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8. STORMWATER AND LAND DRAINAGE

This Part includes:

- The assessment of required infrastructure
- Technical design requirements
- Material requirements
- Completion Documentation requirements for vested asset acceptance

The Resource Management Act (RMA) is the principal statute that controls land development, including stormwater drainage aspects. Territorial authorities have a responsibility to manage land and adverse effects under section 31 of the RMA.

The Land Drainage Act 1908 gives Council power to establish land drainage rating districts and classified drains.

Selwyn District Council's Drainage and Stormwater Bylaw 2018 details activities permitted within a stormwater and land drainage network.

Environment Canterbury Land and Water Regional Plan sets the desired water quality and management practices in Canterbury.

Unless stated in SDC's Engineering Code of Practice (ECOP) Section 9: Water Races and Section 8: Stormwater and Land Drainage, please refer to CCC's Waterways, Wetlands and Drainage Guide and CCC's Construction Standard Specification for further guidance.

Specific requirements provided in this document shall take preference over general requirements provided in the Christchurch City Council Waterways, Wetlands and Drainage Guide *Ko Te Anga Whakaora mō Ngā Arawai Rēpō.*

8.1 Referenced Documents and Legislation

In addition to the documents listed in Section 1, the following documents are also referenced in this Section of the ECOP.

Planning and Policy:

Planning input may be required to incorporate Stormwater features to meet desired outcomes such as urban design guidelines and 'blue green networks.

Design:

- Christchurch City Council's Waterways Wetlands and Drainage Guidance
- Canterbury Regional Stormwater Forum
- Christchurch City Council's Raingarden design, construction and Maintenance manual
- Auckland City Council, Technical Publication #10 Stormwater Treatment Devices Design Guideline Manual, 2003
- Auckland City Council Technical Guides for stormwater
- Christchurch City Council leaflet Stormwater Tanks on Private Property
- Transit New Zealand Bridge Manual (2003)
- Selwyn District – Design Rainfall
- Environment Canterbury 'What are industry agreed good management practices? | Environment Canterbury
- New Zealand Water Environment Research Foundation 'Sustainable Drainage Management Field Guide'

- Christchurch City Council 'Stream Planting Guide'
- Environment Canterbury 'Riparian Zones'
- Selwyn District Council Stormwater and Drainage Bylaw 2018
- Selwyn District Council Water Race Bylaw 2008
- Selwyn District Council - Stormwater
- Selwyn water race guidelines
- Selwyn District Council Selwyn District Council - 5Waters Activity Mgt Plan

Construction:

- Christchurch City Council Civil Engineering Construction Standard Specifications Parts 1-7(CSS)
- NZWWA "New Zealand Pipe Inspection Manual"
- SNZ HB 2002:2003 Code of Practice for Working in the Road
- MFE - works-in-waterways-guideline.pdf (environment.govt.nz)

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

8.2 OVERVIEW OF SELWYN DISTRICTS STORMWATER AND LAND DRAINAGE NETWORK

Selwyn's urban design philosophy, objectives and purpose is outlined in the Selwyn District Council Urban Design Strategy and takes preference over Christchurch City Council documents.

This section outlines Council's design and construction requirements for 2 of Council's 5 water asset types. These assets are described as:

- **Stormwater**: the system of urban runoff collection, treatment, and disposal for the protection of property, environment, land, and amenity values. This includes urban pipework, open channels, soak pits and various treatment devices/facilities. Each township in the Selwyn District has its own stormwater scheme.
- **Land Drainage**: Council's network of classified drainage channels for the primary purpose of lowering groundwater and removing surface ponding. Council has nine classified drainage schemes across the district.

Council does not charge rates for the management of stormwater or land drainage activities outside of the schemes noted above. For requirements and responsibilities relating to this and natural waterways, refer to Environment Canterbury (ECan) or contact Council. ECan approval is also required for any modification to ECan classified drains.

8.2.1 Effects of Development on the Existing Stormwater and Land Drainage Network

System extensions, upgrades and any other specific works required to provide stormwater reticulation/treatment for a new development will be funded in accordance with the Council's Development Contributions Policy.

Any development reliant on the municipal supply will be required to contribute to the infrastructure necessary to connect. The developer is responsible for the cost (or part cost) of any system extension.

8.2.2 Stormwater and Land Drainage Resource Constraints and Consents

When developing land, developers are required to accommodate any upstream discharges and mitigate discharge impacts downstream. All new developments are also expected account for and address any potential and existing flood issues by determining the minimum finished floor levels (FFL) for all properties within the development. The FFL for any new residential unit or other principal building must be 300mm above the 0.5% Annual Exceedance Probability (AEP) rainfall event (200-year storm event). To comply with this requirement developers may be required to update a district wide flood model with the stormwater characteristics of the proposed development. Alternatively, developers may need to undertake an independent study of the catchment area specified by Council to determine the effects and impacts the proposed development will have on overland flow paths and the surrounding area.

Drainage design for **new developments** should include a primary system that must cater for the 10% AEP rainfall event and the secondary system must cater for over-design events and occasions when there are blockages in the primary drainage system (minimum 1% AEP rainfall event). The overall system must consider where flows will go when design is exceeded. Discharges arising from new developments must not exceed pre-development levels.

Any proposed earthworks filling on the site must not cause runoff to discharge onto adjacent properties. If an adjacent neighbour's historical and/or existing stormwater drainage was onto the proposed development, the proposed development must maintain or mitigate the historical discharge and overland flow paths.

Prior to undertaking any works associated with stormwater infrastructure, stormwater management areas, and land drainage networks Council approval (and when necessary ECan approval) must be given in writing. The appropriate construction phase, operational discharge, and any other temporary consents must also be approved by Council and exercised in the name of the developer. Proposed physical works associated with new developments will receive Council approval as part of the of Engineering Approval process. All other projects that propose alterations to the SDC network will require Bylaw approval which is processed by the Water Services Team.

IMPORTANT NOTE – An ECan Resource Consent is required unless ECan provide formal approval by way of a code of compliance certificate a system can operate under permitted activity rules.

All sites must ensure that they have appropriate construction phase consents to include discharge and temporary dewatering consents and land use consents. These are required during construction and must be applied for by, and exercised in the name of, the developer. Any granted consents **must** be exercised before any physical works commence onsite.

All new infrastructure that is to be owned and operated by Council must be vested to Council and provided with an easement in gross that gives council assess rights. A building setback will be required by Resource Consent to prevent building on any Council vested stormwater or land drainage assets located within private property**. Building within an area protected by an easement in gross to SDC is not permitted by Council and doing so will be at the landowner's risk.**

Council must accept and approve any proposed discharge into the reticulated stormwater network, and discharge of stormwater within a global consent boundary. Any accepted discharge must comply with the conditions of the council's relevant global discharge consent.

Council holds several global ECan consents for stormwater discharge for townships. The conditions of these consents must be met by all new development and discharges including any stormwater and land drainage assets that are to vest in Council. The conditions of Councils global consents can be viewed on Council's website (link here).

Council encourages developers to engage with authorising officers from both Council and ECan prior to consent application because it is good practice process subdivision and water-related resource consents simultaneously and deal with any land and water issues at a joint hearing pursuant to section 102 of the RMA.

NOTE: Developments larger than 5 lots must apply for their own Stormwater Discharge Consent for post development discharges. Conditions of these consents including duration must match the global township consent. Transfer to Council can generally occur 2 years after construction discharge ceases. Council cannot only give approval to use SDC's consent. Discussion and early engagement with Council is encouraged.

It is developers' responsibility to obtain formal approval from Council that a resource consent relating to the ongoing operation of an asset will be accepted by the Council, this is generally achieved by ensuring that Council accept draft proposed ECan consent conditions. Where a consent will be transferred to Council, Approval to transfer is required and subject to the developer demonstrating full compliance with all conditions of consent:

- Completion of the two-year maintenance period with all defects rectified.
- Receipt of a fully complying Environment Canterbury compliance report.
- Receipt of an Operation and Maintenance Manual for the consent system.
- Completion of all other requirements specified in the District Council resource consent.

If non-compliances are identified the consent holder will continue to hold the consent until the non-compliances have been addressed. Once all aspects of the system are satisfactory the consent can be transferred to Council.

8.3 INFORMATION REQUIRED AT RESOURCE CONSENT

Information to be provided with drawings in support of Resource Consent (subdivision) application or for approval of a concept design must include:

- Description and plan of the strategy for stormwater collection, treatment, and disposal
- Location of any natural waterways, springs, bores, wells, or wetlands within the site or near a boundary. The location in plan and level of the water's edge and shoulder of the banks must be indicated
- Location of existing drainage and overland flow pathways
- Flood risk assessment
- Location of any archaeological and historical features
- 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 by defined 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 near the site and overland flow paths within the site
- 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
- Protected 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

8.4 STORMWATER AND LAND DRAINAGE DESIGN CONSIDERATIONS

Any proposed design is expected to be in line with current best professional practice. When designing a proposed water supply for Council to review please consider the following and provide supporting evidence in the Design Report:

- **Designers shall also ensure appropriate allowance for future climate change is included in calculations as described in the design rainfall section**
- Stormwater Management Plan
- Hydraulic adequacy of the system
- Capacity and ability to service future extensions and development
- Upstream and downstream effects of the proposed development and strategies to mitigate any identified issues
- Flood Risk Assessment (including modelling)
- The use of alternative technologies – sump filters, pumped stormwater systems, stormwater management systems
- Networking and redundancy
- Maintenance considerations and “Fit-for-purpose” service life of the system
- Property service connection locations and sizes
- Urban design requirements – including the protection of other asset types from erosion (roads)
- Compliance with the Activity Management Plan
- Best way to minimise the whole-of-life cost
- Ability of the stormwater and/or land drainage system to maintain acceptable water discharge quality including consideration of materials used, prevention of back siphonage, and stagnation
- Structural strength of water system components to resist applied loads, including ground bearing capacity
- Seismic design - all infrastructure 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 (manholes and sumps) and natural or made ground
- Pipeline’s ability to withstand both internal and external forces
- Subsoil drainage requirements
- Resistance of each component to internal and external corrosion, degradation, and ground contamination
- Location of major reticulation and its potential for significant traffic disruption. Discuss at an early stage with Council
- Impact of the works on the existing catchment, environment, and community (including the effect of land use changes on receiving waters and downstream impacts and protection of groundwater)

When designing downstream facilities, consider the upstream catchment to be fully developed and comply with any Catchment Management Plan

Council only accepts submerged outlets from sumps that meets the stormwater discharge consent containment requirements.

Permanent stormwater pumping will only be permitted under **exceptional** circumstances at Council’s sole discretion, and where it is clear to Council that no other options are feasible.

Drowned (whether fully submerged or partially) stormwater mains will only be approved, at Council’s discretion once all other practicable options have been exhausted to achieve a free draining system. Council may impose additional maintenance clauses as part of Engineering Approval if drowned systems are proposed.

The used of integrated stormwater systems is Councils preferred solution for all infrastructure proposed for the treatment of stormwater discharge. 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.

When designing overland flow paths designers are expected to consider the following in the design report:

- Allow for overland flow paths in their design
- Design of overland flow paths must ensure that erosion or land instability caused by flows will not occur and suitable protection against erosion is considered
- Overland flow paths on private property for flows more than $100ls^{-1}$ for the 1% AEP event shall be protected by registered easements in favour of Selwyn District Council or by other encumbrances prohibiting earthworks, fences, and other structures, as appropriate
- In most circumstances, limit ponding or secondary flow on roads in depth and velocity such that the carriageway is passable

Any works associated with stormwater and land drainage that will affect water races must comply with Section 9 of this ECOP. Stormwater discharge as a result of a new development must not discharge into a water race. Consultation with ECan staff should be sought to clarify if consent is required for:

- Diverting of water races
- Piping extensive lengths of water race
- Installation of structures, ponds, or enhancements

Ground water is a precious resource. Council expects developers, designers, and contractors to carry out works in a way that prevents adverse effects on ground water quality and levels. This includes ensuring a system does not discharge within a groundwater protection zone for wells including community drinking water supply. Information on these zones can be found obtained from Environment Canterbury.

8.4.1 Design Life

All stormwater reticulation systems are expected to last for an asset life of 100 years with appropriate maintenance and must be designed accordingly to minimise life cycle costs for the whole period.

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.

8.4.2 Material Specifications

Both the developer and the contractor are responsible for ensuring the appropriate handling, storage, transportation and installation of pipes, fittings, and structures 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.

Pipe and fitting materials and classes must meet the requirements set out in Section 8.5.7 and 8.5.8. Civil structure's must be concrete RRCJ class 4 unless approved.

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 ECOP 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.

Proposed pipes and concrete structures that are likely to lie within Aggressive Groundwater zones will need additional protection such as an external plastic wrapping membrane.

8.4.3 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 – NECS consent requirements
- Options for decontaminating the area
- Selection of materials and jointing techniques to maintain the water quality
- Safety of construction and maintenance personnel
- Any special pipeline maintenance considerations
- How any issues identified in the PSI will be mitigated

8.4.4 Flood Risk Assessment

Council's committed Levels of Service for stormwater require that a flood risk assessment is carried out as part of design for subdivisions and infrastructure assets. This assessment must consider effects when the stormwater network exceeds its design level of service. This may require modelling to demonstrate likely areas and extent of ponding/flooding, flow velocities and ponding depths, and duration of flooding in large events. The flood risk assessment shall:

- Be appropriately detailed to suit the size and nature of the total catchment
- Take account of the characteristics of the total catchment
- Include any relevant historical information on flooding. This could include reviewing records held be relevant bodies, discussions with the local inhabitants or appropriate field investigations
- Consider the proximity and nature of any river, stream or watercourse and associated flood plains or overland flow path
- Demonstrate how the capacity of culverts or watercourses downstream of the site will perform, and calculate the likelihood of upstream ponding resulting from under capacity or from blockage by debris or slips
- Investigate the upstream culvert and watercourse conditions and the location of the secondary flow path for floodwater in the event of blockage or under capacity
- Determine required flood levels to protect dwellings from flooding

The proposed design needs to demonstrate how it addresses the assessed flood risk. Flood design shall consider the overall site conditions, details of the drainage system and the probable impediments to free flow (both upstream and downstream) when determining the expected runoff and design flood levels, while meeting agreed minimum levels of performance.

Council reserves the right to impose any requirements on the design and construction to ensure safe, reliable, and economic performance.

8.5 DESIGN PARAMETERS

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:

- Water level at supply point or nearest downstream location to the development where it is known
- First flush of a system should be designed to treat the first 25mm of rainfall unless otherwise stated in the stormwater discharge consent
- Additional development to be allowed for in the design
- Networking requirements
- Other requirements (e.g., minimum mains size)

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).

In areas identified for future growth Selwyn District Council may require the proposed development infrastructure to be oversized. Where this occurs Council would consider a developer's agreement to cover the extra over costs associated with the oversizing.

8.5.1 Estimation of Surface Water Run Off – Peak Flow

Surface water hydrology and the estimation of the peak flow rate for localised urban catchments shall be in accordance with one of the following techniques

(a) IPENZ „Procedure for Hydrological Design of Urban Stormwater Systems', December 1980 (limited to 10 hectares); or

(b) an approved catchment/stormwater computer modelling system.

For (b) above the Council's Group Manager Infrastructure can confirm an acceptable modelling system on request. Furthermore, Christchurch City Council WWDG Part B chapters 21, 22 also provides good guidance for the estimation of surface water run-off.

8.5.2 Design Rainfall Intensities

Design rainfall intensities shall be as per NIWA's High Intensity Rainfall System V4, available online at High Intensity Rainfall System (niwa.co.nz). To allow for climate change, scenario RCP 8.5 (2081-2100) shall be used.

The above procedure shall be used for all urban development within the Selwyn District. Council reserves its right to use discretion when applying this rainfall data and during assessment of applications for engineering acceptance.

8.5.3 Design Rainfall Coefficients

The runoff coefficients shown below are provided as a guide for initial calculation of system requirements (based on a 10yr event, average slope 5% - 10%, saturated soils).

More accurate investigations into appropriate return periods and runoff coefficients will be necessary for detailed design. Detailed design should involve calculating a weighted average runoff coefficient by averaging the value for individual parts of the catchment. This may be done for a representative sample area or the whole catchment. The formula for this calculation is shown in the publication by IPENZ Procedure for Hydrological Design of Urban Stormwater Systems", December 1980.

In refining the estimate of runoff coefficient, the coefficients provided in IPENZ" Procedure for Hydrological Design of Urban Stormwater Systems", clause 4.3.2 shall be used. The following coefficients are provided as a guide and are in keeping with those provided by the New Zealand Building Code – Verification Method E1/VM1 which should also be referenced.

1. Roofs C = 0.90
2. Asphaltic & Concrete Areas C = 0.85
3. Parks, playgrounds, and reserves C = 0.30
4. Gardens, lawns etc C = 0.25

Note:

The run-off co-efficient C is the variable in the rational formula least able to be precisely determined and has a direct result on the estimation of the discharge. Thus, care is required in selecting a value for the co-efficient. The co-efficient represents the integrated effects of infiltration, storage, evaporation, natural retention, interception etc, which all affect the time distribution and peak rate of run-off. The factors required to determine a value for C are surface type, characteristics topography and land use.

In all cases the assumptions used (and the basis of these assumptions) in the calculation of run-off shall be clearly stated. Specifically, the calculation of impervious area and runoff coefficients shall be based on site specific data and account for the ultimate development of the site.

8.5.4 Minimum Flood Protection Standards for New Developments

Designers must refer to the SDC District plan to confirm minimum floor levels and requirements for determining these and engagement with Council is required to determine requirements for setting building floor levels.

Note:

1. Freeboard is the provision for flood level design / 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.
4. Discuss protection standards in tidal areas with the Canterbury Regional Council and the District 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.

8.5.5 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.

An example of stormwater system analysis including a backwater calculation is provided in WWDG Part B Appendix 5 and NZS 4404:2004 Land Development and Subdivision Engineering.

8.5.6 Trenchless Technology

Trenchless technology can be used subject to the confirmation of suitability of ground conditions by the engineer and as detailed in the design report. See Appendix II for more information about Trenchless Technology.

Submit the following, with the Design Report:

- How the required clearances from other services and obstructions will be achieved
- The location of access pits and exit points
- The depth at which the pipeline is to be laid and the tolerance on this, to ensure minimum cover is maintained
- How pipe support and ground compaction will be addressed
- Details of pipe materials and jointing
- Identify risks associated with conducting works in the existing ground conditions

The Council may also request process details.

8.5.7 The Stormwater Catchment

The stormwater catchment is the total system, land, infrastructure, and improvements conveying and disposing of rain water. It consists of:

- A primary drainage system of pipes and waterways and detention areas
- A secondary system consisting of open channels, controlled flood plains, natural ponding areas, and flow paths.
- Natural elements such as overland flow paths, water ways and surface water bodies.

When designing a stormwater catchment consider the following elements:

- Conveyance – Piped network/Swales
- Inlet – Piped network/Swales
- First flush treatment – Basin/Soakpit
- Retention/attenuation – Basin/Soakpit
- Disposal - Controlled outfall and/or soakage
- Overland flow paths, natural waterways and surface water features that will impact even if they are outside of a given site.

Note: The design of the stormwater catchment will govern the FFL of buildings. The FFL must be set to a level that ensures the building remains 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.

8.5.8 Sizing of the Stormwater System

Drainage system hydraulics shall be in general accordance with WWDG Part B chapter 22 and Appendix 5. In addition, Council has the following level of service requirements for any Council vested stormwater system:

- Primary piped system – 10% AEP rainfall event (10-year storm)
- Overall system (primary & secondary) – 1% AEP rainfall event (100-year storm)
- Bridge structures – 1% AEP rainfall event (100-year storm)

- Flood risk assessment and determination of minimum floor levels 0.5% AEP rainfall event (200-year storm)

Water levels computed at manholes and other nodes for the primary system during the 10% ARI design flow **must not** exceed finished ground level while allowing existing and future Connections to function satisfactorily. Open conveyance systems shall be designed to the same specification.

Post development peak rainfall discharges shall not exceed pre-development flows for the following rainfall events:

- 50% AEP – critical storm duration 2-year event
- 10% AEP – critical storm duration 10-year event
- 1% AEP – critical storm duration 100-year event

Where there is no viable overland flow path available the infrastructure shall be designed to convey or contain a 1% AEP rainfall event (100-year storm).

8.5.9 Standard Stormwater and Land Drainage Network Pipe Sizes

When designing stormwater and land drainage reticulation systems the following pipe sizes are acceptable for use in the Selwyn district: (Pipe sizes are Nominal diameter unless otherwise stated):

- Stormwater mains within the carriageway – 225mm and above
- Laterals:
  - Individual Residential Lots – 100mm
  - Residential Lot (shared by no more than 3 properties) – 150mm
  - Commercial Lots – 150mm

8.5.10 Minimum Pipe Class and Fitting Class

When designing stormwater reticulation systems, the following minimum pipe classes are acceptable for use in the Selwyn district:

- PVC pipes:
  - Good ground conditions – SN 8
  - Poor ground conditions – SN 16
- All Concrete pipes – RCRRJ Class 4 within the carriageway (lower grades may be used in un-trafficked areas by approval)

All Council vested PVC infrastructure (including individual laterals connected from mains to the point of supply and culverts) shall be pressure tested to 30 kPa for 2 minutes with an allowable pressure drop of 2 kPa.

All Council vested Concrete infrastructure shall be pressure tested to 10kPa for 2 minutes with **no** allowable pressure drops.

8.5.11 Infrastructure Sizing

Size infrastructure considering projected peak demand, associated pipe friction losses, and any future demand requirements. The design report shall include but not be limited to:

- The method used for sizing (including hydraulic model, calculations, and friction factors as per NZS 4404)
- Design flow rate
- Stormwater mains gradients
- How degradation of material has been included within the design
- Selecting pipework and fittings materials and classes
- Designing and position of thrust and anchor blocks (where required)
- Positioning of valves, flushing points, flush tanks
- How differences in elevation across the subdivision or development have been considered
- Surge and Fatigue analysis

8.5.12 Surge and Fatigue

Plastic pipes are susceptible to damage from cyclic loads, above ground installation and changes in temperature. The design report shall include an assessment of both surge and fatigue in accordance with the criteria set out in Appendix I - Design for Surge and Fatigue.

8.5.13 Stormwater Mains Layout

Adhere to the following factors when deciding on the general layout of stormwater mains:

- Stormwater pipeline layout must conform to natural topography where possible
- Stormwater pipelines must be laid straight and at a continuous grade
- Stormwater pipelines must terminate into either:
    - Suitably sized concrete manhole or sump
    - Precast head wall or outlet structure that has been approved by Council
- Position stormwater pipelines as follows:
    - Within the road formation
    - 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 (in this situation an Easement in Gross in favour of the Council would be required)
- All crossings (e.g., road, railway lines, creeks, drains, and underground services) where practicable must be perpendicular to the asset type being crossed and approval must be given when this requirement cannot be met
- Provide 0.75m minimum cover when pipes are located within the road and the minimum cover specified by the manufacturer elsewhere
- Specify any pipe protection required when minimum cover cannot be achieved or in locations identified as high risk for Council approval
- Pipe gradients and flow velocities must be sufficient to support the hydraulic requirements of the system and comply with WWDG Part B clause 14.2.4
- Specify the use and design water stops on all pipelines with gradients steeper than 1:3 in the design report
- Individual connections directly to sumps are preferred (refer to CCC CSS SD 378 Type A)
- Where stormwater systems require individual lateral connections to the point of supply for privately owned lots, ensure the connection can service the net area of the lot
- Ensure that the stormwater network has appropriate clearances to other services and utilities (refer to Section 11 for more guidance)
- Manholes must be located at points of flow direction change; however, the flow deviation angle must not be greater than 90° (see Figure 1 shown below)
- Manhole spacing must not exceed the following unless approved by Council:
    - Pipelines with pipe diameter < 1500mm – 90m spacing.

- o Pipelines with pipe diameter > 1500mm – 120m spacing.
- Manholes should be benched with strategic manholes left un-benched for maintenance – this is particularly important for submerged or partly submerged systems
- Benching should have a plaster finish and be formed in accordance with CCC CSS SD303 Sheet 3 and 4
- No feature within a manhole should impede flow through the stormwater system
- The design flow of the stormwater system must be sufficient allow the system to discharge to an approved outlet, any non-compliances with this requirement must be address with Council Engineers
- Manholes can be precast circular or precast square with precast concrete tops and approved circular cast iron lids
- Manhole lids shall be bolted down and fixed in place with concrete – **no precast lid risers are allowed**
- Design of any concrete structure to be poured insitu must be approved by Council
- Sumps can be single or double depending on catchment design requirements with wavy grates unless approved by Council (refer to CCC CSS SD301)
- Sump grates shall be installed and recessed in accordance with CCC CSS SD 325 unless the sump is a bubble up sump
- Bubble up sump grates shall be installed flush with the invert of the channel
- Sumps shall be located as necessary to ensure that accessways or pedestrian crossings are not impeded in the 10% AEP rainfall event (but not spaced more than 100m apart)
- The intake capacity of a road sump with grating, back entry, and acceptable ponding, is approximately 28 ls^{-1}
- Sumps located at intersections shall be positioned on the straight section of the kerb near the tangent point
- Terrain with a slope of greater than 10% is considered hilly. In this situation sump efficiency and effectiveness decreases and the Council will require specific design to be submitted for approval

Note: stormwater and land drainage systems must not connect to any other asset type (e.g., wastewater)

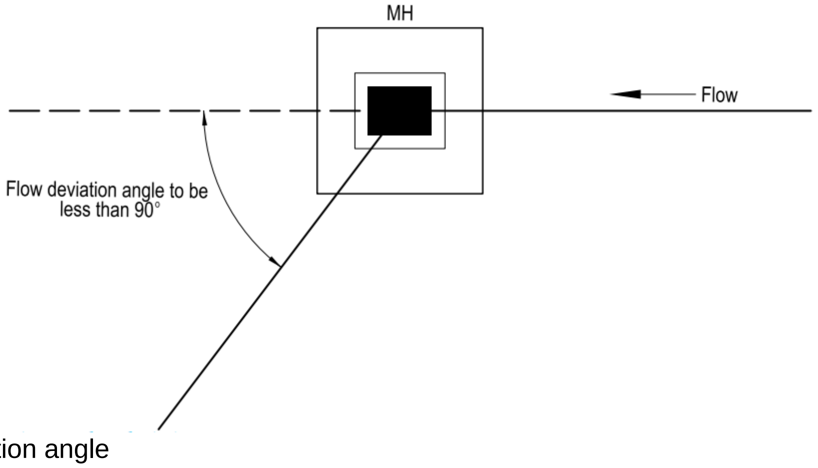

Figure 1 - Flow deviation angle

8.5.14 Bridges and Culverts

Design bridges and culverts in accordance with the Bridge Manual and WWDG Part B chapter 13 for waterway design at bridges and culverts. Council also requires the following design specifications to be met when proposing bridge and culvert designs for approval:

- Where a structure (culvert or bridge) is to be installed within the stormwater or land drainage network approval shall be obtained from Council
- Refer to Council STD Drawing WR10.0 for culverts on SDC Land Drainage networks

- Culverts shall be designed to the 10% AEP rainfall event, refer also to NZTA Bridge Manual Clause 2.3 for heading up and maximum levels below road surface
- Bridges shall be designed to the 1% AEP rainfall event, refer also to NZTA Bridge Manual Appendix A3 for minimum clearance above water level
- As a rule, the cross-sectional area of the proposed structure shall be no smaller than that of the nearest structure up or down stream

Note: prior to constructing individual entranceways/vehicle crossings property owners must apply for a vehicle crossing application and conform to SDC's Vehicle Crossing application package. This includes standard drawings for culverts.

8.5.15 Inlet and Outlet Structures

Design inlets and outlets in accordance with WWDG Part B clauses 14.6 and 14.7. The design report shall include but not be limited to the following:

- Management of the existing water level and effect of the design discharge on the network
- The effects of inlet and tailwater controls when designing culverts, as set out in WWDG Part B clause 22.9
- Consideration of back flow and any back flow prevention devices require
- Acceptable outlet velocities will depend on soil conditions, but should not exceed:
  - 0.5m/s where the substrate is cohesive
  - Velocities given in WWDG Part B Clause 22.7 Table 22-5.
- Requirements and appropriate design (including calculations) of energy dissipation devices in situations where non-scouring velocities at the point of discharge cannot be achieved for approval

8.5.16 Connection Design Requirements

When specifying the connection details, consider the following:

- Pipe materials
- Relative depth of mains
- Standard fittings
- Pipe and fitting restraint and anchorage
- Existing flow levels within the stormwater pipeline and constructability
- Limitations on shutting down major mains to enable connections
- Existing cathodic protection systems

SDC requires all stormwater connections (new mains and individual laterals) to manholes meet the following standards:

- All pipeline connections to manholes shall be by way of starters & shorts or shorts and finishers
- When connecting a pipeline to a manhole the corbel shall be constructed in accordance with CCC SD341 Sheet 4
- When connecting a pipeline to a benched manhole the bottom steel of the corbel shall be imbedded in the benching a minimum of 300mm
- Manhole faces must be scabbled for corbel connections
- All steel works in corbels shall be fixed in place with Chemset or equivalent product

SDC requires all stormwater connections (new mains and individual laterals) to sumps meet the following standards:

- Where practicable, pipelines shall enter the sump perpendicular to the concrete sumps knock out area
- Where the above requirement cannot be met, the connection design shall be included in the design report for approval

SDC requires all individual lateral connections to existing stormwater pipelines to meet the following standards:

- Lateral pipelines serving one single lot shall be at least 100mm diameter.
- When individual properties discharge stormwater directly to kerb and channel use kerb adapters fixed in place at the invert of the channel as per CCC CSS SC 605
- When connecting directly to a concrete stormwater reticulation network designs must be in accordance with CCC CSS SD361
- When connection directly to a PVC stormwater reticulation network Y-junctions shall be used with slip collars

8.5.17 Secondary Flow Path

The secondary flow path sizing and location must be supported by adequate analysis, considering extreme events, to show in the design report:

- That the design is of adequate capacity to cope with the anticipated flow
- That the design discharges to a location that does not detrimentally affect others and can safely dissipate via a controlled disposal system as the storm peak passes
- That the secondary flow velocities are sub-critical where practicable and provide mitigation strategies for situation where this requirement cannot be achieved
- That consideration of the secondary flow path under conditions of total inlet blockage at critical culverts and other critical structures has been undertaken and mitigation strategies have been identified
- That lots created by a new development have been shaped such that they fall towards roadways, which may be used as secondary flow paths
- Provide secondary flow paths within the road reserve or public land where practicable

Secondary flow paths over private land are the least desirable option and will require protection by legal easements.

8.5.18 Basins, Wetlands, and Swales

Basins, wetlands, and swales are being used throughout the district 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.

Adhere to the following factors when deciding on the general layout of stormwater mains:

- Dry basins require low flow channels with a base grading towards the channel to avoid any ponding in the base
- Installation of safety grates is required on all exposed pipes (e.g., inlets and outlets)
- All structures and headwalls require council approval (e.g., splitter structures, bubble ups)
- All flow management structure designs (weirs) require council approval
- Gradient of basins or swales must be:
    - Mowable – 1:5 grade

  - Planted – 1:3 grade
- Provide fail-safe outlet for basins
- Landscaping approval must be granted prior to construction
- All pipelines and associated structures located within a stormwater management basin shall be designed in accordance with Section 8.5.12
- Allow for maintenance requirements where necessary (e.g., mowers, heavy machinery)

Higher level of service may be required for basins located downstream of the primary system.

8.5.19 Stormwater Treatment Devices

The design of water quality devices shall be in general accordance with ARC TP10 and WWDG Part B chapter 6 and the requirements of all discharge consent conditions. The design report shall include, but not be limited to the following:

- Design details (including calculations) for all proposed stormwater treatment devices for trafficked and hardstand surfaces – soakpits, swales, basins, etc.
- Consideration of treatment approaches suited to the expected types and concentration of contaminants of all stormwater runoff associated with the proposed design
- How the proposed design accommodates the first flush requirements of the stormwater system
- The proposed design rainfall intensity and how the proposed design accommodates this event
- How the proposed design complies with all applicable discharge consent conditions
- Environmental and community impacts of the proposed stormwater treatment design
- Demonstrate the ability of the proposed design to control peak rainfall discharges
- Design stormwater systems discharging to ground to accommodate the total detention requirements of the catchment – the combination of storage and overland flow soakage of the 1% AEP rainfall event
- Ground infiltration test results ensuring discharging stormwater to ground will not have any adverse effects to neighbouring properties
- Maintenance requirements must be considered including access points, timing of maintenance and what maintenance requirements recommended by manufacturer.

For stormwater management devices designs based on flow rate the design rainfall intensity shall not be less than $10mmhr^{-1}$

Council or ECan may also specify additional attenuation requirements specifically aimed at providing flood, erosion, and scour protection.

Discussion with Council is recommended prior to final design regarding proposed stormwater treatment devices and suitability in Selwyn’s Stormwater networks.

8.5.20 Waterways System Design

Design any stormwater or land drainage works that will be conducted within a natural waterway in accordance with WWDG Part B chapters 7 – 13. The design report shall include, but not be limited to the following:

- Details how the proposed works will comply with any applicable Resource Consents
- Any restoration works necessary on existing waterways
- Topographical and environmental considerations
- Biodiversity protection plan
- Proposed design performance/level of service

- Future access and maintenance requirements
- Structure integrity of the banks and its future protection from erosion
- Open drainage systems shall be located within a drainage reserve, road reserve, or easement
- Identify the type of easements required for the proposed design – a Local Purpose Reserve is required for significant natural waterways

Where a natural waterway, open stream, or formed drainage channel is incorporated in a land drainage system, then it shall:

- Be designed to accommodate an appropriate freeboard
- Be designed to prevent scour effects and erosion of the natural waterway

Avoid piping or filling in of natural waterways where practicable. Where the activity is unavoidable, a resource consent from ECan **will be required**.

Council approval must be given for any works completed that will result in the construction of Natural waterways. Design constructed waterways to meet the aesthetic and amenity criteria of set out in WWDG Part B chapters 7 – 9, 11, 12 and TP10.

All constructed waterways that are located within private land and be maintained by Council must have an easement in gross favour to Council allowing Council rights of occupation.

8.5.21 Stormwater Disposal

The disposal method of stormwater for any project must be authorised by ECan and meet all the conditions of the approved discharge consent. When designing a stormwater system that discharges to ground the design report shall include but not be limited to:

- Geotechnical assessment of ground conditions – including soakage tests
- Design soakage rates
- Soak pit sizing calculations
- Soakage system design shall be in accordance with WWGD Part B Chapter 6 and SDC standard drawings
- Consideration of soak pit and system maintenance requirements

When designing an outfall for disposal of stormwater into a natural waterway or drain refer to Section 8.5.14 for guidance.

8.5.22 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.

The piped easement width is the greater of:

2 x (depth to invert) + OD

3.0 m

Where OD is the outside diameter of the pipe laid in easement

The open waterway/drain easement width is the greater of:

1.5 x width of drain + 6m

8m

Where the width of drain is measured between tops of bank

The easement registration must provide the Council with rights of occupation and access and ensure suitable conditions for operation and maintenance. The easement must also detail how access (e.g., with heavy machinery) is obtained to the easement area from the nearest available access point.

Council must approve the design and construction of a fence over a waterway or drain. Fences must not prevent access to the waterway or drain and be sized to allow for machinery to perform maintenance.

8.5.23 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 approve a request from a private property owner to install a stormwater tank for water conservation or other reasons. When proposing a development that requires the installation of a stormwater tank on private property the following should be considered in the design report:

- The developer's engineer shall design the minimum requirements of the stormwater tank such that the stormwater discharge consent requirements will be met post construction
- If the installation of the stormwater tank is to be completed under building consent application a consent notice shall be registered on the affected property titles specifying the minimum design specifications and requiring installation at the time of building
- The stormwater tank will be privately owned and maintained by the individual property owner

8.6 CONSTRUCTION

Unless stated below SDC defers to the construction guidance given by CCC CSS.

8.6.1 Installing New Infrastructure

All connections to new and existing stormwater and land drainage infrastructure must be witnessed by a Council representative and comply with the proposed design or Council requirements set out in Section 8.5.22.

Y-junctions installed on new stormwater mains to vest to Council are required to be socket/spigot Y-junctions.

8.6.2 CCTV Inspection

All new PVC stormwater and land drainage reticulation that is vested to Council shall be inspected with CCTV in accordance with the NZ Pipe Inspection Manual (link here) to confirm construction has been completed in accordance with the approved engineering drawings.

Pipes shall be jetted **immediately** prior to CCTV inspections. Council has zero tolerance for debris in wastewater lines.

The CCTV footage and operator analysis (CCTV logs) shall be collated on an indexed USB Drive or sharepoint link supplied to Selwyn District Council with the completion document package for review and acceptance. The CCTV inspection is to be carried out once construction is completed. If requested, a second inspection shall be done at the end of the defect liability period.

8.7 COMPLETION DOCUMENTS

Provide the information detailed in Section 2 of the Selwyn District Council Engineering Code of Practice, including:

- Producer Statements
- As built information (see Section 4)
- Schedule of Materials (AMIS Spreadsheet)
- Warranty Information and manuals
- Pressure test results and witnessed dated certificate
- Extent and locations of each test performed
- CCTV footage and logs
- Commissioning documentation
- Bedding and Backfill Compaction test results and location plan
- ECan compliance monitoring report or certificate of compliance
- Operations and maintenance manuals – including a system overview
- Site photographs as requested
- Final inspection approvals

It is councils' intent that at the time of practical completion or S224 that there are no outstanding works or defects with all surfaces reinstated and established.

8.7.1 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 10.10 – Establishment (Reserves, Streetscape and Open Spaces) expands on these requirements.

The guidelines should describe the design objectives of the structure/facility, describe all major features, explain operations such as recommended means of sediment removal and disposal, identify key design criteria, and identify on-going management and maintenance requirements such as plant establishment, vegetation control, and nuisance control.

APPENDIX I. DESIGN FOR SURGE AND FATIGUE

Introduction

All pipelines are subjected to pressure surges during their lifetimes. Some of these pipelines, e.g. rising mains, will experience significant and regular pressure surges, while others may be subjected only to minor diurnal pressure variations.

Rapid pressure fluctuations and surges generally result from events such as pump start-up and shutdown, or rapid closing or opening of valves, including "slamming" of air valves as can happen during venting of bulk air from pipelines.

For the purposes of the ECOP, a pressure surge is defined as a rapid, short-term pressure variation. Surges are characterised by high-pressure rise rates, with minimal time at the peak pressure. Surge events usually consist of a number of diminishing pressure waves that cease within a few minutes.

The frequency and magnitude of the pressure transients affects the choice of pipe pressure class. Ensure that the following aspects are considered when designing for surges and fatigue:

- That the maximum and minimum pressures are within acceptable limits for the pipe and fittings for all surge events (including infrequent events such as power failure, emergency shut-down, rapid closure of fire hydrants)
- Consider the potential for fatigue and select the pipe pressure class accordingly, to allow for frequent repetitive pressure variations
- The pipe and the quality of installation and their influence on the fatigue resistance of the pipe

The following sections provide a methodology for dealing with surge and fatigue, so that pipe lifetimes are maximised.

Pressure surge events

A surge analysis is required to check whether damaging pressure surges (or surges that could cause customer complaint) could occur in a system. The level of detail of the surge analysis should be appropriate to the pipeline, e.g., a reticulation pipeline may require only consideration of rapid closure of fire hydrants and conservative selection of pipe pressure rating.

Pipelines that may be subjected to more severe surge effects e.g. rising mains, areas close to control valves (reservoir inlet valves and pressure reducing valves) and where specified by the Council, require a more detailed level of analysis, or the selection of pipe materials that may not be subject to surge and fatigue problems.

The source(s) of significant pressure surges in a water system should be identified and included in any surge analysis. Mitigating measures may be needed to minimise any surges generated, and any surge control devices must be designed accordingly. As a minimum, such a surge analysis should consider:

- Identified causative scenarios (e.g. power failure, pump trip, component failure, air valve operation)
- The highest pressure along the pipeline
- The lowest pressure along the pipeline
- Rapid closure of valves
- Vacuum and air relief requirements along the pipeline under all conditions

Note that non-slam air valves may be required on plastic pipelines, to minimise the risk of severe surges being generated by the movement of trapped air, and to minimise the potential for instantaneous "slamming" shut of a conventional air valve.

If, during the design phase, it is found that the minimum pressure in the mains could fall below atmospheric pressure during pressure surge events or drain down, mitigating measures must be designed to eliminate or minimise these effects. If negative pressures are a possibility, buckling of the pipe must be considered and a safety factor of at least 2.0 applied.

The maximum operating pressure for a pressure pipe network must include an allowance for pressure surge (see Figure 4). The allowance for surge to be included must be the higher of the calculated surge value or 200 kPa.

Plastic pipes are able to accommodate occasional short-term surge pressures well in excess of their nominal design pressure (PN) rating, e.g. as caused by power failure or accidental events. In such cases, the material PN may be multiplied by the surge factors given below (Table 3).

Table 1 - Surge factors for various pipe materials

Pipe Material	Surge Factor	Material Capacity (kPa)
PVC-U, PVC-O	1.5	1.5 x pipe PN
PE 80B, PE 100	1.25	1.25 x pipe PN

Fatigue

Consideration of the effect of fatigue is particularly relevant to plastic pipes that are subjected to a large number of stress cycles. Fatigue considerations can generally be ignored for ferrous pipe materials, e.g. ductile iron and concrete-lined steel. The important factors are the magnitude of the stress fluctuations and the frequency of these loads.

For fatigue loading situations, the maximum pressure reached in the pressure cycle must not exceed the capacity of the pipe, as defined above.

Fatigue does not need to be considered if the number of pressure cycles during the pipe‟s designed lifetime does not exceed the values below (Table 4)

Table 2 - Critical number of surges in a pipe lifetime

Pipe Material	Critical Number of Cycles in Lifetime
PVC-U, PVC-O	100,000
PE80B, PE 100	300,000

The procedure for fatigue design is:

- Confirm the design lifetime of pipeline (The pipeline design life must be taken as 100 years unless specified otherwise by the Council)
- Estimate the likely number of pressure cycles during design life
- Calculate the range of pressure surges
- Calculate the fatigue load factor
- Determine the equivalent operating pressure
- Select the pipe PN rating

Number of pressure cycles

Calculate the expected number of cycles during the pipe"s lifetime, based on realistic estimates of the number of pressure cycles per day or per hour. If the primary pressure variation is followed by a smaller number of pressure fluctuations on each cycle, as shown in Figure 4, the calculated number of cycles should be doubled.

Table 5 (shown below) shows the number of pressure cycles over 100 years for various numbers of cycles per day and hour.

Table 3 - Pressure cycles in 100 years for various numbers per hour per day

Cycles Per Hour	Cycles Per Day	Total Number of Cycles in 100 Years
0.04	1	36,000
0.5	12	440,000
1	24	880,000
10	240	8,800,000
60	1440	52,500,000
120	2880	105,000,000

Range of pressure surges

Calculate the pressure range of the regular pressure surges by surge analysis. Figure 2 shows a typical cyclic pressure pattern. Where pumps are controlled by variable frequency drives, select a pressure cycle that is representative of the anticipated worst case operating cycle, unless sound judgement indicates that a lesser pressure cycle will be representative of the pipeline operation over 100 years.

The effects of infrequent or accidental conditions, e.g. power or surge protection device failures, may be ignored provided the peak surge pressure does not exceed the values derived from Table 4.

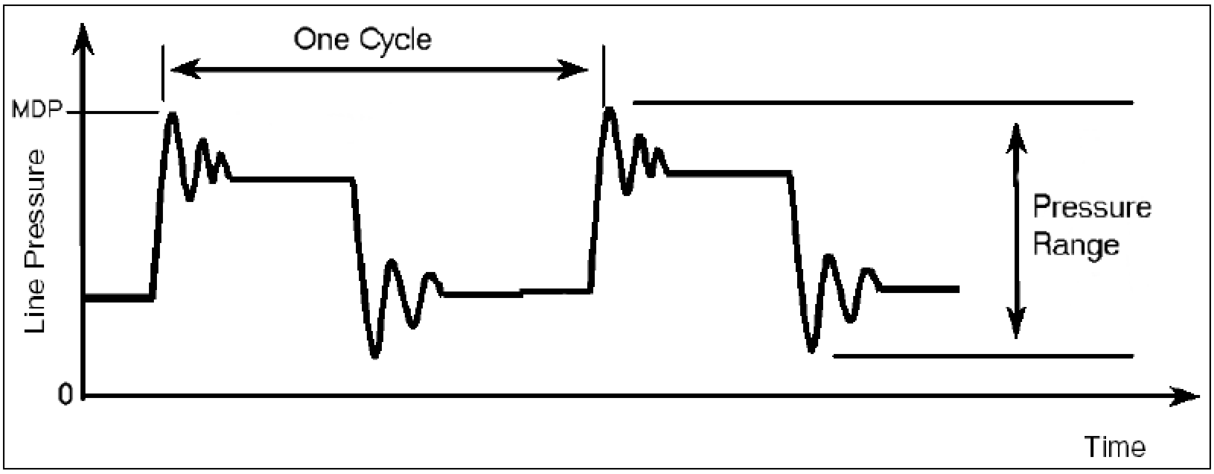

Figure 2 - Pressure cycle And pressure range

Note that the pressure range will vary along the pipeline. Economies may be possible on some pipelines by dividing the pipeline into sections and evaluating the fatigue design for each, subject to the approval of the Council.

Fatigue load factor

The fatigue load factor for the relevant plastic pipe material(s) must be determined from Figure 3. PE 80C (HDPE) is not approved for pressure pipelines in the Selwyn District.

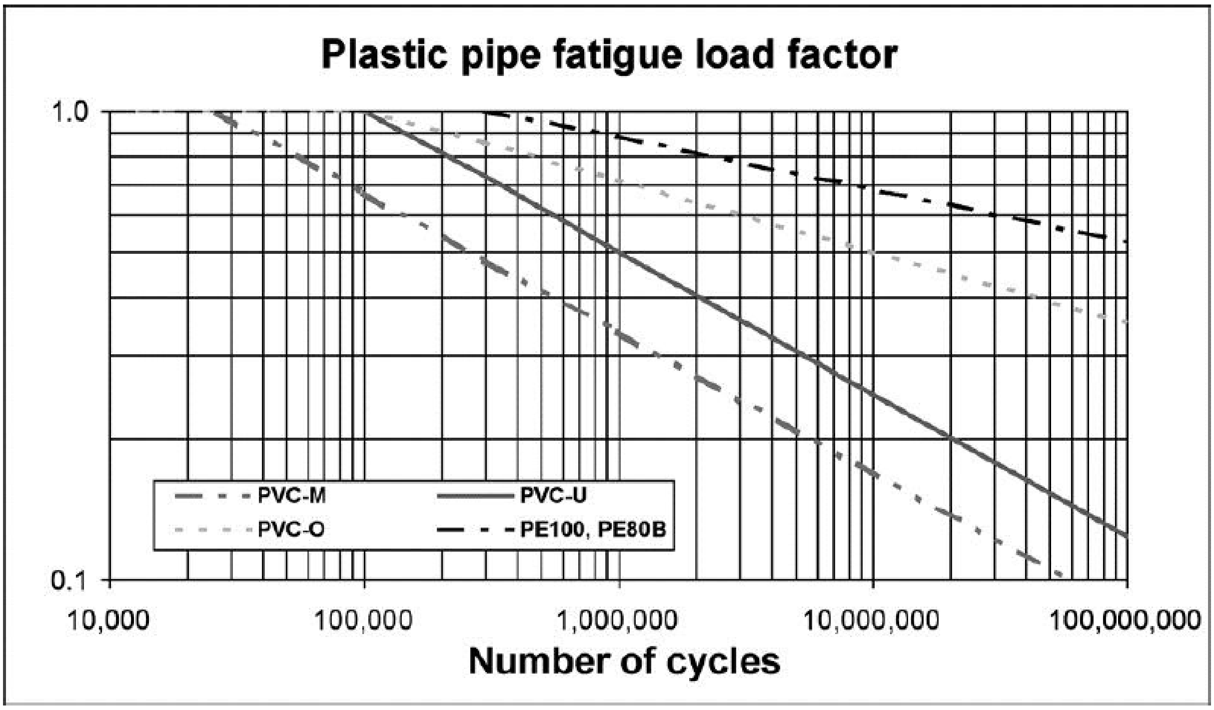

Figure 3 - Determining fatigue load factor

EQUIVALENT OPERATING PRESSURE

Calculate this using the following equation:

$$P_{eo} = \frac{\Delta P}{FLF}$$

Where:

P_{eo} =	Equivalent operating pressure (bar)
ΔP =	Cyclic pressure range (bar) (refer Figure 4)
FLF =	Fatigue Load Factor (refer Figure 5)

Pipe PN rating

The specified pipe pressure rating must exceed both the equivalent operating pressure, Peo and the maximum operating pressure for the system.

De-rating factors for PE fittings

It is necessary to de-rate fabricated or moulded PE sweep bends and tees that are used with PE pipes conforming to AS/NZS 4130. See CSS: Part 4 for requirements for forming and welding. The use of de-rated fabricated fittings is only allowed in special circumstances and requires Council approval.

Table 6 and below show the geometry and manufacturing factors to be applied for various fitting geometries and fabrication techniques.

Table 4 - Geometry factors

Fitting Description	Geometry Factor
Equal Tee	0.6
Reducing Tee (Branch dia < 0.33 x dia of main)	0.6
Reducing Tee (Branch dia > 0.33 x dia of main)	0.8
Formed sweep bends (no reduction in wall)	0.9
Segmented bends (butt welded)	0.7

Table 5 - Manfucating Factor

Welding Technique	Manufacturing Factor
Moulding	1.0
Butt welding	0.9
Socket fusion	0.8
Extrusion welding	0.6
Saddle fusion	1.0

No other welding method is acceptable.

De-rate the nominal pressure rating of the fitting by multiplying its rating by the product of the geometry and manufacturing factors.

APPENDIX II: TRENCHLESS TECHNOLOGY

When working in high volume roads, public areas, adjacent to trees or through private property, consider using trenchless technologies. Factors that need to be considered when making this decision include minimising disruption and environmental damage, social costs, design life of the proposed method, and the economic impact of the work.

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
- Cured in Place Pipe Lining (CIPP)
- Directional drilling and Guided boring
- Slip lining.

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:

- How the required clearances from other services and obstructions will be achieved
- The location of access pits and exit points
- The depth at which the pipeline is to be laid and the effects of any possible ground heave
- Invert levels and grade and the construction tolerances on them
- How pipe support and reinstatement of pits will be addressed
- Details of pipe materials and jointing

Pipe bursting

Pipe bursting is suitable only 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 concrete pipes.

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.

Cured in Place Pipe Lining (CIPP)

Cured in place pipe (CIPP) lining systems are preferable for renovating gravity sewers. Before undertaking CIPP, check the structural integrity of the host pipe and ensure that the hydraulic capacity is sufficient for projected future peak flows.

The CIPP liner must produce a durable, close fit with a smooth internal surface. The liners must 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 CIPP liner, including the required wall thickness under different loading conditions, must comply with the manufacturer's recommendations and specifications. Submit a liner specification to the Council that addresses the design procedure and installation methodology. Follow the layout of the *Specification for renovation of gravity sewers by lining with cured-in-place pipe*.

As the host pipe is blocked during the insertion and curing operations, adequate flow diversion is essential for this method. Repair any structural problems at the junctions by open dig prior to CIPP installation.

The opening of connections must be carried out remotely from within the lined sewer. For this purpose, prepare accurate location records by detailed surveys prior to CIPP installation. Additional grouting of junctions may be required after opening.

Directional drilling and guided boring

Restrict sewer installation using guided boring or directional drilling to instances where their construction tolerances are acceptable. Consider possible ground heave over shallow pipes.

Consider 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.

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.

APPENDIX III. STANDARD DRAWINGS

Drawing Number	Description
STM 2.4	Standard modified soak hole – township
STM 2.5	Direct entry modified soak hole
STM 2.7	Modified soak hole, sump, bubble-up sump inside a basin
STM 2.9	Footpath sump (shallow)
STM 2.11	Subsoil drain