PART 6: WASTEWATER DRAINAGE

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6.1 REFERENCED DOCUMENTS

Planning and Policy

- Timaru District Council Sewer Services Activity Management Plan 2018-2028

Design

- New Zealand Building Code *Compliance Document G13 Foul Water*
- Water New Zealand *Pressure Sewer National Guidelines* (February 2020)
- 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 3996:2019 *Access covers and grates*
- PIPA POP010A *Polyethylene Pressure Pipes Design for Dynamic Stresses* (May 2010)
- PIPA POP101 *PVC Pressure Pipes Design for Dynamic Stresses* (Aug 2018)
- Australasian Society for Trenchless Technology *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking*
- 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

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

6.2 INTRODUCTION

Council's Wastewater Services involves the collection, treatment, and disposal of domestic and industrial wastewater.

Sewer systems are provided in the urban areas of Timaru, Temuka, Geraldine and Pleasant Point. These systems are linked via pipeline to the main Wastewater Treatment Plant (WWTP) and ocean outfall in Timaru. A small collection scheme also serves the Arowhenua community which feeds into the Temuka pond for treatment. Additional sewer is not currently available for any rural zoned areas. Rural houses manage their own effluent.

6.2.1 Wastewater Bylaw

The Timaru District Council Consolidated Bylaw 2018 defines the Council's requirements and protection for the drainage works.

This includes reference to Chapter 15 (Water Services Chapter) Part 5 and 6 (Wastewater and Trade Waste sections) of the Timaru District Council Consolidated Bylaw 2018.

6.2.2 Service Delivery

TDC owns all the public sewer infrastructure assets. Core service functions of asset operation and management, inspection, project supervision and customer services are carried out in-house by staff of TDC's Drainage and Water Unit.

To augment in-house capacity, TDC uses private contractors on a needs basis to carry out identified tasks such as:

i. maintenance and repair of the reticulation network;
ii. physical works to build or renew assets;
iii. some pre-engineering/engineering designs; and
iv. special studies in support of planning/policy development.

In general, contracting of works/services to the private sector is permissible and justified for reasons of cost effectiveness and when a specialist skill is required.

6.2.3 New developments

Gravity reticulation, with conventional pumped systems where necessary, remains the preferred method of reticulation for most developments but alternative technologies for new developments on the perimeter of the older system are considered. Council will also consider pressure sewer systems (PSS) where there are downstream capacity constraints or the site has significant construction issues, natural hazards or poor ground conditions.

In areas where gravity reticulation systems are not achievable due to grades or long distances, common pressure main or PSS, including small privately operated and municipal systems, are an option subject to the Council's approval. If approved by Council, common pressure mains where each lot must have an individual wastewater pump connected to a common pressure main system, the individual pumps shall be privately owned and maintained by the property owner.

Biofilter design is included in this Part of the IDS. Biofilters are required at the terminal of all rising mains likely to generate hydrogen sulphide (H_2S). Provide calculations on the Maximum Hydraulic Residence time before wastewater within any pressure main goes anaerobic for domestic waste streams.

6.2.4 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. Unlined concrete manholes and pipes should only be used where the average airflow concentration of H_2S is less than <1ppm.

6.2.5 Alternative technology

Areas where alternative technologies are appropriate include outlying residential and rural residential areas that intend to vest assets as part of the Council reticulated network. Proposals for the vesting of alternative technologies should be discussed with Council pre-application for engineering design acceptance.

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 design verifier of all wastewater systems that are to be taken over by Timaru District 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;
- 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 *Development Engineering Construction Standard Specifications (TDC CSS)* through the Contract Quality Plan (CQP), including:

- Test method;
- 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, test method 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 in the *TDC CSS* which provides a guide when specifying materials.

Proposed pipes and concrete structures that are likely to lie in aggressive groundwater will need specific design and additional protection such as an external plastic wrapping membrane.

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 *TDC CSS*.

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

Standard design flows shall be determined on the basis of:

Table 1 Design Flows by Zone

Zone	Design Flows
(i) Residential	35m3/hectare/day peak WWF* (37 persons/hectare) (0.0245m3/hectare/minute)
(ii) Commercial and Mixed Use	118m3/hectare/day peak WWF (0.082m3/hectare/minute)
(iii) Industrial	53m3/hectare/day peak WWF (0.037m3/hectare/minute)
* (Wet Weather Flow)	

6.4.1 Site Specific Design Flows

For developments with more site specific limitations, and because sanitary sewer flows vary with the time of day, the climate and the extent and type of development within the catchment must be considered to calculate design flows. Design systems to carry maximum flows without surcharging.

The maximum wastewater flow is given by:

Equation 1 Maximum flow

$$MF = P/A \times SPF \times ASF$$

where MF = Maximum flow occurring during wet weather (l/s)
P/A = Dry weather diurnal peak to average ratio (clause 6.4.2)
SPF = Storm Peak Factor including infiltration (clause 6.4.3)
ASF = Average Sewage Flow (clause 6.4.4 or 6.4.6)

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. Polyethylene (PE) only is specified by a nominal outside diameter (OD).

6.4.2 Peak to average ratios

Use a peak/average ratio (P/A) of **2.0** for wastewater reticulation design.

6.4.3 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.

For new developments, apply a storm peak factor (SPF) of **2.5** 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 (for both greenfield and developed areas) and explain the supporting rationale in the design report.

6.4.4 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

$$\text{Unit ASF} = \text{persons/hectare} \times \text{litres/person/day}$$

And

Equation 3 ASF

$$\text{ASF} = \text{unit ASF} \times \text{area}$$

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	**Net density (households/ha)**	**Unit ASF (l/s/ha)**	**Unit MF (l/s/ha)**
General Residential (GRZ)	15	0.10	0.51
Medium Density Residential (MRZ)	30	0.21	1.03
Settlement Zone (SETZ)	8	0.055	0.28
Rural Lifestyle Zone (RLZ)	2	0.01375	0.07

Note: For mixed density developments or zonings not covered by Table 2, detail in the Design Report how the design flows, based on Table 2 and 3 values, where determined.

6.4.5 Maximum flows for new developments

Calculate the maximum flow for new developments using Equation 1.

For example, at an assumed residential population density (GRZ) 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

$$\begin{aligned} MF &= P / A\ ratio \times SPF \times ASF \\ &= 2 \times 2.5 \times (0.10\ l/s\ ha \times 1\ ha) \\ &= 0.5\ l/s \end{aligned}$$

Where the actual number of lots is known, ASF can be calculated use Equation 5, where a water usage of 220 litres/person/day and an occupancy rate of 2.7 persons/lot are utilised. 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

ASF = number of lots x 220 *l*/person/day x 2.7 persons/lot
= 200 lots x 220 *l* person/day x 2.7 persons/lot
= 118,800 *l*/day
= 1.38 *l/s*

MF= 2 x 2.5 x (1.38 *l/s*)
= 6.9 *l/s*

6.4.6 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)
Local Centre (LCZ)	0.09	0.45
Large format retail (LFRZ)	0.15	0.75
Town Centre (TCZ)	2.00	10.0
City Centre (CCZ)	2.00	10.0
General Industrial (GIZ)	0.38	1.90
Neighbourhood Centre (NCZ)	0.09	0.45

Note:
1) Where the type of commercial or industrial zoning is not known, assume GIZ.
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).

6.4.7 Total design flows for existing developments

Base the design of major renewal and relief sewers (greater than 375mm Internal Diameter [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.

6.4.8 Size of private sewer drains

The minimum size of private gravity sewer drains must be 100mm diameter or minimum set in G13 of the New Zealand Building Code.

For major industrial users, determine the size of the lateral using the maximum flow requirements and the available grade.

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.

Where possible, particularly within greenfield developments, wastewater infrastructure is to be laid outside of the traffic carriageway within berms or footpaths. Refer to clause 6.14 – Embedment and Backfill for further information regarding depths of pipes.

The preferred solution for wastewater reticulation is to avoid easements over private property. However, if an easement is required for new infrastructure determine its width using Equation 6.

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

Subject to resource consent conditions, 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	0.7 (84% pipe–full capacity)
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

$$SCF = P/A \times ASF$$

where SCF = minimum self-cleansing flow (l/s)
P/A = Dry weather diurnal peak to average ratio (clause 6.4.2)
ASF = Average Sewage Flow (6.4.4 – Residential and 6.4.6 – Commercial and Industrial)

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 q = the daily peak flow in l/s
and SCF = minimum self-cleansing flow in 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.

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

$$D_{\min} = 24.35 \times \left(\frac{MF}{i_{\min}^{\frac{1}{2}}} \right)^{\frac{3}{8}}$$

where D_{min} = minimum pipe diameter in mm
and i_{min} = minimum gradient in m/m
and MF = Maximum flow occurring during wet weather in l/s

Size pipelines to cater for future flows from the upstream catchment, when fully developed.

6.5.5 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 of at least 0.6m/s. If flows are expected to increase significantly with time, 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. Design the plugs to be easily removable and provide details in the Design Report.

To improve the transmission of solids, the maximum pipeline slopes, between slope structures, must be 45° and 22.5° on the downward and upward legs respectively, with manholes placed to make cleaning. 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.

6.6 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, or lining of 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 6.6.4 - 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.

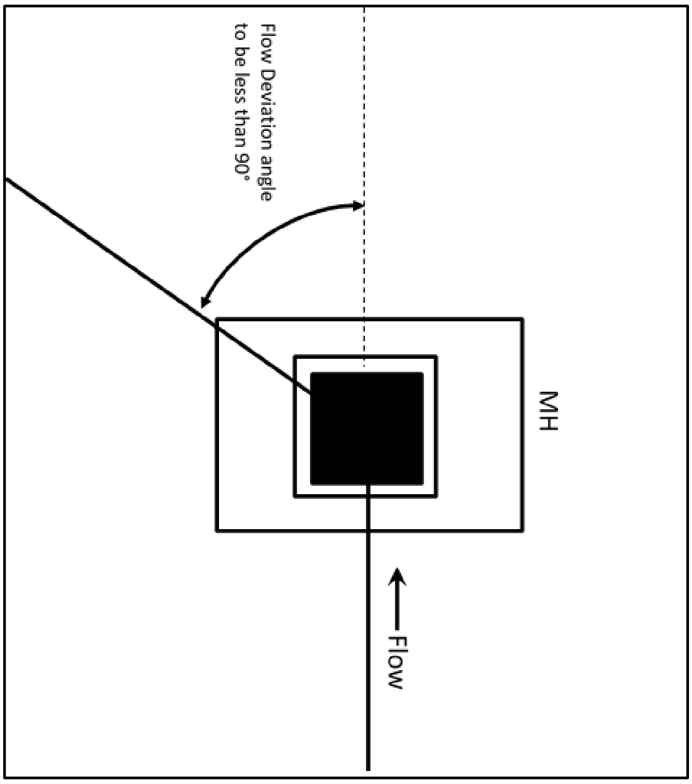
Constraints on depth within the *TDC CSS* will also apply.

6.6.1 Location and spacing

Manholes should be positioned within berms or parking bays to keep the live traffic lanes clear of piped infrastructure.

The flow deviation angle between the inlet and outlet pipes must not be greater than 90 degrees, as shown in Figure 1. Ensure the distance between incoming pipes in the manhole complies with *TDC CSS*.

Figure 1 Flow deviation



Maximum spacing between manholes shall be 120m on all diameters. However in larger diameter pipes, equal to or greater than 450mm, can be subject to specific design and approval.

6.6.2 Pole Vents

Pole vents are designed to allow the intake of fresh air and act as pressure releases for gases that accumulate within a reticulated system. Pole vents are to be designed into the system at high points within the gravity network and in proximity to pressure system discharge points into the gravity system.

Any design for a pressure system should include an assessment of whether a pole vent is necessary based on the location of the discharge point to the gravity system.

See more details on Pressure Pipelines and Pressure Sewer Systems in clauses 6.8 and 6.9 respectively.

Vents shall be designed and installed in accordance with Council's Standard Drawing within the TDC CSS. The vent design allows for the escape of gas at a height well above pedestrian or average residential dwelling heights.

6.6.3 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.

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 are greater at these locations.

Vented manholes shall have grit catch trays under lid in situations where secondary flow intrusion is not avoidable.

Venting of manholes is subject to specific design and should be considered only in situations where a pole vent is not feasible for installation.

6.6.4 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 *TDC CSS*, or with other Council approved designs. Provide yield joints between manholes and pipes in accordance with *TDC CSS*. Where the structure is likely to experience differing movement from the pipeline under seismic loading, replace the yield joints with flexible joints. 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 chamber and saturated ground. Counter increased forces resulting from greater depths and spans by thicker walls, counterweighting or reinforcing.

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.

6.6.5 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 *TDC CSS*.

6.6.6 Fall through manholes

The minimum fall in the invert of angled wastewater manholes is set out in Table 4.

Table 4 Minimum fall in manhole

Angle of deviation	Minimum fall (mm)
30° - 90°	50
0° - 30°	30

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

All pump stations to be vested shall be designed to current industry best practices and approved through Council's Engineering Design Acceptance process. Hydraulic function of any pump station to vest shall be included in the Design Report. All Council pump stations or pump stations to be vested to Council require odour treatment to remove odours and corrosive gases.

Consider the seismic effects on foundations, connections and liquefiable ground, and take these into account in the design and construction of any pumping station.

Include supervisory control and data acquisition (SCADA) functional descriptions and code with required operations and maintenance manuals.

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.

Try to minimise the time fluids spend in a rising main, and maintain velocities high enough to transport solids. Both these objectives can be achieved by minimising the length and diameter of the pipe. A maximum rising main diameter of 150mm is preferred.

Rising mains 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 *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 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 9.6.3 – Pipe Depths are not achieved.

Allow for issues such as operation and maintenance and consider failure of any mechanical surge protection measures and protection from damage during these situations.

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 pressure
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 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 5 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 5 Minimum pressure ratings for flexible pipes

Material type	Pressure rating (kPa)
PVC-U	900
PE 80	800
PE 100	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

$$Tractive\ Shear\ Stress\,(Pa)\ \tau = \frac{f\ \gamma V^2}{8g}$$

where *f* = friction factor
γ = fluid density (N/m^3)
V = flow velocity (m/s)

The friction factor '*f*' should be determined from the Colebrook-White Equation 12.

Equation 12 Colebrook-White equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left\{\frac{k_s}{3.71D} + \frac{2.51}{\text{Re}\sqrt{f}}\right\}$$

where k_s = hydraulic roughness (m)
D = pipe diameter (m)
Re = Reynolds number (VD/v)
v = kinematic viscosity 1.11 x $10^{-6}m^2/s$ at 15ºC

The hydraulic roughness 'k_s' 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 6 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. The use of these values is suitable for Timaru District. 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 6 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 7.

Table 7 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 Manholes

Manholes receiving discharge from a pressure pipeline shall be constructed from non-corrosive material. This is due to the corrosive nature of effluent within the pressure system that may become septic.

PE or other non-corrosive material linings may be used on concrete manholes structures with the prior consent of Council at the design phase of the process.

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 7.8.1 – Sluice valves.

Label air valves with 10mm Helvetica text using a 200 x 70mm label on W/B/W traffolyte.

6.8.6 Thrust blocks

Specify thrust blocks sized for the pressure class of the pipe as a minimum and 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 *TDC CSS* 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

The Council will only consider pressure sewer systems on a case-by-case basis where other methods are inappropriate. Generally use the Water New Zealand *Pressure Sewer National Guidelines* for the detailed design of pressure sewerage systems except as amended as follows.

Subject to resource consent conditions, 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 constrain 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 72 hours of average sewage flow (ASF) in the pump unit and storage chamber
- The minimal pipe length and diameter appropriate, to reduce retention times.

Construct PSS pipelines from polyethylene pipe.

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.

6.11 BIOFILTERS

A biofilter is a device used to treat odours arising from the wastewater system. Prevent odours by:

- avoiding the use of rising mains;
- reducing turbulence generally;
- minimising retention times.

The usual form of biofilter used in sewerage systems is a media bed, through which the odorous gas is passed. The principal odour component of wastewater is H_2S (hydrogen sulphide) and the biofilter operation makes use of the ability of naturally occurring bacteria to convert the H_2S to acid and elemental sulphur.

The use of passive carbon odour treatment devices should be avoided. The use of these devices are only to be considered when all other options have been exhausted.

Typically, the situations where odours cause nuisance are where the wastewater is more than eight hours old, held in anaerobic conditions in rising mains and where there is high turbulence that encourages H_2S to come out of solution.

6.12 LATERALS

All lateral connections shall be connected directly to the main or manholes and comply with *TDC CSS*.

6.12.1 Sanitary junctions and laterals

Gradients are subject to Ministry of Business, Innovation, and Employment (MBIE) 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.

Lay laterals at least 0.6m clear from property side boundaries, to terminate 0.6m inside the net site area of the lot with a Maintenance Access Point (MAP) as per *TDC CSS*. 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.

Form all junctions with a Y or riser junction so that the side flow enters the main at 45^{o}, to reduce deposition of solids.

Avoid lateral connections to manholes at the top of a line where minimum gradients are involved.

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 MBIE 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 *TDC CSS*, 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 *TDC CSS*.

6.12.3 Common drains

Read the following notes in addition to the MBIE 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 *TDC CSS*.

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 *TDC CSS* as a guide when specifying materials. Specify polyethylene materials for wastewater mains installed adjacent to or that cross waterways and which may experience lateral spread under seismic loading.

6.13.1 Approved materials

All materials must comply with those listed in the *TDC CSS* which provides a guide when specifying materials.

6.13.2 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.

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.

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 Gravity sewers immediately downstream of pressure pipelines

PVC and PE are suitable for use in gravity sewer pipelines.

Where a new rising main or PSS will discharge to an existing gravity system, use measures that will mitigate against H_2S corrosion or reduce the level of dissolved sulphides and remove hydrogen sulphides. These measures could include any one, or a combination, of:

- detailing corrosion protection treatment or replacement with plastic structures for all manholes within 400m of and including the receiving manhole.
- designing for velocities below 1.5 m/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.

6.13.5 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, specify wear-resistant pipes such as cast iron, ABS or PE100. 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 EMBEDMENT AND BACKFILL

Consider the whole trench, including the pipe, the in-situ material, the embedment and the backfill as a structural element. Design it to withstand all internal and external loads.

Specify wrapping of the embedment for plastic pipes and laterals in liquefaction prone areas with a geotextile that complies with TNZ F/7 strength class C. This may improve the longitudinal strength of the pipeline, reducing potential alterations in grade.

Use the manufacturer's material specifications, design charts or computer models to design bedding and embedment, unless these provide a lesser standard than would be achieved through applying the requirements of *TDC CSS* and *TDC Land Transport Unit Backfill & Reinstatement Requirements Guide (BRRG)*. 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 *TDC CSS* and *BRRG*.

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 embedment or foundation metal, protect the embedment and foundation metals with an approved geotextile.

6.14.1 Pressure pipes

Embed pressure pipelines as detailed in *TDC CSS* 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.

Embedment 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 embedment 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 *TDC CSS*. This treatment must be carried out under the direction of the engineer.

Embedment and backfill materials for hillside areas include lime stabilised AP20 and AP40 respectively (40kg/m^3) and 'lime stabilised backfill' as defined in *TDC CSS*.

Use lime stabilised AP40 for backfilling all carriageways, and lime stabilised AP20 in all areas outside carriageways.

Specify water stops at 5m spacing on all pipelines with gradients steeper than 1 in 3. Where impermeable backfill, i.e. lime stabilized backfill, is utilized for embedment and backfill, water stops are not required. Construction must comply with *TDC CSS*.

6.14.4 Redundant infrastructure

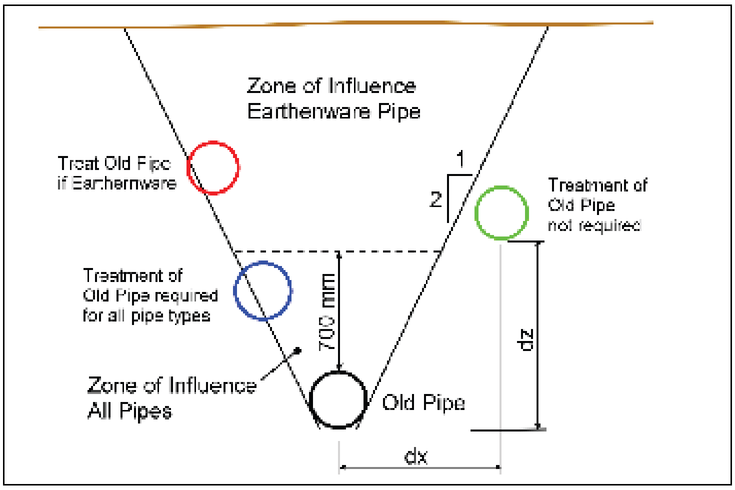
Where works will produce redundant in-ground piping, treat the potential void by either removing or by filling the pipe as detailed below.

- Treat obsolete pipes below new pipes where the new pipe is within the zone of influence of the obsolete pipe, as illustrated in Figure 2.
- Treat all pipes on the hillside.
- Where treating obsolete AC pipes, fill them and leave them in the ground to avoid contamination issues.
- For all other pipes that are outside the zone of influence illustrated in Figure 2, only detail sealing of the ends of the abandoned pipes with concrete or grout, including the lateral junctions.

These treatments should prevent voids forming that could undermine the foundations of pavements and adjacent services or could disrupt groundwater flows.

Flowable fill with a minimum strength of 1.5 MPa is the suggested material for filling old 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 2 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.

TDC CSS – 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 *TDC CSS* – New pipe invert in existing manhole.

6.15 CLEARANCES

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.

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;
- dilapidation survey when planned work is near buildings or structures;
- 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 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.

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 variation as the burst line will maintain the existing grade. 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 embedded in concrete. Take special care when the existing pipe has been concrete embedded, 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 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. Council will not accept lining of 100mm diameter wastewater mains.

The CIPP liner must produce a durable, close fit with a smooth internal surface. The liners must have a 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 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.

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;
- existing services.

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 *TDC CSS*– 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, or smaller, sewers is not permitted.

6.17 INFRASTRUCTURE APPROVED CONTRACTORS

Only Timaru District Council Infrastructure Approved Contractors are permitted to install pipework that will be vested into the Council, install connections to Council mains within legal roads or private property. A full list of authorised drainlayers and conditions of approval may be found on the Council webpage for Infrastructure Approved Contractors[1].

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

[1] https://www.timaru.govt.nz/services/consents-licences-and-registrations/infrastructure-approved-contractors

www.beforeudig.co.nz. The work must comply with requirements as set out in *TDC CSS* for this type of work.

6.18 AS-BUILT INFORMATION

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

APPENDIX I. TRACTIVE FORCE DESIGN CHARTS

Chart 1 Tractive force design chart (grade as %)

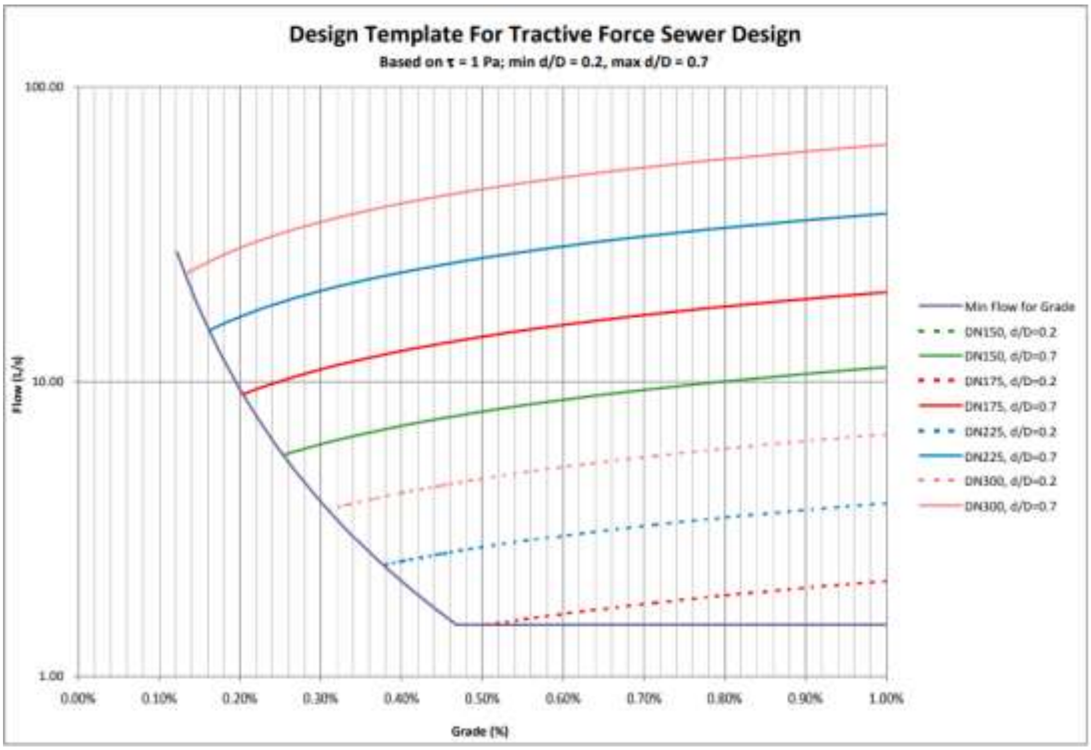
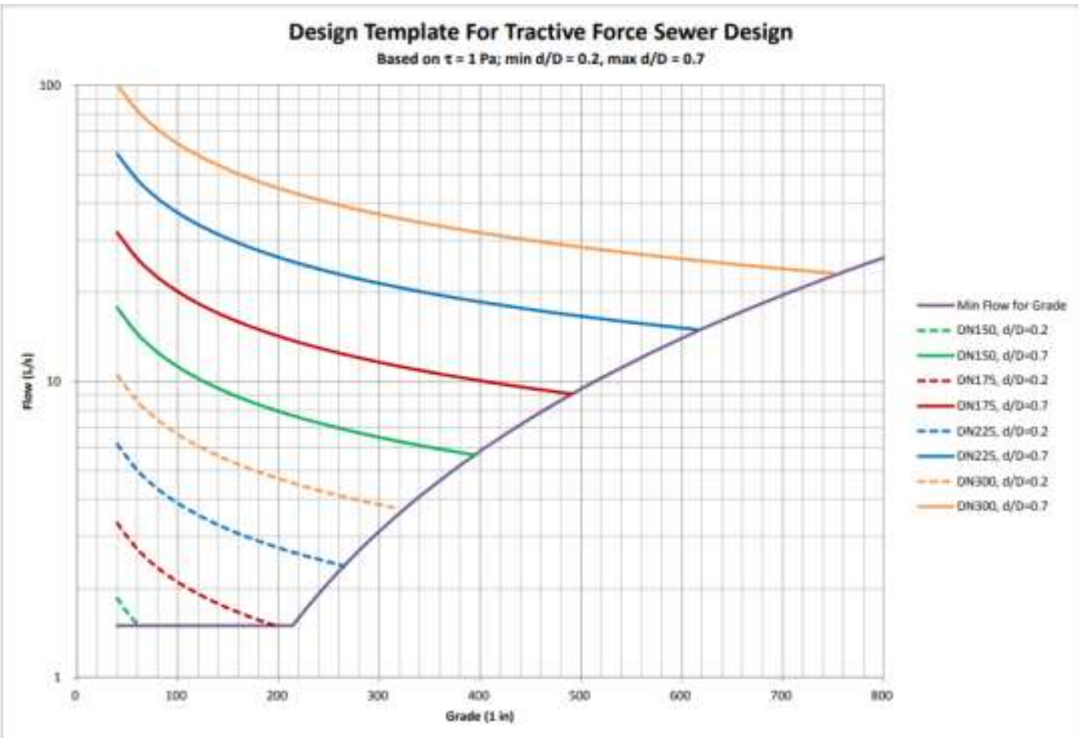


Chart 2 Tractive force design chart (grade as ratio)



APPENDIX II. DETERMINATION OF MINIMUM GRADIENT AND HYDRAULIC DESIGN EXAMPLE

An area of 12.0 hectare is zoned GRZ, with a corresponding unit ASF of 0.10 l/s/ha. The minimum SCF from Equation 7:

$$SCF = P/A\ x\ ASF$$

P/A – Dry Weather Diurnal Peak to Average Ratio = 2.0

ASF – Average Sewage Flow = 0.1 l/s/ha

SCF = 2.0 x (0.1 l/s/ha x 12 ha)

SCF = 2.4 l/s

Drawing the minimum SCF on the Tractive Force Design Chart (Chart 1 Above), the horizontal line intersects the minimum grade line at an approximate grade of 0.38% or 1 in 263.16.

Calculate the maximum flow:

Equation 15 Maximum flow calculation example based on area

MF = P / A ratio x *SPF* x *ASF*
= 2 x 2.5 x (0.10 *l/s ha* x 12 *ha*)
= 6 *l/s*

Drawing a horizontal line at 6 l/s on Chart 2 from Appendix 1, the vertical line representing 0.38% or 1 in 263.16 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

Table 2 Wastewater materials

Property	CLS	DI	PE	PVC-U
approved for gravity wastewater	As special only	As special only	yes	yes
approved for wastewater pressure	As special only	As special only	yes	yes
suitable for trenchless methods			yes except gravity	yes
provide a restrained system	yes	yes	yes	with restrained joints
suitable for anaerobic conditions	requires cathodic protection	no	yes	yes
suitable for tidal zones	requires cathodic protection	no	yes	yes
suitable for above-ground applications	yes	yes	no	no
Fatigue resistant	yes	yes	requires design	requires design
Approved in internal diameters > 600	yes	no	yes	no
Wear resistant (flow regular, velocity > 4m/s)	yes	yes		
Suitable for industrial zoning			yes	yes
H_2S resistant	Lining requires design	Lining requires design		