessing arterial roads. As explained above, Environment Canterbury plan and manage the public transport network, so discuss potential routes with their staff.

Bus priority measures such as bus lanes may be required in certain locations. Consult with Christchurch City Council before submitting engineering drawings to ensure that intersections conform to the Council's requirements.

8.7.2 Bus stops

Plan and co-ordinate the bus stop locations and associated infrastructure on the street with Christchurch City Council at the consent stage. Extra space may be required to site bus shelters or other required infrastructure, which can be incorporated in the engineering design.

Bus stops must be located in accordance with the *Bus Stop Guidelines*. Bus stops should be located close to key facilities to enhance accessibility for the community.

If the width of the roadway does not provide for roadside parking, allow for the construction of inset bus bays or bus boarders. Construction details for bus stops may be found in *CSS: Part 6*.

8.8 Road Classification

The road network is the system of interconnected road links that provides for the movement needs of people and goods, property access and servicing needs. It is usually arranged and operated in a manner to recognise and best serve the varying demands expected of different elements (usually using a hierarchical classification system). Developments must provide road networks internally to achieve these purposes, and connect appropriately to the existing network.

The length and arrangement of these roads within the development and connections to the existing network determine the amount of traffic each element is likely to carry and the role it plays in providing for property access or longer journeys.

The place function and movement function of each link, determines its classification, and therefore its geometric characteristics and preferred speed regime. See the *District Plan, Appendix 8.6.3*.

The classifications of existing roads in Christchurch are listed in the *District Plan, Appendix 7.12*.

Be aware of any local area traffic management schemes or neighbourhood improvement plans which may incorporate street requirements for the area.

8.8.1 Local roads

The primary purpose of local access roads is to provide access to properties. These are not intended as a through road for vehicles to other streets. Design such roads to provide an environment where pedestrians and cyclists can mix with vehicular traffic, so that the road becomes a useable public space. These roads could be a cul-de-sacs or a short access road with a minimal width and a low speed environment, preferably 30kph or less. Typically, access is provided for not more than 25 households, meaning that traffic volumes are not usually more than 250 vehicles per day (vpd).

Other local roads provide access to properties and local streets. Their design should encourage a low speed environment of 30-40kph. These roads are likely to be closer to areas of demand such as shops and schools. The traffic volumes will be higher with an expected range for traffic volumes of 250 to 2,000 vpd.

Local roads should not generally connect to major or minor arterials, except in exceptional circumstances and with the Council's approval.

8.8.2 Collector (Distributor) roads

The function of collector roads is to provide the link between the local roads and the arterial roads. Collector roads should not generally connect to major arterials, except in exceptional circumstances and with the Council's approval. Collector roads on Banks Peninsula generally have equivalent car movements (as defined in the *Banks Peninsula District Plan)* of over 750 in the urban areas and over 200 in the rural area.

In the urban area, collector roads usually have predominantly residential frontage and will often contain the bus routes within the neighbourhood. A speed environment of up to 50kph with traffic volumes of up to 6,000 vpd is expected.

8.8.3 Arterial roads

Arterial roads cater primarily for traffic movement, and property access is a secondary function. Traffic volumes are normally more than 6,000 vpd in Christchurch City. Major arterial roads are the dominant elements of the roading network connecting the major localities of the region, both within and beyond the main urban area. They are constructed and managed to minimise their local access function. Minor arterial roads provide the connections between major arterial roads and inter-connect the major rural, suburban, commercial and industrial areas. Generally, they cater for trips of intermediate length and some are essential routes to more remote parts of the region.

These roads must be designed in conjunction with the appropriate roading authority. Discuss access to the existing road network with the Council and the New Zealand Transport Agency at the consent stage, if a State Highway will be affected. Use the *Planning Policy Manual* for the design of any works on or adjacent to a state highway.

8.8.4 Classified roads

Classified roads are a subgroup, comprising collector and both minor and major arterial roads. Selecting this classification influences the traffic network so consult with the Council about the location of these roads.

8.8.5 Traffic volumes

Identify the likely volumes of traffic that will be generated by a development, using the following average household trip generation rates.

Table 1 Household trip generation rates

Flat urban areas	10 trips/household/day
Hillside & rural areas	8 trips/household/day

If surveyed data is available for areas with similar characteristics, use this in preference to the values above, due to the variation in generation rates throughout the city. Some traffic count data is available on the council websitewww.ccc.govt.nz/transport/road-improvement-projects/traffic-count-data.

8.9 Speed Environment

The speed environment of roads can have a huge impact on the actual and perceived safety of the facilities; therefore it is important to design for the appropriate speed of the roads involved. Determine the speed environment for the road classification first as it is the primary design control. All other factors relate to and can reinforce the design speed e.g. road alignment, width, intersection location and treatment, landscaping. Ensure that the speed environment is consistent along the road section.

Traffic management devices should not be installed where the speed environment does not require alteration. Use the process in the flow chart in Figure 5 for determining alternative design options.

Traffic speed for lower speed environments may be controlled, so that it is conducive to a mixed use street environment and function, through a variety of means:

- roadway width – a narrow roadway may provide space for only one vehicle at a time. Parked vehicles reduce the available space for moving vehicles so that there may only be a single usable lane. If cyclists use the road, their presence may control the traffic speed and the design requirements of the road.
- landscaping – appropriately designed on-street landscaping can visually narrow the road. It can also be used with changes to the kerb alignment to physically narrow the roadway.
- corners – the use and spacing of tight corners to maintain short lengths of straight road makes it difficult to gain speed.
- intersection spacing – short lengths of road between intersections make it difficult to reach high speeds.
- intersection design – tight kerb radii force motorists to slow down when entering an intersection. This can be combined with an intersection treatment (e.g. change in road width or surfacing) to indicate a change in the speed environment to drivers.

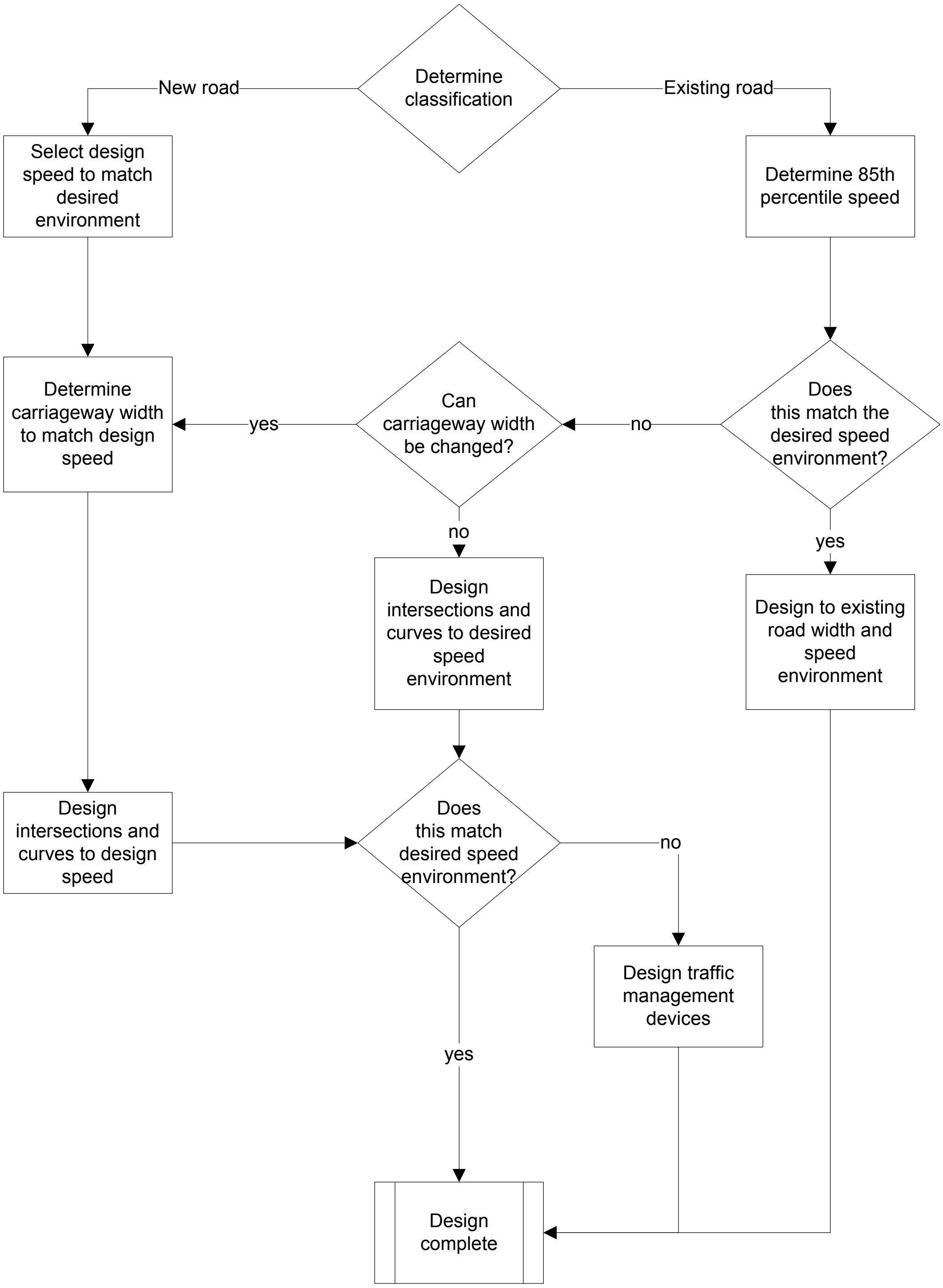


Figure 5 Application of traffic management

> traffic calming – localised road narrowing, changes in road texture, changes in the road alignment (both horizontal and vertical) can all be used to reduce speeds on local roads and to create safe crossing points for pedestrians and cyclists.

> rural thresholds – localised narrowing of the road through kerbs, road markings, signage and/or roadside planting can provide a signal to drivers that they are entering a residential area with lower speed limits.

Find standards for the design of higher speed environments, such as are appropriate on various classified and rural roads, in the *Austroads* series and TNZ manuals.

8.10 Road Design

Areas that require particular attention during the road design are:

> speed environment;
> intersection design and spacing;
> connections and intersections with the existing transport network;
> future road linkages to unzoned land;
> bus movement requirements and bus stop locations and facilities;
> pedestrian and cycle facilities;
> parking requirements;
> road crossings for pedestrians;
> access requirements of mobility impaired pedestrians;
> the connection of off-road facilities to roads and property access;
> lighting;
> road surfacing;
> Over Dimension and Overweight Vehicles.

Minimise life cycle costs and benefits for all new road elements. When choosing materials in particular, consider the replacement and maintenance cost whilst ensuring levels of service are met.

Council allows over-dimension and over-weight vehicles to operate on limited sections of the road network by permit, as shown in the Over Dimension Route Maps. The maximum dimensions for which permits are normally issued are:

> Width: up to 11 m
> Height: up to 6.5 m
> Length of vehicle combination: up to 35 m.

Avoid detailing permanent objects within the streetscape that will conflict with the over-dimension envelope on these routes.

Refer to New Zealand Heavy Haulage Association Road Design Specifications for Over Dimensions Loads. www.hha.org.nz/assets/Resources/NZHHA-Roading-Design-Spec-For-OD-Loads-Version-8.pdf

For route maps and permit applications refer to www.ccc.govt.nz/transport/legal-road/over-dimension-permits

8.10.1 Access to existing roads

Discuss access to the existing road network with the Council, and also the New Zealand Transport Agency, if a State Highway is to be affected.

The safety and efficiency of the existing roads must be maintained, when considering connections or accesses from the development.

8.10.2 Cul-de-sacs/Hammerheads/No exit streets

Cul-de-sacs can provide pleasant residential environments with a sense of community and little traffic but a balanced approach to their use is required. Refer to the District Plan for further information.

Where possible, provide walking and/or cycling linkages at the end of cul-de-sacs to parks, reserves or other roads. When designing large cul-de-sac heads, consider incorporating islands or other measures to break up large expanses of seal. Surface all turning heads and hammerheads with asphaltic concrete.

NZS 4404 details hammerheads.

8.10.3 On-street parking

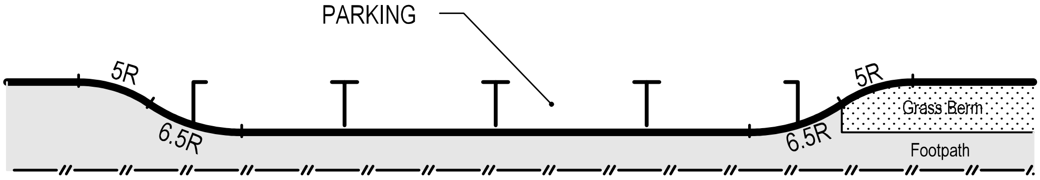
The off-street parking requirements for various activities are listed in the *District Plan*. Refer also to the *Parking Strategy for the Garden City*.

Design parking lanes widths from 2.2 - 2.5m. Increase stall lengths to 6.5m in high turnover areas.

Provide mobility car parks which meet the requirements of NZS 4121 where required by the brief or resource consent.

Wherever reconstructed street-side parking in residential areas is provided in bays, rather than as part of the carriageway, it should be at the minimum rate of one space per three residential units and evenly distributed along the street. Construct all parking bays to the same design loading as the adjacent road pavement and with a minimum width of 2.5m for parallel parking. Radii should match those shown in Figure 6.

Figure 6 Parking bay



When parking bays are located in front of properties, consider the possible location of the property access, which may need restriction by a Consent Notice.

Design angle parking to *Parking facilities - On-street parking*. Wherever parking is provided at 90 degrees to the kerb line, a minimum stall depth of 5.0m and a stall width of 3.0m are required. Make allowance in the footpath width or location for a 0.8m overhang wherever the kerb is to act as a wheel stop (included in the 5.0m stall depth).

Mark the parking lane or spaces in accordance with the *Kerbside Parking Limit Lines Policy*. Marking is required for all angle parking and where parking restrictions are in place. Mark mobility car parks in accordance with the *Manual of Traffic Signs and Markings* Part 2. There will also be other circumstances where roadmarking of parking is advisable e.g. outside schools and on arterial roads.

The Council has delegated the approval of the installation of parking signs to the Community boards. This is separate from and additional to engineering acceptance.

8.11 Intersection Design

The potential for crashes to occur at intersections is higher than other areas of the road network, due to the number of conflicting vehicle, cycle and pedestrian movements. Proper design of intersections can reduce the number of conflicts, while providing for a range of turning movements at the intersection.

Consider traffic safety issues due to the location of existing above-ground structures e.g. columns/poles or trees, at the time of design.

8.11.1 Comprehensibility

Comprehensibility of the network improves the ease with which people can negotiate their way through and around an area.

Generally, the geometry of any road intersection should be designed so that the major route is the through road and has traffic priority. Wherever the roads are of equal classification or one classification different, a roundabout may be used. This can also limit vehicle speeds. Wherever a local road intersects with a classified road, a perimeter threshold treatment may be appropriate to reinforce traffic priority and assist with comprehending the layout.

Improve comprehension by designing each classification of road to reflect its function, through consistency of appearance, width and geometric design of the road; e.g. the main arterial roads may have a central median. Reduce confusion by minimising the use of cul-de-sacs and, in particular, cul-de-sacs accessing other cul-de-sacs. See clause 8.10.2 - Cul-de-sacs/Hammerheads/No exit streets above.

8.11.2 Intersection types and controls

To support the safety and efficiency of the road network, roads should preferably only intersect if they are classified the same or are one level different in status. If it is unavoidable that roads more than two classification levels apart must intersect, then the Council may consider applying movement controls such as left in/out only or entry only.

Within new residential areas, appropriate intersection types include:

> Priority, roundabout or signal controlled T or Y-intersections (3-way), depending on the balance of traffic flows and classification of the approach roads. All approach legs to Y junctions should be separated by 120 degrees and T junctions by 90, 90 and 180 degrees.

> Four-way intersections at grade must be roundabout or signal controlled due to their high crash risk. Local roads should not intersect with the main road network as cross roads and should only form cross junctions with themselves where necessary. Where unavoidable and a reasonable volume of traffic across the busier road is anticipated, offset the quieter roads as a left – right stagger, to minimise the risk of crashes.

Wherever traffic from the planned roading network for a development will access a classified road, the intersection may require roundabout or traffic signal control or have certain movements restricted. Consult with the Council before submitting the Design Report, to ensure that the intersection conforms to the Council's requirements.

8.11.3 Unsignalised urban intersection spacing

Locate intersections sufficiently far apart to separate their traffic movements and provide drivers with sufficient lead-time for decision making. The minimum spacing requirements must be the greater of those listed in Table 2 or the spacing necessary to meet the requirements of the *Guide to Road Design, Part 4: Intersections and Crossings - General*. Discuss spacings for arterial – arterial intersections with the Council before the Design Report is submitted.

Table 2 Minimum intersection spacing in urban areas

Classification	Minimum spacing
Arterial - Collector	150
Arterial - Local	150
Collector - Collector	150
Collector - Local	150
Local - Local	40

Note:

1) Distances are measured centreline to centreline.
2) Double these distances to allow for future intersections into undeveloped land adjacent or opposite to this development.
3) Where the frontage road is divided by a median, intersection spacing may need to be increased to provide for construction of adequate-length turning bays
4) This table is derived from Austroads.

Use the following standards and guidelines for the design and operation of intersections and vehicle crossings:

- > *Guidelines for the Implementation of Traffic Controls at Cross Roads, RTS 1*
- > *Guide to Traffic Management, Part 6: Intersections, Interchanges and Crossings*
- > *CSS: Parts 1-7*

8.11.4 Sight distances

Adequate sight distances at an intersection must be provided as sight distance is fundamental to safe intersection design. When designing intersections and/or small radius curves, use the *Guide to Road Design, Part 3: Geometric Design*, which provides guidance on the minimum sight distance requirements. Refer to *Banks Peninsula District Plan, Appendix XIV – Standards for Vehicle Access and Loading* for requirements in Banks Peninsula.

8.11.5 Permanent signs and markings

Locate street name signs between 450mm and 1500mm behind the new kerb or 600mm and 1500mm behind the new shoulder and within the area formed by the intersecting legal road boundaries, as specified in *RTS 2*. Ensure that reconstruction projects include the relocation of the street name sign, if the works make its old position inappropriate. Position signs at least one metre away from a vehicle entrance or kerb cutdown where possible.

Consider the proximity of overhead power lines: design signs and other infrastructure to provide the clearances required in the *Code of Practice for Electrical Safe Distances*.

When signs are used within the road corridor, they must comply with the following standards and guidelines:

- > *Setting of Speed Limits 2003 Rule*
- > *Traffic & Parking Bylaw*
- > *Guidelines for Street Name Signs, RTS 2*
- > *Road Signs and Markings for Railway Level Crossings, RTS 10*
- > NZS 8603 *Design and application of outdoor recreation symbols*
- > *CSS: Parts 1-7*
- > *Compliance Standard for Traffic Signs*
- > *Manual of Traffic Signs and Markings Part 1*

The Council has delegated the approval of the regulatory signage and roadmarking on existing roads to the Community boards. This is separate from and additional to engineering acceptance.

8.11.6 Signalised Intersections

If the road controlling authority decides that traffic signals are necessary to provide safe and efficient access to the area, use the guidelines in:

- > Austroads “Guide to Traffic Management, Part 6: Intersections, Interchanges and Crossings”

> NZTA "P43 Specification for Traffic Signals"
> Christchurch City Council Regional Special Conditions for Traffic Signals for the design and operation of the traffic signals. The location and design of each installation must conform to the requirements and approvals set by the Council, to enable coordination of the traffic signals.

for the design and operation of the traffic signals. The location and design of each installation must conform to the requirements and approvals set by the Council, to enable coordination of the traffic signals.

8.11.7 Roundabouts

Roundabouts provide control at intersections in a variety of circumstances e.g. they can control speeds or improve traffic flows. Their location must be agreed with the Council at the consent stage.

Consider these issues in the design:

> the classification of the intersecting roads;
> the vehicle types expected to use the intersection;
> the speed environment;
> the distribution of turning traffic;
> pedestrian and cyclist safety;
> landscaping;
> heavy vehicle access requirements.

Roundabouts at the intersection of local roads can be used to control speeds, and may be designed with semi-mountable aprons for effective traffic calming. The semi-mountable apron slows cars (it must be high enough to discourage drivers from over-running it), whilst providing for the larger turning requirements of vehicles such as rubbish trucks and emergency vehicles. Discuss the geometric design of such roundabouts with the Council.

Roundabout with mountable apron (Hawford/Ford intersection)

Use the following standards and guidelines for the design and operation of roundabouts:

> *Guide to Road Design, Part 4: Intersections and Crossings*
> *Guide to Road Design, Part 4B: Roundabouts*
> *Guide to Road Design, Part 6A: Pedestrian and Cyclist Paths*
> *CSS: Parts 1-7*

Refer to clause 10.9.12 - Protection of sightlines (Reserves, Streetscape and Open Spaces) for planting in roundabouts.

8.12 Service Lanes, Private Ways and Access Lots

Access to a site (or sites) that will be provided by a private way must comply with the requirements of the *District Plan*.

Accessway design and construction standards, including drainage, for service lanes, private ways and access lots must comply with the requirements for an equivalent construction within legal road, including the 50-year design life. This includes the provision of a secondary flowpath for stormwater, as detailed in clause 5.6.2 - Secondary flow paths (Stormwater and Land Drainage). When designing accessways, balance the long term maintenance costs for the residents against the benefits of providing access through a vested road.

Use the Waste Management Bylaw 2009 (Terms and Conditions), see Section 17 of the document: www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Bylaws/Waste-Management-Bylaw-2009-Terms-and-Conditions.pdf to determine the requirement for either refuse truck access or refuse container storage areas at the road boundary. Where there is insufficient space, clear of the footpath and within the legal road, for the short-term storage of refuse containers, provide a collection point within the accessway but close to the road boundary.

As work within private ways, service lanes and accessways will not be taken over by the Council upon completion; the Council will be placing the onus for confirming both the suitability of design and construction on the developer.

These works must comply with the requirements of Part 3: Quality Assurance.

8.13 Geometric Design

8.13.1 Design speed

Classified roads are typically designed to a higher speed than local roads. The *Guide to Road Design, Part 3: Geometric Design* states that major urban roads should be designed for an operating speed 10km/hr above the legal speed limit. The desired speed environment or target speed for local urban roads may determine the design speed. Refer to *Guide to Traffic Management, Part 8: Local Area Traffic Management* clause 3.3.

The *Guide to Road Design, Part 3: Geometric Design* states that rural roads should be designed for the 85th percentile operating speed.

The *Speed Limits Bylaw* and its related register of speed limits, found at www.ccc.govt.nz/environment/speedregister/registerofspeedlimits.pdf, set out the speed limits for the listed roads. Use the *Speed Limits New Zealand Schedule 1* incorporated in the *Setting of Speed Limits Land Transport Rule* to estimate the relevant speed limit for new or reclassified roads in Christchurch. The Council will determine the relevant speed limit using the *Setting of Speed Limits Land Transport Rule*.

8.13.2 Horizontal alignment

Generally, horizontal curves conform to the *Guide to Road Design, Part 3: Geometric Design*. Design the elements of the road network for the appropriate design speed.

Design the kerb radii at local road intersections for a 2 axle truck, as detailed in *Guide to Road Design, Part 4: Intersections and Crossings - General*, whilst minimising pedestrian crossing distances.

Design intersections of a collector or arterial road to meet the tracking curve requirements in *RTS 18 New Zealand on road tracking curves for heavy vehicles*.

Avoid reverse curves where possible. If they are necessary, balance and separate them by a sufficient length of straight road to allow for a satisfactory rate of superelevation reversal (where the design speed is greater than 50kph).

Curves in the same direction in close proximity must be compounded. Avoid "broken back" effects.

Where horizontal curves of less than 60m radius are necessary for topographical or other reasons, extra widening of between 0.5 and 1.5m may be required, according to the width of carriageway available to moving traffic, the radius of the curve and the classification of the street. The *Guide to Road Design, Part 3: Geometric Design* Table 7.11 provides further information to calculate this extra widening.

Horizontal curves in 50kph areas are usually circular with a minimum centreline radius of 80m for through streets, reducing to 20m for cul-de-sacs.

8.13.3 Vertical alignment

Gradient lengths must be as long as possible, with vertical curves provided in compliance with the *Guide to Road Design, Part 3: Geometric Design*.

Gradients at any point on the kerb line should not exceed 1:6 or be less than 1:500, with a minimum gradient of 1:300 on the outside kerb line of any curve. Kerb grades less than 1:500 may be acceptable in conjunction with underchannel piping or frequent stormwater outfalls.

Where the change of gradient exceeds 1%, generally join the change with appropriate vertical curves of not less than 30m for through roads and 20m in cul-de-sacs.

Design the crown line at intersections to ensure a smooth ride on the main road. Normally, this means running the crown of the minor road into the nearside edge of the main road lane line or quarter point.

Wherever a roadway crosses a waterway or a drainage path, a conveyance system such as a single culvert structure (or multiple parallel pipes) is required. These drainage structures shall be designed and specified in accordance with Chapter 13 – Waterway Structures, Part B: Design, Christchurch City Council Waterways, Wetlands and Drainage Guide, Dec 2011. The new structures shall consider all aspects (waterway configuration, hydraulic capacity, depth of cover, secondary flow path etc.) to avoid exacerbating the existing flood prone areas or create new flooding issues. The designer shall also be aware that raising the road crown in an existing secondary flow path will increase the ponded flood water height and flood risk for upstream properties.

8.13.4 Crossfalls

Normal carriageway crossfalls should be 3% for urban roads and unsealed crossfall should not exceed 4%. The carriageway crossfall must be formed in accordance with the *CSS: Part 6* camber detail, SD 623.

Some variation from this requirement may be necessary in cases where a differential level between kerb lines is adopted and/or the crown is offset from the centreline.

Design turning circles to avoid an excessive differential between the crown and fender. Minimum crossfall must be 2% for asphaltic concrete and 2.5% for chipseal. Wherever an off-centre cul-de-sac head is used, offset the road crown to create symmetrical crossfall conditions.

Generally, crossfall should not exceed 6%, when measured from the carriageway edge to the crown.

8.13.5 Superelevation

Normally superelevation is not applied to urban local roads. For speed limits over 50kph, specific design of superelevation will be required. Where superelevation is required, the maximum value on local and collector roads is 5%.

8.13.6 Cross-section design

For new roads, provide carriageway and legal road widths that comply with the *District Plan*. Use table 3 when altering existing roads. Design widths as part of an optimal road cross-section, to achieve the following objectives:

> Minimise the capital costs of construction by not exceeding the desirable widths for high cost elements like carriageway, cycleway and footpath;

- Minimise the ongoing maintenance costs by designing and constructing elements to achieve their design life;
- Provide all the specified roadway elements;
- Provide bus lanes or bus priority measures where required;
- Reinforce the speed environment through appropriate lane and carriageway widths;
- Provide an attractive streetscape, adding to the amenity and character of the area;
- Facilitate a safe, efficient and effective drainage system by ensuring that the new works do not detrimentally affect the existing drainage pattern or road users;
- Provide a safe layout for all users.

Table 3 Carriageway elements

Road classification	Indicative total daily traffic flows (VPD)[1]	Min traffic lanes[2]	Cycle facilities[3]	Shoulder / parking lane[4]
Major arterial - Urban	>12,000	4	separate	parking lane / none
Major arterial - Rural	>10,000	4	separate	shoulder
Minor arterial - Centres	>10,000	2	marked in c/way	parking lane/ none
Minor arterial - Urban	3,000 to 15,000	2	marked in c/way	parking lane/ none
Minor arterial - Rural	2,000 to 12,000	2	separate	shoulder
Collector - Urban	1,000 to 6,000	2	marked in c/way	parking lane/ none
Collector - Industrial	1,000 to 6,000	2	marked in c/way	parking lane/ none
Collector - Rural (Christchurch City)	100 to 2,500	2	marked in c/way	shoulder
Collector - Rural (Banks Peninsula)	>200	2	within traffic lane	shoulder
Local - Industrial		2	within traffic lane	parking lane
Local - Urban	>250	2	within traffic lane	parking lane
Local - Centres	>250	2	within traffic lane	parking lane
Local - Urban	<250	2	within traffic lane	parking lane
Local - Rural	25 to 200		within traffic lane	shoulder
Local - Rural	<25		within traffic lane	shoulder

Notes:

1) These volumes are indicative only, and should not be used as a reason for changing classification of any road.
2) Design traffic lane widths to the Guide to road Design, Part 3: Geometric Design.
3) Design cycle facilities in accordance with clause 8.6 - Cycle Facilities.
4) On higher category roads the movement function of the route becomes more critical. Therefore, consider the removal of on-street parking where indicated by capacity/road safety/road space allocation requirements.
5) Mark parking lanes in accordance with clause 8.10.3 – On-street parking.
6) Provide swales where required by the project brief or subdivision consent.

The desirable traffic lane width excluding in local roads is 3.5m. This width is only appropriate where a discrete cycle facility is provided e.g. a marked or separated lane. The lane width may be increased to 4.2 – 4.5m, to provide shared wide kerbside lanes, where parking is not provided. Do not design widths between these values as they cause cyclist/vehicle conflicts. Where cyclists are expected to mix with general traffic, refer to the guidance for mixed lanes in the *Cycling Network Guidance*.

When proposing narrower widths or where all elements may not be provided, carefully consider the reasons and balance them against the above objectives. Submit a non-conformance report detailing the process of trading off these objectives to arrive at the non-complying design widths, as part of the Design Report.

Refer to *Streets and Spaces Design Guide, Chapter 5 - Streets* for guidance within the central city.

8.13.7 Shoulders

The *Guide to Road Design, Part 3: Geometric Design* states that the minimum formed shoulder width for a rural road with traffic volumes over 150 vpd is 1.5m. Make an allowance for off-road parking areas on roads with 1.0m shoulders.

Table 4 Shoulder width

Design Traffic Volume (AADT)	Formed Widths (m)	Sealed widths (m)
Single lane road <150vpd	2.0	0.5
<500	1.5	0.5
500-1000	1.5	0.5
>1000	2.0	1.0
>3000	2.5 – 3.0	2.0

Note: This table is derived from *Guide to Road Design, Part 3: Geometric Design.*

Sealing of the shoulder varies from 0.5 – 2.0m, depending on traffic volumes and site conditions. Mark edgelines to prevent shoulders being incorporated in the traffic lane. On local rural roads, the shoulder widths may be determined by the width required to provide cycle facilities.

8.13.8 Medians

The *District Plan* sets out requirements for the installation of medians in new roads.

Determining median widths is typically dictated by the function of the road, the type of median and intersection details. The *Guide to Road Design, Part 3: Geometric Design* clause 4.7 provides guidance on median functions, types and widths.

8.13.9 Hillside construction

Where the road is or will be constructed on a slope, this can affect the ability to provide all the required elements of a streetscape and therefore impact on the achievable widths for some or all of those elements. Consider batter stability and property access, in addition to issues detailed in clause 8.13.6 - Cross-section design.

Options available for hillside construction:

- Design narrower legal road widths. Wider widths may be impracticable as it may be impossible to utilise more than a certain width due to crossfall restrictions. Property access may also be compromised if wide roads require high cuts or retaining walls.
- Use localised widening to construct passing or parking bays or to accommodate heavy vehicles.
- Provide a lesser standard of elements; through restricted parking, constructing only one footpath or combining elements e.g. shared cycle paths and footpaths.
- Construct retaining walls(the installation of new concrete crib retaining walls will not be approved by CCC).
- Locate pedestrian and cycle facilities separately from the carriageway.

8.14 Traffic Management Devices

Initiatives to enhance road safety are built around the three E's – engineering, education and enforcement. Engineering the environment to 'solve' a problem may not always be the most efficient solution but is likely to be the most expensive. Consider education or enforcement as well as engineering in the design process.

Design a road at the outset for its environment and function, as it is difficult to retrospectively alter the speed environment. Analyse the existing speed environment, including the 85th percentile speeds, for assessment against the design operating speed and comparison to the constructed speed environment.

The installation of traffic management devices (TMD) is most appropriate to local residential streets where:

- the posted speed limit $<$ 85th percentile operating speed $<$ posted speed limit + 20km/hr;
- peak hour traffic volumes exceed 60 vehicles (equivalent to approximately 600 vehicles/day);

- the length of the road segment under consideration > 250m;
- the road has a documented crash history of the type that could be corrected by the devices considered for implementation;
- there are significant pedestrian safety issues.

Install TMD in classified or rural roads:

- at the transition from the open road to a lower speed limit;
- to enhance pedestrian safety;
- to reduce conflict points.

Use the following standards and guidelines for the design and operation of traffic management devices:

- *Road Safety to 2010 Strategy*
- *Guidelines for Urban-Rural Thresholds, RTS 15*
- *Guide to Traffic Management, Part 8: Local Area Traffic Management*
- AS/NZS 1158 Set *Lighting for roads and public spaces - series*
- *CSS: Parts 1-7*
- *Manual Of Traffic Sign and Markings Part 2*

8.14.1 Device selection

When designing traffic management, be clear about the objective of the measure's installation and the strategy or strategies that the device should achieve. Make the differentiation clear between "neighbourhood improvement" type works and traffic management works, to ensure the measures don't have unexpected effects. Wherever possible, make the objective measurable, to allow an assessment of its effectiveness.

Both the street environment and traffic control must be in tune with each other, and compatible with the desired character of the street. Select traffic management devices which reinforce the road function, through inhibiting inappropriate behaviour or through changing the user's perception of the environment. Where alternative devices support the same objectives, consider the degree of effectiveness required and the likely environmental effects. Ensure that alternative devices do not create inequitable barriers for disabled people.

Factors such as traffic noise and air pollution can have significant impacts both locally and remotely. When selecting the device, consider other environmental effects e.g. noise from deceleration and acceleration, increases in travel distances or traffic volumes on arterial roads.

The four main types of measure are listed in Table 5, with an indication of the objectives to which they are most applicable and of their degree of effectiveness. The environmental effects are also indicated.

Refer to *Guide to Traffic Management, Part 8: Local Area Traffic Management* for an in-depth examination of these devices, their application, advantages and disadvantages.

Table 5 Traffic Device Measures and Objectives

Traffic Device Measures and Objectives The number of ticks indicate the degree of effectiveness. The number of crosses indicate their negative impact. **Measure**		**Reduce speeds**	**Reduce traffic volume**	**Increase pedestrian safety**	**Reduce crash risk**	**Traffic related environmental effects**
Vertical Deflection Devices	Raised mid-block tables	√√	√√	√	√√	XX
	Wombat crossings	√√	√√	√√√	√√	X
	Road humps	√√√	√√	√	√√	XX
	Road cushions	√√	√√	√	√√	X
	Raised intersection platforms	√√	√√	√	√√	XX
	Perimeter threshold treatments with hump	√√	√√	√	√√	XX
Horizontal Deflection Devices	Lane narrowings / kerb extensions	√		√√√	√	
	Splitter islands	√		√√√	√X	
	Slow points – one-lane	√√√	√√√	√	X	
	Slow points – two-lane	√	√			
	Blister (wide) islands	√	√	√		
	Driveway links	√√√√	√√√√	√√√√	X	√√
	Mid-block flush median treatment	√		√√	√√√	
	Mid-block raised median treatment	√		√√√	√√√	
	Roundabouts	√√√		√	√	XX
Diversion Devices	Full road closure		√√√√√	√√√√√	√√√√√	XX√√
	Half road closure	√√√	√√√	√√√	√√√	X√√
	Diagonal road closure	√√	√√√√	√√√√	√√√√	X√
	Modified T intersection	√√	√√		X√	
	Left in/Left out islands		√√√	√√√	√√√	X√
Signage, Road marking and Other treatments	Speed limit signs	√		√	√	
	Prohibited traffic movement signs		√√√√	√√	√√√√	X√√
	One-way signs	X	√√√	√√√	√√√	X
	Stop signs/ Give way signs	√	√	√	√	
	Pedestrian crossings	√		√√√	√	X√
	Perimeter threshold treatments			√		√√
	Rural threshold	√				√√
	Tactile surface treatments	√				XX√√
	Bicycle facilities				√√	√√
	Bus only treatments		√			√√√
	Shared zones	√√√	√√√	√√√	√√√	√√√

8.14.2 Design considerations

Overuse of devices will reduce their effectiveness globally, as will the passage of time reduce it locally, as drivers become familiar with them. Regardless of this, ensure a degree of consistency in the use of traffic management devices:

- Use similar devices in similar ways.
- Design devices so that drivers can recognise and react to them appropriately both in approach speed and alignment.
- Provide roadmarking, signage and lighting to support the device's purpose.
- Ensure sight distances comply with clause 8.11.4 - Sight distances and the *Guide to Road Design, Part 3: Geometric Design*.
- When designing the device layout, first consider where in the street the device is best placed to achieve the objectives.
- Design longitudinal vertical gradients under 3% at intersections where traffic management devices will be installed.

Install devices with operating speeds that are within 20km/hr of the speed environment. Commentary 18 Figure C18.2, in the *Guide to Traffic Management, Part 8: Local Area Traffic Management*, has a range of indicative operating speeds for various devices. Space devices with a high degree of restraint, like road humps, 80 -120m apart.

Design devices to remove any confusion with pedestrian crossings. Surface footpaths and traffic devices in different colours, to help define their limits. Use tactile surface treatments where there is no level difference between the footpath and the road.

Use landscaping or different surfacing to clarify pedestrian routes and to enhance the effectiveness and safety of the devices. Where devices are used as pedestrian or cycle refuges, ensure that landscaping does not obstruct sightlines.

Select lane widths carefully. Generally only either a vehicle or bicycle can use a 3.0m lane. Both cars and bicycles can use wide kerbside lanes (3.7m or over) at the same time, which are best for roads over 60km/hr or where devices must cater for buses or heavy vehicles. Avoid intermediate widths as these can create squeeze points for cyclists.

8.14.3 Vertical deflection devices

Design the type of treatment stated in Table 6 for the intersection of a local street with the relevant through-road classification. Figure 9 illustrates how this hierarchy of treatments may be applied.

Table 6 Intersection treatment types

Through-road classification	Threshold type
Local	Raised Platform
Collector	Threshold Type B
Minor Arterial	Threshold Type C
Major Arterial	Threshold Type C with median island closure on arterial

Notes: 1) Thresholds Type B and Type C are shown in Figures 10 and 11.
2) Type A is obsolete.

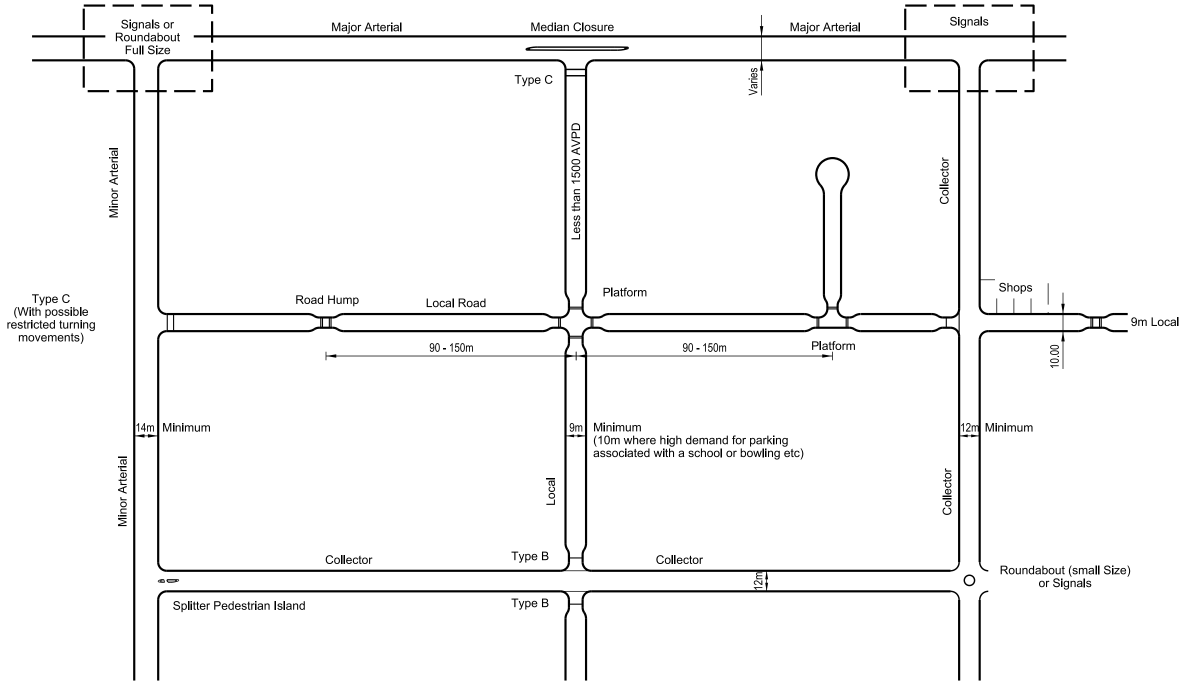


Figure 7 Roading Hierarchy

Locate mid-block devices on local roads that are intended to deter traffic and to control speed between 90m and 150m from intersections. They may be shifted around 30m in either direction without affecting their effectiveness, if their location conflicts with vehicle entrances or to position the device under an existing street light.

Design raised tables and platforms to be 75 – 100mm above the road surface, with flat platforms between 2 – 6m long. The design height of the table or platform should be related to the type of transition from the ramp to the platform or road surface. Rounded transitions are smoother to travel over than sharp transitions so may require a greater height increase. Also examine the longitudinal profile of the adjacent centreline to ensure that it doesn't amplify or nullify the vertical deflection experienced by the vehicle.

Install road humps constructed in accordance with *CSS: Part 6* SD 631.

Consider the types of traffic which will negotiate these devices. Where buses and heavy vehicles will regularly negotiate devices, specify flatter ramps (1 in 20) and longer platforms (6.0m). Cyclists also prefer longer ramps (1 in 15) but these do not reduce speed as effectively as short ramps (1 in 12).

8.14.4 Horizontal deflection devices

Design bicycle lanes to bypass horizontal deflection devices where demand warrants it. If cycles use the traffic lane, eliminate squeeze points in, before and after devices.

Assume operating speeds of 10-20 km/hr for slow points and design them with deflection angles between 10 to 30 degrees. Where bicycle usage is not significant, design lane widths between 2.8 and 3.0m.

Detail blister islands at least 2.0m wide and 3.0m long.

Roundabouts are also horizontal deflection devices and are discussed in clause 8.11.7 - Roundabouts.

Reducing traffic speed through traffic calming (Geraldine/Gresford intersection)

8.14.5 Diversion devices

Construct pathways through diversion devices for bicycles and pedestrians and ensure that the devices can cater for the permitted users.

Carefully consider the use of full road closures and design them to minimise disruption. Design half road closures to make prohibited manoeuvres difficult. Provide turning facilities for both forms of road closure. Maintain two way movement through diagonal closures for all users.

Design modified ‘T’ intersections with mountable kerbs and reinforce changed priorities where appropriate. Combine left in/left out islands with central median islands to improve efficiency.

8.14.6 Thresholds

Detail the continuous kerb across the front of a threshold as a cycle cutdown.

Design perimeter thresholds which are at least 5.0m long and entirely flush with the road. Provide for the turning movements of commercial vehicles and buses.

Install rural thresholds only where there is more than 20km/hr between the posted speed limits on each side of the threshold site and where there are no existing constraints which reduce the speed environment. Vertical design elements are an essential component of rural thresholds and include evergreen planting, signs, lights and their columns. Utilise horizontal design elements like planting, medians and lane narrowing. Refer to *Guidelines for Urban-Rural Thresholds* for widths in differing traffic conditions.

Where designing Type B or Type C thresholds to deter through traffic, the maximum width should be 7.0m. Where designing these thresholds to accommodate full access, the minimum width should be 9.0m.

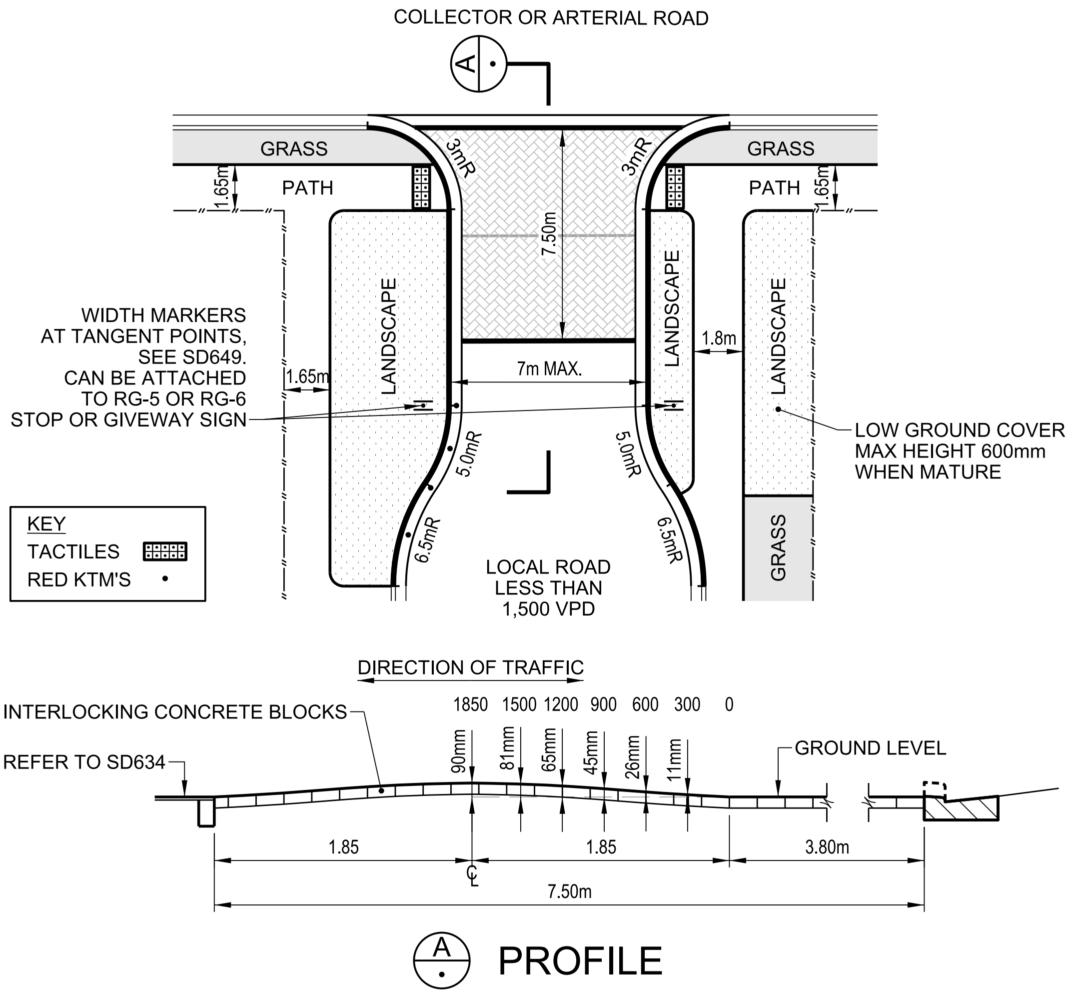


Figure 8 Type B threshold

Where buses and heavy vehicles will regularly negotiate Type C thresholds, the rise in the road hump may be reduced to 50mm.

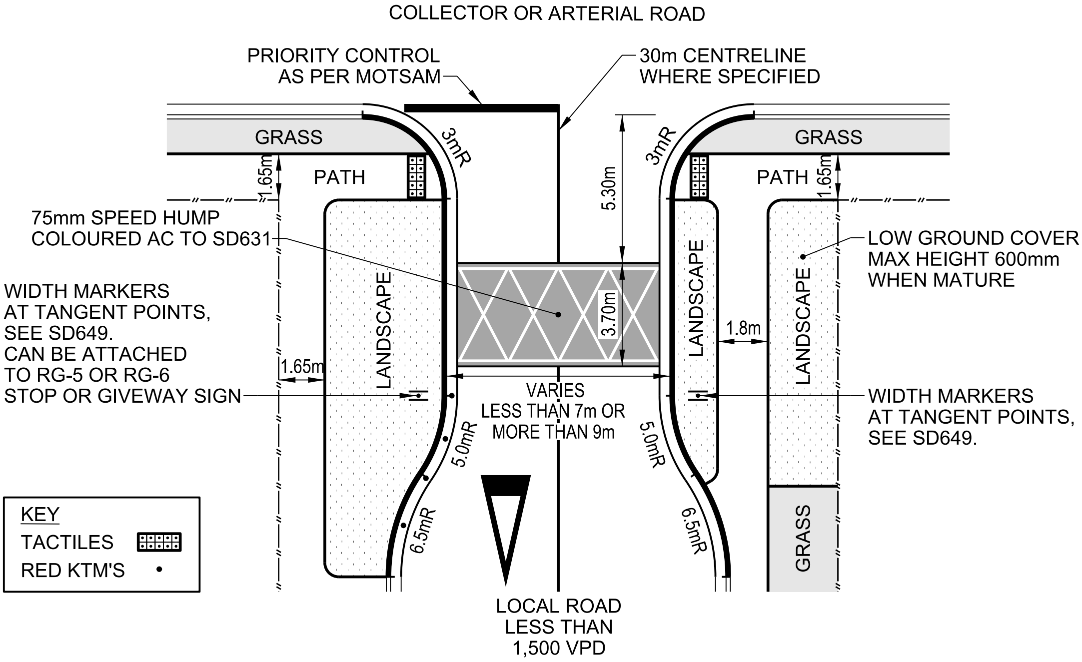


Figure 9 Type C threshold

These thresholds do not require road hump or speed advisory signs. Detail width or hazard markers where the kerb build-out exceeds 1.5m and red kerb top markers (KTM) on the left hand approach only to the tee. Space them evenly around the curves at the curve tangent point (CTP), both mid tangent points (TP) and the outside TP, as shown. They should not be placed on cutdowns.

Design modified versions of the Type B and C thresholds, shown in Figures 10 and 11, where there is known heavy vehicle or bus use of the local road. Compound curves shown in Figure 14 should be used for light 'trucks' or buses and heavy vehicles respectively.

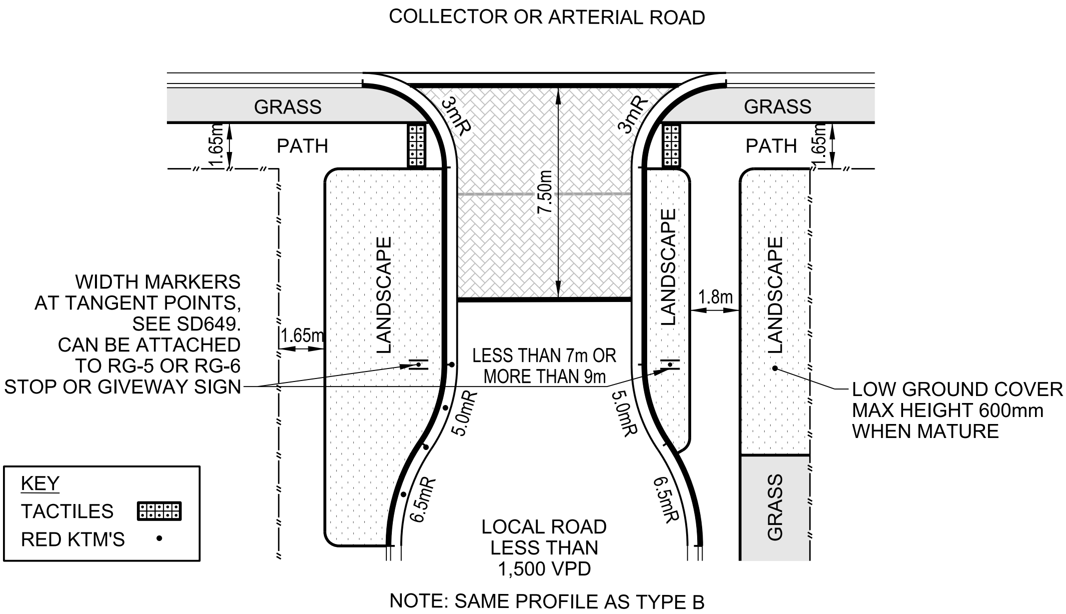


Figure 10 Type B modified threshold

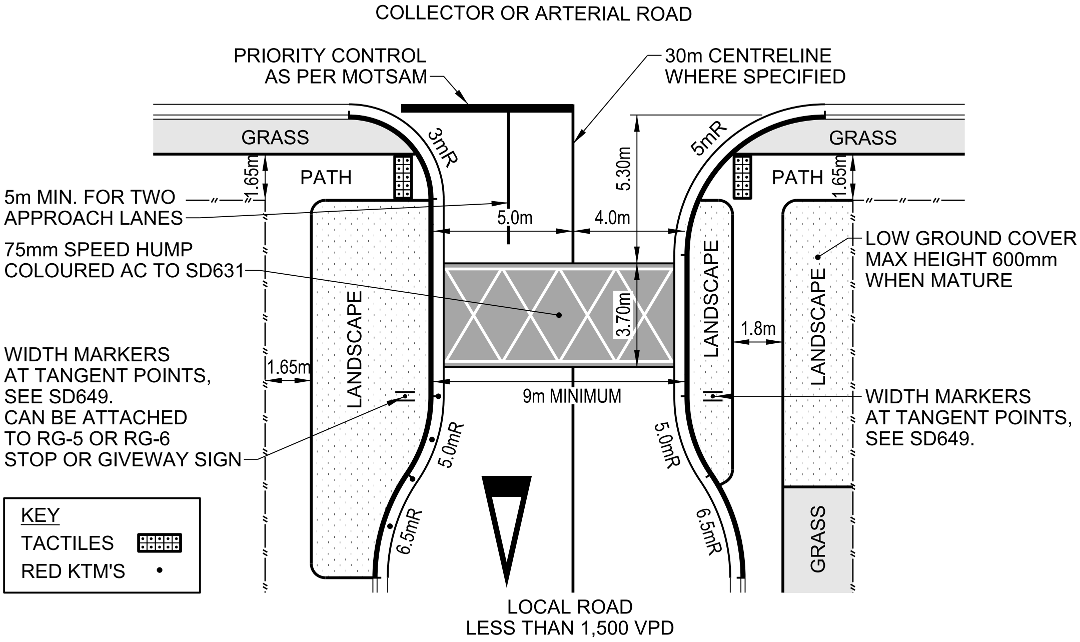


Figure 11 Type C modified threshold

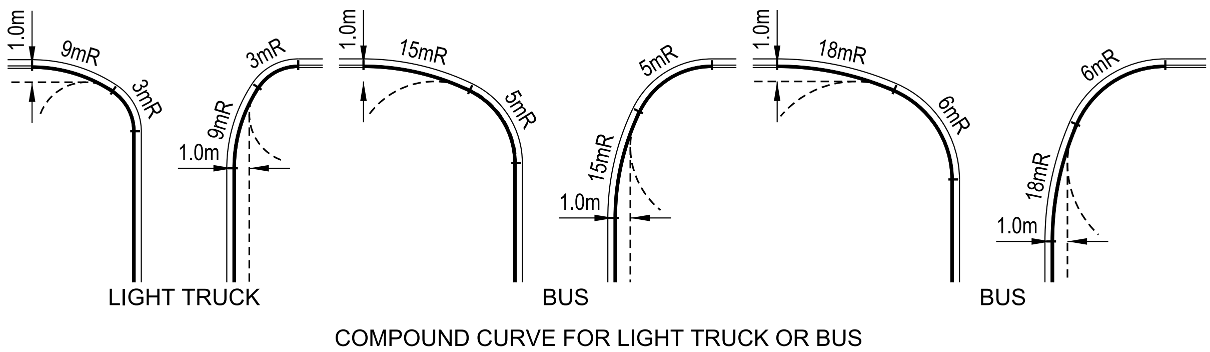


Figure 12 Compound curves

8.14.7 Signage

Reinforce the effectiveness of signage by combining it with other devices. Install zebra crossings or signalised pedestrian crossings only where there is a warrant for it, as defined in NZTA *Pedestrian Planning and Design Guide.*

Ensure that all the traffic control devices are visible. Signs or raised studs, which comply with *CSS: Part 6*, or supplementary lighting, may be required. For lighting, refer to Part 11: Lighting.

The Council has delegated the approval of the installation of regulatory signs and roadmarking, including stop, give way and prohibited traffic movement signs, to the Community boards. This is separate from and additional to engineering acceptance.

8.14.8 Road markings

Install centrelines on rural roads with an AADT over 250 or where a road with an AADT over 100 has frequent or substandard horizontal or vertical curves. Install centrelines on classified urban roads carrying substantial volumes of non-local traffic.

Install lane lines wherever there is more than one lane in the same direction. Replace centrelines and lane lines with raised pavement markers on roads with a fine textured surface.

Install edge lines on rural roads with an AADT over 750 or where a road with an AADT over 250 has frequent or substandard horizontal or vertical curves. Install edge lines on urban arterial roads and where the lane requires definition or may conflict with parking.

Consider the requirement for no overtaking and no stopping lines. Install no-stopping lines adjacent to the kerb where a cycle lane is located against the kerb. The Council has delegated the approval of no stopping line installations to the Community boards. This is separate from and additional to engineering acceptance.

Where road markings are required, use the following standards and guidelines:

> *Guidelines for Flush Medians, RTS 4*

> *Guidelines for Safe Kerbline Protection, RTS 8*

> *Guidelines for Rural Road Marking and Delineation, RTS 5*

> NZ Supplement to *Guide to Traffic Engineering Practice, Part 14: Bicycles*

> *CSS: Parts 1-7*

> *Manual Of Traffic Signs and Markings* Part 2

8.15 Streetscape

The streetscape elements include paths, grassed berms, trees, shrub beds, streetlights, structures and hard landscaping. These can provide various benefits including:

> a network of safe, pleasant, comfortable, convenient and efficient paths.

> positive guidance for pedestrians and/or cyclists.

> seats, lighting, litter bins (where required) and other facilities.

> enhancement of the street environment by the inclusion of grassed areas, specimen street trees and plant beds, built structures e.g. fences, low walls, art works.

> attractive 'rain gardens' with safe overflow provision, which can provide a water quality and air quality improvement component for air and water borne vehicle pollutants.

Discourage vehicle access to berms, footpaths and swales by using landscape elements (e.g. kerbing, bollards, planting or fences).

Detail surfacing or treatment interfaces, e.g. where a path/berm intersects with a kerb, to avoid acute angles and so facilitate compaction and reduce maintenance issues.

Bollards prevent vehicles parking in the swale (Waiwetu St)

8.15.1 Footpaths

The number of footpaths required for each road classification must comply with the requirements in the *District Plan*.

Footpath widths are measured from the footpath edge of the kerb or service strip. The service strip may be sealed with the path. The minimum widths set out in Table 7 must be **clear of all obstructions** such as vegetation when fully mature, light standards, traffic signs, utility furniture and bollards. The building or fence line is the preferred path of travel for the majority of pedestrians who have a vision impairment and should always be prioritised as the continuous accessible path of travel (CAPT). Extra widening will be required wherever such obstructions cannot be avoided or relocated. Figure 15 indicates situations where extra widening is required.

Table 7 Minimum footpath widths

Adjacent land use	Minimum width (m)	Preferred location
Residential	1.5	Adjacent to boundary
Retail/town centre	2.5	Adjacent to kerb
Industrial	1.5	Adjacent to kerb

Notes:

1) Residential footpaths are normally separated from the kerb by a grass berm and from the road boundary by a service strip.
2) Allow for any planting (e.g. trees) between the footpath and the kerb.
3) On slopes, it is most practicable to construct the footpath against the kerb.
4) Transitional widths may be required on the boundary between residential and retail/town centres.

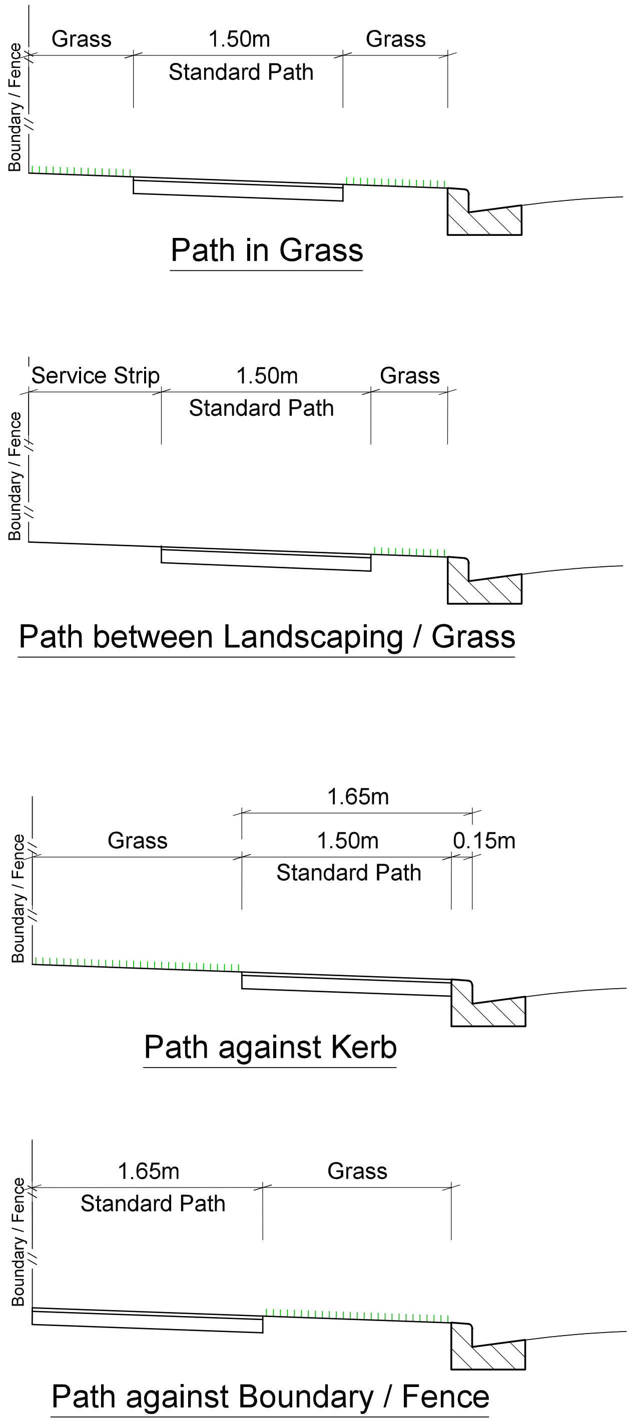


Figure 13 Extra footpath widening

Where topography or existing features preclude providing the minimum widths, discuss options with the Council.

Lateral changes of the footpath direction should normally be achieved using smooth continuous curves. This is particularly relevant where the path deviates around obstacles (e.g. utility boxes, columns/poles) or adjacent berm areas (e.g. trees, shrubs or structures) or shifts laterally to join another footpath.

Wherever the footpath deviates from pedestrian desire lines and positive guidance is required, install plant beds, fences or comparable barriers. Wherever possible, plant shrubs to soften the appearance of the guidance element. Also consider the needs of people with disabilities e.g. mitigate the possible safety risks for a person with a visual impairment by indicating the change.

Path deviates around an obstruction (Carlton Mill Rd)

Use the *Footpath Berm Policy* when designing a footpath. The following documents should also form the basis of the design:

> *Equity and Access for People with Disabilities Policy*

> *Guidelines for Planting for Road Safety*

> *NZS 4121 Design for Access and Mobility – Buildings and Associated Facilities*

> *CSS: Parts 1-7*

For residential areas the Council's preference for footpath and vehicle crossing pavement type is asphalt. An NCR for any alternative footpath and vehicle crossing pavement construction will be required for Council consideration.

8.15.2 Crossfalls and gradients

The optimum crossfall for sealed footpaths is 2.0%, with a minimum of 1.25% and a maximum of 3%. Grass areas and plant beds between the footpath and the carriageway or on median islands must have crossfalls flatter than 6%.

To provide access for wheelchairs and prams, steps must not be used on footpaths within public roads, unless approved by the Council.

Grassed areas for tree planting, which are additional to the minimum berm width, must be specifically designed. In these areas, steeper slopes may be permitted provided that the area can be mown or otherwise easily maintained. Gradients up to one in two may be planted. The treatment of all gradients steeper than one in four requires Council approval.

8.15.3 Grassed berms

Install berms where specified in the *Footpath Berm Policy*. Berms could be planted in selected areas. Where the width from the legal boundary to the kerb or road edge exceeds 2.5m in residential areas, install a berm.

Squaring the point of a berm (Richardson Tce)

The minimum width for grassed berms is 0.7m. Typical cross sections, showing minimum berm widths, are shown in *CSS: Part 6*. The width of service strips against property boundaries shall be set to accommodate service and utility cabinets and structures. The smallest area of berm permitted is $2m^2$ and areas smaller than this must be formed and sealed/paved as footpath.

Where adjoining pavement surfaces meet, forming a point in the grass area with an angle of less than 60 degrees, square or round off the point of the grass berm to be no narrower than 0.7m.

8.15.4 Batters

Generally, batters should match any existing stable slope of similar material. Flatter slopes that are integrated into the natural landscape are preferred.

Where the formed batter is not required to cater for foot traffic, grassed batters are permitted, to a maximum of one in four. These must be mowable, as defined in clause 10.9.17 – Reducing grass maintenance (Reserves, Streetscape and Open Spaces).

The top edge of every fill, and the toe of every cut, must have a crossfall of 3% and extend at least 500mm beyond the outside edge of the footpath. If there is no footpath, measure this dimension from the back of the kerb or the outside edge of the trafficable shoulder as applicable.

Retain all new cut faces or stabilise with vegetation. Slopes steeper than one in two must be retained. Structures supporting the road must be located on legal road. Locate stabilised faces or retaining structures that support private assets or property outside of the legal road. Refer to clause 8.20 – Retaining walls for design criteria.

Some of these structures may require building consent.

8.15.5 Utilities

Show any existing utilities and services on the drawings.

Both existing and proposed underground and above-ground utility services can impact on the design through conflicts with the proposed carriageway elements. The cost of relocating existing utilities is significant and may therefore not be a viable option. Existing roads are often reconstructed at a lower finished level but restrictions on lowering carriageways, and the corresponding kerb, due to the presence of utilities can lead to property and upstream drainage problems.

To ensure there is no conflict with the road geometrics or between any utilities and proposed street features or planting, become familiar with the required clearances from both existing and proposed above-ground and underground utilities. Ensure they do not create a safety risk for people who are blind or visually impaired. Refer to clause 9.5.3 – Typical services layout and clearances (Utilities) for guidance and standards for the work. Any conflicts should be resolved during the design process.

Pothole existing underground services, to confirm both their location and depth. When utilities constraint the design, there are a range of solutions available:

- Consider moving the carriageway alignment. This can allow either underground utilities to be positioned towards the centreline or underground utilities and columns/poles to be positioned outside of the carriageway or footpath.
- Design element widths to achieve the same result as moving the carriageway alignment.
- Provide a lesser standard of elements, through restricting parking or constructing only one footpath.

8.15.6 On-street planting

Plant beds are generally used to soften the street environment and to provide visual guidance to pedestrians, cyclists and drivers. Landscaping is also an important component of traffic management devices but must be carefully designed to enhance the safety and effectiveness of these devices. The location of streetlights, sight line visibility and hazard criteria are critical when designing the on-street planting.

Must refer to clause 10.9 - Landscape Planting, before designing plant beds or street trees.

Planting that obstructs the visibility of approaching traffic

8.15.7 Street furniture

Landscaping structures such as planter boxes, seats, bins, sculptures, memorials and entrance structures on legal roads must be constructed in long-life materials (20-year minimum). Refer to the *Public Places Bylaw* and clause 10.6.4 – Structures (Reserves, Streetscape and Open Spaces) for further information. Some of these structures may require building consent, which the developer must obtain.

In low speed environments, locate continuous structures like low walls at least 450mm behind the kerb, with a maximum height of 700mm if adjoining the footpath.

Locate them so that they do not obstruct the sightlines of intersections, pedestrian crossings or signs. Ensure they do not create a safety risk for people who are blind or visually impaired.

Refer to *Streets and Spaces Design Guide, Chapter 4 - Street Furniture* for work within the central city.

8.15.8 Road crossings for pedestrians

Provide pedestrian crossing facilities that comply with the *Intersection & Pedestrian Crossing Design for People with Disabilities Policy* and *CSS: Part 6* at all road intersections and other locations, wherever these will provide logical and safe movement of pedestrians. Mid-block crossing facilities may be combined with kerb build-outs and pedestrian islands, to minimise the crossing distance for users.

Provide a one metre separation between new pedestrian cutdowns and existing columns/ poles or signs.

Pedestrian islands or other facilities, to aid safe crossing of roads, may be required in areas where high numbers of pedestrians are expected to be crossing (e.g. local commercial areas, reserves, schools, retirement homes, public facilities).

Provide tactile warning pavers or tactile ground surface indicators (TGSI) for vision-impaired pedestrians on public footpaths at all pedestrian crossing kerb cut-downs. Specify tactile types, preferably pavers, which will achieve the 20 year operational life of the contrast between the path surface and the tactile. Plastic TGSI are not permitted in Council paths.

Avoid designing pedestrian crossing facilities that can be interpreted by pedestrians as official zebra crossings.

Use the following standards and guidelines for the design and operation of pedestrian crossing facilities:

> *Guidelines for Facilities for Blind and Vision-Impaired Pedestrians RTS 14*

> *CSS: Parts 1-7*

> *Guide to Road Design, Part 4: Intersections and Crossings -General*

> *Guide to Road Design, Part 4a - Unsignalised and Signalised Intersections*

> *Guide to Traffic Management, Part 6 - Intersections, Interchanges & Crossings*

Tactile pavers at a pedestrian crossing cut-down (New Brighton Mall)

8.15.9 Site access

Design all kerb crossings and cut-downs to chapter 7 of the *District Plan*.

Design residential vehicle crossings in accordance with Christchurch District Plan-Planning Maps- Chapter 7 - Appendix 7.5.7 Access Design and Gradient table 7.5.7.1. Also refer to the CSS Part 6 standard detail SD 606 for vehicle crossing and typical footpath geometry.

Design commercial crossings with a maximum width of 9.0m at the boundary. The designs shown in *CSS: Part 6* are acceptable design solutions. Wherever access to property is required across a swale, the crossing design must be specific for the affected site(s).

Use the following standards and guidelines for the design and operation of intersections and vehicle crossings:

- *Guide to Road Design, Part 4: Intersections and Crossings -General*
- *Guidelines for the Implementation of Traffic Controls at Cross Roads, RTS 1*
- *CSS: Parts 1-7*

8.15.10 Clear zones

The clear zone is the width from the edge of the traffic lane in which an errant vehicle can recover. To provide this zone, locate new hazards e.g. above-ground utilities, street furniture and trees, streetlights, at a distance from the edge of the traffic lane greater than the widths in Table 8. Remove or treat existing roadside hazards within this distance.

Table 8 Clear zone widths

One way AADT	≤ 50km/hr	70km/hr	100km/hr
≤ 1000	3.0m[1]	3.4m	6.0m
>5000	3.0m[1]	5.4m	9.0m

Note:

1) Where the above setbacks are not achievable, discuss alternative options with the Council early in the design process.
2) Interpolate between the given values for AADT between 1000 and 5000.
3) This table is sourced from the *Guide to Road Design, Part 6: Roadside Design*

Street trees planted within clear zones should have frangible trunks.

Some on-street structures in urban areas cannot feasibly be relocated. If they are not frangible, they should be protected. Formal barriers may not be the best option. Alternatives to barriers that could be considered in low speed urban areas include frangible planting and bollards.

When providing a barrier to a hazard within the clear zone, include the barrier deflection when determining the offset between the edgeline and the structure.

Guide to Road Safety, Part 9: Roadside Hazard Management provide details on clear zones, hazards and safety barriers.

8.16 Pavement Design

8.16.1 Pavement and surface treatment design

Design roads to have an infinite life for the subbase and a 50-year life for the basecourse. Use a traffic growth rate of 2% per annum for design purposes.

Design roads to preferably be flexible pavements, with a 50-year life, using the general principles of the current New Zealand Supplement of the *Guide to Pavement Technology*.

All roading and private access rights of way must comply with the Benkelman Beam criteria shown in Table 9. Refer to CSS: Part 6 clause 11.6.3 – By Benkelman Beam for more detail on analysing test results.

Table 9 Benkelman Beam criteria

Traffic Loadings (heavy vehicles/day)	95% of readings (mm)	Maximum (mm)
>500, top basecourse* prior to structural AC	<1.5	1.7
>500 top of AC	<1.0	1.0
>500	<1.2	1.5
100-499	<1.6	2.0
<99	<2.0	2.5

Note: *or existing surfacing/pavement

The pavement design must detail the:

> asphaltic mix type and layer thickness. Refer to NZTA M/10 for further information;

> geotechnical requirements – test the subgrade and establish an in-situ or soaked CBR. Establish a correlation between the local soils and the test methods used;

> structural design – design pavements to meet the (modified) life-cycle requirements of the *New Zealand Infrastructure Asset Valuation and Depreciation Guidelines* as modified by the Council. The pavement designs are, however, restricted to a 50-year life for the basecourse layer.

Other considerations in the design may include, but should not be restricted to:

> type of edge restraints – in most urban environments a concrete edge restraint or kerb and channel must be provided. In other areas, provide road shoulders, as defined in clause 8.13.7 – Shoulders, to prevent edge break.

> semi-rigid and rigid pavements – semi-rigid and rigid pavements (e.g. those that require structural layers of asphaltic concrete, cement or bitumen stabilised metalcourses, concrete roads and similar) require specific design.

> coal tar - determine its presence through testing for PAHs and either specify to dispose of, encapsulate or reuse on site, whilst applying contaminated material handling methodologies.

> specifying the asphaltic mix type under the TNZ specification e.g. PA15HS for high traffic shear stress or PA20 otherwise.

> the local subgrade – many sites have subgrades where the CBR values are so low that the pavement design requires a sacrificial layer of aggregate, sand or the use of geotextiles.

> the subsurface drainage – the Council recognises that the lack of subsurface drainage outfalls often results in the inability to avoid a “bath-tub” design where the pavement materials will, at times, become saturated. However, the acceptance criteria related to life-cycle traffic loadings still apply.

> the local water table – basecourse layers must be above the water table during a 1 in 10-year flood event.

> cover to underground services – maintain adequate cover to utilities when the project proposes lowering the road level or crown.

8.16.2 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 waste by selecting materials with minimal installation wastage.

> Use materials with a high recycled content e.g. recycled concrete subbase, foamed bitumen. Proposed recycled materials will need approval from the Council to ensure that environmental contamination does not occur.

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.

8.16.3 Pavement materials

The design and construction of the road must comply with the following criteria:

> materials – see *CSS: Part 1* for details of approved pavement materials, gradings, etc. Any proposed variations from these materials, such as the use of cement- stabilised metalcourses or concrete roads, will require specific design;

> the extent of work – pavement materials must extend at the same thickness beyond the edge control devices, such as kerb and channel or the concrete edge restraints, as detailed in *CSS: Part 6*.

8.16.4 Surfacing

All surfacings must meet site-specific traffic loading requirements including skid resistance requirements as defined in TNZ T/10 *Skid Resistance Investigation and Treatment Selection*. Skid resistance should exceed either the values in Table 10 or a British Pendulum number of 50.

The selection of surfacing material is critical. Consider the benefit, performance and life-cycle costs of the material, particularly for pavers as these surfaces have higher maintenance costs i.e. select pavers for traffic management purposes, not just aesthetic reasons. Do not use pavers in narrow road medians or small islands as this location significantly increases maintenance difficulties.

Table 10 Skid resistance criteria

Site Category	Site Definition	Sideways Force Coefficient (SFC)
1	Approaches to railway level crossings, traffic lights, pedestrian crossings, roundabouts.	0.55
2	Curve < 250m radius Down gradients > 10%	0.50
3	Approaches to road intersections Down gradients 5 – 10% Motorway junction area	0.45
4	Undivided carriageway (event – free)	0.40
5	Divided carriageway (event – free)	0.35

Note: This table is sourced from TNZ M/10:1998.

All newly constructed road surfaces must comply with the NAASRA roughness counts in Table 11.

Table 11 NAASRA roughness criteria

Surfacing	Average (mm/km)	Maximum (mm/km)
All new asphaltic concrete and open graded porous asphalt surfaces	55	75
Asphaltic concrete and open graded porous asphalt overlays and shape corrections	65	90
Chipseal through streets with 10,000-20,000+ vehicles per day (Pavement Use T6 and T7).	60	80
Chipseal through streets with 2,000-9,999 vehicles per day (Pavement Use T4 and T5).	65	85
Chipseal through streets, cul-de-sacs and rights of way with 0-1,999 vehicles per day (Pavement Use T1-T3).	70	90

Note:

1) See *CSS: Part 6* clause 11.7 – Testing for more detail on analysing test results.
2) Pavement use codes refer to RAMM categories.

All surfacing materials must meet the appropriate *CSS* requirements.

The general minimum surfacing requirement is a two-coat (wet lock) chipseal – grade 4 and grade 6. At the head of a cul-de-sac, the minimum surfacing requirement is a 30mm layer of paver-laid AC10 laid over a Grade 5 chipseal.

Skid resistance on the new surface through all intersections must match that of the existing road, particularly back to the transition point (TP) of the road. Skid resistance can be improved through grooving in asphaltic concrete.

8.17 Drainage Design

8.17.1 Road drainage control

All road runoff must be contained in the legal road or within land over which drainage easements have been created in favour of Council. Take into account the road hierarchy when assessing the possible use of the legal road as a secondary flow path.

Guidance and standards for the work can be found in:

> Integrated Catchment Management Plans (ICMP) for the development area

> Part 5: Stormwater and Land Drainage

> *CSS: Parts 1-7*

8.17.2 Primary stormwater treatment

On-street treatment of stormwater is a required part of the design. Design for the removal of contaminants throughout the stormwater system, but particularly before the stormwater enters existing open water-bodies.

Collect surface water in kerbs and channels or within grassed swales. Provide on-street stormwater treatment depending upon the requirements of that particular water catchment area, as detailed in the resource consent or project brief. *WWDG Part B* chapter 6 suggests macropollutant traps, swales and bio-retention devices (rain gardens and stormwater tree pits) as on-street stormwater treatment options. Council may also consider proprietary devices on a case by case basis. Refer to clause 5.6 - Drainage System Design for further information.

Do not detail sumps in kerb crossings. Where sumps are located in this position, consider the relocation of either the sump or crossing or detail the installation of a corner sump top and provide additional drainage capacity elsewhere if necessary.

All pipework downstream from sumps contained within the carriageway must have a minimum internal diameter of 225mm. Sump or access chamber spacing must not exceed 100m, for maintenance purposes.

Provide a stormwater outfall in classified roads whenever the channel flow exceeds 25 litres/sec at a grade of 1in 500 for a 5 year event. Provide a stormwater outfall in local roads whenever the channel flow exceeds 50 litres/sec at a grade of 1 in 500 for a 5 year event. Refer to *WWDG Part B* chapter 22.10.

8.17.3 Subsoil drainage

In areas of high groundwater, install subsoil drainage to protect the carriageway subgrade and/or metalcourse.

The subsoil drainage pipework must be drilled PVC or other approved perforated pipe.

8.17.4 Swales

Design swales for temporary water storage or retention as this provides attenuation of stormwater peaks. It may also reduce the downstream flood peak. Normally this design consists of shaped grass berms, with no permeability built in to the construction materials.

Primary treatment is achieved by a detailed design that uses suitable permeable material to allow soakage to subsoil levels. Volumes undergoing primary treatment through infiltration can be increased through longer resident times in permeable swales. Provide opportunities for sediment to settle out in swales through slower velocities, longer resident times and dense grass cover, as these all slow overland flows.

Planting installed in the swale should not include bark, similar organic mulch or other loose easily transported material.

Note that repeated use of vehicles or the heavier ride-on mowers will substantially reduce the permeability of swales that have been constructed for primary treatment - take this into account. See Part 5: Stormwater and Land Drainage and Part 10: Reserves, Streetscape and Open Spaces, for guidance on design.

Temporary stormwater retention swale (William Brittan Ave)

8.17.5 Drainage patterns

The existing drainage pattern may provide a constraint on possible design solutions. Ensure that the upstream catchment, including existing channels, can drain through the new works without ponding and that property outfalls, either at the kerb or at the boundary, are not raised above inlet levels. Thoroughly investigate the catchment around the project area, to determine accurate falls, transition levels and the most effective outfall.

8.18 Street Lighting

Refer to Part 11: Lighting for street lighting requirements.

8.19 Bridges, Culverts and Other Structures

Bridges, culverts and other structures within the legal road perform a key role in ensuring continuity of access for the public. Design these items to ensure their continuous function (including during extreme events) throughout their design life. For timber bridges, this is 75 years. For steel or concrete bridges and all culverts, this is 100 years. For all other structures, this is 50 years. Refer to the *Bridge Manual* for specific design information.

Determine the width of bridges and culverts in conjunction with the site-specific current and future road requirements for carriageway widths. Take into account the land drainage requirements, as set out in clause 5.6.5 - Bridges and culverts (Stormwater and Land Drainage) and Chapter 13 of the *WWDG*. The length of these structures is also site-specific and must make allowance for waterway requirements during extreme events and the requirement for footpaths. Design the wing wall and anti-scour structures to provide support and to prevent scour, as required.

Design guardrails generally in accordance with the *Bridge Manual* except that:

> side protection in low speed environments (under 50km/hr) is not always required to comply with Appendix B of the *Bridge Manual*. Where Appendix B requirements are not achieved, provide a road safety audit or assessment with the site specific design in the design report, confirming the design impact speed used in the guardrail design.

> guard rail transition distances in speed zones of 50km/hr or less may be reduced.

Design barriers for cycle or shared paths to be 1.4m high and in accordance with the *Bridge Manual*. Design the barrier to resist the loads detailed in Appendix B clause B6.4 of the *Bridge Manual*. The application of *CSS: Part 6* SD 621 Pedestrian Safety Fence is still appropriate for situations where the impact from cars and cycles is not being mitigated.

Other design issues include, but are not limited to:

> legal compliance – building and resource consents are required for bridges, culverts and other structures, as appropriate. The *Policy on Structures on Roads* details the requirements for the Deed of Licence;

- technical requirements – provide space on bridges and culverts for cyclists. The surfacing of bridge decks must meet the site-specific traffic loading requirements including skid resistance requirements. Footpaths must be separated, where they are specified;
- waterway requirements - consider the effect of the road on the secondary flow path for any waterway crossing. Refer to clause 8.13.3 – Vertical alignment;
- aesthetic contribution – use the design of the new structure to enhance the attractiveness of the built environment. Refer to *WWDG* clause 13.2.2.1 – Appearance;
- services using a bridge for support – *WWDG* clause 13.2.2.1 – Appearance and clause 3.4.3 of *The National Code of Practice for Utilities' Access to the Transport Corridors* provide guidance on the installation of services on bridges. Obtain the Council's approval for the installation of services on bridges.
- existing structures – ensure lane widths are not compromised when retrofitting existing structures to cater for future traffic needs.

8.20 Retaining Walls

Only retaining structures that will be vested in Christchurch City Council may be located on legal road. Retaining structures that support private assets or private property e.g. driveways, must be located outside of the legal road unless approved otherwise by Council.

Design guardrails generally in accordance with the *Bridge Manual* except that:

- side protection in low speed environments (under 50km/hr) is not always required to comply with Appendix B of the *Bridge Manual*. Where Appendix B requirements are not achieved, provide a road safety audit or assessment with the site specific design in the design report, confirming the design impact speed used in the guardrail design.
- guard rail transition distances in speed zones of 50km/hr or less may be reduced.

The application of *CSS: Part 6* SD 621 Pedestrian Safety Fence is still appropriate for situations where the impact from cars and cycles is not being mitigated.

Other design issues include, but are not limited to:

- safety in design - including throughout the life cycle of the constructed works.
- legal compliance – building and resource consents are required for retaining walls. The *Policy on Structures on Roads* details the requirements for the Deed of Licence;
- aesthetic contribution – use the design of the new structure and any fall protection to enhance the attractiveness of the built environment;
- heritage – protect and retain existing historic retaining walls and design adjacent structures in context with these features;

> existing structures – ensure lane widths are not compromised when retrofitting existing structures to cater for future traffic needs.
> maintenance – ensure access for mowing and other maintenance activities.

Design retaining walls to ensure their continuous function (including during extreme events) throughout their design life as detailed in Table 12.

Table 12 Design and durability

Wall Type	Design Life (years)
A: Uphill of road	75
B: Uphill of road directly supporting infrastructure to be vested or existing private buildings, structures and urban gardens	100
C: Directly supporting road	100*
D: Not directly supporting road	75

Note*: The design life of minor walls (less than 1.5m height that can be maintained or replaced without impeding the function of the adjacent road) may be reduced to 50 years with the approval of Council.

State the key achievement criteria and assumptions in the Design Report, as detailed in clause 3.3.2 – Design Report. Specify hold points for construction, for inclusion in the Contract Quality Plan and required material or performance tests to be included in the Contractors Inspection and Test Plan.

8.21 As-Built Information

Provide as-built information as set out in Part 12: As-Built Records, including a safety audit of the constructed works.

Part 9: Utilities

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9.1 Referenced Documents

Planning and Policy

> The *Christchurch City District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan

> Electricity Act (1992)

> Resource Management (*National Environmental Standards for Telecommunication Facilities*) Regulations (2008) www.legislation.govt.nz/regulation/public/2008/0299/latest/DLM1576701.html

Design

> NZUAG *The National Code of Practice for Utilities' Access to the Transport Corridors* nzuag.katipo.co.nz/wp-content/uploads/2018/02/NZUAG-Code.pdf

> New Zealand *Code of Practice for Electrical Safe Distances* NZECP 34: 2001 www.transpower.co.nz/resources/new-zealand-electrical-code-practice-electrical-safe-distances-nzecp-34

Construction

> 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/

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).

9.2 Introduction

This Part discusses issues that must be considered for any developer installing utilities that will not be maintained or owned by the Council. The design requirements of the utilities themselves are not covered here but can be obtained from the individual operators. To achieve good outcomes, view *The National Code of Practice for Utilities' Access to the Transport Corridors* on the working road-share and the objectives agreed by the industries.

9.2.1 Council requirements

The requirements for the provision and installation of utilities are set out in the *District Plan*.

Ensure that the appropriate resource consents are obtained for work in the vicinity of protected trees and that the work is carried out in accordance with *CSS: Part 1* clause 22.0 – Protection of Natural Assets and Habitats.

9.3 Quality Assurance Requirements and Records

Provide the information detailed in Part 3: Quality Assurance and the *Construction Standard Specifications (CSS)*, during design and throughout construction.

9.4 Network Utility Operator Requirements

Ensure that the design and construction of any network to be adopted by a utility operator complies with their standards.

Electrical design standards are written by individual electrical utility operators to comply with the requirements of the Electricity Act and its associated Regulations. There is a degree of consistency due to the continuous nature of the network.

Telecommunications design standards are also written by telecommunication utility operators. The telecommunications network is a series of separate networks with some interconnection. The design and construction standards can vary between the different operators.

Details of network utility operators can be found at
www.ccc.govt.nz/consents-and-licences/construction-requirements/network-utility-operators/.

9.5 Utility Design

Design all services to be installed on bridges and culverts to enhance the visual qualities of the site. Refer to *WWDG* Part B clause 13.2 - Bridges and culverts for utility design at bridges and culverts.

9.5.1 Service plans

Use the latest service plans when preparing engineering drawings. Be aware that connections to properties from any service or utility may not be shown. There may also be differences between utility digital data and utility paper plans.

9.5.2 Location of utilities

Consider the following when planning the layout of a development:

> utility services are generally installed parallel to road or legal boundaries;

> laterals are perpendicular to the main supply and configured to service two lots, wherever possible;

> boundary boxes and distribution pillars are installed together on a boundary junction and clear of likely vehicle access;

> allow for maintenance access;

> tree planing.

Minimise the cross-sectional area occupied by utility services through detailing shared trenches where practicable, to allow for possible future utility reticulation. Also consider the possible location of future cabinets in service strips or footpaths.

Discuss major reticulation and its potential for significant traffic disruption at an early stage with Council.

Consider the following when planning the location and design of structures and their corresponding utility lots:

> place and design them to minimise adverse visual impact by integrating them with the design of hard and soft landscaping;

> design to minimise the potential for damage to the structure from vandalism;

> reduce their impact on traffic movement;

> structures must not reduce vehicle sight distances and should not interrupt pedestrian movement;

Using streetlight poles to display artworks (Spencer St)

> ensure that they do not compromise property rights or access;

> provide access to the structure.

Refer to the *National Environmental Standards for Telecommunication Facilities* for further information regarding telecommunications cabinets.

Some structures may contribute to the environment if designed to enhance the neighbourhood character.

Consult comprehensively with the relevant network utility operators regarding the location of utilities and the spacing and final location of the structures. Refer to IDS Part 10 Reserves, Streetscape and Open Spaces clause 10.5.3 – Utilities before considering locating utilities in reserves.

9.5.3 Typical services layout and clearances

There are specific working clearances required between different utility services. Confirm these clearances with the network utility operators before deciding on any utility layout or trench detail.

Table 1 Crossing utility clearances - outside to outside

	preferred location	vacuum sewer	water main	HV power	LV power	gravity sewer	storm water	water submain	phone	gas
pressure >110Ø sewer ≤110Ø	path	n/a	100	50	50	50	50	100	50	50
vacuum sewer	c/way		100	100	100	100	100	100	100	100
watermain	c/way			150	100	100	100	n/a	100	100
HV power	berm/path				n/a	500	500	150		
LV power	berm/path							100		
gravity sewer	c/way						50	100	50	50
stormwater	c/way							100	50	50
water submain	path								100	100
phone	berm/path									
gas	berm									

both services likely to be in berm/path

both services likely to be in carriageway

Table 2 Parallel utility clearances - outside to outside

	preferred location	vacuum sewer	water main	HV power	LV power	gravity sewer	storm water	water submain	phone	gas
pressure >110Ø sewer ≤110Ø	path	n/a	1000 600	450	450	450	450	450	450	450
vacuum sewer	c/way		600	600	600	600	600	600	600	500
watermain	c/way			1000	300	1000	450	n/a	450	450
HV power	berm/path				300	1000	1000	300	300	300
LV power	berm/path					500		300	300	300
gravity sewer	c/way						1000	300	1000	1000
stormwater	c/way							300	500	500
water submain	path								300	300
phone	berm/path								300	150
gas	berm									

both services likely to be in berm/path

both services likely to be in carriageway

Note:

1) Where the clearances in Table 1 or 2 cannot be achieved, provide a non-conformance Report, in accordance with Part 3 Quality Assurance clause 3.7.1 – Control of non-conforming work

2) Ducts may be suitable where clearances are unavailable.

3) Where the crossing clearance is under 200mm, consider the use of alternative fillers to metalcourse, due to difficulties in compaction.

Consider the proximity of overhead power lines: design infrastructure to provide the clearances required in the *Code of Practice for Electrical Safe Distances*. Refer to *The National Code of Practice for Utilities' Access to the Transport Corridors* and *CSS: Part 1* where working around trees. Part 10 clause 10.9.11 - Location of trees in streets details root barrier requirements to protect underground power cables.

Typically, the utilities are installed as indicated:

> gravity sewer located centrally in the road or right of way formation.

> vacuum sewer located between 2.0m and 5.0m from the road centreline.

> pressure sewer system pipes located 0.6m to 1.5m from the road boundary.

> stormwater located between the sewer and 1.5m inside the kerb or directly under the kerb and channel.

> watermains located between 2.0m and 2.5m off the kerb in the carriageway.

> submains located 150mm off the property boundary.

> electricity located 0.6m to 2.1m from the road boundary, and 0.6m away from the legal boundary in a right of way.

> telecommunications located at a convenient offset. Locate as the final option in the carriageway.

> gas located at a convenient offset, preferably within the berm. If this is not practicable, locate it under the path or, as the final option, in the carriageway.

Where possible, locate service covers outside of potential cycle lanes and preferably outside of wheel tracks. Locate vacuum collection chambers outside of the carriageway where possible or otherwise in the carriageway within 2.5m of the kerb.

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

9.5.4 Network reticulation

The telecommunications layout is not usually designed until the electricity layout is substantially complete - this is an economic decision as the layouts are inter-related and, in land developments, service trenches are shared wherever possible. Ensure that power is provided to telecommunication cabinets, cable television cabinets and amplifiers.

Ensure that drawings sent to the utility designer and the network utility operator show all the existing services. Ideally, these drawings should be the approved subdivision consent or engineering drawings. This reduces the likelihood of conflicts between existing and new services and increases the cost-efficiency of service provision.

9.5.5 Above-ground utilities

Locate above-ground utilities within legal road to provide the clear zone required by Part 8 Roading clause 8.15.10 – Clear zones. Locate street light columns in accordance with Part 11 Lighting clause 11.4.6 - Column locations. In addition to clear zone distances within the 50km/hr speed environment, locate new utilities clear of the footpath, at least 1.0m away from kerb cutdowns and at least 0.7m behind the kerb.

9.6 Construction

9.6.1 Proposed installation method

There are various methods of installing underground services. These include open trenching, directional drilling, pipe bursting, sliplining, pipe ramming and thrusting. Refer to Part 6: Wastewater Drainage for further information.

Factors that may affect the choice include the ground conditions, disruption to traffic, presence of trees, site safety, the availability of Council blue ducts and redundant services, e.g. old gas mains or their offsets.

When the intention is to lay a number of utilities in a common trench, ensure the minimum covers and separation distances for each utility in the trench cross-section are obtained.

9.6.2 Installing new reticulation within legal roads

Wherever utility services are installed along existing legal roads, obtain a Network Service Operators Works Access Permit (WAP) from the Council for that work, unless the works form part of an approved roading design. Apply for a Corridor Access Request (CAR) at www.myworksites.co.nz. Typically, the WAP is obtained after the utility reticulation layouts are confirmed.

If granted, the WAP defines the Council's requirements for the restoration of the construction within the legal road and any constraints on the permitted hours of work within that road. To avoid possible conflicts, ensure that the requirements of the WAP are included in any contract documentation. Also refer to *Guide for Safety with Underground Services*.

9.6.3 Pipe depths

Minimum and maximum covers specified elsewhere in the IDS are summarised in Table 3 and Table 4. Where values are not provided, use the manufacturer's specifications or values from the relevant installation standard.

Table 3 Installation depths

Installation depth for material types (m)	within c/way		Other trafficked areas		untrafficked areas	
	min	max	min	max	min	max
Rising, vacuum and PSS main			0.75	1.5	0.75	1.5
PSS and vacuum sewer laterals			0.6	1.5	0.45	1.5
wastewater gravity plastic (LRI ≤2)	0.75	3.5	0.6	3.5	0.5	3.5
wastewater gravity other (LRI ≤2)		3.5		3.5		3.5
wastewater gravity plastic (LRI >2)	0.75	5.0 or 3.0 below water table	0.6	5.0 or 3.0 below water table	0.5	5.0 or 3.0 below water table
wastewater gravity other (LRI >2)		5.0 or 3.0 below water table		5.0 or 3.0 below water table		5.0 or 3.0 below water table
stormwater gravity concrete						
stormwater gravity plastic	0.75		0.6		0.5	
watermain ≥100mm			0.75	1.1	0.75	1.1
water submain <100mm (metal)			0.5	0.7	0.3	0.7
water submain <100mm (plastic)			0.6	0.7	0.45	0.7

Note: 1) New watermains are 150mm minimum diameter.

Table 4 Installation depths in reserves

Installation depth for material types (m)	Trafficked areas		untrafficked areas	
	min	max	min	max
Enable cables			0.5	
water submain <100mm (metal)	0.5	0.7	0.5	0.7
water submain <100mm (plastic)	0.6	0.7	0.5	0.7

9.6.4 Backfill

Bedding materials should comply with the network utility operator's requirements.

Specify backfill materials individually. The material used must be capable of achieving the backfill compaction requirements set out in CSS: Part 1 clause 32.0 – Backfilling. The WAP specifies the final surfacing to the excavation. Refer to the *National Code of Practice for Utilities' Access to the Transport Corridors* for further information.

Part 10: Reserves, Streetscape and Open Spaces

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10.1 Referenced Documents

Planning and Policy

- The *Christchurch City District Plan* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- Resource Management Act (RMA) (1991)
- Building Act (2004)
- Fencing Act (1978)
- Heritage New Zealand Pouhere Taonga Act 2014
- New Zealand *Building Code* (Schedule 1, Building Regulations 1992)
- Ōtautahi Christchurch Climate Resilience Strategy (2021) www.ccc.govt.nz/assets/Documents/Environment/Climate-Change/Otautahi-Christchurch-Climate-Resilience-Strategy.pdf
- Christchurch City Council *Equity and Access for People with Disabilities Policy* (2001) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/community-policies/equity-and-access-for-people-with-disabilities-policy
- Christchurch City Council *Footpath Berm Policy* (1999) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/streets-roads-and-pavements-policies/footpath-berms-policy
- Christchurch City Council *Parks and Waterways Access Policy (PWAP)* (2002) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/parks-and-reserves-policies/parks-and-waterways-access-policy-2002
- Christchurch City Council *Artworks in Public Places Policy* (2002) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/community-policies/artworks-in-public-places-policy
- Christchurch City Council Tree Policy (2021) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/policies/trees-policies/tree-policy
- Christchurch City Council *Safer Christchurch Strategy* (2016) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies/safer-christchurch-strategy-2016/
- Christchurch City Council *The Styx Vision 2000 – 2040* www.ccc.govt.nz/environment/water/policy-and-strategy/the-styx-vision-2000-2040
- Christchurch City Council *Biodiversity Strategy* (2008) www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies/biodiversity-strategy-2008
- Christchurch City Council *Parks or Reserves Management Plans* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/park-management-plan
- Christchurch City Council *Parks & Open Spaces Services Plans* *www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/long-term-plan-and-annual-plans/ltp/long-term-plan-documents/*
- Canterbury Regional Council *Canterbury Regional Pest Management Plan 2018-2038* www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-regional-pest-management-plan/

Design

- Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō Ngā Arawai Rēpo (WWDG)* (2003) www.ccc.govt.nz/environment/water/policy-and-strategy/waterways-wetlands-and-drainage-guide
- Christchurch City Council Christchurch Otautahi Agenda 21 Committee *Indigenous Ecosystems of Otautahi Christchurch* Sets 1-4
- Christchurch City Council *Streamside Planting Guide* www.ccc.govt.nz/environment/water/waterways/waterway-restoration
- Christchurch City Council *Central City Lanes Report – Lanes Design Guide* www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/urbandesign/urbandesignguides
- Christchurch City Council *Tree Planting Guide www.ccc.govt.nz/tree-planting-guide*
- Christchurch City Council *Central City Street Trees and Gardens Master Plan (Draft)* (TRIM 10/384477)
- Christchurch City Council *Parks Sign Manuals* (TRIM 10/129592, 16/98409)
- National Guidelines for *Crime Prevention Through Environmental Design in New Zealand* www.mfe.govt.nz/publications/towns-and-cities/national-guidelines-crime-prevention-through-environmental-design-new
- Christchurch Central *Streets and Spaces Design Guide* www.otakaroltd.co.nz/assets/BalanceOfLand/streets-and-spaces-technical-guide-dec-2015-full-document.pdf
- NZS 4121: 2001 *Design for Access and Mobility: Buildings and Associated Facilities*
- NZS 4241: 1999 *Public Toilets*
- NZS 4404:2010 *Land development and subdivision infrastructure*
- NZS 5828:2015 *Playground equipment and surfacing*
- NZS/AS 1657:1992 *Fixed platforms, walkways, stairways and ladders. Design, construction and installation*
- SNZ HB 8630:2004 *Tracks and outdoor visitor structures*
- International Mountain Bike Association *Trail Solutions* www.imba.com/explore-imba/trail-creation-and-enhancement/trail-solutions
- *Barrier Free NZ* www.barrierfree.org.nz
- Sport and Recreation Victoria *The Good Play Space Guide: "I can play too"* https://sport.vic.gov.au/resources/documents/good-play-space-guide-i-can-play-too
- Transit New Zealand *Guidelines for Planting for Road Safety*
- Ministry for Primary Industries *National Pest Plant Accord* www.biosecurity.govt.nz/NPPA
- Tree Health and Maintenance (MIS313) *Minimum Industry Standard* (Arboriculture Australia 2020)

Construction

> 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

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).

10.1.1 Source documents

This Part of the IDS is based on Part 7 of NZS 4404:2010, by agreement, and with the consent of Standards New Zealand.

10.2 Introduction

Landscape design for reserves, streetscape and open spaces is required at all levels of the subdivision and development process, in order to promote the social, economic, environmental, and cultural well-being of communities, in the present and for the future. Integrate it with the engineering design to:

- enhance the character, quality of life and environmental appeal of each development;
- complement and improve the environmental quality of the surrounding neighbourhood;
- provide trees as critical infrastructure
- provide recreation opportunities;
- increase the region's biodiversity;
- enhance the Garden City image of Christchurch;
- provide areas for social interaction;
- contribute to the character, shape and form of the city and surrounding environments.

Consider the application of urban design principles in all development projects with a landscape component. Council has highlighted particular areas as having special character and seeks to strengthen this through applying particular actions. Be familiar with these documents where applicable:

- *District Plan*
- *Tree Policy*
- *Central City Report – Lanes Design Guide*
- *Christchurch Central Streets and Spaces Design Guide*
- *Central City Street Trees and Gardens Master Plan (Draft)*
- Local Area Plans

All landscape developments must seek to **optimise long-term community and environmental benefits** whilst **minimising ongoing maintenance costs**, in order to provide for the **safe use and enjoyment** of the public assets.

Establish the overall objectives for the landscape design, such as wildlife corridors, canopy cover, the provision of reserves, the connection of open spaces, access to and location of watercourses and wetlands, and protection of existing valued vegetation at the outset and incorporate them into the initial concept for the development.

10.3 Quality Assurance Requirements and Records

Provide the information detailed in Part 3: Quality Assurance and the *Construction Standard Specifications (CSS)*, during design and throughout construction.

10.3.1 The designer

The designer must possess both experience and qualifications that are relevant to the scope of the project.

10.3.2 Design report

The Design Report must include a design statement that:

> shows an understanding of the inherent characteristics and values of the site (e.g. social, cultural, environmental/ecological, economic, historic, recreational), including the existing landform and vegetation;

> outlines the design philosophy and intent;

> confirms compliance with the IDS;

> confirms compliance with the guidelines for safe environmental design outlined in *CPTED* and Chapter 15 of the *WWDG Part B;*

> confirms compliance with the principles of providing a barrier free environment outlined in the *Parks and Waterways Access Policy*.

The Design Report must include:

> the safety audit;

> details of the subsoil, water table, any earthworks and potential effects on compatibility with the planting design and establishment, including remedial measures where applicable.

10.3.3 Design records

Provide detail of the unmodified site gained from a site visit and records which clearly demonstrate it e.g. coloured aerial photographs.

All drawings and documentation must be of sufficient detail and accuracy to ensure understanding of all aspects of the development proposal and assessment of the maintenance implications of the works. To aid in this assessment, amend Appendix II - Generic Guides for Riparian Maintenance to show the required maintenance regime for the riparian planting, which will ensure the planting is maintained in accordance with the design.

Ensure specifications for all proposed works or items that are not covered in the *CSS* provide sufficient detail that construction standards are not compromised and the Council does not inherit faulty items, features or plantings that require removal, replacement, repair or high levels of maintenance.

Wherever the developer is using a cash-in-lieu contribution to carry out works on behalf of the Council, present a schedule of prices and rates with the Design report.

10.3.4 Engineer's Report

The developer must provide, upon completion of physical works, certification that all assets to be vested have been inspected, audited and tested, and comply with the design and quality requirements. Any trees to be vested must have documentation to support this which has been prepared by a qualified arborist.

Where playground equipment has been installed, ensure maintenance manuals and as-built drawings are presented with the Engineer's Report, as detailed in Part 12: As-Built Records.

10.3.5 Drawings

Refer to Part 2: General Requirements Appendix I - Standard Draughting Layout and Format Requirements for landscape and planting plan content and format requirements.

Landscape plans must show all streetscape and reserve planting and all facilities, structures and furniture that are proposed to be installed, including existing features to be retained. Make reference to all other related drawings, including irrigation, lighting, utilities, engineering and earthworks, and any applicable resource consent conditions. Include the location of existing and proposed underground services, irrigation systems and streetlights.

Planting drawings must have a plant list/schedule. A typical planting list is included in Appendix I - Standard Draughting Layout and Format Requirements (General Requirements). Use a clear reference system to identify the location and set-out of species. Note the supplier and source of the plants.

Refer to CSS: Part 7 clause 4.0 – Supply of Tree and Plant Materials for tree and plant specifications.

10.4 Existing Features

Discuss the layout of potential developments and the interaction with existing features with Council at the earliest opportunity.

10.4.1 Existing waterways and wetlands

The retention and enhancement of natural waterways and wetlands is an integral part of any development. Maximise opportunities for viewing them by establishing reserves to contain them, providing walkways and cycleways along their banks, specifying planting, designing streetscapes that feature them, and ensuring that all boundary fencing is designed to enable clear visibility from neighbouring properties.

Refer to the *WWDG* for further information and for definitions.

10.4.2 Existing vegetation

The Council may undertake an inspection of existing vegetation on land to be subdivided at the time of the application for subdivision consent, and may require that some trees and other existing vegetation deemed to be of ecological importance or significant amenity value e.g. vegetation that provides a visual screen, be protected and retained.

Retain and protect all trees/vegetation protected under the District Plan rules or by other legal means.

Mark existing trees/vegetation on the engineering drawings and plot the extent of all tree canopies, out to their drip lines as per SD110 (CSS PART 1: Standard drawings).

Provide an arboricultural assessment that is produced by a qualified arborist where trees are to be retained within a subdivision development.

The CSS: Part 1, 22.0 – Protection of Natural Assets and Habitats details particular measures to be taken during construction in order to protect trees/vegetation.

All trees and vegetation must be in a safe, healthy and undamaged condition when accepted by the Council.

A qualified Arborist must undertake any arboricultural maintenance. Any trenching, excavation and filling within the drip line of the trees must be undertaken in accordance with CSS Part 1: 22.0 Protection of Natural Assets and Habitats and the Tree Policy.

10.4.3 Historic & cultural features

Protect and retain culturally significant areas, historic areas (including Significant Ecological Sites), objects and buildings protected under the *District Plan* or by other formal/legal means, those features of importance to the community, monuments and memorials. The treatment of archaeological remains must be in accordance with the requirements of the *Historic Places Act* and any accidental discovery protocol.

10.4.4 Natural landforms

Where practicable, protect natural landforms as they not only convey the natural heritage of the site, but also provide landscape features that add to the sense of place and local identity. Refer to clause 2.5.4 – Balancing landform choices (General Requirements) for further information.

10.4.5 Existing soils

Protect the structural and functional integrity of the soil system. Soils contain most of the life-sustaining features of the terrestrial ecosystem. These include the soil structural features such as organic and inorganic particles, nutrients, and living components such as invertebrates and bacteria. These support and sustain the roots of plants that are dependent upon these components. If soils are degraded, their ability to support the range of living organisms declines and their contribution to their own and associated ecosystems will be compromised.

Preserve topsoil in its existing state in reserve areas unless its removal is specifically necessary to allowance the construction of infrastructure. Refer to clause 4.6.1 – Suitability of Landform (Geotechnical Requirements) for further information.

10.5 Design and Development of Reserves

10.5.1 General considerations

The Council gives priority to the integration of reserves, open space and recreation opportunities into developments and their equitable distribution throughout the city and within each area of urban expansion.

Consider the community's needs and aspirations, environmental criteria, existing features, and the direct and indirect economic implications of the reserve when locating, planning and designing each reserve.

Consult the Council through a pre-application meeting before applying for a resource consent, to ensure that the provision of reserves will satisfy all of these requirements.

A developer who wishes to contribute to the early development of recreation facilities and/or landscape features on a proposed reserve should enter into negotiations with the Council to reach agreement on:

> a landscape plan for the reserve;

> what elements of the landscape plan the developer will implement;

> the standard of finish to which completed works are carried out;

> the level of development to which completed works are carried out;

> the balance of reserve contribution owing to the Council in cash (if applicable).

In terms of a subdivision development, once the reserve is developed to the specified level and the 224(c) certificate is issued, it will be vested in the Council. The reserve will then continue to be maintained by the developer until handed over to Council to maintain following the specified establishment period. The Council will if necessary carry out further landscape development as and when capital funding becomes available.

10.5.2 Design factors

Consider the following factors when designing reserves:

> the suitability of the site for its intended purpose;

> the extent and nature of the topsoil and subsoil, including their fertility, structure, moisture-holding capacity and drainage;

> compatibility between ground conditions/earthworks design, engineering design and planting design;

- existing and proposed levels and their relationship to the levels of the surrounding land and to the provision of underground services;
- the presence of contaminants and/or imported materials and how any adverse effects can be accommodated and/or mitigated. Existing *Park or Reserve Management Plans* may provide further information;
- the stability of the site and how any instability can be accommodated and/or mitigated;
- opportunities for shared use of the land for both recreational and infrastructural purposes, such as drainage easements and stormwater retention in an extreme event (20 year return period or greater), provided the main purpose of the reserve is not unduly compromised;
- the movement desire lines for pedestrians and cyclists through the area;
- current and future tree planting sites.

10.5.3 Utilities

Show any proposed primary utility lines and structures located on reserves on the landscape drawings.

Do not locate above-ground structures, such as power kiosks and pump stations, on recreation and esplanade reserves. Locate above-ground structures on other types of reserve where they do not reduce the use of the reserve for its prime purpose or interfere with pedestrian and cycle paths. The Council must approve the location of any above-ground structure and underground utilities in any reserve. Clause 9.5.5 – Above-ground utilities (Utilities) sets out criteria to consider when planning above-ground structures.

Locate utility cables and structures with sufficient clearance from current and future tree planting sites.

10.5.4 Local purpose (utility) reserves

Where the terrain is suitable and space is available, the Council prefers the use of swales, soakage basins and wetlands within new developments to store, filter and move stormwater through reserves. In most situations, the Council will agree to the vesting of these areas as local purpose (utility) reserves.

Provide sufficient open space for general recreational purposes (if this is part of the reserve's primary purpose), so that land set aside for utility purposes does not limit the provision and use of open space for the community to enjoy. Refer to Part 5: Stormwater and Land Drainage and *WWDG* for further information.

10.5.5 Design criteria

The assessment criteria used when evaluating development layouts and reserve designs are:

Community - The provision of recreational assets that cater for the needs of the surrounding community, as identified by the Council in *Activity Management Plans* and through analysis of local demographics, residential densities, and activity and leisure trends.

Accessibility - The provision of logical, safe and attractive access from the surrounding community and good linkages within and between reserves and community facilities. Refer to *CPTED* and *PWAP*.

Existing features – protection of existing features as set out in clause 10.4 – Existing Features.

Use and enjoyment - The provision of assets which are safe, function efficiently, have high aesthetic appeal, and do not cause unjustified nuisance for adjoining landowners.

Maintenance - The provision of durable assets whose on-going maintenance and eventual replacement will not place a disproportionate burden on Council resources.

10.5.6 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 waste by selecting materials with minimal installation wastage.

> Use materials with a high recycled content e.g. recycled concrete subbase.

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

10.5.7 Planting on slopes

Safe and efficient maintenance operations on sloping ground must be allowed for.

Planted slopes that are to be maintained by Council contractors must be no steeper than a 1 in 3 gradient where fall height safety risks exist. In some situations planted slopes that are steeper than a 1 in 3 gradient are allowed where they are to be classed as natural areas that will not be maintained by Council contractors. Refer to clause 10.9.8 Revegetation, restoration and connection of habitats for further information.

All grass slopes must be no steeper than a 1 in 4 gradient. Transitions between gradients must be seamless to allow for effective mowing operations. Refer to clause 10.9.17 for further information.

10.6 Reserve and Streetscape Facilities, Structures And Furniture

All built assets (e.g. signs, fences, artworks, lighting, structures and furniture) must be robust, low-maintenance, and safe for use by the public. Consider the life-cycle of built assets, to reduce the frequency of renewing or replacing such assets in the future.

Consider colours and construction materials in aesthetic terms, for built assets that form part of a reserve.

Note that the developer is responsible for gaining all necessary building consents required under the Building Act.

10.6.1 Sports fields

Good drainage and a firm turf surface are the prime requirements for providing good sports fields. Areas prone to ponding, high water tables and slow drainage are generally not suitable for use as sports fields. The slope of the turf surface must not be greater than 1 in 100.

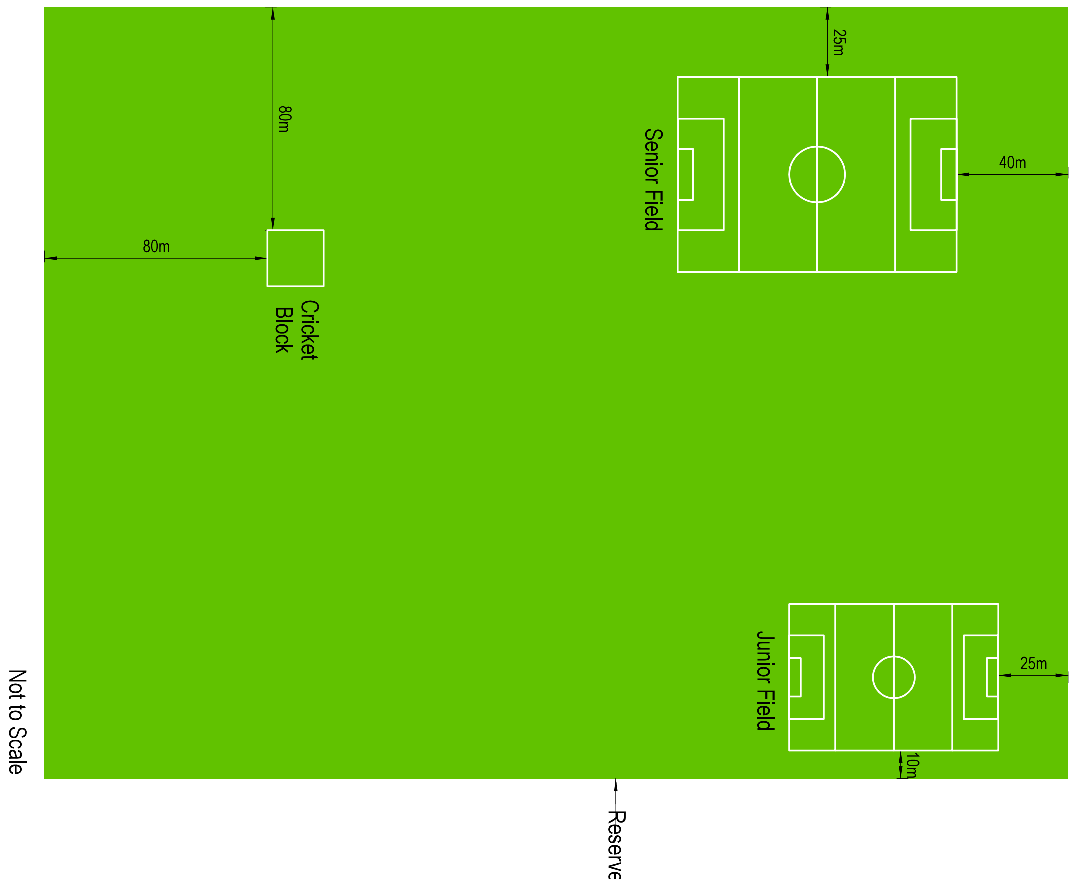


Figure 1 Offsets from sports fields

Winter sports fields must have a minimum of 25m between the sidelines and any reserve boundary, and a minimum of 40m between the goal lines and any reserve boundary. Junior winter sports fields must have a minimum of 10m between the sidelines and any reserve boundary, and a minimum of 25m between the goal lines and any reserve boundary. Cricket blocks must have a minimum of 80m between any point on the block and any reserve boundary. Figure 1 illustrates this.

Wherever sports fields will be provided, supply a sewer connection and a water connection as specified in the consent conditions and show these on the reserve development plan. Install these over the legal boundary into the reserve and to the specified location.

10.6.2 Playgrounds and play structures

Council's objective is to provide and develop interesting and exciting play spaces that meet the needs of the local community and, in the case of destination facilities, the needs and aspirations of the greater community. As a guide, parks with playgrounds will be provided within a 500m walking distance (approximate 10 minute walk) to urban residential dwellings. Council's aim is to acheive this for 80% of urban residential dwellings.

Obtain approval from the Council for any play equipment within a reserve, including the types and style of equipment. This prevents oversupply or duplication of play facilities in other reserves nearby.

Provide fully inclusive playgrounds with surfacing that allows easy access where specified.

It is important that any proposal integrates the formal and informal play equipment into the entire landscape design for the reserve. The use of natural features and open space to promote opportunity for informal play in conjunction with formal play structures is desirable.Provide structures which cater for a wide range of ages and abilities.

Locate seating where there is a clear view of the entire playground. In larger parks locate toilets, rubbish bins and drinking fountains within the vicinity of the playground.

Specific design plans of proposed play spaces shall demonstrate compliance with:

- NZS 5828 *Play equipment and surfacing*.
- *Christchurch City Council Parks and Waterways Access Policy.*

Design plans must also clearly identify the following;

- All equipment types and manufacturers.
- Free space/fall zone requirements.
- Safety surface material.
- Edge Treatment to contain safety surfacing.
- Drainage Treatment.
- Any associated amentities (e.g. drinking fountains, seating).

Playgrounds and play equipment must be certified as compliant prior to public access and acceptance by Council.

10.6.3 Recreational hard surfaces, ball courts and skate-boarding facilities

Recreational hard surfaces are designed to be suitable for many different uses such as skateboarding, rollerblading or handball games.

Obtain approval from the Council for any recreational hard surfaces, ball courts and skateboarding facilities within a reserve, including the types and style of equipment. This prevents oversupply or duplication of these facilities in other reserves nearby.

New basketball courts are to be located a suitable distance of at least 30m from residential dwellings. Skate and scooter facilities are to be located a suitable distance of at least 40m from residential dwellings.

10.6.4 Structures

Structures are installed at the discretion of the Council. These include: pergolas, bridges, jetties, boardwalks, barbeques and internal walls, fences and screens.

The design of structures must fulfil both functional and aesthetic requirements. They must be durable and not require a high level of maintenance.

Ensure accessible piers and jetties are at least 1800mm wide to allow wheelchair turning. In most cases observation towers and bird hides will be inaccessible, but where possible they should be designed in accordance with clause 10.8.3 –Boardwalks and ramps, including landings and 150mm upstands.

Install handrails complying with clause 10.8.4 – Steps and handrails and which preserve the view. Where windows are offered, ensure they cater for a range of eye-level heights.

Consider the impact of structures on traffic safety. Guidelines for the placement of structures in urban environments are available in clauses 8.15.7 – Street furniture and 8.15.10 – Clear zones (Roading).

10.6.5 Artworks and sculptures

The Council will consider any requests to install sculptural or other artworks on their merits. The Council will only accept artworks that are durable and do not require a high degree of maintenance and will also assess their artistic integrity.

Any artwork must be appropriate to the character of its setting. Integrated or functional artworks are preferred, such as bridges, light standards and seats.

Refer to the *Art in Public Places Policy* which sets out the process and purpose of public artworks.

10.6.6 Signs

Signs and information boards orientate visitors, describe places of interest, warn of hazards and direct traffic flow. Use and locate signs consistently in context with the local environment whilst minimising usage to avoid clutter. Consult the *Greenspace and Waterways Sign Manual* and Council for guidance on sign type. If signs would be inappropriate or obtrusive to the natural landscape, use other methods of communication.

Use the international symbol for access only where an area, facility or building is fully accessible in accordance with the *Building Code* or *Design for Access and Mobility*.

Locate signs alongside an accessible route, ensuring they can be viewed close up by people with impaired vision. Consider detailing tactile or colour cues to help people with impaired vision locate signs. Locate signs that are near or on buildings outside of the swing circle of doors.

Provide signs and information boards at a uniform level in each park for consistency, with mounting heights between 700mm to 1700mm from ground level. Signs and information boards should be easy to look at for adults that are standing, sitting or for children. Slope smaller signs mounted at lower levels to improve visibility.

10.6.7 Seats and picnic tables

The design of proposed seating and tables must be consistent with the character of the reserve and its locality.

The proposed seating and tables must be robust, low-maintenance and safe for use by the public. They can be constructed from materials such as timber, concrete, steel or stone, but the material is not restricted to these examples.

As people with disabilities and the elderly tend to tire more easily than able-bodied people, the provision of more seating may encourage increased usage of tracks and paths. Place seating every 100 - 200m on shorter paths and tracks (less than one kilometre) and every 200 - 250m on longer paths and tracks. Place seats strategically to allow a balance of shaded and sunny sites.

Provide at least one accessible table in each picnic area (a small park can be considered as one picnic area). Locate seats in various parts of the park, e.g. playgrounds, tracks and picnic areas. Additional rest areas should be provided at main park entrances for the use of people waiting for transport.

Specify the standard park bench in CSS: Part 7 SD 712 or detail seats that comply with *Design for Access and Mobility* for metropolitan and major parks. Seats should be 300mm-520mm high, but a height of 450mm is preferable. Slope seats slightly (105^{o} max) to allow water runoff. Where possible, provide a range of seat heights, preferably with a chair back and armrests as they provide additional support, comfort and assistance to people with disabilities and the elderly.

Detail tables755-775mm above ground level, with seats between 280mm and 320mm below the tabletop. Provide a clear space to the underside of the table 675mm from the ground and at least 800mm wide. Table types include an ‘A frame’ table with an extended end, or a hexagon style table, with one or two spaces for wheelchairs and prams.

Ensure accessible tables and seats are serviced by an accessible path, without obstructing its design width. Locate tables and seats on firm, level surfaces and provide 1500mm wide surfaced manoeuvring areas at the end of tables and a 900mm wide surfaced accessible space beside each seat to accommodate wheelchairs, prams, or mobility aids. Set the front of seats back at least 540mm from the edge of access routes to preserve the pathway width.

10.6.8 Drinking fountains

Provide a minimum of one drinking fountain, complying with *CSS: Part 7* SD 719 per metropolitan or major park. Incorporate the dog bowl only where dogs will be permitted to use the park.

These items must be durable, vandal-resistant and consistent with other proposed site furniture and the overall character of the reserve. Obtain approval of the Council for installation of these items.

Ensure drinking fountains are serviced by an accessible path, without obstructing its design width. Place drinking fountains on firm, level surfaces which extend 1500mm wider on one side to provide access from a wheelchair.

10.6.9 Boundary fencing

The Council promotes the concept of open frontages onto reserves. This concept ranges from no fence, so that private gardens merge with the reserve landscaping, to a low fence up to 1.2m high. Hedges, climbers on trellis and other “green living” barriers are encouraged up to this height.

Funding of boundary fencing must comply with the Fencing Act, whereby if one of the occupiers of adjoining lands not divided by an adequate fence wants a fence, both parties are liable to contribute in equal proportions to the cost of a basic boundary fence. The Act does not apply to fences alongside legal roads or esplanade reserves.

Where permanent fencing of common boundaries of reserves, including esplanade reserves, is required by a resource consent condition, by the Council, or by the adjoining landowner, the Council will contribute half of the cost of a basic boundary fence. Where the proposed fence complies with the open frontage concept, the Council may contribute towards the additional cost.

Council wishes that boundary fences over 1.2m high be at least 80% open, in order to enable clear visibility from neighbouring properties and that fence designs around any reserve or waterway be determined before the subdivision is completed and sections are sold, in order to establish a consistent character.

Fences that promote overlooking of the reserve (Hansens Park)

Refer to *CPTED* and chapter 13.9 of *WWDG Part B* for more information about open frontage fencing.

Fences that promote overlooking of the reserve (Aidanfield)

10.6.10 Lighting

The Council prefers to light only those paths and cycleways that are designated safe routes, as identified through *CPTED*. Although lighting can be beneficial, areas that are lit are not necessarily safer and can give an undesirable message that it is safe to use an area after dark. *CPTED* explains how to use lighting appropriately. Refer to clause 8.5 – Off Road Linkages (Roading) and clauses 11.4.2 – Category P (cycleways and paths in reserves) lighting and 11.4.8 – Pole locations (Lighting) for more detail.

10.6.11 Public toilets

The provision of toilet facilities is essential to allow people with disabilities to use parks. Consider the needs of that locality and the numbers of expected visitors at any one time when determining the toilet facilities. One unisex toilet for up to 300 people is recommended. Locate toilets to be easily accessible from and within 50m of parking areas.

Design the toilet and its access to conform to NZBC / G1, *Public Toilets* and *Design for Access and Mobility* except as amended in this clause. The minimum requirement for a facility is a pan and a washbasin.

Specify fittings, where possible, that comply with *Design for Access and Mobility*, including tap and flush fittings that can be used with minimum strength. Do not use small or narrow half seats.

Provide two grab rails beside the toilet, one on the wall and one on the opposite side. Ensure the grab rails don't obstruct the flushing control or the movement of an individual onto the toilet.

Provide a lockable door for privacy which allows a means of rescue for trapped individuals. Do not specify time release devices as they don't allow people with mobility restrictions privacy. When specifying swinging doors, ensure they swing out, so that wheelchairs do not have to negotiate the door when exiting.

10.7 Park and Reserve Access

The design and construction of roadways, parking areas, vehicle crossings and cut downs must comply with Part 8: Roading and *CSS: Part 6*.

10.7.1 Vehicle access

Access points are required for vehicles to undertake mowing, waterway management, rubbish collection, general maintenance, and for emergency vehicles (such as ambulances) at sports parks. Consider the location of the vehicle access points as part of the overall design. Also consider the usage and any requirement for ground treatment to prevent deterioration.

Vehicle access points must be large enough to allow the entry of heavy machinery to clear dangerous vegetation and blocked waterways during storm events and fire fighting equipment wherever structures or planting present a potential hazard.

Locate and design removable barriers to prevent unauthorised vehicles from damaging the reserve. The design of barriers must be consistent with other design elements in the reserve.

10.7.2 Parking

Access roadways and off-street parking may be required for reserves such as garden and heritage parks, regional parks and the starting points of tracks.

Design parking areas, including accessible parking spaces, to comply with the minimum standards, including number, size, signage, set out in the *District Plan, Building Code* and *Design for Access and Mobility*. Provide pedestrian cut-downs from the parking area at regular intervals, so that there is no need to move into or near traffic to gain access to footpaths. Textile or colour cues should be used to indicate cut-downs.

Specify wheel stops complying with *CSS: Part 6, SD 626* and fences complying with *CSS: Part 7* to the parking area. Provide gaps in any fencing or barrier around a parking area to allow pedestrians, prams and wheelchairs to pass through without the need to step over the barrier.

Areas to lock up bicycles should be provided close to entrances or facilities.

10.7.3 Entrances and fences

Ensure entrances will be clearly visible from set-down points. Detail the main entrance, complying with SD 716, as part of the accessible route. Fence the road boundary of all reserves, detailing fences complying with *CSS: Part 7*. Specify 1200mm wide access points every 50m, utilising 1.1m high entrance bollards. A formed path is not necessary at every access point. Textural cues should be laid to indicate pedestrian entranceways.

10.7.4 Gates

Specify gates with a minimum clear width of 1200mm and simple, easy to open mechanisms, requiring minimum strength to open latches. A grab bar is desirable for easy closing. Detail the grab bar and latch at between 900-1200mm high.

10.8 Pedestrian and Cycle Paths or Tracks

Pedestrian and cycle paths are an integral part of the reserve design, as they connect access points and activity areas within and across the reserve. They must be convenient and safe, in accordance with *CPTED*. Walking, mountain bike and multi-use tracks and bridle paths are also integral to the development of some reserves and the enhancement of existing networks, if new tracks can be linked to them.

A path is primarily a means of travel between activity areas, is accessible in accordance with *Design for Access and Mobility* and is typically sealed, whereas tracks, typically finished with a metalcourse surface, can also be used as a recreation facility and may be accessible. Boardwalks may be used over wet terrain, sand or very uneven areas.

Tracks can be designed to meet a variety of needs and interests and should reflect the range of people's preferences and abilities, so that the parks do not replicate each other, losing their individual characteristics.

Where paths and tracks are more than 25mm above or below the surrounding ground surface provide edging complying with the *Guide to Road Design, Part 6A: Pedestrian and Cyclist Paths*.

Clause 8.5 – Off Road Linkages (Roading) has further information on designing off-road linkages and Part 11: Lighting has information on providing lighting. The design and construction of pedestrian and cycle paths must comply with Part 8: Roading and *CSS: Part 6*.

10.8.1 Pedestrian paths and tracks

Start accessible paths at the set-down point or car park. Detail the installation of international access symbol signage for fully accessible paths. Design and construct walkways or other tracks to comply with *Fixed platforms, walkways, stairways and ladders. Design, construction and installation* and *Tracks and outdoor visitor structures*. Paths must comply with the *Parks and Waterways Access Policy* and the *Equity and Access for People with Disabilities Policy.*

Formed pedestrian-only paths should be between 1.5m and 2.0m wide. Accesses to playgrounds should be 1800mm wide. Design accessible tracks to be at least 1500mm wide, with a minimum width of 1200mm and with no abrupt changes in level greater than 20mm. Accessible paths and tracks shouldn't include steps.

Provide passing widths of 1800mm, at an average of 5 every 100m. This can be reduced where there is a 50m or greater clear line of sight, to an average of one bay every 40m.

Design crossfalls to comply with clause 8.15.2 – Crossfalls and gradients. Ensure changes in camber are gradual. Specify surfacing to provide a colour contrast with the vegetation verges, to aid the visually impaired.

10.8.2 Cycle and shared paths and tracks

Paths shared by pedestrians and cyclists should be at least 2.5m wide. Increase the width to 3.0m wherever a lot of people are expected to use the path. Indicate shared paths by painting cycle and pedestrian symbols at the start of paths.

Design mountain bike tracks in accordance with *Trail Solutions*.

10.8.3 Boardwalks and ramps

In some reserves, boardwalks may be required as part of the path or walkway/track network to allow the area to be accessible to disabled people and to protect sensitive areas such as wetlands and the root zones of protected trees. Design and construct walkways to comply with *Fixed platforms, walkways, stairways and ladders. Design, construction and installation.*

Design ramps on all accessible paths and tracks with a gradient steeper than 1:12. Minimise the longitudinal gradient as much as possible. Design longitudinal ramp gradients, lengths and spacings to comply with *Design for Access and Mobility*.

Detail boardwalks with the boards at a 90^{o} angle to the direction of travel, with gaps between the boards of 6 - 10mm. Specify a coating to increase slip resistance for boardwalks that are on a slope greater than 1:33.

10.8.4 Steps and handrails

Design each step with a maximum rise of 180mm and with a minimum tread of 310mm. Round the nosings of the steps and detail them to project a maximum of 25mm. Steps should have a very slight slope downwards (1%) to allow water to drain.

Consider providing textural cues at the approach to the steps, and colour cues on the edge of each step (nosing). Avoid a single step as in many cases they are seldom seen and can be a hazard.

Where stairs or steps are designed to be fully accessible, detail handrails on both sides. Also specify a handrail for accessible paths with gradients over 1:20 except for sections of path that follow the natural contours of the land.

Specify non-splintering handrail materials that do not get too hot detailed to comply with Appendix F3 of *Design for Access and Mobility*. Turn the end of the handrail down to remove hooking hazards - a domed button is not required.

10.9 Landscape Planting

10.9.1 Benefits of landscape planting

Landscape planting may not be compulsory for some developments. All planting must be appropriate to the scale and character of the development and the local conditions. Design planting to make a positive contribution to the subdivision and the surrounding local district in one or more of the following ways:

Functionally

> Provide shade, shelter and privacy.
> Reduce noise and air pollution.
> Calm traffic.
> Assist drivers to recognise road bends, intersections and the type of road.
> Reduce glare and reflection.
> Control erosion.
> Create physical barriers.
> Provide recreation and amenity value.
> Protect and restore cultural and historical resources and values.
> Protect and enhance indigenous biodiversity.
> Protect and improve water quality.
> Reduce urban heat island.
> Increase wildlife habitat.

Aesthetically

> Frame views.
> Emphasise landforms, soil types and landscape features.
> Structure spaces.
> Reduce the visual impact of roads and hard surfaces.
> Screen unsightly outlooks.
> Provide colour, form and texture.
> Extend and enhance the city's tree heritage and Garden City image.
> Provide a legible and imaginative planting framework for the city.

10.9.2 Planting design

Locate and design plant beds and specimen trees to be appropriate for the particular requirements of a street or reserve. Public safety, potential effects on neighbouring properties and infrastructure, access and maintenance costs are important determinants of the planting design.

Consider the proximity of houses, buildings, services, footpaths, cycleways and accessways when selecting plant and tree species and deciding on their locations.

All tree planting must comply with the Tree Policy (Part 1 of the Tree Policy relates to tree planting). For example, Tree Policy 1.2 specifies: All projects on Council land will actively incorporate new planting locations and prioritise the retention of existing suitable planting locations. This may include but is not limited to installing new underground services outside of grass berms to allow sufficient rooting environment for new trees.

Design and implement all planting around waterways and detention ponds in accordance with the *WWDG*.

All planting must comply with the guidelines for safe environmental design outlined in *CPTED*, plus the additional guidelines in Chapter 15 of the *WWDG* (Part B) where applicable.

10.9.3 Amenity floral beds

Amenity floral beds are beds that contain plants which require significant horticultural management. Their unsustainability and the cost of establishment and maintenance may make them unsuitable for most streets and reserves.

Approval for any amenity floral bed proposal will be given to developers only under extenuating circumstances.

10.9.4 Compatibility with engineering design

Associate planting drawings with engineering and earthworks drawings, to ensure that the engineering works, earthworks and planting works are all compatible. Engineering and earthworks designs must facilitate healthy tree and plant growth and ensure that the potential for future conflicts and damage to infrastructure are avoided.

Planting locations must comply with the legal overhead and underground clearance requirements of the network operators, with allowance made for the natural growth of the trees and plants to maturity.

10.9.5 Species selection

The selection of trees, shrubs, groundcover plants and turf species must be appropriate for the conditions at the planting site, such as soil type, drainage and local climate, to ensure healthy, attractive, well-formed, mature plants. Refer to *CSS: Part 7* clause 4.0 - Supply of Tree and Plant Materials. Additional selection criteria include low maintenance and longevity. The Tree Planting Guide: www.ccc.govt.nz/tree-planting-guide provides a comprehensive list of tree species for planting selection, including their size class and suitability. Another table specifies the projected tree canopy cover for each tree size class and the minimum soil area/volume requirements for planting.

Design the location of specimen trees and plant beds to ensure they do not compromise the efficient operation of infrastructural services. Ensure planting in swales does not obscure or obstruct the access to structures and that it does not compromise the hydraulic functionality of the system over time. Trees and plants used in swales must be able to tolerate both waterlogged soils and dry conditions.

Various plant species must not be planted in Christchurch streets or reserves due to undesirable characteristics, such as:

> known potential to become weeds

> invasive root systems

> weak branch structure

> high maintenance

> heavy production allergenic pollen

> susceptibility to disease and pests

Unsuitable tree and plant species, and situations where those trees and plants are inappropriate are included in a list on the CCC website – Tree Planting Guide: www.ccc.govt.nz/tree-planting-guide.

10.9.6 Tree selection and placement

Select and locate trees to minimise ongoing pruning requirements and infrastructure damage. For urban collector and arterial roads, specify one tree species to be planted on both sides of each road section i.e. between intersecting collector and/or arterial roads. For urban local roads, each side of the road may have one species for that road's length i.e. one species planted on each side of the road.

Restrict representation of any one species of tree to 10% of the total tree asset (city wide) and for any one family to 30% and genus to 20% of the total tree asset. This will prevent an overdependence on a limited range of species. Council's arborists maintain an asset database to determine which species should be restricted in numbers.

Select trees with consideration of their adult dimensions, and proximity to neighbouring properties, buildings, electrical conductors, right-of-ways and other assets.

When selecting and locating trees, make allowance for each tree to grow healthily for an expected life of at least 50 years without unduly compromising services, safety or amenities, or causing excessive boundary encroachments or shading. Also, space trees sufficiently far apart to allow healthy development of mature canopies.

Specify reserve trees and street trees with a minimum grade of 25 Litres.

Bare root stock will be accepted only in exceptional circumstances, at the discretion of the Council. Whips and trees planted with canes will not be accepted.

Refer to the *CSS: Part 7*: Landscapes for more information.

10.9.7 Shrub and groundcover selection and placement

Select and space shrubs and groundcover plants to achieve good form and coverage of the planted site within 2 to 3 years and to grow healthily for a design life of 10 to 15 years without unduly compromising services, safety or amenities, or causing unacceptable shading. Planting must not result in congestion that requires removal, pruning or thinning in the medium term.

Specify shrubs or groundcovers with minimum grades of Rx90 for revegetation plantings, PB5 for shrubs and amenity plantings and one litre for groundcover. Root trainers may be used where more appropriate (e.g. to establish quicker more consistent and less 'clumpy' coverage in a dry pond).

Plant low maintenance shrubs and/or groundcovers in medians, traffic islands and other places where grass mowing would be difficult.

Position plants with drooping stems or leaves that might trip pedestrians a minimum of 500mm from the edge of the plant bed, so that the leaves of the mature plants will not hang over any footpath, kerb or lawn.

10.9.8 Revegetation, restoration and connection of habitats

Revegetation means planting native trees, shrubs and groundcover plants, based on ecological principles. It may involve infill planting in existing remnant plant associations or the re-establishment of lost associations.

Identify such opportunities at the earliest stage in planning. Seek opportunities to use waterway corridors, recreation reserves and street trees to form "green corridors" linking existing and proposed habitats.

Revegetation and restoration planting may also be required along stream and riverbanks and into and around swales, soakage basins and wetlands. Include the use of species that will tolerate inundation and variations in the groundwater and surface water levels. Take into account existing and future variations in micro-topography and microclimate.

Plants are to be eco-sourced and selected from the plant lists contained within the Ōtautahi/Christchurch Ecosystems Map located on the CCC website www.ccc.govt.nz/environment/land/ecosystem-map. Eco-sourcing means that the plants are grown from seeds which have been collected from old naturally established plants (e.g. forest remnants) that are as close as possible to the revegetation site.

Group the plants informally or space them individually to produce a natural appearance. Plant spacings must be between between 1.5m and 0.5m centres, dependent on the species and site requirements. For example, in some circumstances (e.g. steep slopes or unstable ground) reduce spacings to less than 0.5m centres to ensure quick coverage, promote bank stability and lessen maintenance costs. The selection and placement of plants must reflect the natural succession process.

Revegetation and restoration sites are not usually mulched. However, if weed suppression or moisture retention are major issues, mulch or individual weed mats may be applied. Mulch must not be placed where it is likely to be washed into the stormwater system during heavy rain.

Establishment will focus on eradicating plant pests and controlling exotic weed species. Utilise stem protectors and identification stakes, installed to *CSS: Part 7* clause 9.0 – Staking Trees and Shrubs, to aid in plant establishment.

Further information and guidance is provided in the *Streamside Planting Guide* and the *WWDG*.

10.9.9 Plant beds

Group all shrubs and/or groundcovers together in mulched plant beds that are designed to minimise maintenance requirements. The edge definition may be a boundary fence, footpath, kerb, timber batten or informal trench margin. Informal trench margins are not appropriate in sandy soils.

Any one bed must have a minimum area of 8.0m^2 and a minimum width of 1.5m, with the exception of roundabouts. This means that tapered ends of traffic islands less than 700mm width will be hard surfaced.

Do not plant service strips between the footpath and the private property boundary that are less than 300mm width.

Passengers must be able to exit parked vehicles without traversing a planted area. The noses or tails of vehicles must be able to extend over kerbs without damaging planting.

Where adjoining pavement or grass surfaces meet, forming a point in the plant bed with an angle of less than 70 degrees, square or round off the point of the plant bed to be no narrower than 1.5m.

When the area between is grassed, plant beds must be more than 3m apart.

Refer to *CSS: Part 7* for planting and mulching specifications.

10.9.10 Location of trees in reserves

Locate specimen trees and large shrubs sufficiently far apart to allow healthy development of mature canopies with consideration of their adult dimensions. Provide adequate offsets from boundaries with neighbouring properties, buildings and other assets to prevent future conflicts and excessive maintenance requirements.

Streetlights and reserve lighting may be constrained in their location due to design spacing requirements. Where the lighting and tree locations conflict, change the tree locations, as they are not constrained by the required lighting standard.

10.9.11 Location of trees in streets

All street tree planting must comply with the minimum separation and sight distances shown in Figure 2 and Figure 3. These distances may need to be increased to protect sightlines, depending on the road geometry and speed environment.

Plant street trees at a distance from the edge of the traffic lane that provides a clear zone as specified in clause 8.15.10 – Clear zones (Roading). Locate street trees to ensure that they will not affect street lighting, create dark spots or create shaded areas that could lead to icing of carriageway areas in winter.

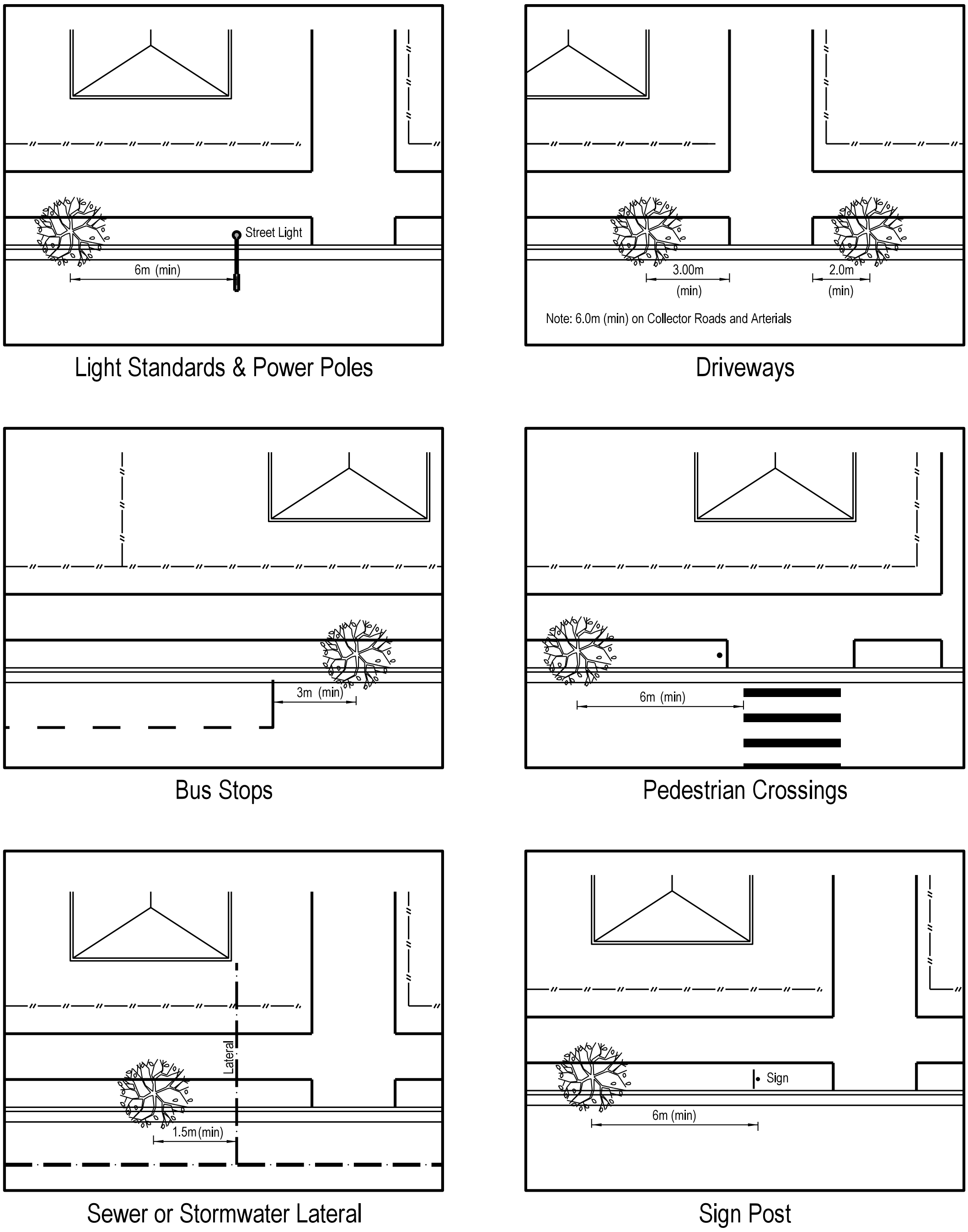


Figure 2 Street tree planting separation[1]

When selecting street trees consider the adult dimensions, and proximity to boundaries with neighbouring properties, buildings, infrastructure and other assets to prevent future conflicts and excessive maintenance requirements. Make allowance for each tree to grow healthily for an expected life of at least 50 years without unduly compromising services, safety or amenities, or causing excessive boundary encroachments or shading.

Plant street trees in berms that are at least 1.5m wide (measured from the back of the kerb). Minimum clearances required are shown Figure 3. Carefully consider the relationship between

[1] Based on fig 7.1 NZS 4404

the final tree trunk/base diameter size and the potential for infrastructure damage. For example very large growing species require berm widths greater than 2.5m to avoid future infrastructure damage, and even some smaller growing species may require greater than 1.5m berm widths for root system development.

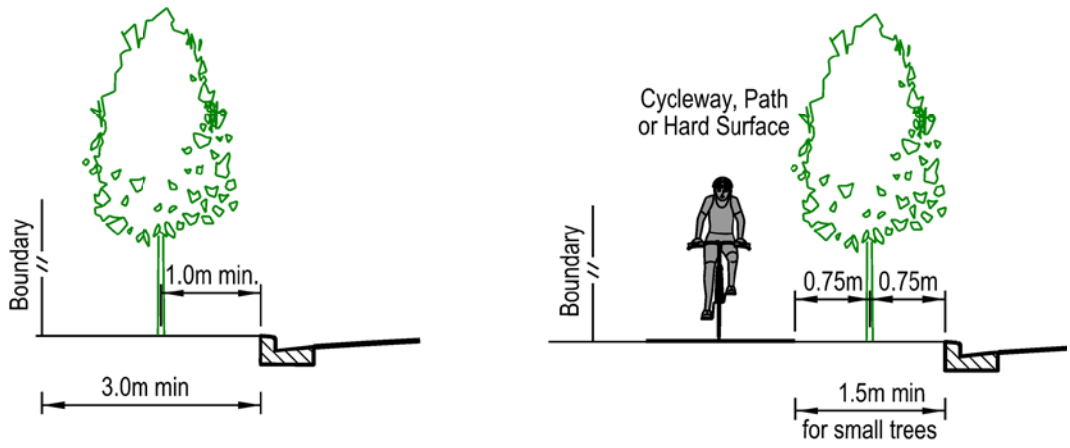


Figure 3 Tree offsets in streets

Install root barrier where trees are planted in close proximity to underground power cables at the setback distances specified in Table 1 and in accordance with *CSS: Part 7* SD 704. Where root barrier is installed to minimise potential damage to other infrastructure, the root barrier must be installed as close as possible to the infrastructure to avoid roots growing past the root barrier. Do not install root barrier within the tree pit.

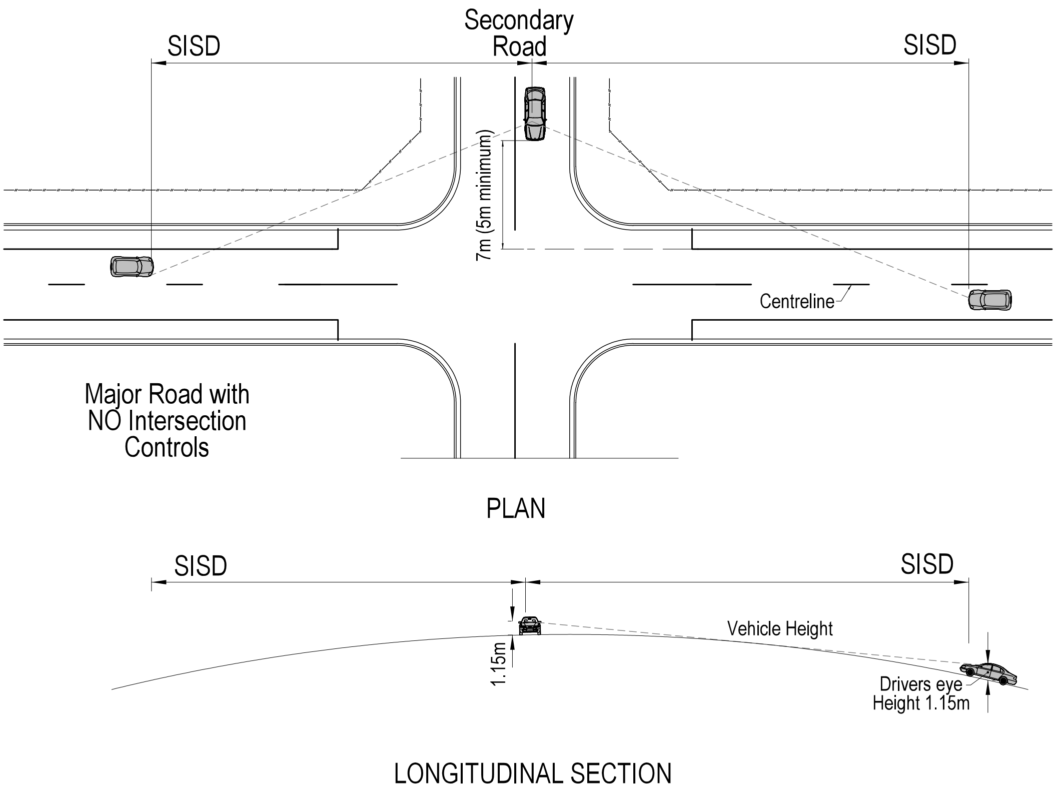
Table 1 Root barrier clearances

Clearances from cable (to barrier) to tree				
Cable voltage (kV)	66	33	11	0.4
Minimum tree clearance without barrier (m)	5.0	5.0	3.0	2.0
Minimum tree clearance with barrier (m)	2.5	2.5	1.0	1.0
Minimum cable to barrier clearance (m)	2.0	2.0	0.3	0.3

10.9.12 Protection of sightlines

Select all roadside vegetation on roundabouts, on traffic islands and within traffic sightlines shown in Figure 4 to have either a maximum height of 0.6m or to be limbed to provide a clear trunk to a height of 2.5m as trees develop. This will preserve sightlines to and from vehicles. The planting must be easily maintained within this height.

Sightlines preserved through pruning and plant choices (Mairehau/Burwood intersection)



Speed Value (km/hr)	Safe Intersection Sight Distance (SISD)	
	Rural	Urban
40	70	60
50	90	80
60	115	105
70	140	130
80	175	165
90	210	-
100	250	-
110	290	-
120	330	-

Notes:
1. It is desirable that plants are placed far enough back from the intersection so that even when mature the SISD is maintained.
2. See Transit New Zealands Guidelines for Planting for Road Safety for more details

Figure 4 Intersection sight distances for clear sightlines [1]

[1] Fig 7.2 NZS 4404

10.9.13 Maintenance of street planting

All street planting requires maintenance. Reduce the potential negative impact on traffic of planting in medians, roundabouts and traffic islands by:

> selecting and locating plants so that they will not encroach onto the kerb or adjacent hard surfaces during their design life;

> ensuring maintenance can be entirely conducted from within the planted area;

> detailing mulch levels flush with the kerb to prevent material migrating onto the adjacent hard surfaces.

10.9.14 Innovative street planting layouts

Opportunities for street planting range from the planting of specimen trees within the standard road berm to planting associated with traffic calming devices and specific landscape features within the subdivision.

Alternative location and design proposals will be encouraged, such as: boulevards, the provision of trees in a dedicated “non-services” berm on either side of a footpath; meandering footpaths; trees placed in specialised tree planting pits within the carriageway but outside of the live lane; rain gardens and stormwater tree pits designed to provide stormwater treatment. Refer to clause 5.12.9 - Stormwater quality for further information. Provide protection for trees planted within the carriageway from vehicles being parked.

Variation of the boundary lines along streets can create spaces for trees to be planted in groups and can help accentuate road perception, particularly at intersections. Strategically placed grouped plantings of trees may have more impact than individual trees placed outside each house, and this type of planting may also be required where ground conditions are not suitable for street tree establishment within parts of a subdivision development.

10.9.15 Irrigation

The Council’s long-term goal is efficient and sustainable use of the city’s water supply. Minimise the need for irrigation by matching plant species to the local site conditions. Consider detailing stormwater tree pits to provide passive irrigation within carriageways. Refer to clause 5.12.9 - Stormwater quality for further information.

Permanent irrigation in streets or reserves will be approved only when it is necessary to overcome significant difficulties with local site conditions that could prevent the reasonable growth, health and survival of lawns and amenity plantings. Contact the Council to discuss the type and control of the irrigation system.

Providing temporary irrigation of plant beds during the establishment period may be acceptable, in which case the water supply must be disconnected and the irrigation pipes removed at the end of the establishment period. Revegetated and restored sites will not be watered unless extreme drought conditions prevail during establishment.

Generally, all materials must comply with those listed on the Council's web page for approved materials at www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list. Install irrigation systems in accordance with *CSS: Part 2* clause 7.0 – Irrigation. Specify the backfill material to the irrigation trench.

10.9.16 Lawns and berms

All lawn areas must have gradients that ensure that surface water drains to a suitable area or outlet. Wherever gradients are flat the subsurface must have sufficient free drainage to ensure that water does not pond or settle, to maintain grass growth and health and to ensure that use of the area is not compromised. Areas that may be inundated by water regularly or for long periods are not appropriate for lawns. Consider establishing a wetland area instead.

All lawns in reserves must have a minimum width of 2.0m. Refer to clause 8.15.3 - Grassed berms (Roading) for details regarding berms on legal road.

10.9.17 Reducing grass maintenance

Provide access for mowers to all lawns and berms. Lay out lawns in reserves so that the tractor-mounted or ride-on mowers typically used by maintenance staff can mow them.

All grass slopes must be no steeper than a 1 in 4 gradient. On mounds, or where there is a significant change in gradient, design and construct lawns to avoid mowers scalping the ground surface. Refer to clause 8.15.4 – Batters (Roading) for further information.

Use grass mixes appropriate to the lawn use e.g. playing field mix in playing field areas.

10.10 Construction

Any variation to the design plans requires Council's acceptance in accordance with the non-conformance process set out in clause 3.7.1 – Control of non-conforming work (Quality Assurance).

Provide a Tree Protection Management Plan, within the Environmental Management Plan if appropriate, as required by the Tree Policy (draft).

10.10.1 Earthworks

Aim to protect original soils and drainage patterns and to minimise disturbance, compaction, earthworks and importation of topsoil in all areas identified for revegetation and restoration.

10.10.2 Plant supply

Sourcing plants locally maximises the plant's chance of thriving in the local environment and makes obtaining further supplies, for later replacement or extension of the planting, easier.

10.11 Establishment

10.11.1 Establishment

The developer is responsible (and may be bonded) for the establishment and routine maintenance and any replacement of the planting, lawns and associated works during the establishment period. This includes all those works set out in clause 14.0 – Establishment of *CSS: Part 7*. Maintain riparian planting as detailed in the amended Appendix II - Generic Guides for Riparian Maintenance for the project.

Replace, at the developer's cost, all missing, dead, dying, diseased or damaged trees and plants (damage includes inappropriate pruning, vandalism, theft, animal damage and acts of God) or those trees and plants that do not conform to the standards set out in *CSS: Part 7*.

CSS: Part 7 outlines the minimum establishment and maintenance standards required, and the recommended procedures to be followed, to ensure that all landscape works are at an acceptable standard prior to final inspection and release of the bond (if a bond was required).

Clause 2.13 – Bonds (General Requirements) elaborates on bonding requirements.

10.11.2 Pruning

Keep paths, roads and all other accessways clear of excess growth. This includes sightlines as set out in Figure 5 and clear heights over paths and cycleways of 2.0m minimum.

A qualified arborist must undertake pruning of trees, once planted. All pruning must comply with recognised international arboricultural practice. A qualified horticulturalist must undertake pruning of all plants (e.g. shrubs and groundcovers) once planted. All pruning must comply with recognised horticultural practice.

10.11.3 Presentation of reserves and streetscape

At the time of practical completion, all reserves and streetscapes must be presented in a tidy condition to the satisfaction of Council (see clause 10.5.1 – General considerations). Undeveloped reserves must be mowable with all debris removed.

The Council will inspect all trees, plants and landscaping including grassed areas prior to the release of the section 224 certificate (and at the end of the establishment period) to ensure that the minimum standards and specifications set out in *CSS:Part 7* are met before the Council will accept ownership.

Landscaped areas that have been developed must, as a minimum, meet the following general requirements:

> be completed by the developer in accordance with the accepted plans and required quality standards, within agreed timeframes and to the satisfaction of Council;

- be free of weeds, tree stumps (above and below ground) and other specified vegetation;
- be free of surplus, unwanted construction materials, debris, waste (liquid or solid) and rubbish;
- pre-existing trees and vegetation must be in a safe, healthy and undamaged condition.

10.12 As-Built Information and Asset Data

Present as-built records and associated reserve asset data, which complies with Part 12: As-Built Records and this Part. Where reserves may be geologically unstable, present a geotechnical completion report, as detailed in Part 4: Geotechnical Requirements, with the as-built records.

APPENDIX I

Generic Guides For Riparian Maintenance

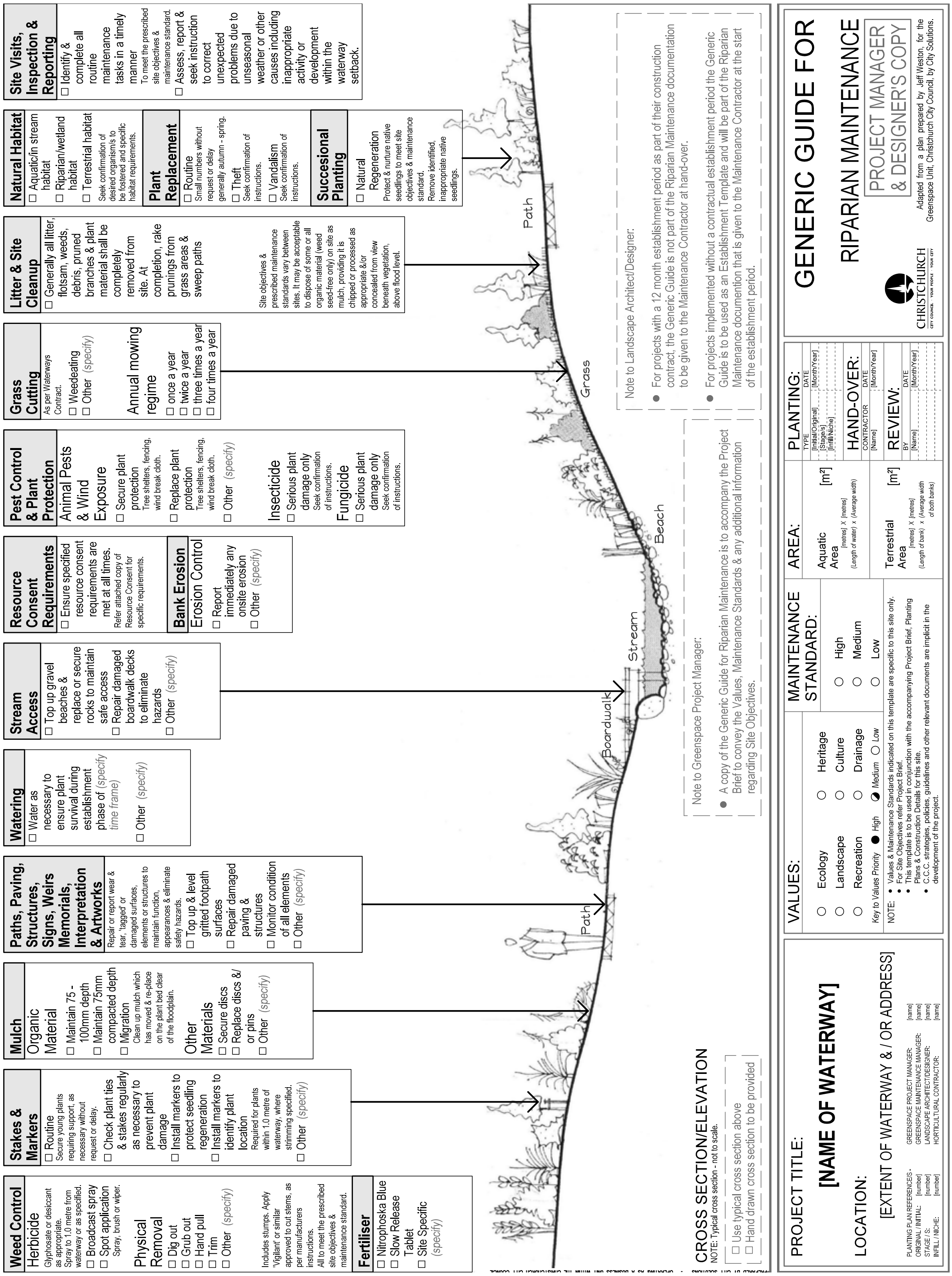


Figure 5 Generic Guide for Riparian Maintenance

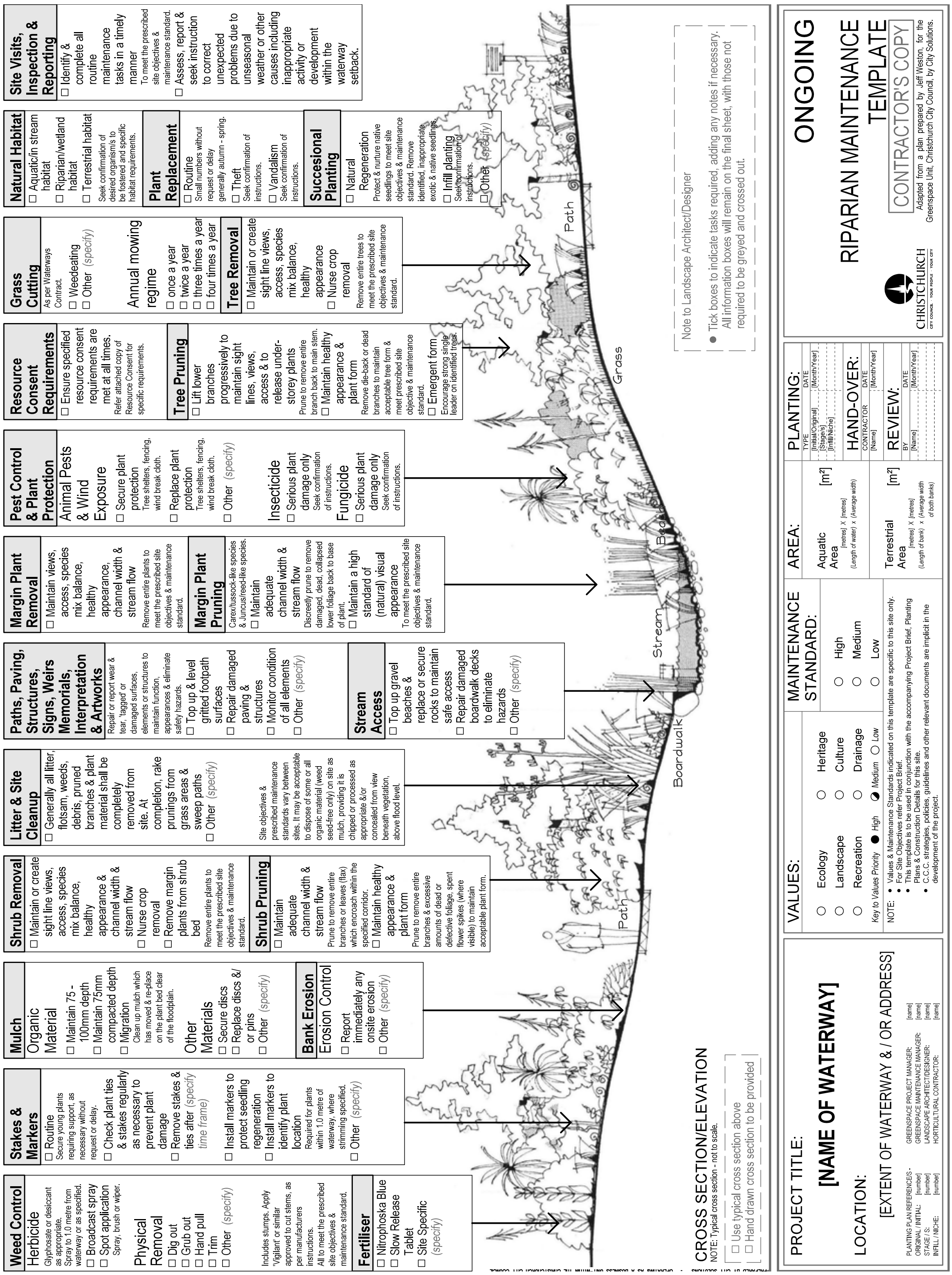


Figure 6 Ongoing Riparian Maintenance Template

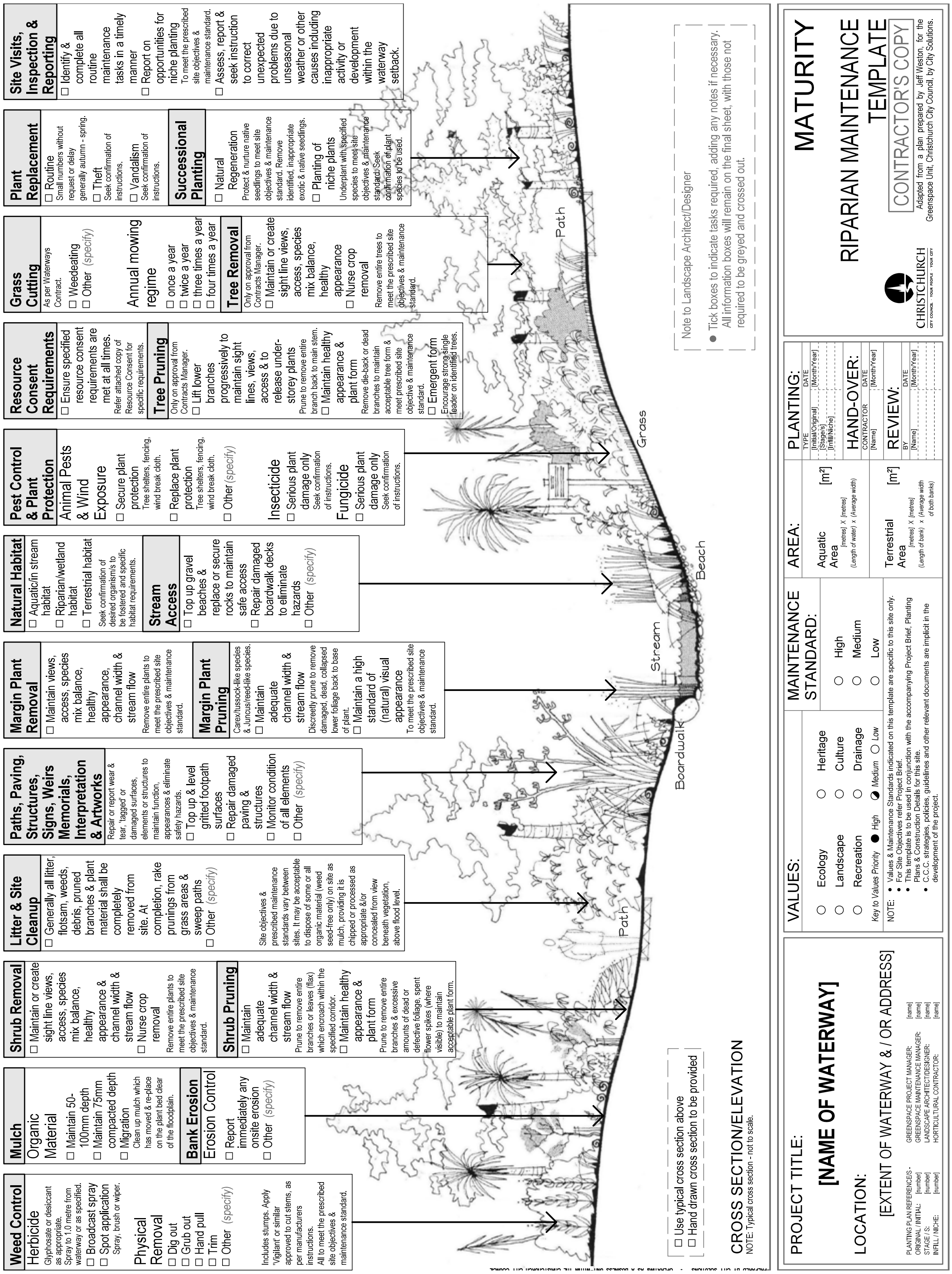


Figure 7 Maturity Riparian Maintenance Template

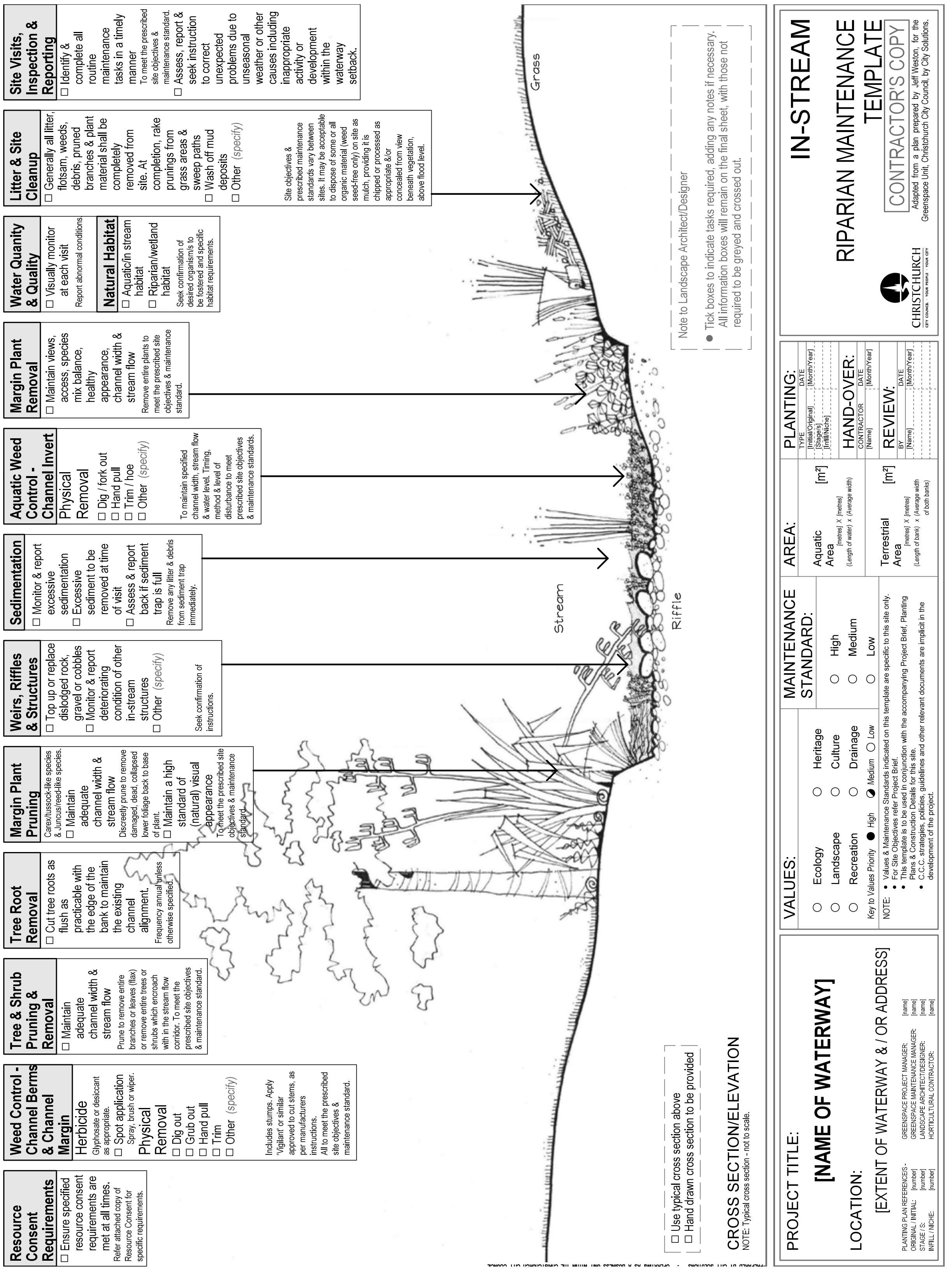


Figure 8 In-stream Riparian Maintenance Template

Part 11: Lighting

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11.1 Referenced Documents

Planning and Policy

> Electricity Act (1992)

> Electricity (Safety) Regulations (2010)

> Radiocommunications Regulations (2001)

Design

> *Christchurch Central Streets and Spaces Design Guide* www.otakaroltd.co.nz/assets/BalanceOfLand/streets-and-spaces-technical-guide-dec-2015-full-document.pdf

> Orion NW72.21.01 *Conditions for Connecting Equipment to Orion's Lighting Network*

> New Zealand Transport Agency *M30 Specification and Guidelines for Road Lighting Design* www.nzta.govt.nz/resources/specification-and-guidelines-for-road-lighting-design

> New Zealand Transport Agency M26: 2012 *Specification for Lighting Columns* www.nzta.govt.nz/resources/lighting-columns

> AS/NZS 1158 Set *Lighting for roads and public spaces - series*

> AS/NZS 3000: 2018 Electrical Installations AS/NZS CISPR 15:2011 *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*

> EngNZ Practice Note 02 *Peer Review – Reviewing the work of another engineer* www.engineeringnz.org/resources/practice-notes-and-guidelines

Construction

> 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/

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).

11.2 Introduction

This Part explains the Council's lighting design requirements where the lighting is (or will be) managed by the Council and connected to the Electricity Distribution Asset Owner street lighting network.

It covers lighting design requirements for both privately funded developments and Council funded new installations or upgrading of existing installations.

11.3 Quality Assurance Requirements and Records

Provide quality assurance records that comply with the requirements in Part 3: Quality Assurance and the *Construction Standard Specifications (CSS)*, during design and throughout construction.

11.3.1 Project brief

The Council must provide or agree to the lighting requirements for a project before any detailed design is undertaken. These lighting requirements will be specified in a project brief or, for developer-funded projects, in the Council's consent conditions. The project brief does not require updating within 12 months of design.

11.3.2 The designer

The designer must be suitably qualified and experienced and have an excellent track record in road lighting design. Refer to NZTA M30 *Specification and Guidelines for Road Lighting Design* and clause 2.7.1 – Investigation and design (General Requirements) for further information. The designer must ensure the lighting scheme meets the requirements of the IDS and the CSS.

Where the role of the engineer for the lighting component of the project's construction is being undertaken by another party apart from the designer, provide the company and individual's name, qualifications and contact details in the Design Report.

11.3.3 Design peer reviewer

Where a peer review is required as a condition of consent, peer review the design in accordance with *Peer Review – Reviewing the work of another engineer*.

11.3.4 Design records

Provide the following information in addition to that required by NZTA M30 *Specification and Guidelines for Road Lighting Design*, to support the Design Report defined in clause 3.3.2 - Design Report (Quality Records).

- A comparative whole of life cost analysis between the options considered;
- Records of any non-compliant design elements and any departures from the design spacing that have been used in the design process in the form required in clause 3.7.1 - Control of non-conforming work;
- A safety audit complying with clause 8.4.2 - Safety audit.

11.3.5 Engineering drawings

Provide drawings complying with clause 2.9 - Drawings and NZTA M30 *Specification and Guidelines for Road Lighting Design*.

In addition to Appendix I - Standard Draughting Layout and Format Requirements of Part 2: General Requirements, clause 8 - Title blocks, include:

a) The peer reviewer's name and signature (where a reviewer was specified)

b) An amendment box providing for a brief description of each amendment and sign off by the designer and peer reviewer.

11.3.6 Acceptance of design

Submit the Design Report for acceptance under clause 2.10.3 - Engineering acceptance, including the Lighting Design Statement (LDS1) - Design (refer NZTA M30 *Specification and Guidelines for Road Lighting Design*). Supply the lighting related documents as one package along with ALL other disciplines in the project's Design Report.

Where materials are not ordered within 12 months of the completed design's date of acceptance by Council, the acceptance is revoked.

11.3.7 Engineer's Report

Provide an Engineer's Report, including the Engineer's Completion Certificate for the lighting work. Include those documents required in clause 11.6 – Completion Procedures and Certification, and documentation to prove compliance with clause 3.3.4 – Engineers report (Quality Assurance). Provide audit and test records to confirm that the design has been implemented in its entirety, including records generated at hold or witness points. Where non-conformances have occurred, provide non-conformance reports in accordance with clause 3.7 – Non-Conformance and Quality Improvement (Quality Assurance).

The engineer must be suitably qualified and experienced and have an excellent track record in road lighting construction. The engineer may also be the designer but cannot be the contractor. The engineer must:

- ensure the lighting installation meets the requirements of the IDS and the *CSS*;
- manage the lighting construction to its conclusion, including regular site supervision;
- resolve any complaints to the satisfaction of the Council, prior to 224(c) certification;
- sign-off the project at completion.

11.4 Lighting Design

The lighting design must maximise safety and efficiency while minimising the life cycle cost and impact on the environment.

Design the lighting to blend in with adjacent street lighting, complement the neighbourhood character and, as far as is reasonably practicable, minimise the impact on the neighbouring properties and environment with regard to aesthetics, glare and spill light. Appendix I – Lighting Categories explains how the different categories identified in AS/NZS 1158.1.1 and 1158.3.1 apply to the Council's roads.

Reticulate all 'greenfields' developments underground. In areas where the existing overhead network is for street lighting only, or where the Electricity Distribution Asset Owner network is underground, cable the power supply for the new lighting underground. The overhead network must not be extended.

The Electricity Distribution Asset Owner network usually determines whether the lighting will have an overhead or underground power supply. When lighting is being upgraded in an area where the Electricity Distribution Asset Owner network is overhead and is not part of an underground conversion project, use the Electricity Distribution Asset Owner poles to support the lights. Obtain the permission of the pole owner beforehand. This solution minimises the number of poles in that area.

This Part defines the minimum standards but it is important not to over-design and provide a standard of lighting higher than that required. Ensure that all parts of the lighting installation conform to the following:

> NZTA M30 *Specification and Guidelines for Road Lighting Design*
> AS/NZS 1158
> Electricity Distribution Asset Owner's requirements
> AS/NZS 3000.

Refer to *Streets and Spaces Design Guide* where designing lighting in the central city. Council requires lights to be located on columns due to issues securing electricity supply for building mounted lights.

11.4.1 Category P (local road and pedestrian area) lighting

The luminaires must be approved by Council. See Approved Materials list for street lighting, www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list/streetlighting-materials.

Specify a minimum maintained illuminance for subcategory PR4 of 0.26 lux.

Specify mounting heights:

> between 6.0m and 7.5m in residential areas.
> between 7.0m and 9.0m in industrial areas.
> consistent along the street on each column type.

11.4.2 Category P (cycleways and pathways) lighting

The lighting category is usually Category PP3 or PP4.

Submit a non-conformance report where proposing the lighting of paths or cycleways that are not designated safe routes.

If the lights are located near trees, it may be appropriate for them to be mounted at a lower height, to illuminate underneath the tree canopy and avoid shadowing. In this case, a minimum mounting height of 4.5 metres may be accepted.

11.4.3 Pedestrian crossings

Design the lighting to comply with AS/NZS 1158.4 *Lighting for roads and public places - Lighting of Pedestrian Crossings*. The luminaires must meet the light technical parameters for New Zealand conditions detailed in AS/NZS1158.4, Table 3.5.

11.4.4 Intersections

Wherever an existing Category V road intersects with a new Category V road or an existing Category V road being upgraded, apply the requirements of AS/NZS 1158.1 *Road lighting - Vehicular traffic (Category V) lighting* to the intersection, even if the intersecting road is not lit to the appropriate Category V Standard.

Wherever an existing minor (Category P) road intersects with a new Category V road or an existing Category V road being upgraded, apply whichever of the following options provides the higher lighting standard:

> the requirements of AS/NZS 1158 for such intersections.

> the provision of a new light positioned in the side road near the intersection. (For an underground power installation the light shall be less than 10 metres away from the kerb line of the Category V road.)

The first light from an intersection on a Category P road shall be less than 10 metres away from the through road, measured from the kerb line. Where the lighting is attached to reticulation poles, this distance can be increased to 0.4 of the designed light spacing. The design light spacing requirements for the through road continue through the intersection.

11.4.5 Traffic management devices

Design lighting of traffic management devices to support the purpose of the device:

> Where the device is intended to regulate traffic, the lighting may need to be installed to a higher standard than normal road lighting. This will provide sufficient visibility to alert the drivers of the presence and speed constraint of the device.

> Where the device is intended to deter through traffic, the device may be identified by reflectors or by road lighting.

Ensure all lighting is designed to AS/NZS 1158 Set *Lighting for roads and public spaces – series*.

11.4.6 Column locations

If an adjacent property has not been developed (e.g. a new subdivision) and the column cannot be positioned in line with the common boundary, locate the column at least eight metres from the side boundary to allow for a future vehicle entrance. Position columns at least one metre away from a vehicle entrance or pedestrian kerb cutdown, including in traffic islands. Refer to NZTA M30 *Specification and Guidelines for Road Lighting Design* for guidance on locating columns.

Trees in a legal road or on Council land must be at least six metres away from lighting columns and more clearance may be necessary for some tree species or if the tree is protected. Consider the requirements for working near existing trees in *CSS: Part 1* clause 22.0 – Protection of Natural Assets and Habitats, when locating lighting columns.

Where retaining walls are being constructed in the likely area of column locations, consider incorporating column foundations into the walls.

Columns should not be installed in swales. This is because of the additional details for this installation type that are required to comply with AS/NZS 3000 and because of the use of geotextiles in swale construction.

Excluding columns located on the boundary, provide 0.5m clearance between the column face and the footpath edge. Where columns are in the footpath, ensure the path width is adjusted to compensate. Refer to clause 8.15.1- Footpaths (Roading) for footpath widths.

Specify frangible columns that comply with the requirements of NZTA M26 *Specification for Lighting Columns*. If non-frangible poles are being specified, clearly state this on the drawings.

11.4.7 Signs

Identify any signs that need to be altered, relocated onto lighting columns or onto their own posts. Locate these to comply with NZTA M30 *Specification and Guidelines for Road Lighting Design* and clause 8.11.5 - Permanent signs and markings (Roading).

11.4.8 Lighting equipment

NZTA M30 *Specification and Guidelines for Road Lighting Design* details the design life of lighting equipment. The design life for lighting columns shall be a minimum of 40 years.

Luminaires and control systems must comply with the requirements of AS/NZS CISPR15 with regard to electromagnetic compatibility. Non-compliance with this standard is an offence under the Radiocommunications Regulations 2001. All luminaires and columns must also comply with those listed on the Council's web page for approved materials at www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list/streetlighting-materials.

Luminaires shall be LED and include a DALI 2 dimmable driver, 7 pin NEMA socket and Luminaire Controller (LC) programmed to work on the Council's Central Management System (CMS).

Individual lights can be dimmed via the CMS. Therefore a higher wattage light (approximately 20% higher) should be installed and dimmed to the designed wattage via the CMS. To ensure the lighting is correctly set up the CMS the luminaire wattage on the drawing shall show the luminaire wattage first followed by the dimmed wattage, e.g. 112W/D90W.

11.4.9 Backfill and bedding

Specify backfill materials individually. The material used must be capable of achieving the backfill compaction requirements set out in *CSS: Part 1* clause 32.0 Backfilling. Bedding materials should comply with the Electricity Distribution Asset Owner requirements. Carry out trench restoration in accordance with *CSS: Part 1* clause 30.0 – Restoration and Final Surfacing.

11.5 Installation and Commissioning

Carry out installation and commissioning in accordance with *CSS: Part 5*. Prior to accepting any newly commissioned lighting installation onto Council's network, Council will audit the installation as detailed in clause 2.11 - Approval of construction.

The MAC ID and location of the Luminaire Controller shall be accurately captured when installed, failure to provide this information will prevent practical completion

11.6 Completion Procedures and Certification

At the completion of the physical works, and after receiving the lighting contractor's Completion Certificate, inspect the work and certify that:

> the project has met all the requirements of the project brief, the standards and specifications; and

> all the documentation detailed below has been completed, is correct and has been forwarded to the Council.

Provide the following documentation:

> Test Certificates for each lighting standard;

> Earth test sheets;

> Compliance Certificate for the complete installation;

> Electrical Safety Certificate (ESC);

> Record of Inspection (RoI);

> As-built drawings of Council owned cables, to Electricity Distribution Asset Owner requirements;

> As-built information in RAMM format (refer to Part 12: As-Built Records);

> Engineers Completion Certificate (refer to Appendix VII, Part 3: Quality Assurance);

> Lighting Design Statement (LDS4) - Construction Review and Audit (refer NZTA M30 *Specification and Guidelines for Road Lighting Design*);

> Contractor documentation required by the *CSS*;

> Luminaire Controller e.g. MAC ID.

At the end of the defects liability period, carry out an audit and certify that lighting columns are vertical and lights have been installed correctly and are at the correct mounting height in compliance with *CSS: Part 5*.

APPENDIX I

Lighting Categories

Table 1 Lighting categories

Road classification	Other criteria	Traffic volume	Lighting category
Urban			
Arterial	Major shopping area with bright surroundings	> 20,000	V1
Arterial		> 15,000	V2
Arterial		7,000 to 15,000	V3
Arterial		3,000 to 7,000	V3
Collector		> 15,000	V2
Collector		7,000 to 15,000	V3
Collector		3,000 to 7,000	V4
Collector		1,000 to 3,000	PR4
Local			PR4
Rural			
Arterial		> 15,000	V3
Arterial		7,000 to 15,000	V3
Arterial		3,000 to 7,000	V4
Collector		> 15,000	V3
Collector		7,000 to 15,000	V4
Collector		3,000 to 7,000	V4
Local	Footpath and/or on road cycle lanes		PR4
Local			PR5

Note

1) This table is intended to be a guide only.

2) Some rural roads may not require lighting.

3) PR4 and PR5 lighting categories must comply with clause 11.4.4 – Category P (local road and pedestrian area) lighting.

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12.1 Referenced Documents

Design

> Christchurch City Council *IDS Survey As-Built Guideline (SAG)* and appendices www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/as-built-survey-and-data-requirements/

> Christchurch City Council *IDS As-Built Template (CAT)* for the various asset types 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/

> Christchurch City Council *CWW Tagging Convention* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/as-built-survey-and-data-requirements/

> Pump Station Design Specifications www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/pumping-station-design-specification

> Christchurch City Council *Requirements for RAMM Inventory Updates* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/ramm-and-costing-as-built-requirements/

> Christchurch City Council *RAMM Inventory for Renewal Assets* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/ramm-and-costing-as-built-requirements/

> Christchurch City Council *Buyer Created Tax Invoice Template* www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/ramm-and-costing-as-built-requirements/

> NZS 4431:1989 *Code of practice for earthfill for residential purposes*

> NZS 5828:2015 *Playground equipment and surfacing*

> New Zealand Transport Agency *State Highway Database Operation Manual* (SM050) www.nzta.govt.nz/resources/state-highway-database-operation-manual/index.html

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).

Contact Council for access to those Council reference documents available only through TRIM.

12.2 Introduction

Where required by a condition of contract or as a condition of subdivision consent provide as-built records, complying with this part.

Where the developer is not providing the as-built records, provide adequate notice and access to the Council to allow sufficient measurements to be obtained for an accurate record of built assets.

Some asset classes can be maintained by more than one area of the council, e.g. bollards, bridges, footpaths/tracks, lights, etc. This means that different templates may be required as a part of the same project. Engage with the Council representative, e.g. project manager, to ensure the correct as-built template is used to capture asset information before field data collection commences to minimize potential rework.

12.3 As-Built Accuracy

Provide as-built stormwater, wastewater and water supply pipe and pipe-related asset locations and park asset locations to the accuracies specified in the *Survey As-Built Guideline (SAG)*.

Ensure all reference states NZGD2000, Mt. Pleasant.

12.4 As-Built Records

Provide as-built records for all infrastructure to be vested in Council ownership. Use the *Buyer Created Tax Invoice Template* to provide the asset construction cost.

Provide a full drawing set of as-built plans, in the same form (e.g., scale, size) as the accepted engineering or landscape plans and to at least the same level of detail. They must show all built assets to be taken over by the Council. Include details of any decommissioned assets. Provide details of the datum used, in accordance with clause 2.8.1 – Level datum (General Requirements).

Mark any changes from design in red on as-built plans and provide with the associated non-conformance reports in .pdf format. Such changes might include:

> Reduction in or additional assets installed
> Change in material type
> Additional bends in pipe
> Change in the depth of pipe, e.g. 0.8m changed to 1.5m
> Change in asset size e.g. 1050mm dia changed to 1200mm
> Any unexpected findings, e.g. redundant 1m brick barrel sewer
> Change in structure type

Clearly mark plans as “As-built” by stamping or changing the title block, including where the as-built is built ‘as designed’. Date and sign the as-built records.

Submit as-built word documents digitally in either Microsoft Word .doc or Adobe .pdf format. Submit as-built spreadsheet records digitally in either .xlxs or .csv format. The drawing file format may be Microstation (.dgn), 12Da or AutoCAD (.dwg). Format dates as day/month/year. For all supplied geospatial data, use the Mt Pleasant 2000 projection, New Zealand Geodetic Datum 2000 (NZGD2000). See more at: www.linz.govt.nz/data/geodetic-system/datums-projections-and-heights/geodetic-datums/new-zealand-geodetic-datum-2000-nzgd2000.

Each Part of the IDS may have additional requirements or documentation e.g. calculations, manuals, for that type of work, which must be supplied with the as-built records. Check with each Part for further information.

12.4.1 Part 4: Geotechnical Requirements

Provide the geotechnical completion report and tabulated results, where required.

The geotechnical completion report will be used by the Council to update the Information Register, or property files for LIM or PIM data. To aid in transferring this information into the LIM system, provide the data in a tabulated form, related to lot numbers where possible. Consent Notices under Section 221 of the Resource Management Act (1991) may be required for such sites as a condition of subdivision consent such as:

- the need for an appropriately qualified specialist to carry out further geotechnical investigations as part of a building consent application.
- the specific requirements or recommendations that need to be considered.

If NZS 4431 was applicable to the development, prepare as-built records in accordance with that standard.

If NZS 4431 was not applicable, prepare an as-built plan as follows. It must show the extent and depth of fill in the form of lines that join all points of equal depth of fill at vertical intervals, which adequately define the fill. Alternative methods of representing the fill depths may also be acceptable. It must show areas of filling of low density, any fill areas that the geotechnical engineer considers as not complying with the IDS, and areas where the standards have been varied from the original construction specification.

The as-built plan must record the position, type and size of all subsoil drains and their outlets. It must also provide information about any underrunners and springs located.

12.4.2 Part 5: Stormwater and Land Drainage

Provide as-built records for stormwater pipes and pipe-related assets conforming to the *SAG*. Deliver asset data electronically using the *CAT*. Refer to IDS 5.4.4 for other Construction Records to be returned to CCC.

Provide as-built records for all open waterway-related assets conforming to the asset features, materials and types listed in Appendix I – As-built data checksheet – land drainage (which generally covers open waterway-related assets). Itemise the construction cost into at least the major asset types from Table 2, Appendix I, and to separate assets (e.g. costs of each of two basins) within the asset types.

Use the checklists provided in the appendices when compiling field CAT sheets or plans. Provide the following additional as-built information for non-pipe stormwater assets (e.g. stormwater treatment device). Provide one hard copy and an electronic copy of:

> the spare parts, workshop (overhaul) and individual installed plant and equipment product manuals;

> the master drawings;

> AutoCAD 2000 engineering drawings;

> AutoCAD .tif file (or hardcopy) for Building, Reticulation, Pumps, Reservoirs, Cables and Wells;

> Asset Owners Manuals (AOM) and Operations & Maintenance Manuals: Electrical, Mechanical including Asset (Equipment) Information and Geospatial Information;

> CAT sheets;

> diesel generator capacity details;

> power connection ICP number;

> digital photos of new assets;

> grounds maintenance plans (in pdf).

12.4.3 Part 6: Wastewater Drainage

Provide as-built information for wastewater pipes and pipe-related assets conforming to the *SAG*. Deliver asset data electronically using the *CAT*. Refer to IDS 6.3.3 for other Construction Records to be returned to CCC.

Provide the following additional as-built information for non-pipe wastewater assets (e.g. pump station, odour treament). Provide one hard copy and an electronic copy of:

> the spare parts, workshop (overhaul) and individual installed plant and equipment product manuals;

> the master drawings;

> AutoCAD 2000 engineering drawings;

> AutoCAD .tif file (or hardcopy) for Building, Reticulation, Pumps, Reservoirs, Cables and Wells;

> SCADA functional descriptions and code. For standard pumping stations, level 1 process description only is required. For pumping stations or processing

plants that differ from standard, submit full level 2 functional descriptions before coding, using the Level 2 functional description template.

> Piping and instrumentation diagrams for pumping stations and treatment plants, tagged in accordance with CWW Tagging Convention.

> Asset Owners Manuals (AOM) and Operations & Maintenance Manuals: Electrical, Mechanical including Asset (Equipment) Information and Geospatial Information;

> CAT sheets;

> diesel generator capacity details;

> power connection ICP number;

> digital photos of new assets;

> grounds maintenance plans (in pdf).

12.4.4 Part 7: Water Supply

Provide as-built information for water supply pipes and pipe-related assets conforming to the *SAG*. Deliver asset data electronically using the *CAT*. Refer to IDS 7.3.3 for other Construction Records to be returned to CCC.

Specify details of the commercial restrained joint systems on the as-built records, including the location of restrained portions of pipelines, including joints.

Provide the following additional as-built information for non-pipe water supply assets (e.g. pump station, reservoir, new well). Provide one hard copy and an electronic copy of:

> the spare parts, workshop (overhaul) and individual installed plant and equipment product manuals;

> the master drawings;

> AutoCAD 2000 engineering drawings;

> AutoCAD .tif file (or hardcopy) for Building, Reticulation, Pumps, Reservoirs, Cables and Wells;

> SCADA functional descriptions and code. For standard pumping stations, level 1 process description only is required. For pumping stations or processing plants that differ from standard, submit full level 2 functional descriptions before coding, using the *Level 2 functional description template*;

> Piping and instrumentation diagrams for pumping stations and treatment plants, tagged in accordance with *CWW Tagging Convention*;

> Asset Owners Manuals (AOM) and Operations & Maintenance Manuals: Electrical, Mechanical including Asset (Equipment) Information and Geospatial Information;

> CAT sheets;

- well information: well consent details, well log, water quality results (in hard copy and electronic template, available from project manager);
- diesel generator capacity details
- power connection ICP number;
- digital photos of new assets;
- grounds maintenance plans (in pdf).

12.4.5 Part 8: Roading

When collecting hard asset data, load as-built records for the tabulated asset types in the Council's RAMM database using pocket RAMM or use the RAMM Inventory for Renewal Assets template. Base the collection of data on the *State Highway Database Operation Manual* amended by the *Requirements for RAMM Inventory Updates*.

Details of approved contractors, currently able to carry out this work, can be obtained from www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-contractors

Before compiling any as-built RAMM data, obtain the following information from the Council:

- Road ID;
- Road name;
- Start Displacement.

Council RAMM uses the road origin as the zero point so record all Reference Points (RPs) with reference to the origin.

Provide as-built records of any coal tar present on site, including the location, depth and method of treatment e.g. reuse or encapsulation.

Provide an Asset Owner's Manual for retaining walls, using the *Professional Services Guide Asset Owner's Manual* as a template. Include a labelled grid in the as-built drawings.

Provide as-built records conforming to the SAG for all green assets located within, or that are going to be vested with, legal road. Deliver asset data electronically using the Land Improvements Green Assets CAT.

12.4.6 Part 10: Reserves, Streetscape and Open Spaces

Provide as-built records for all landscapes and structures conforming to the *SAG*. Provide as-built records for all landscapes and structures conforming to the SAG. Deliver asset data electronically using the Land Improvements CATs for those assets located within, or that are going to be vested with, recreation or utility reserve.

Provide the following additional as-built information for built assets e.g. play equipment, buildings, bridges and structures (including walls and fences, artworks and monuments, furniture, park utilities). Provide one hard copy and an electronic copy of:

> certification as required by *Playground equipment and surfacing*;

> the Code Compliance certification under any building consent;

> Asset Owners Manuals (AOM) and Operations & Maintenance Manuals;

> the spare parts and individual installed plant and equipment product manuals;

> digital photos of new assets.

Provide planting maintenance plans where they are part of the accepted design.

12.4.7 Part 11: Lighting

When collecting asset data, load as-built records for the roadlighting assets in the Council's RAMM database using pocket RAMM or use the *RAMM Inventory for Renewal Assets template*. Refer to clause 12.4.5 - Part 8: Roading for further information.

APPENDIX I

As-Built Data Checksheet - Land Drainage

Table 1 Watercourse features

Watercourse Features - This includes all open channels, rivers, creeks, swales, ponds, etc.	
Watercourse	**Notes and Explanations**
☐ Position X,Y	
☐ Installation Date	
Watercourse Lining	
☐ Position X,Y	
☐ Installation Date	
☐ Lining Type	refer Watercourse Lining Type list
☐ Top Width	
☐ Bottom Width	
☐ Depth	
Watercourse Basin	
☐ Position X,Y and extent	include contour plan
☐ Installation Date	
☐ Basin Type	refer Watercourse Basin Type list
☐ Invert levels on inlet(s)	lip of sump or pipe invert
☐ Invert levels on outlet(s)	lip of sump or pipe invert
☐ Design volume	
☐ Design return period	
Watercourse Structure	
☐ Position X,Y	position of a point marked on the as-built plan if the structure is a point feature, or start and end points if it is a linear feature e.g. retaining wall
☐ Installation date	
☐ Reference level	level of a point marked on the as-built plan
Watercourse Valve	
☐ Position X,Y	
☐ Installation Date	
☐ Valve Type	refer Watercourse Valve Type list

Enchancement Features - This includes all plantings, stabilisation of banks, etc.	
Enhancement	
☐ Start Position X,Y	upstream
☐ Finish Position X, Y	downstream
☐ Installation Date	

Table 2 Watercourse type lists

Watercourse Type Lists	
Watercourse Lining Type	
CON-C	Concrete Slab with Concrete Frame
CON-I	Concrete Cast In-situ
CON-P	Concrete Precast
CON-T	Concrete with Timber Posts
INVT	Concrete Invert
INVT-R	Concrete Invert with Retaining Wall
LTIMB	Low Timber Lined
ROCK	Rock Lining
ROKMTR	Mortared Rock Lining
SPRAY	Sprayed Concrete
TIMB	Timber Lined
TIMB-T	Timber Lined with Top Struts
Watercourse Basin Type	
Detention	
Infiltration	
Lake	
Pond	
Retention	
Silt Trap	
Soak Pit	
Swale	
Watercourse Valve Type	
Gate	
Flap Gate	
Tidal Gate	