AMF L8 Sewerage Planning and Design Principles

YVWCD-2-4853

JANUARY 2023

Table of Contents

Preface

The intent of the Sewerage Planning and Design Principles (hereafter and herein referred to as the Principles) is to:

- Promote uniformity in design practices for delivery of new infrastructure that is compatible with existing Yarra Valley Water's assets.
- Provide information on Yarra Valley Water's current best practice from asset creation and operational experience.
- Improve Yarra Valley Water's sewerage assets resilience to climate change and growth through the proper design and management of assets.
- Ensure effective design and delivery of Yarra Valley Water's assets based upon a whole of life value with the lowest risk exposure to a reduction in service standards, safety, and environment.

In satisfying this intent, the Principles provides the following information:

- Minimum acceptable technical criteria for planning, design, and management of Yarra Valley Water's sewerage networks, facilities, and associated components.

In this document, the word 'must' and 'requires' relates to Yarra Valley Water's mandatory requirements that must be complied with. The word 'shall' and 'should' are used to indicate a recommended course of action, while 'may' and 'can' are used to indicate an optional course of action.

This document is intended for Planners, Designers and Constructors servicing the land development industry and for contract work done on behalf of Yarra Valley Water.

Enquires or suggestions relating to the information set out in this Design Principles are welcome and can be directed via email to standards@yvw.com.au.

Yarra Valley Water will update this document as changes become necessary, and the most up to date version will be available on our website.

The major changes in this revision are summarised as follows:

- Restructure of the document and content to improve its use and readability.
- Update to reflect Yarra Valley Water's current practices and response to external influence.

Document Status

Approval Record (This Revision)

Function	Position	Name	Date
Prepared by	Ripple	Aby Alex	23rd November 2022
Reviewed by	Senior Standards and Products Engineer	Savalan Pour	
Approved by	Manager Capital Works & Industry Partnerships	Ryan Leon	

Amendment Record

Rev No.	Amendment Description	By	Initials	Date
1.0	Original document	-	-	July 2009
2.0	Complete review of document	Paul Patrick	PP	July 2017
3.0	Standards Working Group Amendments	Ripple	-	November 2022
3.1	Updated formatting and branding	Craig Aistrope	CA	January 2023

Abbreviations

Note the abbreviations listed below are only those not used within MRWA

ABBREVIATION	INTERPRETATION
ADWF	Average Dry Weather Flow
CSA	Complete Servicing Advice
DEECA	Department of Energy, Environment and Climate Action
DH	Victorian Department of Health
DHHS	Department of Health and Human Services
EPA	Environment Protection Authority
ERS	Emergency Relief Structures
ESC	Essential Services Commission
GDA	Gross Development Area
GIS	Geographic Information System
GWI	Groundwater infiltration
H_2S	Hydrogen Sulphide
MH	Maintenance Hole
MW	Melbourne Water Corporation
NPV	Net Present Value
OGP	Omni Grid Plus
OGT	Omni Grid Turbine
OPEX	Operating Expense

PDWF	Peak daily dry weather flow
PSA	Preliminary Service Advice
PWWF	Peak Wet Weather Flow
RA	Residential Area
RDI	Peak inflow and infiltration
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SFC	Sewage Flow Control
SPS	Sewage Pumping Station
SRM	Sewer Rising Main
STP	Sewage Treatment Plant
UV	Ultraviolet Radiation
YVW	Yarra Valley Water

Glossary of terms

TERM	DEFINITION
Annual Exceedance Probability (AEP)	The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year. This term is used in this document as a reference to the measure of the rarity of a rainfall event. Table below shows the conversion between ARI and AEP:
Average Recurrence Interval (ARI)	ARI is defined as the average period of time between rainfall events which exceed a certain magnitude
Branch Sewer	Sewer pipes nominally DN300 to DN975 that collect sewage primarily from reticulation sewers
Boundary Trap	An inverted siphon trap installed in a customer sanitary drain to prevent sewer gas passing and entering the building through the drain.
Boundary Valve Kit (BVK)	Valving arrangement located at the boundary of properties connected to a pressure sewer system which prevents sewage within the pressure sewer from re-entering the property. It also allows for isolation of the property from the system for maintenance purposes

ARI (years)	AEP (%)
1	63.2%
2	39.3%
5	18.1%
10	9.5%
20	4.9%
50	2.0%
100	1.0%

Community Sewerage Areas (CSA)	Areas identified by Councils with properties on septic tanks that are not capable of on-site containment. (Previously referred to as 'backlog' areas).
Dangerous Goods	Dangerous goods are substances that are corrosive, flammable, explosive, spontaneously combustible, toxic, oxidising or water reactive.
Diversion Sewer	A sewer that diverts flow from one sewer to another, usually a different main or branch sewer
Dry Weather Flow	The combined daily sanitary flow into a sewer plus the non-rainfall dependent groundwater infiltration
Dry Well	The part of the SPS that contains the pumps where the SPS contains both a 'dry' and 'wet' well' (Note: SPS with an 'in-series' arrangement will contain pumps in the wet well as well as in the dry well)
Duplex	A pressure pump site containing two grinder pump units in a duty/assist arrangement
Easement	A right held by one party to make use of the land of another for certain purpose
Educt Vent	A vent pipe designed to allow 'sewer gases' to be expelled from the sewerage system
Emergency Relief Structure (ERS)	A directed overflow structure designed to permit controlled discharge of sewage that exceeds downstream system capacity. May be caused by system failure e.g., blockage, collapse etc. Also called an overflow (structure)
Emergency Storage	A storage tank located at a sewage pump station, which enables flows to be stored in the event of a mechanical or power failure.
Force Main	Refer to Rising Main definition
Gas Check Maintenance hole	A combination of two maintenance holes separated by a water seal to prevent migration of sewer gas
Ground Water Infiltration (GWI)	Infiltration of groundwater into the sewerage system via faults which is not dependent on rainfall (i.e., cracks, holes, joints etc.). Also referred to as 'infiltration'
Hazardous Substances	Hazardous substances are substances that have the potential to harm human health. They may be solids, liquids, or gases, they may be pure substances or

	mixtures. When used in the workplace these substances often generate vapours, fumes, dusts, or mists. Hazardous substances may enter the human body in a number of ways, depending on the substance and how it is used. They may cause immediate or long-term health effects, and exposure to these substances may result in poisoning, irritation, chemical burns etc.
House Connection Branch (HCB)	A short sewer, owned and operated by the Water Agency, which connects the sewer and the customer sanitary drain; it includes a junction on the main sewer, a property connection fitting, in some cases a vertical riser, and sufficient straight pipes to ensure the property connection fitting is within the lot to be serviced (sometimes referred to as Property Connection Branch).
House Connection Drain (HCD)	A sewer owned by the customer which connects the property to the house connection branch (sometimes referred to as a sanitary drain).
Hybrid Sewerage System	A sewerage network that is a combination of a pressure sewer system and gravity sewerage system. Hybrid systems are typically found in Community Sewerage Areas
Hydraulic Grade Line (HGL)	A line (hydraulic profile) indicating the piezometric level of flow at all points along a conduit, open channel, or stream. In pipes under pressure, each point on the hydraulic profile is an elevation expressed as the sum of the height associated with the pipe elevation and the pipe pressure (head),
Induct Vent	A vent pipe designed to draw air into the sewerage system
Inflow	Ingress of surface water entering the sewer system, usually by illegal stormwater connection or other surface openings (i.e. cracked or missing maintenance hole covers).
Interlock	An interconnection between two devices to ensure their coordinated operation (i.e., simultaneous, or alternating operation or to shut down the upstream Sewage Pumping Station due to a failure at the downstream Sewage Pumping Station)
Internal Diameter (ID)	Refers to the internal diameter of the pipe. It is denoted as the internal diameter followed by the letters “ID” (i.e., 300ID)
Invert	Lowest point of the internal surface of a pipe or channel at any cross-section

Inverted Siphon	A pipe which dips below an obstruction and rises back up on the other side (i.e., U shaped) where the soffit drops below the hydraulic grade line and in which the sewage flows under gravity
Full Lot Control	Highest level at which a sewer may be constructed to ensure a gravity service is possible for the whole area of the lot
Main Sewer	Sewer pipes nominally >DN 975 that collect sewage primarily from branch sewers.
Must	Indicates that a statement is mandatory
Nominal Diameter (DN)	Refers to the nominal (not exact) closest standard pipe diameter. It is denoted as the letters "DN" followed by the nominal diameter (i.e., DN300)
Obvert	Inside top of a pipeline (sometimes referred to as the soffit)
Pressure Discharge Line	Also called 'House Service Line'. The small diameter pipe (DN40) which connects the Pressure Pump Unit to the pressure sewer in the street.
Pressure Main	Refer to Rising Main definition
Pressure Pump Unit	A small pump unit comprising of prefabricated polyethylene tank, grinder pump unit and control panel. The units are available in 'Simplex', 'Duplex' and 'Triplex' configurations.
Pressure Sewer System	A sewer system which is fully sealed and operates under pressure, collecting property flows from individual property pressure pump units and transferring them to an outfall location
Private Pump Station	A on property pressure pump unit that is owned, operated, and maintained by the property owner.
Property Connection Sewer	Refer to House Connection Branch definition
Pump Snort	The point at which a pump starts sucking air instead of sewage
Pump Well	Sometimes used instead of "wet well"
RDI	Rainfall Dependant Inflow

Relieving Sewer	A sewer that diverts wet weather flows from one sewer to another due to insufficient capacity
Reticulation Sewer (Gravity)	Sewer pipes nominally DN100 to DN280, for the collection of sewage from individual properties and conveyance to branch sewers.
Rising Main (Falling Main)	A section of the sewerage system connected immediately downstream of an SPS. Flows within the pipe can either be conveyed under pressure 'rising main', by gravity 'falling main' or both
Roughness Value (k_s)	A measure of the resistance of the surface of a pipe or channel under turbulent flow which is expressed in millimetres; it is used in the Colebrook White formula
Roughness Coefficient (n)	A measure of the resistance of the surface of a pipe or channel under turbulent flow which is expressed as a dimensionless constant; it is used in the Manning formula
Sewage Flows	Average Dry Weather Flow (ADWF) The combined average daily sanitary flow into a sewer from domestic, commercial, and industrial sources. Peak Dry Weather Flow (PDWF) The most likely peak sanitary flow in the sewer during a normal day. It exhibits a regular pattern of usage with morning and evening peaks related to water usage for toilets, showers, baths, washing and other household activities Peak Wet Weather Flow (PWWF) The estimated maximum flow, i.e. Peak Wet Weather Flow (PWWF) into a sewer comprising the sum of peak dry weather flow (PDWF), ground water infiltration (GWI) and peak rainfall dependent inflow and infiltration (RDI).
Sewage Flow Control Facility (SFC)	Sewage Flow Control facilities are designed to store wet weather flows for release into the downstream system when capacity is available, enabling downstream upgrades and augmentations to be avoided whilst preventing overflows.
Sewer Odour Control Facility (SOC)	Any installation which is designed to deliver either liquid or gas phase odour treatment

Sewage Pump Station (SPS)	A pump station used to transfer sewage from a low point to a high point. Within Yarra Valley Water's system, Sewage Pump Station's typically includes submersible centrifugal pumps
Sewage Treatment Plant (STP)	Sewage Treatment Plants are designed to treat all dry weather flows and part or all wet weather flows delivered by the transportation network to effluent standards commensurate with the environmental impact of their discharges on receiving waters and any associated reuse schemes.
Simplex	A pressure pump unit containing a single grinder pump unit
'Smart' pressure sewer network	A 'smart' pressure sewer network utilises two-way telemetry communication between the property and central control system and utilises algorithms to effectively manage the storage on each property and peak flows generated in the network
Soffit	Refer to 'obvert' definition
Should	Indicates that a statement is a recommendation
Surcharge	Condition in which sewage is held under pressure within a gravity sewerage system but does not overflow.
Temporary	Used to describe non-permanent assets (i.e., Sewage Pump Stations) that are typically constructed to allow development to connect to the sewerage system before the permanent assets are constructed.
Tenement	Building with rooms for residential purposes
Triplex	A pressure pump site containing three grinder pump units arranged in a duty/assist/assist arrangement.
Water Hammer	Caused by pressure surges in a closed pipe system due to sudden changes in velocity of fluid. It results in vibration and may be accompanied by a thumping noise. Water Hammer can cause damage to the pipe
Wet Well	The part of the Sewage Pump Station into which the sewerage system discharges prior to pumping. The wet well may or may not contain submersible pumps depending on the pump station setup (i.e., dry well/wet well setup)

WSAA	Water Services Association of Australia (WSAA) is the peak body of the Australian urban water industry and has offices in Melbourne and Sydney. Its members provide water and wastewater services to approximately 24 million Australians and many of Australia's largest industrial and commercial enterprises. Founded in 1995, WSAA provides a forum for debate on issues of importance to the urban water industry and provides a focus for communicating the industry's views. WSAA develops and is responsible for national design and construction codes that are adopted across industry. The relevant national code for sewer infrastructure is: • WSA02-2014-3.1 Sewerage Code of Australia (Melbourne Retail Water Agencies Version 2.0 (MRWA)) • WSA04-2022 Sewage Pumping Station Code of Australia Version 2.1 (Not used by Yarra Valley Water) • WSA07-2007 Pressure Sewerage Code of Australia Version 1.1

1. INTRODUCTION

1.1. SCOPE

This document specifies requirements for the design, installation, commissioning, and operation of sewerage infrastructure.

The requirements are based on operation, safety, maintenance, durability, and value for money considerations.

This document seeks to ensure Yarra Valley Water customer service levels and sound asset management practices are achieved by defining the principles and philosophies not necessarily covered elsewhere.

This document has been prepared by collating the data and design criteria used for planning and design purposes by the Growth Futures and Distribution Services Groups. Different criteria and/or exceptions may apply to unique situations, but all such exceptions will require the written approval of Yarra Valley Water.

1.2. APPLICATION

This document is to be read in conjunction with the Water Services Association of Australia WSA02-2014 Gravity Sewerage Code of Australia (MRWA Edition Version 2.0), hereafter referred to as the “WSA02 MRWA”, MRWA Sewer Drawings and Yarra Valley Water’s Technical Standards listed below:

DOCUMENT NUMBER	DOCUMENT NAME
YVWCD-2-4930	AMF L8 Naming Conventions for Infrastructure Assets
YVWCD-2-7655	Asset Security and Fencing Standard
N/A	Decommissioning a Sewer Asset
YSGD0522	Design Guidelines for Gas Phase Treatment Facilities
YSGD0521	Design Guidelines for Magnesium Hydroxide Dosing Facilities
YWIN1043	E6 Eduction Management Roles and Responsibilities
YFRM0616	Eduction Management Plan
N/A	Emergency Relief Structures Technical Standard
N/A	Inverted Siphons Technical Standard
YVWCD-2-8119	Large Sewer and Complex Maintenance Hole Standard

YVWCD-2-8005	Maintenance Holes with Vortex Drops Technical Specification
YBUS0179	Management of Sewer Surcharge and Philosophy for Hydraulic Capacity Upgrades
N/A	Pressure Main Technical Standard
N/A	Report for Odour Management Strategy Review
N/A	YVW Odour Risk Calculator
N/A	Sewage Flow Control Facilities Technical Standard
N/A	Sewage Pumping Station Technical Standard
YVWCD-2-6885	Sewer Pump Station System Control Philosophy
YVWCD-2-6719	Standard and requirements for Portable and Fixed Plant Generators
YVWCD-2-4889	Water Supply and Sewerage Facilities Standards.
N/A	Proportional Discharge and Velocity for Partially Full Pipes
N/A	Sewer Mining Guidelines
N/A	Sewer WSA Flow Estimation
N/A	Melbourne Water Industry and Sewer Demand Builder Tool
N/A	Growth Area Lot Forecast and Demand Assumptions.
N/A	Modelling Concept Community Sewerage Systems in InfoWorks

Where sections of the MRWA specify that advice or guidance should be sought by the relevant Water Agency; this document is intended to provide that guidance.

1.3. REFERENCED DOCUMENTS

DOCUMENT NUMBER	DOCUMENT NAME
AS3500.2	Plumbing and Drainage – Sanitary Plumbing and Drainage
Melbourne and Metropolitan Board	Hydrogen Sulphide Control Manual – Volume 1 and 2
MRWA	MRWA Version of the Gravity Sewerage Code of Australia, WSA 02-2014

MRWA	MRWA Sewerage Standard Drawings (S Series)
MRWA	MRWA Pressure Sewer Supplement Standard Drawings
MRWA	MRWA Supplement of the Pressure Sewerage Code of Australia, WSA 07-2007
WSA	Pressure Sewerage Code of Australia, WSA 07-2007 Sewer Mining Guidelines

1.4. ORDER OF PRECEDENCE

In the event of differences or discrepancies between this document and referenced documents, the order of precedence is as follows:

1	• This Document – SEWER PLANNING AND DESIGN PRINCIPLES
2	• Yarra Valley Water Technical Standards as per Section 1.3 of this document
3	• WSAA Guidelines & MRWA Sewer Standards
4	• Australian Standards
5	• Referenced Manufacturers Guidelines

1.2

1.5. CONNECTION ENQUIRIES

Yarra Valley Water provides advice regarding future development within Yarra Valley Water's existing sewerage network (hereafter referred to as "infill"), and developments located in growth strategy areas (hereafter referred to as "greenfield").

All enquires are received through the easyACCESS system.

Assessment of these applications by Yarra Valley Water will identify the following:

(a) If there is sufficient capacity in the sewerage system to service, the proposed development.
(b) Hydraulic deficiencies created within the existing sewerage system resulting from the additional inflow.
(c) Compliance with existing Yarra Valley Water Business Rules.
(d) Any required upgrades to accommodate the increased inflow.

Assessment of applications by Yarra Valley Water is typically undertaken using hydraulic modelling and applies hydraulic criteria as detailed in this document.

Yarra Valley Water adopts a “first in- first served” approach to providing access to available capacity within the existing network.

If the capacity of the existing network is exceeded due to the proposed development, developers are liable for any upsizing costs.

2. GENERAL PRINCIPLES

2.1. INFRASTRUCTURE PHYSICAL SECURITY

All new major facilities must be assessed in accordance with YVWCD-2-7655 Asset Security and Fencing Standard to determine the appropriate security measures to protect the community and the asset. This includes all treatment plants, storage facilities, pump stations, pipelines or any other infrastructure affecting supply of water or sewerage services.

All new facilities shall also comply with requirements under YVWCD-2-4889 Water Supply and Sewerage Facilities Standards.

2.2. LEVEL OF SERVICE

Full lot control must be provided to every lot connected to the sewerage system unless approved by Yarra Valley Water.

Where full lot control is not feasible, Yarra Valley Water may consider acceptance of partial lot control (information will be included on the Water Information Statement related to these limitations.)

The required level of service for gravity sewers conveying PWWF for a 18.13% AEP rainfall event (peak duration) shall follow the requirements noted below:

(a) New sewers – Refer to Section 4.3 of this document.
(b) Existing sewer – Surcharging existing sewer for peak wet weather flows within the Yarra Valley Water network is allowed. Refer to YBUS0179 Management of Sewer Surcharge and Philosophy for Hydraulic Capacity Upgrades for allowable surcharge levels.

2.3. PROPERTY CONNECTIONS

2.3.1. Gravity Connections

For typical details on new gravity connections to the sewerage system, refer to standard drawings MRWA-S-301, MRWA-S-302, MRWA-S-303 and MRWA-S-304.

For typical layouts of sewers and general arrangements for property connection sewers, refer to standard drawings MRWA-S-106, MRWA-S-107, MRWA-S-108, MRWA-S-109, MRWA-S-110 and MRWA-S-111.

Property connection points shall be located at the ties and offsets described within Table 108-A in standard drawing MRWA-S-108, Table 109-A in MRWA-S-109 and Table 110-A in MRWA-S-110.

Property connections to closed systems must be fitted with a boundary trap. Property connections to open systems relies on natural ventilation and therefore must not be fitted with a boundary trap. Refer to Section 5.1.4 for more details.

Yarra Valley Water ownership responsibility ends at the Inspection Opening or up to 1m from the property boundary (whichever is less) when sewer main is outside of property boundary or from sewer main if main is inside property boundary.

Figure 2-1 below outlines the delineation of responsibilities between Yarra Valley Water and customer.

The customer is responsible for providing, connecting and maintaining an inspection opening and sanitary drain in accordance with AS/NZS 3500.2.

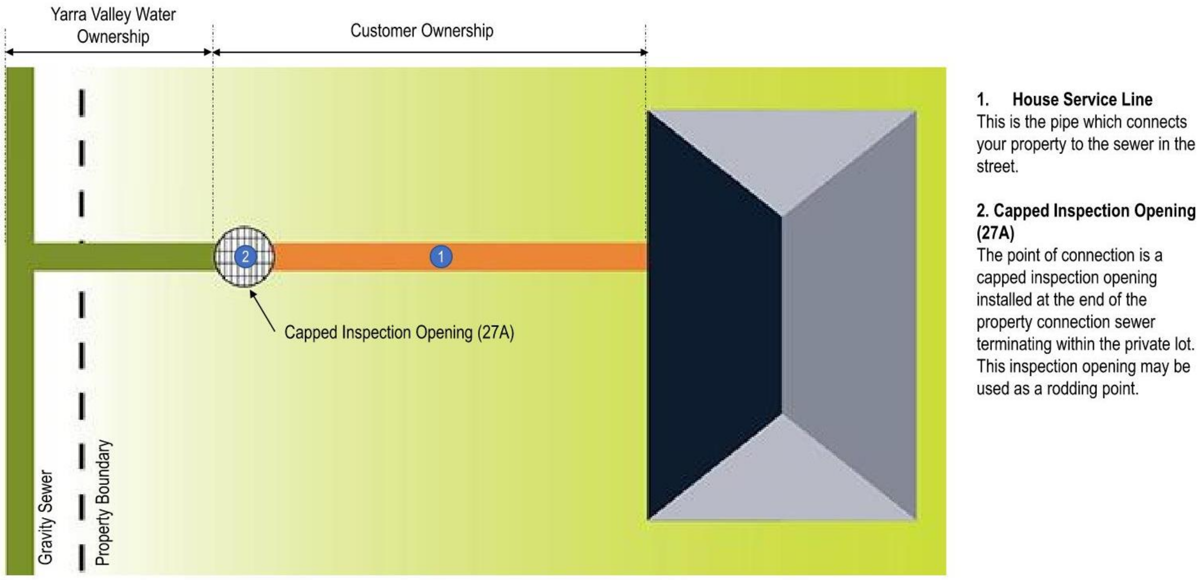


Figure 2-1 - Delineation of Ownership on Gravity Sewer Connections

2.3.2. Pressure Sewer Connections

For typical details for pressure sewer connections to the sewerage system, refer to WSA07 Standard Drawings PSS-1101 and PSS-1102.

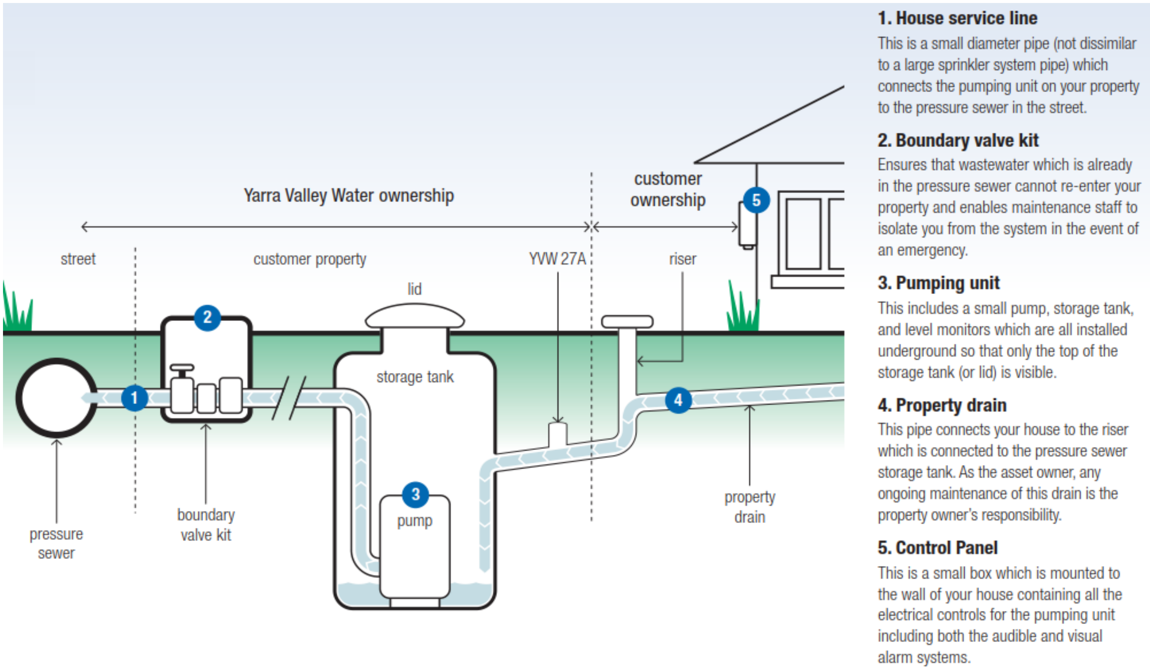


Figure 2-2 - Delineation of Ownership on Pressure Sewer Connections

2.3.3. Hybrid Systems

All hybrid systems containing both pressure and gravity connections must have either a boundary valve kit or boundary trap installed.

2.3.4. Connection to Branch Sewers

Yarra Valley Water only permits direct connection of property connections to Branch Sewers $<$ DN450.

For Branch Sewers $\geq$ DN450, property connections shall be connected via a maintenance hole.

Refer to Section 5.2 for requirements on property connections to Gas Check Maintenance holes.

2.3.5. Depth

Refer to Section 6.3.5 of WSA02 MRWA for details on the maximum allowable depth of property connections.

2.4. CONNECTION TO RELIEVING SEWERS

Relieving sewers are constructed to provide relief from one Branch or Main sewer to another during wet weather events.

No reticulation sewers must connect to relieving sewers.

No property connections must connect to relieving sewers (regardless of relieving sewer diameter).

These sewers can be identified on Yarra Valley Water GIS by their name (example Blackburn Branch Relieving).

2.5. PRIVATELY OWNED PUMP STATIONS

The policy and requirements for Privately Owned Pump Stations can be accessed on Yarra Valley Water Private Sewage Pumps Webpage.

Any deviations from this policy requires Yarra Valley Water approval.

2.6. PACKAGED SEWAGE PUMP STATIONS

Packaged Sewage Pump Stations are custom made, complete units manufactured and supplied comprising with pumps, motors, wet-well, drive systems, valves, inter-connecting piping, level controls and motor control centre.

The Packaged Sewage Pump Station must meet all requirements detailed under Section 8 of this document.

All Packaged Sewage Pump Station designs must be reviewed and approved by Yarra Valley Water prior to manufacture and installation on any project.

2.7. TEMPORARY SERVICING

Temporary servicing is often provided to enable development to proceed in ‘Greenfield’ areas that are currently remote from the existing sewerage network.

Temporary servicing may be instigated by the Developer to facilitate development and avoid the significant capital bring forward costs associated with the premature construction of major permanent downstream infrastructure.

Temporary servicing may also be prompted by Yarra Valley Water to facilitate initial development in a 'greenfield' area whilst enabling the deferral of significant permeant capital expenditure.

Yarra Valley Water will work with Developers to identify acceptable temporary servicing solutions for 'greenfield' development in circumstances where the development is remote from the existing sewerage network.

Yarra Valley Water aims to develop a servicing solution that is mutually beneficial to both parties, which delivers on community and environmental expectations and defer major capital expenditure in a commercially and operationally sustainable manner.

Options for temporary servicing may include the following:

(a) Eduction.
(b) Pump Station pumping flows intra or inter catchment.
(c) Limited capacity gravity pipeline into an adjoining catchment.

When considering the use of temporary servicing and adequate allowance must be made for wet weather infiltration.

The sizing and viability of temporary servicing must consider the likely maximum growth rates in the catchment and the worst-case scenario for the timing of the planned permanent sewer servicing assets.

Yarra Valley Water's order of preference for a temporary servicing strategy is as follows:

(a) Temporary gravity sewer.
(b) Eduction.
(c) Temporary Sewage Pump Station and Rising Main.

A temporary gravity sewer is the preferred choice as it requires no or minimal active on-going management, unlike the use of eduction or a temporary Sewage Pump Station.

Eduction shall be utilised where flow management is required for a short time frame.

A temporary Sewage Pump Station shall be used when flow management is required for a long duration > 2 years.

All temporary works must be designed and constructed in accordance with all relevant Yarra Valley Water Technical Standards.

2.7.1. Temporary Gravity Sewer

A temporary gravity connection into an adjoining catchment may be possible in circumstances where the receiving catchment is partially developed and/or is considered to have sufficient spare capacity across the expected timeframe of the temporary flow regime.

If the temporary servicing strategy is proposing to allow the use of a temporary gravity sewer, the strategy must clearly indicate the maximum allowable number of lots that can be developed.

A temporary outlet sewer (i.e., smaller diameter pipe) along the planned ultimate outlet sewer alignment is considered sub-optimal in several aspects, which include marginal cost savings over the ultimate size pipe, the need for additional area along the alignment and subsequent community disturbance along the alignment.

2.7.2. Eduction

The maximum numbers of lots that will be allowed and approved to be educted shall be determined on a case-by-case basis, taking into account the following factors:

(a) Expected duration of eduction.
(b) Travel distance from eduction point to discharge point.
(c) Volume of buffer storage in the sewerage network.
(d) Suitable access available for eduction vehicles to eduction point.
(e) Frequency of eduction (No. of trucks per day).

In addition to the above factors, Yarra Valley Water has placed the following limits on eduction for a development before connection is required to the permanent sewerage outlet:

(a) Maximum allowable lots permitted to be educted – 300 Lots.
(b) Maximum allowable eduction duration – 2 years.

The Developer will be liable for all costs of eduction and will be required to sign an Eduction Management Plan.

Refer to YWIN1043 E6 Eduction Management Roles and Responsibilities and YFRM0616 Eduction Management Plan for more details.

2.7.3. Temporary Sewage Pump Stations and Rising Mains

Yarra Valley Water allows the use of a 'Temporary Sewage Pump Station' to service a development until the permanent sewerage outlet is available, in general when the timeframe for the permanent works is too long for eduction to be practicable.

Temporary pumping shall generally be allowed for periods from three (3) to ten (10) years; however, an operational life in excess of 10 years is possible.

All temporary pump stations shall be designed and constructed in accordance with all relevant Yarra Valley Water Technical Standards, and fully funded by the Developer.

Yarra Valley Water may apply Operation and Maintenance costs on the Developer for temporary pump stations at a minimum rate of $15,000 per annum for a maximum of 5 years.

When a temporary servicing strategy is developed allowing the use of the temporary Sewage Pump Station, the cost of the Sewage Pump Station is to include an allowance to cover the future decommissioning of the Sewage Pump Station upon the development being connected to the permanent outlet. Any decommissioning required is to be done immediately and as a part of the permanent servicing works.

All Yarra Valley Water owned assets, including temporary pump stations and rising mains are the responsibility of Yarra Valley Water to manage and operate. Where maintenance or other agreements exist with the Developer, these must be clearly documented in accordance with Yarra Valley Water document management procedures.

2.8. SEWER GAUGING STATIONS

Sewer gauging stations are used for the following:

(a) to monitor flows within new development areas.

(b) to monitor the rate of growth within the catchment to allow for the efficient staging of growth works.
(c) to monitor areas with restricted hydraulic capacity and at inverted siphon inlets that are at increased risk of spill.

Refer to Yarra Valley Water Sewer Gauging Station Site Selection Guidelines (available on request), for requirements for selecting a gauging station site.

The guidelines generally provide the following details:

(a) Minimum pipe size.
(b) Changes in pipe size.
(c) The presence of junctions, drop pipes and landings.
(d) Change of direction.
(e) Sewer grade.
(f) Low flows.
(g) Installation.
(h) Access.
(i) Power source (solar panel(s), solar regulator, and pole if no mains power available).
(j) SCADA equipment (RTU, NextG Modem, batteries, cabinet, wiring).

2.9. PIPE CRACKING

Pipe Cracking (or pipe bursting) is a pipeline rehabilitation technique that can be utilised for the following purposes:

(a) For the renewal of sewers when 'relining' is not appropriate.
(b) To increase the hydraulic capacity of the sewer.

Yarra Valley Water has further internal guidelines and processes to determine if pipe cracking is a suitable method of rehabilitation on a case-by-case basis. For more information, please contact standards@yvw.com.au.

Figure 2-3 shows the process of the pipe cracking.

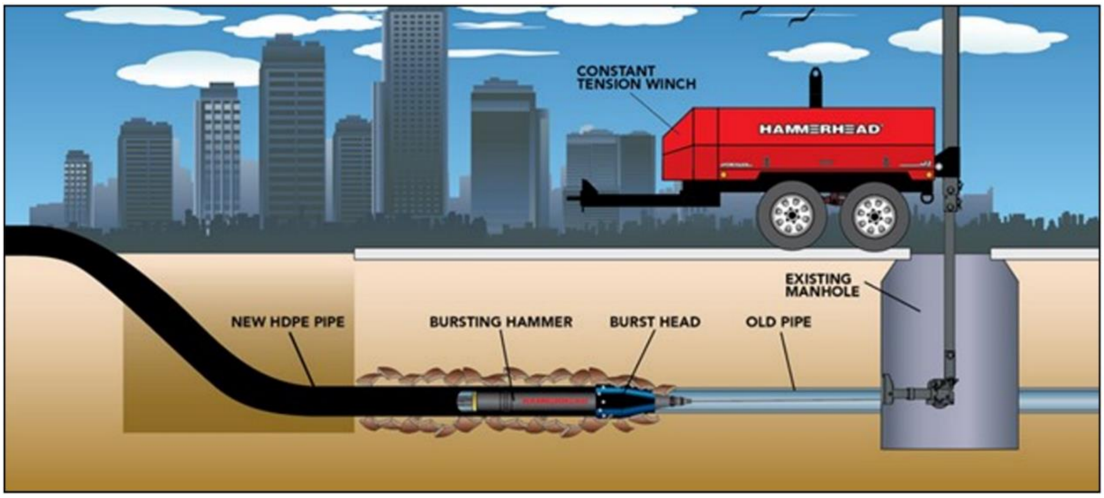


Figure 2-3 - Pipe Cracking Process Diagram

2.10. SEWER MINING

2.10.1. General

Sewer mining is the practice of extracting sewage from a sewer and treating the sewage to recover a desired resource (i.e., recycled water). Mining can be conducted by Yarra Valley Water or by individuals or businesses.

A sewer mining facility can be large or small, and consist of

(a) A connection to a sewerage system to extract sewage.
(b) A system to transport sewage from the extraction point to the treatment site.
(c) A sewage treatment plant designed to meet water quality standards required for desired end use.

All sewer-mining schemes require regulatory approvals from various agencies, being, but not limited to:

(a) Yarra Valley Water.
(b) Department of Energy, Environment and Climate Action.
(c) Essential Services Commission.
(d) Melbourne Water Corporation.
(e) Department of Health.
(f) Environment Protection Authority.
(g) Local Council.

The Victorian Government in conjunction with water agencies developed 'Sewer Mining Guidelines'[1] which outlines the steps required for establishing a sewer mining scheme.

2.10.2. Sewer Offtake

When designing the offtake from a Branch or Main sewer for sewer mining, the following principles shall be considered:

(a) The offtake that will deliver flows to the Sewage Treatment Plant can either be via a controlled (i.e., via a control valve) gravity discharge directly to the Sewage Treatment Plant or into a Sewage Pump Station, which pumps flows into the Sewage Treatment Plant.
(b) For an offtake connected to an Sewage Pump Station, the offtake diameter shall suit the capacity of the Sewage Pump Station.
(c) The Sewage Pump Station capacity shall be calculated based on the proposed Average Dry Weather Flow capacity of the Sewage Treatment Plant and its proposed operational regime.

2.10.3. Sludge Return Line

When designing the sludge return line from a sewer mining operation, the following principles shall be considered:

(a) The discharge point to the Branch or Main sewer shall be located downstream of the sewer offtake location.
(b) The discharge line shall enter the maintenance hole at the invert level of the Branch or Main sewer to avoid the formation of turbulence.

[1] Sewer Mining Guidelines

(c) A level sensor may be required at the first downstream maintenance hole from the sludge. discharge point, to provide notification of any potential blockages caused by sludge build up.
(d) Consideration of the impact of sludge returns on sewage quality and flow in the receiving sewer (i.e., solids volume, Trade Waste etc.).

The discharge shall not contain any rags or inorganic debris extracted as part of the treatment process.

2.11. ASSET NAMING

The conventions used to assign names and numbers (IDs) for water and sewer assets must be in accordance with YVWCD-2-4930 AMF L8 Naming Conventions for Infrastructure Assets.

3. FLOW ESTIMATION

3.1. SEWER FLOW ESTIMATION

Sewer flows shall be estimated using one of the following methods (listed in order of preference):

(a) Computerised hydraulic modelling using InfoWorks ICM (described in Section 3.2).
(b) WSA02-2014 flow estimation method (described in Section 3.3). A spreadsheet with default values can be accessed at Sewer WSA Flow Estimation. Note: This method is only applicable for calculation of gravity sewer flows.

Yarra Valley Water uses hydraulic models to develop servicing strategies and size sewer assets for greenfield and complex infill developments, whilst land development design consultants utilise the WSA flow estimation method to size branch sewer assets for greenfield developments. For reticulation assets Yarra Valley Water and land development consultants utilise WSA02 MRWA Table 5.6 (or MRWA-S-104A Table 104A-B) for greenfield and infill developments.

3.2. COMPUTERISED HYDRAULIC MODELLING FLOW ESTIMATION METHOD

3.2.1. Dry Weather Flows

Residential

The dry weather flow multiplier shall be obtained via the Water and Sewer Demand Builder Tool. This tool shall be utilised for hydraulic modelling of greenfield areas only.

In lieu of detailed information relating to lot numbers in a development (i.e., Precinct Structure Plan), the following methodology shall be adopted to determine the number of lots to be considered in the hydraulic model:

(a) Calculation of the Total Area.
(b) Calculation of the Constrained Land within the Total Area (i.e., freeways and encumbered open space, including major drainage reserves).
(c) Calculation of the 'Gross Development Area' (GDA) i.e., Total Area – Constrained Area
(d) Adoption of the following development split per GDA hectare.
    I. 57.5% - Residential.
    II. 25% - Roads.
    III. 10% - Drainage.
    IV. 7.5% - Public Open Space.
(e) Calculating the total 'Residential Area (RA) from the GDA (i.e., 57.5% x GDA).
(f) Total lot forecasts based on the following upper and lower sensitivities.
    I. 19 lots per RA hectare (base case).
    II. 25 lots per RA hectare (higher density sensitivity analysis).

Reference: Growth Area Lot Forecast and Demand Assumptions.

Commercial/Industrial

Yarra Valley Water categorises commercial and industrial premises via trade waste agreements into three categories as noted in Table 3-1.

Table 3-1 - Trade Waste Categories

CATEGORY	DESCRIPTION	TYPICAL TYPES OF BUSINESSES
A	Discharge volume > 1000 kL/year	Industrial factories and large commercial businesses (e.g., chemical processing, food manufacturing, large shopping centre)
B	Discharge volume < 1000 kL/year	Commercial businesses or community facilities (e.g., restaurant, takeaway, car wash, laundromat)
C	Very minor discharge volumes	Small commercial businesses (e.g., home caterer, florist, pharmacy) and transport and warehousing

Based on the categories detailed above, Yarra Valley Water has adopted the following EP demands per hectare:

(a) Category A – 75 EP/contributing ha.
(b) Category B – 75 EP/contributing ha.
(c) Category C – 45 EP/contributing ha.

If the type of commercial and industrial premises is known, then the appropriate demand based on its trade waste category shall be adopted.

If the type of commercial and industrial premises is unknown, a value of 75 EP/ha shall be adopted.

3.2.2. Wet Weather Flows

The design of new infrastructure shall be tested using an 18.13% AEP (1 in 5-year ARI) rainfall event. Design storms covering 1 hour, 2 hours, 6 hours, 12 hours, 24 hours, 36 hours, 48 hours, and 72 hours' duration are to be modelled, with the event producing the highest peak flow to be used for the design of any new assets (excluding Sewage Flow Control facilities) *.

For Yarra Valley Water catchments, the following is typically observed:

(a) Short duration storms (< 12 hours) typically generate higher peak flows than long duration storms.
(b) Long duration storms (> 12 hours) typically generate higher flow volumes than short duration storms.

* Sewage Flow Control facilities are not sized using the highest peak flow storm as this storm may not be the storm duration that produces the maximum volume to be stored. Sewage Flow Control facilities are to be sized based on the storm which produces the maximum volume.

Table 3-2 below indicates the infiltration rates that shall be used for various asset types.

Table 3-2 - Wet Weather Flow Assumptions

Asset type	Expected asset life	Fast response (% of rainfall entering system during and immediately following storm)	Slow response (% of rainfall entering system for an extended period following the storm)	Total (% of rainfall entering system during and after the storm)
Permanent	$\geq$ 15 years	1	1	2
Temporary [2]	< 15 years	0.25	0.25	0.5

3.3. WSA02-2014 FLOW ESTIMATION METHOD FOR UN-DEVELOPED AREAS

The ‘Design Sewer Flow’ (or Design Capacity) of a gravity sewer is a combination of the following:

(a) Peak daily dry weather flow (PDWF).
(b) Groundwater infiltration (GWI) – This is non-rainfall dependent.
(c) Peak inflow and infiltration (RDI) – This is rainfall dependent.

Design Sewer Flow = PDWF + GWI + RDI

The estimated design sewer flow is also called the Peak Wet Weather Flow (PWWF).

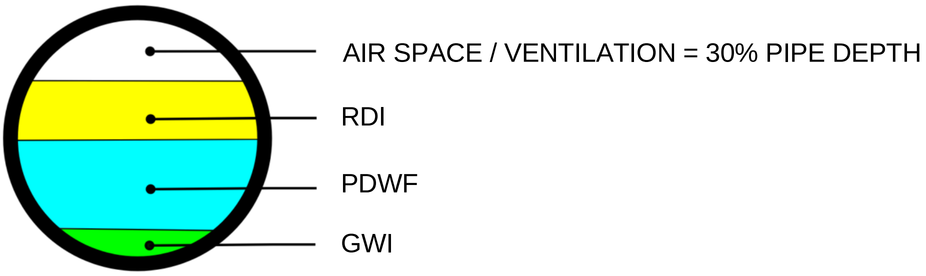


Figure 3-1 - Flow components in a gravity system

PDWF = d x ADWF

where

PDWF = peak dry weather sanitary flow

d = peaking factor = $0.01(\log A)^4 - 0.19(\log A)^3 + 1.4(\log A)^2 - 4.66\log A + 7.57$

(Refer to Table 3-3 for typical peaking factors)

A = gross plan area of the development’s catchment in hectares

[2] Derived from a statistical modelling analysis of flow monitoring data collected from catchments of various ages completed during 2006 G063 II Green.

ADWF = Average Dry Weather Flow = **'X'** L/sec/EP x **EP**

where **'X'** is based on the density and type of development consistent with the demands being used by Water Growth Planning.

Refer to the Water and Sewer Demand Builder Tool to determine the current **'X'** value

It should be noted that WSAA adopts 0.00208 L/sec/EP (180 L/day/EP) for the **'X'** value, assuming an occupancy of 3.5 persons per lot.

EP is based on the type of development (Refer to Table 3-4). The current assumptions are 3 EP/lot and allotment size of 450m2 for growth areas.

If there is a mix of development types, the EP calculations should combine them together to get a single ADWF.

Table 3-3 - Peaking Factors (d) for Various Catchment Areas

CATCHMENT AREA IN HECTARES (A)	1	5	10	25	50	100
PEAKING FACTOR (D)	7.57	4.93	4.13	3.31	2.85	2.49

Table 3-4 - Equivalent Population for Various Development Types

DEVELOPMENT TYPE	UNITS	EP PER UNIT	COMMENT
RESIDENTIAL			
Single lots – houses	per lot	3	Use if number of lots known
Single lots – houses	per ha	19 and 25	Refer to Section 3.2.1
Single apartment	per apt	3	Only use if number and type of apartment known
Medium density group housing	per ha	120	Small hotels/motels, hostels up to 3 storeys high. Density of 40 dwellings/units per ha
Medium density walk up flats	per ha	210	Up to 3 storeys high. Density of 70 dwellings per ha
High density multi-storey apartments	per ha	375-1000	Above 3 storeys high. Depends on locality. Density of 125-333 dwellings per ha
COMMERCIAL			
High density commercial	per ha of lettable floor space	800	Typically, CBD style commercial
Local commercial	per ha	75	Typically, suburban commercial

Warehouses	per ha	75	
Future industrial	per ha	150	Use only when type of industry is unknown; otherwise, table A2
Schools	per student	0.2	Includes teaching staff
Public events	per visitor	0.05	Shows, races, sporting events
Clubs	per occupant	0.25	Use maximum patrons permitted
Hospitals and nursing homes	per bed	3.4	Includes staff quarters
Parks and gardens	per ha	20	Contributing area to be adjusted to match footprint of building etc. that is discharging to sewer
Golf courses	per ha	10	Treat club houses same as 'Clubs'

GWI = 0.025 x A x Portion $_{wet}$

where

GWI = groundwater (no rainfall dependent) infiltration

A = gross plan area of the development's catchment in hectares

Portion $_{wet}$ = portion of the pipe network below the groundwater table level

(If unsure use a default value of 0.35 which equates to 35% and is based on 100% of branch sewers (10% of the network) being below the water table and 25% of reticulation sewers (90% of the network) being below the water table)

RDI = 0.028 x A $_{eff}$ x C x I

where

RDI = rainfall dependent inflow and infiltration

A $_{eff}$ = effective area capable of contributing rainfall dependent infiltration

C = leakage severity coefficient - ranges from 0.4 to 1.6

(If unsure use a default value of 0.9, the origin of which is described in Table 3-5)

I = function of rainfall intensity at the developments geographic location, catchment size and the required sewer system containment standard

For residential developments

A $_{eff}$ = A x (Density/150)$^{0.5}$ *for Density <= 150EP/ha*

A_{eff} = A for Density > 150EP/ha

where

A = gross plan area of the development's catchment in hectares

Density = the developments EP density per gross hectare

For commercial developments

A_{eff} = A x (1 – 0.75 Portion $_{impervious}$)

where

A = gross plan area of the development's catchment in hectares

Portion $_{impervious}$ = portion of the gross plan area likely to be covered by impervious surfaces

(If unsure use a default value of 0.9 which equates to 90%)

C = S_{aspect} + N_{aspect}

where

C = is the RDI leakage severity coefficient. It defines the contribution of rainfall runoff to

sewer flows via RDI.

S_{aspect} = soil aspect (Yarra Valley Water default value of 0.8)

N_{aspect} = network defects and inflow aspect (Yarra Valley Water default value of 0.6)

Table 3-5 - Leakage Severity Constants (C)

INFLUENCING ASPECT	LOW IMPACT	MEDIUM IMPACT	HIGH IMPACT
Soil aspect (s_{aspect}) **(Description)**	0.2 (Rock)	0.5 (Sandy loam or clay soils with good drainage)	0.8 (Clay soils with poor drainage)
Network defects and inflow aspect (n aspect)	0.2 (Minimal network defects fully welded PE)	0.4 (Moderate network defects PVC)	0.8 (Many network defects VC, Concrete)
C = s_{aspect} + n_{aspect}	0.4 (minimum)	0.9 (median)	1.6 (maximum)

I = $I_{1,2}$ x Factor $_{size}$ x Factor $_{containment}$

where

I	= is a function of rainfall intensity at the development's geographic location, catchment area size and required sewer system containment standard

$I_{1,2}$	= 1 hour duration rainfall intensity at the development location for an 39.3% AEP (2-year ARI) as shown on the relevant 'Design Rainfall Isopleth' in Volume 2 Australian Rainfall and Runoff (2001) (If unsure use a default value of 18, which is for Melbourne)
$Factor_{size}$	= accounts for the fact that II flow concentration times are faster for smaller catchments $= (40 / A)^{0.12}$
where	
A	= gross plan area of the development's catchment in hectares
$Factor_{containment}$	= reflects the design containment standard (defined by the EPA).

Table 3-6 - Factor Containment versus AEP

AEP	FACTOR CONTAINMENT
63.2%	0.8
39.3%	1.0
18.1%	1.3
9.5%	1.5

4. GRAVITY SEWER SYSTEMS

4.1. GENERAL

The following principles for planning and design under this section is applicable to all gravity sewer systems within Yarra Valley Water network.

The planning and design of gravity sewers $\geq$ DN675 must be read in conjunction with the Yarra Valley Water Large Sewer and Complex MH Technical Standard. Both this document and the Large Sewer Standard outline the design requirements for gravity sewers for sizes > DN675.

The definitions of the three types of gravity sewers within Yarra Valley Water's network has been listed under Table 4-1.

Table 4-1 - Types of Sewers Definitions

TYPE	DEFINITION
Reticulation Sewer	Sewer pipes nominally DN100 to <DN300, for the collection of sewage from individual properties and conveyance to branch sewers
Branch Sewer	Sewer pipes nominally DN300 to DN975 that collects sewage primarily from reticulation sewers. Sewer pipes $\geq$ DN675 are also classified as large and complex sewers.
Main Sewer	Sewer pipes nominally >DN 975 that collect sewage primarily from branch sewers. These are also classified as large and complex sewers.

When designing gravity sewers, the following aspects should be taken into account:

- Capacity.
- Minimum grade and velocity.
- Maximum grade and velocity.
- Hydraulic jumps.
- Materials.
- Water seals, Gas check maintenance holes and boundary traps.
- Emergency Relief Structures.
- Easements.
- Access requirements.
- Odour control.
- Flow monitoring.
- Hazardous Area Assessment.
- Cost estimation.

4.2. DESIGN HIERARCHY

When designing a gravity sewer, the 'Designer' needs to take a holistic approach, which takes into account the required capacity, site topography and alignment in order to design a sewer that meets the design standards and minimises construction issues and cost.

Yarra Valley Water's hierarchy for its design standards in order of importance are as follows:

(a) Capacity – All sewers must be designed to convey the calculated 'Design Capacity'. The required design capacity for reticulation, branch and main sewers are detailed in Section 4.3.
(b) Minimum Grade (Self-Cleansing) – All sewers shall be designed to achieve self-cleansing velocities under PDWF conditions.
(c) Minimum Grade (Slime Shearing) – Ideally all sewers shall be designed at an appropriate grade that allows slime shearing to be achieved under PDWF conditions (Note: When slime shearing grades are not able to be achieved the sewer and downstream network must be assessed for the increased odour and corrosion risk that is created by the build-up of slimes.).
(d) Odour Control – All sewers shall be designed to minimise the potential for odour generation, generally achieving a Froude No. of < 1 at ultimate development ADWF is desirable.

In addition to the above, the ability to undertake future maintenance activities in an easy and safe manner must be considered when developing the proposed horizontal and vertical alignment of the sewers.

4.3. DESIGN CAPACITY

Refer to Section 3.3 for estimation of Design Capacity (or Design Sewer Flow) for gravity sewers.

The 'Design Capacity' for a gravity sewer will depend on whether it is classified as a reticulation, branch, or main sewer.

'PWWF' must be used to determine the 'Design Capacity', and this shall be completed using a computerised hydraulic model over a range of storm durations.

Assessment should also be made of which storm duration produces the greatest spill volume (if applicable).

For sewers located within infill areas, the YBUS0179 Management of Sewer Surcharge for Hydraulic Capacity Upgrades shall be used to determine the design capacity of the sewer.

4.3.1. Reticulation Sewers

For reticulation sewers at PWWF, the depth of flow shall not be more than 70% of the pipe internal diameter.

An air gap is required for PWWF in reticulation sewers to allow for the uncertainty of wet weather peaking factors and concurrent customer sanitary flows in small catchments.

Design on-Grade Capacity = 70% (Design Capacity) + 30% (Air Space Allowance)

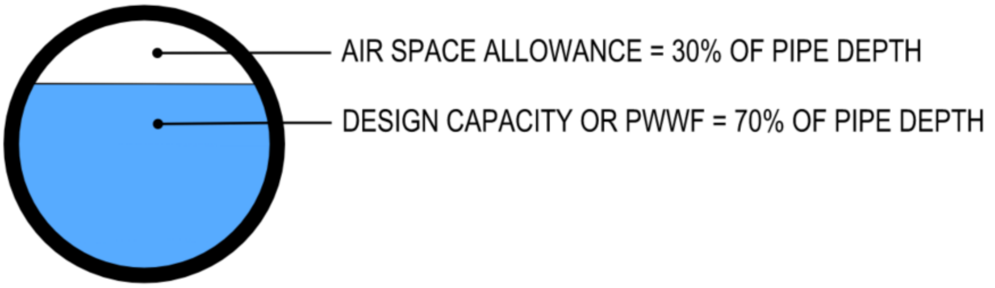


Figure 4-1 - Design Capacity for Reticulation Sewers

To prevent overloading of reticulation sewers and to prevent spills that occur as a result of hydraulic deficiency, the maximum number of lots allowed to connect to reticulation sewers depending on grade shall be as per MRWA-S-104A Table 104A-B. Exceptions to this requirement may apply if land upstream cannot be developed. Dispensation must be obtained from Yarra Valley Water upon completion of the capacity assessments.

The MRWA-S-104A Table 104A-B has been developed based on a demand of 450L/hh/day. This value is greater than the Water Demand Builder value used by Yarra Valley Water. The Development Industry utilise this table for sizing of reticulation sewers for infill and greenfield projects.

The design default assumptions utilised to calculate the maximum lot numbers on MRWA-S-104A Table 104A-B are detailed in Appendix A.

4.3.2. Branch Sewers

For branch sewers at PWWF, the depth of flow shall not be more than 70% of the pipe internal diameter.

An air gap is required for PWWF in branch sewers to allow for the uncertainty of wet weather peaking factors and unexpected growth.

Design on-Grade Capacity = 70% (Design Capacity) + 30% (Air Space Allowance)

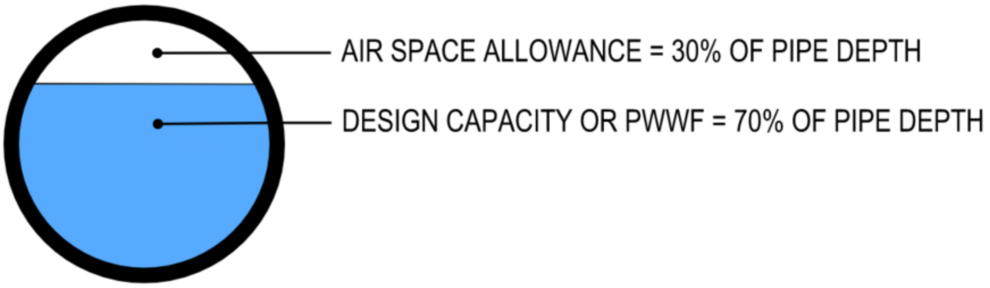


Figure 4-2 - Design Capacity for Branch Sewers

4.3.3. Main Sewers

For main sewers at PWWF, the depth of flow shall not be more than 82% of the pipe internal diameter.

As main sewers receive attenuated flows and more predictable flows than reticulation or branch sewers, the need for an air space/safety factor for capacity reasons is reduced.

Design on-Grade Capacity = 82% (Design Capacity) + 18% (Air Space Allowance)

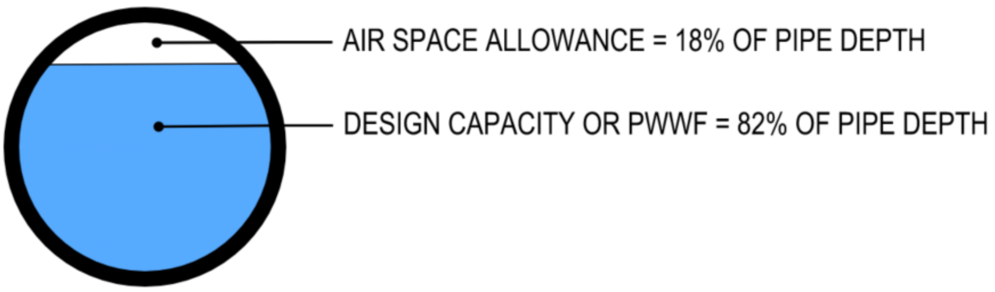


Figure 4-3 - Design Capacity for Main Sewers

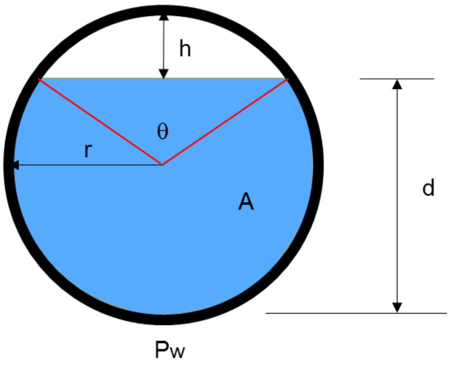
For main sewers at major road crossings, the depth of flow shall not be more than 70% of the pipe internal diameter, providing a 30% Air Space allowance.

4.3.4. Design on Grade Capacity (Manning's Equation)

The 'Design on Grade Capacity' for a sewer should be assessed based on the maximum depth of flow in the sewer using the following part-full pipe formulas.

$$Q = V \; x \; A$$

$$V = \frac{1.49 \, R^{2/3} S^{1/2}}{n}$$



Where

Q	= on grade capacity (l/s)
V	= velocity (m/s)
A	= circular segment area (m^2)
	$= \frac{r^2 \, (\theta - \sin\theta)}{2}$
θ	= central angle (radians)
	$= 2\cos^{-1}\left(\frac{r-h}{r}\right)$
q	= central angle (radians)
n	= pipe roughness (Manning's)
r	= radius of pipe (m)
S	= hydraulic gradient (m/m)
h	= circular segment height (m)
	$= 2r - d$
d	= depth of flow (m)
P_w	= wetted perimeter (m)
	$= r \; x \; \theta$
R	= hydraulic radius
	$= \frac{A}{Pw}$

Table 4-2 - Pipe Roughness Values based on diameter and material

PIPE MATERIAL	VC	CONCRETE	GRP	PVC	HDPE	PP
n [1]	0.01201	0.01278	0.01116	0.01116	0.01116	0.01116

n [2]	0.01243	0.0130	0.01172	0.01172	0.01172	0.01172
n [3]	0.01272	0.01335	0.01203	0.01203	0.01203	0.01203
n [4]	0.013	0.0136	0.01233	0.01233	0.01233	0.01233

[1] 'n' value based on pipe diameter < 300mm at 70% depth of flow

[2] 'n' value based on pipe diameter of 600mm at 70% depth of flow

[3] 'n' value based on pipe diameter of 1000mm at 70% depth of flow

[4] 'n' value based on pipe diameter of 1500mm at 70% depth of flow

Note: Values of 'n' may be linearly interpolated for intermediate diameters

4.3.5. Pipe Full Capacity (Colebrook-White Equation)

Pipe full capacity for a sewer shall be assessed using the Colebrook-White equation

$$Q = V\ x\ A$$

$$V = -2\sqrt{2gDS}\ \log\left(\frac{k_s}{3.7D} + \frac{2.51v}{D\sqrt{2gDS}}\right)$$

where

Q	= pipe full capacity (l/s)
V	= velocity (m/s)
A	= cross sectional area (m^2)
D	= diameter of pipe (m)
k_s	= pipe roughness (m)
S	= hydraulic gradient (m/m)
g	= gravity (m/s^2)
v	= kinematic viscosity 1.14 $x10^{-6}$ (m^2/s)

Table 4-3 - Pipe Roughness Values to be used Based on Diameter and Material

PIPE MATERIAL	VC	CONCRETE	GRP	PVC	HDPE	PP
k_s (mm)	1.0	1.5	0.6	0.6	0.6	0.6

4.3.6. Pipe Flowing Partially Full

If the pipe full capacity has been calculated using the Colebrook-White equation the graph below can be used to determine flow rate and velocity for various depth of flow, or the depth of flow for various ratios of flow or velocity.

For example, if d/D is 0.4 then Vd will be 0.902VD and Qd will be 0.337QD.

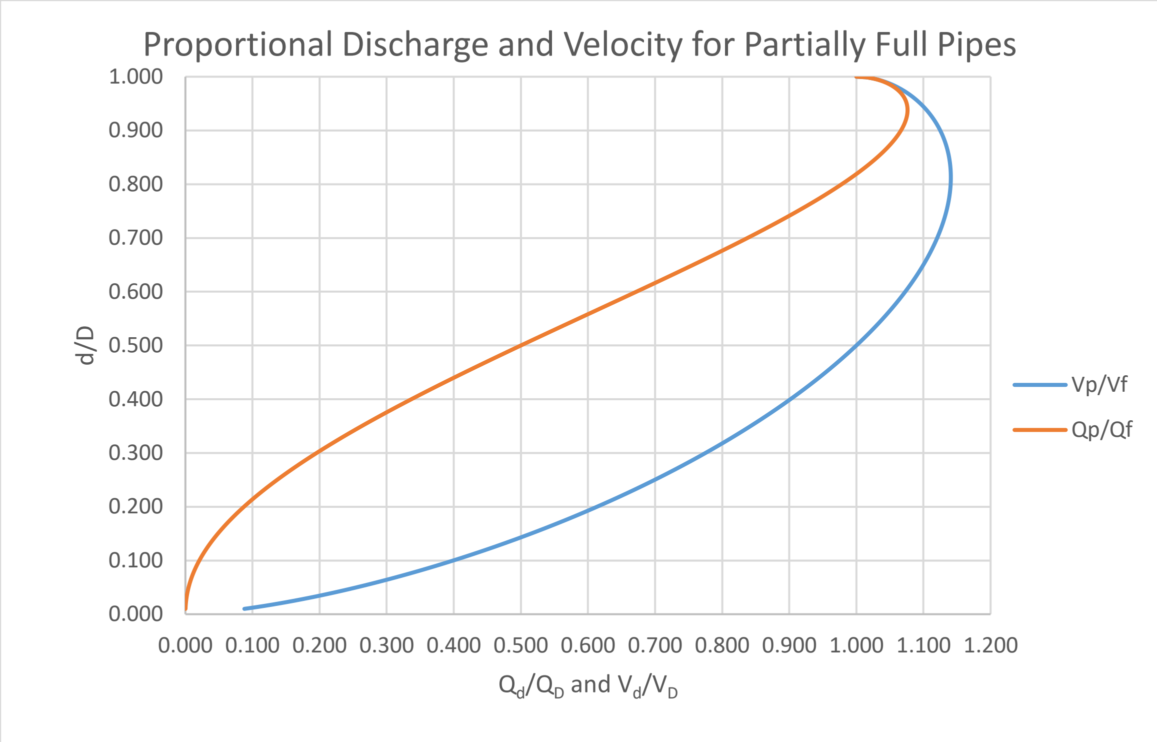


Figure 4-4 - Proportional Discharge and Velocity for Partially Full Pipes

Spreadsheet with graph data – Proportional Discharge and Velocity for Partially Full Pipes

4.4. MINIMUM GRADE AND VELOCITY

The design of gravity sewers shall consider the minimum grade required to achieve self-cleansing and slime control under PDWF conditions.

The shear stress (τ) to achieve self-cleansing at PDWF is 1.6 Pa, whilst the shear stress (τ) to achieve slime control is 3.35 Pa. This difference in shear stress values means that the required minimum grade to achieve self-cleansing will always be flatter than the grade required to achieve slime control.

If the topography of the land is flat, a sewer graded to achieve slime control may end up unacceptably deep.

Therefore, when undertaking the hydraulic design of a gravity sewer the Designer shall determine the required grades to achieve self-cleansing and slime control. The Designer shall then undertake an evaluation to determine, based on the topography of the land, whether grading the sewer to achieve slime control is warranted, based on its impact on constructability and cost.

The following formulas are used to calculate the minimum velocities and critical slopes for slime control and sediment transfer. The graphs in Figure 4-5, Figure 4-6 and Figure 4-7 have been derived from the formulas below:

where

t = shear stress (Pa)

$$V_s = \left[\frac{\tau\,(R)^{1/3}}{\rho g n^2}\right]^{1/2}$$

$$S_c = \left[\frac{V_s\, n}{(R^{2/3})}\right]^2$$

V_s	= Velocity required to achieve shear stress (m/s)
S_c	= Critical slope required to achieve shear stress (%)
R	= Hydraulic radius (m)
r	= Liquid density (kg/m^3)
g	= Gravity (m/s^2)
n	= pipe roughness (Manning's) (m)

4.4.1. Self-Cleansing

All gravity sewers shall be graded such that they will achieve a self-cleansing sheer stress (τ) of 1.6 Pa at PDWF.

For the permanent upstream ends of 'end of line sewers' on DN150 and DN225 sewers in residential areas with an EP < 20, the minimum grade shall be 1 in 100.

At low values of EP, daily flows may not be continuous but will display an intermittent pulsing pattern. Self-cleansing is generally achieved via the mechanism of successive 'impulse-shunting' jolts that transport grit and debris along the sewer to sections of continuous flow.

Figure 4-5 below details the minimum velocities required to be achieved at various depths of flow in order to achieve self-cleansing. The velocities are based on a Manning's 'n' value of 0.01278 (equivalent to Colebrook-White k = 1.5mm).

In general, a velocity > 0.7m/s shall be sufficient to achieve self-cleansing in reticulation sewers.

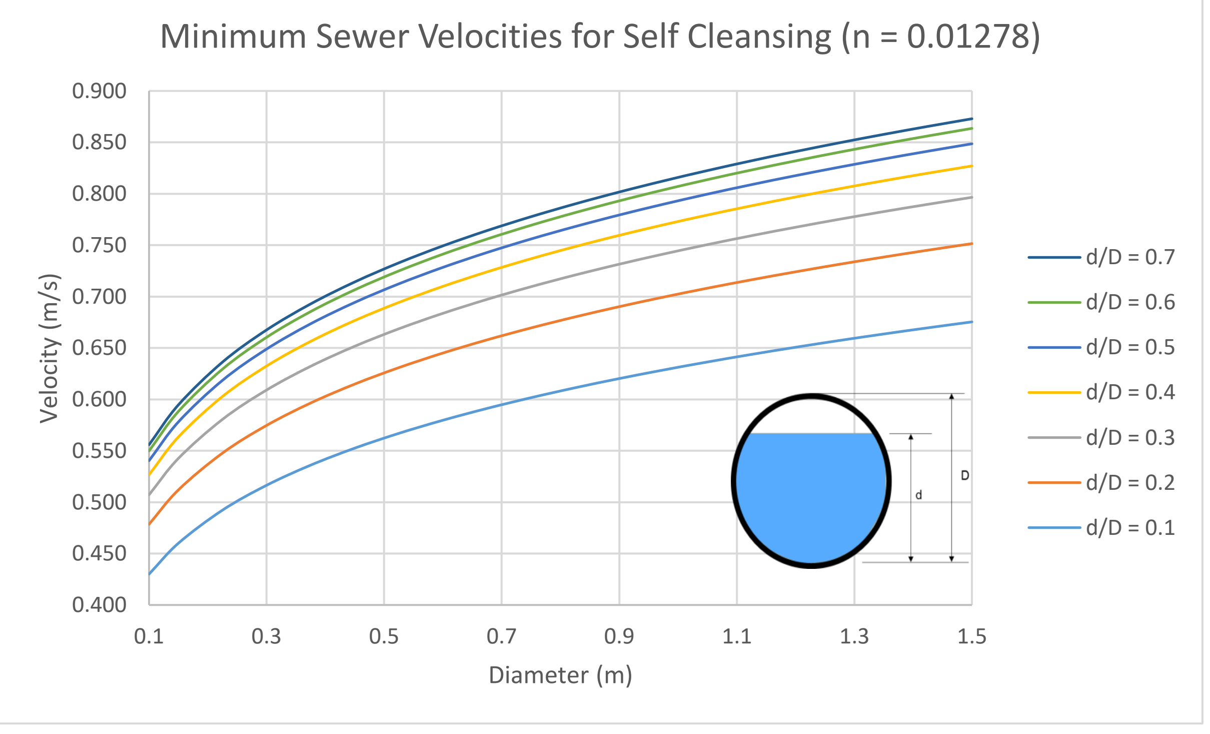


Figure 4-5 - Minimum Sewer Velocities for Self-Cleansing

4.4.2. Slime Control

In order to achieve slime, control a critical shear stress of 3.35Pa must be achieved at PWWF.

As detailed in Section 4.4, an evaluation to determine whether grading the sewer based on topography of the land to achieve slime control is warranted, based on its impact on constructability and cost.

Figure 4-6 below details the critical slopes at various depths of flow required to ensure the critical slime shear stress is achieved.

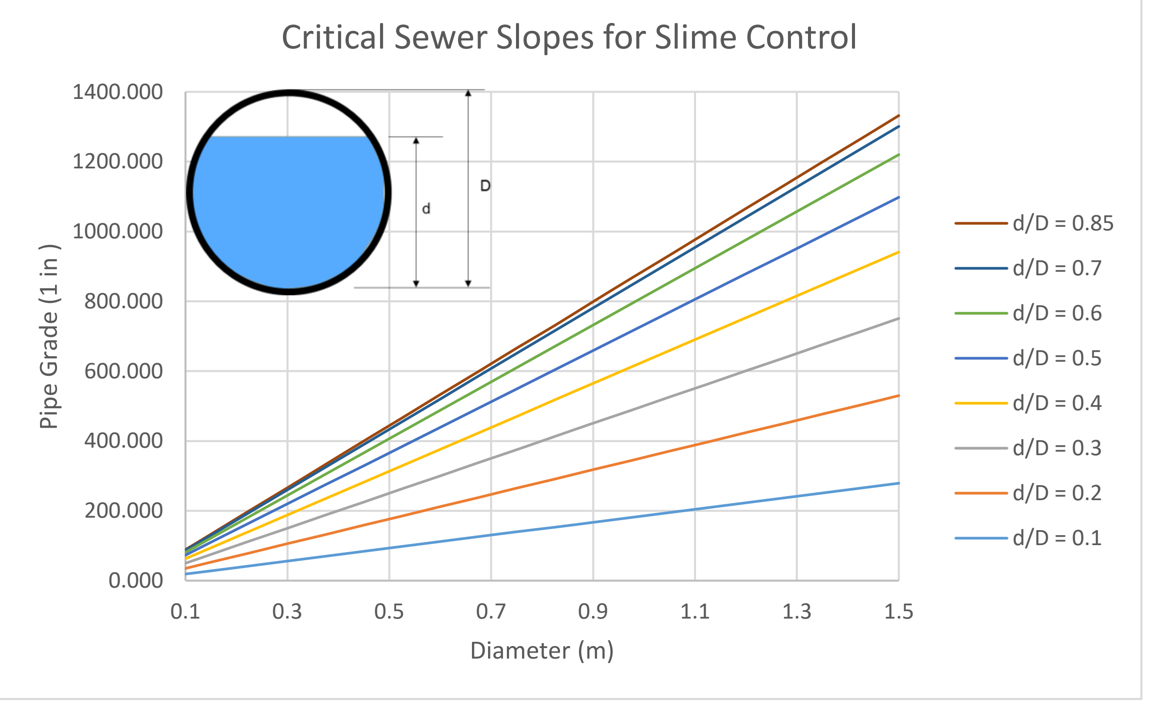


Figure 4-6 - Critical Sewer Slopes for Slime Control

Figure 4-7 below details the minimum velocities required to be achieved at various depths of flow in order to achieve slime shearing. The velocities are based on a Manning's 'n' value of 0.01278 (equivalent to Colebrook White k = 1.5mm).

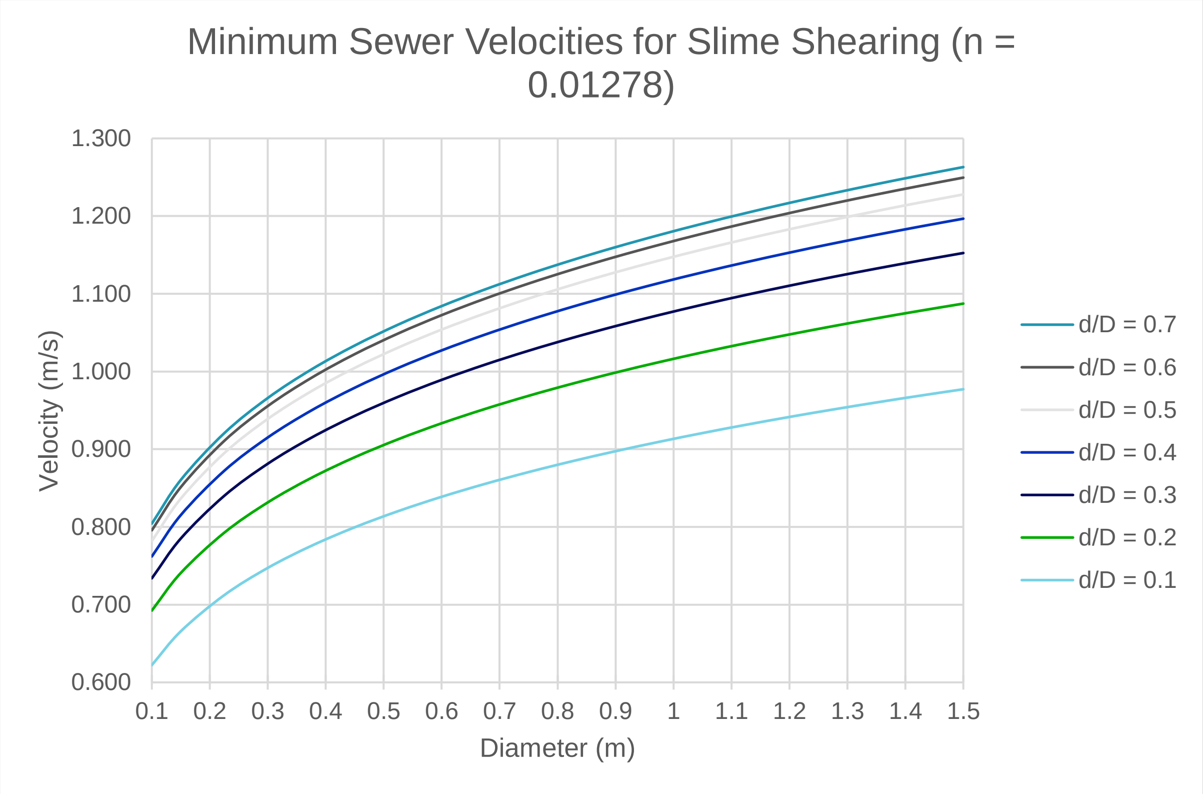


Figure 4-7 - Minimum Sewer Velocities for Slime Shearing

If slime shearing cannot be achieved, the Designer shall investigate the resulting implications of slime growth and identify measures to minimise the risk of odour, safety, and corrosion issues.

4.5. MAXIMUM GRADE AND VELOCITY

The maximum grade allowable in a gravity sewer shall be such that the maximum velocity does not exceed 3.0m/s.

4.6. HYDRAULIC JUMP

A hydraulic jump occurs when the upstream flow is ‘supercritical’ (Froude Number > 1), and a downstream impediment causes the flow to pass through critical depth and become ‘subcritical’ (Froude Number < 1). For gravity sewers, the impediment could be increased pipe friction or a sharp change of grade. Detrimental effects of a hydraulic jump may include:

(a) Turbulence that will reduce or block air flow along the sewer.
(b) Increased water levels in the MH that may impede flow from incoming sewers.
(c) Turbulence that will liberate gases causing increased rate of corrosion and erosion damages to the MH and sewers.
(d) Pulsating air creating a vacuum resulting in loss of boundary trap seals and plumbing fixture seals, leading to a risk of sewer gases entering buildings, which may in turn cause (in extreme cases) explosions and impact on the health and safety of the occupants, not to mention an increase in odour complaints.

The Froude number can be calculated using the following formula

$$F = V/\sqrt{gDm}$$

where

F	= Froude number (dimensionless)
V	= Velocity (m/s)
g	= gravity (m/s^2)
Dm	= Depth of flow

The Froude number can also be calculated using the Colebrook-White calculator or obtained from the InfoWorks hydraulic model.

Based on the Froude number hydraulic jump is classified in the Table 4-4 .

Table 4-4 - Classification of Hydraulic Jumps Based on the Froude Number

FROUDE NUMBER RANGE	CLASSIFICATION
1.0 < Fr <1.7	Undular Jump
1.7 < Fr <2.5	Weak Jump
2.5 < Fr <4.5	Oscillating Jump
4.5 < Fr < 9	Steady Jump

Yarra Valley Water prefers Froude number to be F<1, but may accept F values up to 1.7 .

Hydraulic jumps should be avoided. Where it is not practical to eliminate hydraulic jumps on the sewer design, appropriate measures shall be taken to design the hydraulic jump to occur at MHs whereby:

(a) There is less impact on air flow along the sewer.
(b) Damage from corrosion and erosion can be readily inspected, monitored and repaired by providing easy access.

In addition to the above, also refer to WSA02 MRWA Section 5.6.6.6.2 and 5.6.6.6.3 for details on appropriate measures that can be implemented.

4.7. MATERIALS

There are several different suitable materials available to be used for gravity sewerage pipes. Determination of the most suitable material is based on, but not limited to, the following criteria:

(a) Required pipe diameter.
(b) Ground conditions.
(c) Depth.
(d) Construction method.
(e) Catchment type (i.e., residential, or industrial/commercial).

All approved products and materials are specified on the MRWA Portal.

A summary of the advantages and disadvantages, along with the range of sizes available for the various pipe materials is detailed in Appendix D of this document.

4.8. MAINTENANCE STRUCTURES

4.8.1. Types of Maintenance Structures

Five types of maintenance structures are approved for use on Yarra Valley Water's network. Details of the appropriate use and limitations for each type of structure is detailed on standard drawing MRWA-S-300. Table 4-5 provides additional Yarra Valley Water requirements to MRWA-S-300.

Table 4-5 - Type of Maintenance Structures

PARAMETER	MAINTENANCE HOLE (MH)	MAINTENANCE CHAMBER (MC)	MAINTENANCE SHAFT (MS)	INSPECTION SHAFT (IS)
Locatable in rear of properties	Y[2]	Y	Y	Y
Accommodate worker entry	Y	N	N	N
Trafficable	Y	Y[1]	Y[1]	N
Allowable for use in Industrial/commercial areas	Y	Y	Y	N

[1] – Use allowed in trafficable areas subject to Yarra Valley Water approval.

[2] – Allowable under certain situations. Refer to MRWA-S-106 Figure 106-A for details.

4.8.2. Spacing of Maintenance Structures

Refer to Standard Drawing MRWA-S-300 Table 300-B for requirements on maximum spacing of maintenance structures for sewer < DN675.

Refer to Yarra Valley Water Large Sewer and Complex MH Standard for spacing requirements for sewers ≥ DN675.

4.8.3. Drop Structures

Drop structures are required in maintenance holes where the difference in invert levels between the incoming and outgoing sewer pipes is greater than the minimum height of a drop (e.g., for DN150, minimum drop height is 0.6m).

Standard drawing MRWA-S-307 provides guidance on the use of drop structures, which includes minimum drop height and the type of drop structure which can be used based on the maintenance hole depth (i.e. vortex, plunge pool).

For design principles on maintenance holes containing vortex drops, refer to Yarra Valley Water Maintenance Holes with Vortex Drops Technical Specification.

4.9. EMERGENCY RELIEF STRUCTURES

The planning and design principles for Emergency Relief Structures are documented in Yarra Valley Water Emergency Relief Structures Technical Standard.

An emergency relief structure permits controlled overflows of sewage at predetermined locations in order to prevent overloaded or blocked sewers from discharging at sensitive locations, on private property and inside buildings.

Emergency Relief Structures are provided:

(a) On incoming sewers to a pumping station to enable controlled overflow during facility failure or rainfall events greater than 18.13% AEP.
(b) Along branch and trunk sewers to allow overflow of excessive inflow/infiltration following rainfall events greater than 18.13% AEP.

Yarra Valley Water shall decide whether an Emergency Relief Structure is required based on an assessment of whether it is essential for the proper and efficient operation of the sewer system. To facilitate this, where an Emergency Relief Structure is proposed, the Designer shall submit a report that addresses the following issues (as a minimum):

(a) The risk of harm to public health, environment, or property if the proposed Emergency Relief Structure is not constructed.
(b) The risk of harm to public health and the receiving environment if an overflow from the Emergency Relief Structure occurred.
(c) The systems to be used to monitor overflows, power failures or mechanical failures of pumping or electrical equipment relating to or affecting the proposed Emergency Relief Structure.
(d) Details of the proposed methodology for responding to overflows.

Consultation with the receiving asset owner must be undertaken (i.e., Melbourne Water or the relevant Council) during the design phase for the Emergency Relief Structure to ensure the connection to the drain or waterway incorporates their requirements.

To install a new an Emergency Relief Structure, approval from the Environment Protection Agency is generally not required. However, the Environment Protection Authority must be notified of Emergency Relief Structure locations and spill volumes as per regulatory requirements.

4.10. INVERTED SIPHONS

4.10.1. Overview

Inverted Siphons are sewers operated under gravity pressure, where the lowest soffit level of the siphon is lower than the invert level of the outlet.

Inverted siphons are typically used to allow the gravity sewer to pass beneath a waterway, road, railway, or other obstruction (e.g., large diameter stormwater pipe).

Without the use of an inverted siphon, sewer depths would need to increase to allow the gravity sewer to pass beneath the waterway, road, or railway, resulting in increased construction costs.

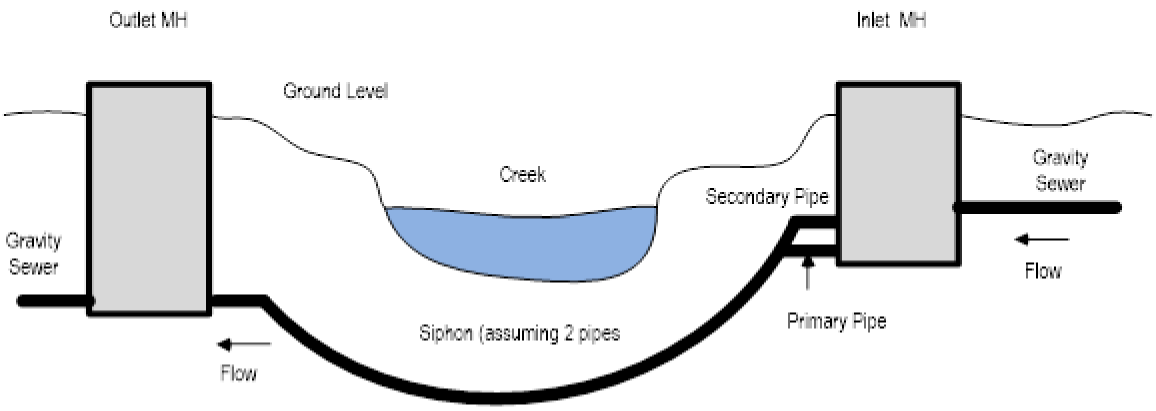


Figure 4-8 - Typical Inverted Siphon Arrangement

The planning and design principles for Inverted Siphons are documented in Yarra Valley Water Inverted Siphons Technical Standard, WSA02 MRWA Section 8.6 and standard drawings and MRWA-S-207B (for on grade crossings).

Consultation must be undertaken with the asset owner (i.e., Melbourne Water, Parks Vic, Department of Transport and Planning, VicTrack or the relevant Council) during the design phase for the Inverted Siphon to ensure their requirements for the crossing are incorporated.

4.11. EASEMENTS

Easements are required when sewers are located:

(a) Along the side, front, or rear boundary of a lot.
(b) Where the sewer does not abut a title boundary for any lot size.

Maintenance shaft or chambers must be located within the easement.

Refer to Yarra Valley Water Large Sewer and Complex MH Standard for easements and pipe track requirements for sewers ≥ DN675.

The Yarra Valley Water easement requirements for gravity sewers based on land zoning are detailed in sections below.

4.11.1. Residential Zoning

Yarra Valley Water requirements on easements are listed under Table 4-6.

Table 4-6 - Easement Requirements in Residential Zoning

LAND USE	PIPE SIZE	PREFERRED LAND TENURE ACTION
Private Property	≤ 225mm	• Refer to Standard Drawing MRWA-S-112 for details • Community Sewerage Areas do not require easements
	≥ 300mm and <675 mm	• Only allowed subject to Yarra Valley Water approval • If approved, minimum easement width shall be as per Standard Drawing MRWA-S-112 • Refer WSA02 MRWA Section 5.2.4 for more details.
	≤ 225mm	• Refer to Standard Drawing MRWA-S-112 for details

Public Open Space	> 300mm and <675 mm	• Sewers to be offset at least 1m from all private property boundaries • For DN>600, A minimum 3m+DN wide access (including offset) is required along the entire length of sewer, clear of vegetation and other obstructions. • For ≤ DN600, A minimum 3m wide access (including offset) is required along the entire length of sewer, clear of vegetation and other obstructions.

4.11.2. Commercial/Industrial Zoning

Yarra Valley Water requirements on easements are listed under Table 4-7.

Table 4-7 - Easement Requirements in Commercial/Industrial Zoning

LAND USE	PIPE SIZE	PREFERRED LAND TENURE ACTION
Private Property	All	• Only allowed subject to Yarra Valley Water approval • If approved, minimum easement width shall be as per Standard Drawing MRWA-S-112 • Refer WSA02 MRWA Section 5.2.4 for more details.
Public Open Space	< 225mm	• Refer to Standard Drawing MRWA-S-112 for details
	> 300mm and <675 mm	• Sewers to be offset at least 1m from all private property boundaries • For DN>600, A minimum 3m+DN wide access (including offset) is required along the entire length of sewer, clear of vegetation and other obstructions. • For ≤ DN600, A minimum 3m wide access (including offset) is required along the entire length of sewer, clear of vegetation and other obstructions.

5. ODOUR AND CORROSION CONTROL

5.1. VENTILATION

Hydrogen Sulphide (H_2S) is universally present in sewerage systems, and its presence in the sewer atmosphere can present the following problems:

(a) Damage to sewer structures by sulphide initiated corrosion.
(b) Build-up of toxic and odorous gases in the sewer with possible emission to the atmosphere leading to odour complaints.
(c) Unsafe OH&S conditions in and around sewer.

The provision of ventilation is one possible method for overcoming these problems within the sewer via either a system designed to impose an air flow (mechanical or forced ventilation) or produce an air flow by harnessing natural driving forces (natural ventilation).

Natural or forced ventilation systems can be designed and operated to meet one or both of the following objectives:

(a) To control sulphide corrosion.
(b) To control odour emission.

The objectives of an ideal ventilation system for odour and corrosion control are as follows:

(a) Use of ventilation to prevent hazardous atmospheres to develop, that may pose a safety risk.
(b) Minimise the rate of H_2S emission and evaporation from the sewage surface by maintaining a zero relative velocity between the sewage and ventilating air, and/or
(c) Change the air frequently enough to maintain a dry sewerage system at all times.

Further details on ventilation in sewers can be found in the Hydrogen Sulphide Control Manual (Monograph 6.1).

5.1.1. H_2S Risk Assessment

Initial Assessment

(a) The initial H_2S risk scoring shall be calculated utilising standard drawing MRWA-S-401 Sewerage Network Airflow Management.
(b) The risk score is calculated using MRWA-S-401 Table 401-B to identify the appropriate points value to be applied to the key risk factors such as age of sewage, sewage content, ventilation and turbulence and detention time for pressure mains.
(c) The points values are then used to calculate a risk score for each length of sewer. Each sewer length is then given a risk score of ‘low risk’, ‘medium risk’ or ‘high risk’.

Detailed Assessment

(a) If a sewerage network is classified as ‘medium’ or ‘high risk’ based on the criteria of MRWA-S-401, a more detailed analysis shall be undertaken to determine the level of odour control that is required and the types of odour control which are most appropriate for the system.

(b) This analysis shall be undertaken using Yarra Valley Water Odour Management Strategy.

(c) This document contains the Odour Potential Risk Calculator that can be used to undertake a more detailed assessment of whether odour control is required. The asset decision trees in Appendix D of the Yarra Valley Water Odour Management Strategy can then be used to further identify the recommended treatment.

(d) Refer to Appendix B for Liquid Phase Chemical Odour Control Methods and refer to Appendix C for Gaseous Phase Odour Treatment and Ventilation Methods.

Safety and Hazard Assessment

(a) The source and impact of flammable / noxious atmospheres (e.g., H_2S, hydrocarbons, methane) remains a primary concern due to its health and safety impacts, effect on corrosion and odour emissions.

(b) Managing the risks of hazardous or explosive atmospheres on Yarra Valley Water assets is a requirement as part of the code of practice issued by Safe Work Australia[3], the federal safety regulatory authority. This code of practise states that:

"A person conducting a business or undertaking must manage the risk to health and safety associated with a hazardous atmosphere or an ignition source in a hazardous atmosphere at the workplace"

(c) Refer to Safe Work Australia's Exposure standards[4] for exposure limits that must not be exceeded for H_2S.

(d) The Designer must consider the potential hazardous or explosive atmospheres for all linear infrastructure, pump stations and wastewater treatment plants. Risk assessment shall be undertaken, and appropriate controls and mitigations identified for each risk item.

(e) Hazardous area assessments shall be undertaken in compliance to AS/NZS 3000. Where the risks are identified and consideration of use of intrinsically safe or explosion rated electrical equipment.

5.1.2. Design Considerations

Ventilation systems shall be designed and installed as an integral feature of any sewerage network (i.e., at initial sub-divisional development), rather than added as an appendage once the system is operational.

Ventilation shall be assessed when any upgrade works are being performed on the system.

Sections of sewer that have risk scores of medium or high are often associated with the following features in the sewerage network:

(a) Sections of sewer with flat grades.
(b) Large diameter sewers.
(c) Pump stations and associated discharge maintenance holes (refer to Section 5.1.3).
(d) Pressure sewer discharge maintenance holes (refer to Section 5.1.3).
(e) Air valves located on pressure mains.

---

[3] SafeWork Australia, Managing Risks of Hazardous Chemicals in the Work Place: Code of Practice, 2020, ISBN 978-0-642-78335-6

[4] Safe Work Australia, Workplace Exposure Standards for Airborne Contaminants, April 2013 and Safe Work Australia, Amended Workplace Exposure Standards for Hydrogen Sulphide, 2019

(f) Inverted siphons (upstream and downstream).
(g) Drop structures (refer to Section 5.3).
(h) Sewer junctions.

These features shall be designed out of the sewerage network. However, if they cannot be removed; an appropriate ventilation system either natural or mechanical, based on the expected sewage condition should be implemented.

Table 5-1 - Types of Ventilation

Type	Criteria
Natural Ventilation	• This should be considered when the sewage is fresh and predominantly domestic (i.e., low risk), • The sewage network is steep graded (i.e., > 1 in 100) and has venting via property connections (i.e., no boundary traps). • Standard Drawing MRWA-S-401 indicates that systems with a 'low' H_2S risk score can be designed as open systems. • Refer to Section 5.1.5 for more details
Mechanical Ventilation	• This should be considered when either the wastewater is septic, turbulent flow will occur and sewage is classed medium or high risk, • The sewer is flat graded (i.e., < 1 in 200) or discharges into pump station or storage. • Standard Drawing MRWA-S-401 indicates that systems with a 'medium' or 'high' H_2S risk score should be designed as closed systems. • Ventilation setup shall consider air treatment (such as odour scrubbing, carbon filters, etc) • Refer to Section 5.1.6 for more details

Following establishment of the appropriate ventilation required for the system, the design and location of the ventilation infrastructure (induct and educt vents) shall be completed taking into consideration the following:

(a) Topography.
(b) Land use (i.e., proximity to 'nearest receptor', either existing or future).
(c) Historical data on wind speed, direction and duration and frequency of calm periods.
(d) Historical occurrence of atmosphere inversions.

Refer to Appendix G of this document for a schematic diagram of a typical sewerage network containing reticulation sewers; branch sewers, main sewers, and sewage pump stations, highlights the general philosophies, preventative, and curative actions, which can be taken to limit H_2S within the network.

5.1.3. Pressure Sewer Discharge into Gravity System

Pressure sewer discharges into gravity systems (from a pressure sewer network or sewer pump station) are typically classified as 'high risk', due to the sewage becoming septic following long detention times in the pressure pump unit/sewage pump station and pressure mains.

The following design aspects should be considered:

(a) Ventilation systems at these locations shall consider the impact on sewage quality and sewage septicity.
(b) Design shall ensure that sewage surcharging does not occur when pumped flows enter the system, particularly at the discharge maintenance structure and the first downstream gravity sewer.
(c) The volume of odorous air released at the discharge maintenance structure. Educt vents at the maintenance structure shall be located away from nearby sensitive receptors and/or provided with odour control (i.e., carbon canisters etc.).
(d) Ventilation and odour control downstream of the discharge location shall be reviewed to confirm that the discharge will not adversely affect existing customers/assets within the sewerage catchment. Assess whether any augmentations to existing sewer network are required (e.g., installation of water seals).
(e) Assess whether the discharge connection will adversely affect the integrity of the existing sewer.
(f) Assess whether the new pressure sewer connection could cause a change of system classification (i.e., open to closed) and/or H_2S risk score rating.
(g) Assess whether corrosion protection should be undertaken for downstream concrete maintenance structures using PVC lining or CIPM.

5.1.4. Open System vs Closed System

An ‘open’ system contains properties without ‘boundary traps’ installed, and natural ventilation is provided via each property’s ‘property drain vent’.

A ‘closed’ system contains properties with ‘boundary traps’ installed and water seals at all junctions between open and closed systems.

In general, sewers located higher up the system (i.e., reticulation sewers) where the sewer is still considered ‘fresh’ lend themselves to an ‘open’ system configuration, whilst sewers located in the lower part of the system (i.e., branch and main sewers) where the sewer is considered ‘stale’ or ‘stagnant’ are more suited to a ‘closed’ system configuration.

For new developments in ‘greenfield’ areas an assessment should be completed to determine whether an ‘open’ or ‘closed’ sewerage system should be adopted. Ideally, this should be completed at a ‘strategy’ level.

An example sewerage network showing ‘open’ and ‘closed’ systems is detailed on standard drawing MRWA-S-401.

Refer to Section 2.3.3 for requirements on hybrid systems (e.g., community sewerage areas).

5.1.5. Natural Ventilation

The natural forces that produce or influence airflow in, through and out of sewers can be classified as being produced by:

(a) Sewer air condition – relative density of sewer air and outside air.
(b) Sewage flow – sewage ‘drag’ (i.e., passage of flow drags air along pipe).
(c) Meteorological conditions – change in barometric pressure along the sewer and wind velocities over ventilation stacks.

All of these natural forces will either act on the sewer individually or concurrently depending on the conditions at the time (i.e., peak flow, summer day, windy day).

In general, the best method to achieve effective natural ventilation is via multiple induct and educt vents.

For reticulation systems, this is best achieved via venting sewers directly at each property connection (i.e., eliminating all or most boundary traps), whilst for branch or main sewers specially designed ‘induct’ and ‘educt’ vents are installed at regular intervals along the sewer (refer Clause 8.4.2 and Appendix D of WSA02-2014).

5.1.6. Mechanical Ventilation

Mechanical or forced ventilation is best used when natural ventilation is not suitable, and a high degree of control is required. In general, forced ventilation is used on branch or main sewers or at SPS and SFC facilities.

5.2. IN-LINE WATER SEAL

5.2.1. General

An in-line water seal is used to prevent sewer gases from travelling upstream and venting into the atmosphere via house connection drains.

5.2.2. Residential Flow Requirement

Refer to Standard Drawing MRWA-S-401 to determine whether a water seal should be provided on sewers.

Any reticulation sewer with fewer than 5 properties or property connection which connect directly to a closed system (as per MRWA-S-401) must have a boundary traps installed.

Property connections within an open system shall be connected to the upstream maintenance hole of the in-line water seal.

5.2.3. Industrial/Commercial Flow Requirement

In-line water seals shall not be specified on any sewer, which has commercial or industrial discharge entering upstream.

All industrial/commercial properties must have a boundary trap installed at each property connection.

5.3. DROP STRUCTURES

If drop structures are required in the sewerage network, they shall be designed to minimise the level of turbulence and potential for H2S released.

Refer to Section 4.8.3 of this document for details.

5.4. ODOUR CONTROL

Yarra Valley Water preferred technology for odour control for gravity sewers are noted below in the order of preference:

(a) Odour confinement through construction of boundary traps or in-line water seals.
(b) Passive ventilation via inducts and educt vents is for 'open systems' only. Green domes may be used to replace vents in problem areas, but performance is variable. Most vents do not use filter media.
(c) Mechanical extraction through filter media at odour hot spots (where suitable).

(d) Forced flow through activated carbon or media filter (where power available and gas rate suitable).
(e) Forced flow through Bio Filter where power available and high flows require treatment
(f) Chemical dosing.

Refer to Section 7, Section 8, and Section 9 for additional requirements on odour control for pressure mains, sewage pump stations and flow control facilities.

5.5. H_2S CORROSION RISK CONTROLS FOR MAINTENANCE STRUCTURES

Maintenance Structures shall be installed or modified with protective coatings based on their H_2S risk score, to provide protection against degradation.

Refer to Appendix F Corrosion Protection of Maintenance holes: Yarra Valley Water Supplement to MRWA Table 307-E (this document) and standard drawing MRWA-S-307 Table 307-E for requirements on protective coating applied to new and existing structures.

Epoxy coating for maintenance structures requires approval by Yarra Valley Water on a case-by-case basis.

6. PRESSURE SEWER SYSTEMS

6.1. GENERAL

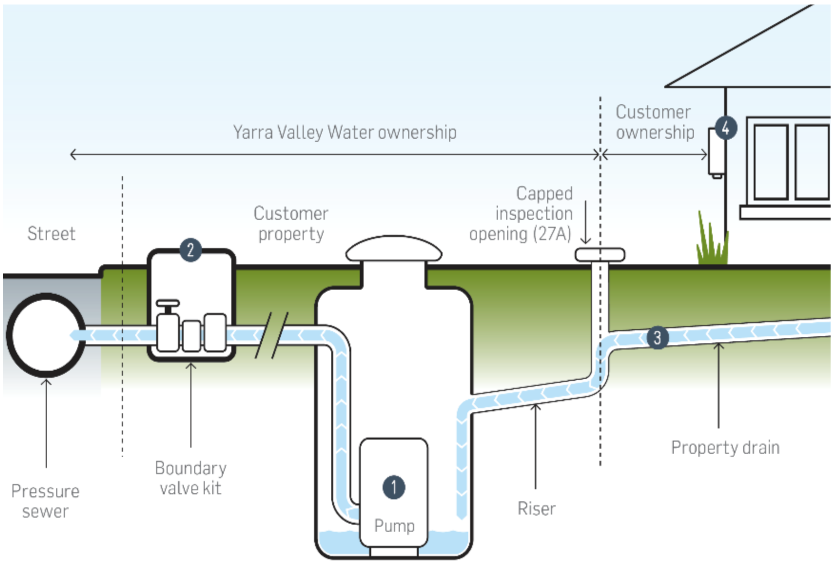
The following principles for the planning and design of pressure sewer system must be read in conjunction with WSA 07 'Pressure Sewerage Code of Australia' and MRWA Supplement to WSA 07.

A pressure sewer system is made up of a network of fully sealed pipes, or a combination of fully sealed and gravity pipes (hybrid system). Full pressure sewer systems are fed by pumping units located at each individual property, whilst hybrid systems are a combination of pressure units and gravity connections. The pumping unit processes the household wastewater and transfers it to the pressure or gravity sewer located in the street via a small pipeline within the property.

Pressure sewer networks are most commonly used to service 'Community Sewerage Areas'

The pressure sewer system is made of the following key elements:

- Pressure or gravity sewer in the street.
- Pumping unit located on the customers property.
- Boundary valve kit located on the customers property.
- House service line.
- Control panel.
- Customer drain (inlet).



1. **Pumping unit**
   This includes a small pump, storage tank, and level monitors which are all installed underground so that only the top of the storage tank (or lid) is visible.
2. **Boundary valve kit**
   Ensures that wastewater which is already in the pressure sewer cannot re-enter your property and enables maintenance staff to isolate you from the system in the event of an emergency.
3. **House service line**
   This is a small diameter pipe (not dissimilar to a large sprinkler system pipe) which connects the pumping unit on your property to the pressure sewer in the street.
4. **Control panel**
   This is a small box which is mounted to the wall of your house containing all the electrical controls for the pumping unit including both the audible and visual alarm systems.

Figure 6-1 - Pressure Sewer System Components

When designing pressure sewers, the following aspects should be taken into account:

- Flow estimation.
- Materials.
- Pipe Sizes.
- Capacity.

- Minimum velocity.
- Maximum velocity.
- System head.
- Valves.
- Air Management.
- Easements.
- Odour control.
- Cost estimation.
- Operational requirements (includes consideration of the location of the pressure main, valves etc.).
- Consideration of impact on receiving sewerage (refer to Section 5.1.3).

6.2. PRESSURE SEWER PUMPS AND CHAMBERS

6.2.1. Pressure Sewer Pumps

Yarra Valley Water has approved the use of submersible grinder pumps for pressure sewer systems as specified under Table 6-1.

Table 6-1 - Pressure Sewer Systems - Pump Units

PROPERTY TYPE	PUMP TYPE	PRODUCT NAME	DESCRIPTION
Residential	Single-Stage Centrifugal Pump	Aquatec's Omni-Grind Turbine 'OGT'	• Pump features a Single-stage centrifugal design • The pump operates on a pump curve • Pump operating flow ranges between 0.1L/s and 1.25L/s with a maximum head of 80m. However, based on Yarra Valley Water's experience regarding the performance of single-stage centrifugal pumps, 48m shall be adopted.
Industrial, commercial, and multi-unit residential	Multi-Stage Centrifugal Pump	Aquatec's Omni-Grind Plus 'OGP+'	• Pump features a Two-stage centrifugal design. • The pump operates on a pump curve • Pump operating flow ranges between 0.2L/s and 1.8L/s with a maximum head of 60m. • Pump motors are available in single phase and three phase. The three-phase motor are recommended where extra torque is required (i.e., high concentration of wet wipes from childcare centres etc.).

Yarra Valley Water shall be consulted for requirements if servicing requires higher pump heads (than mentioned above) and for the use of booster pressure stations.

6.2.2. Pressure Sewer Pump Chambers

Yarra Valley Water has approved the use of four types of pump chambers for pressure sewer systems. These are specified under Table 6-1.

Table 6-1 - Pressure Sewer Systems - Pump Chambers

PROPERTY TYPE	PUMP TANK TYPE	DESCRIPTION
Residential	Single Pump Product Aquatec's Enduraplex Simplex	• Pump type used is Aquatec's OGT pump • The tank has a diameter of 1.0m, depth of 1.6m and capacity of 950 litres. • The tank has an emergency storage capacity above alarm level of 667 litres
Residential	Single Pump Product Aquatec's Enviroplex Simplex	• This unit is for residential applications where 'rock' is encountered at shallow excavation depths. • Pump type used is Aquatec's OGT pump • The tank has a diameter of 1.2m, depth of 1.45m and a capacity of 900 litres (Note: A tank with an extended neck is available which increases the depth to 1.8m and capacity to 1000 litres). • The tank has an emergency storage capacity above alarm level of 600 litres.
Small to Medium sized Industrial, commercial, and multi-unit residential (up to 40EP)	Multi 2-Pump Product Aquatec's Duplex	• Pump type used is Aquatec's OGP pump • The tank has a diameter of 1.0m, depth of 2.2m and capacity of 1500 litres. • The tank has an emergency storage capacity above alarm level of 1070 litres.
Large sized Industrial, commercial and multi-unit residential (from 40EP to 60EP).	Multi 3-Pump Product Aquatec's Triplex	• Pump type used is Aquatec's OGP pump • The tank has a diameter of 1.5m, depth of 3.0m and capacity of 5000 litres. • The tank has an emergency storage capacity above alarm level of 3850 litres

6.3. FLOW ESTIMATION

Flow estimation within a pressure sewer network shall consider normal operational flows and post power outage flows, along with the type of system: full pressure, 'smart' pressure, or hybrid system. Flow estimation is best completed via the use of a hydraulic model (Modelling Concept Community Sewerage Systems in InfoWorks).

For Community Sewerage Areas, the systems are modelled based on a residential demand of 514L/hh/day (based on 3 EP per household).

Flow estimation for individual developments (i.e. multi-unit residential, apartments, industrial/commercial) are to be assessed based on the requirements set out in Section 3 (if not located in a Community Sewerage area), or Section 6.5 and Section 6.6 (if located in a Community Sewerage Area).

When designing pressure sewers, it is assumed zero inflow and infiltration occurs, meaning the design flow equation can be amended as follows:

Design Sewer Flow	= PDWF
Where PDWF	= peak dry weather sanitary flow (as calculated using a hydraulic model or the method described in Section 3)

Following a power outage, it is assumed in full pressure and hybrid systems that the majority of pumps will attempt to pump. This will result in the following scenarios depending on the type of system and pump installed:

(a) Full pressure system with OGT pumps: The OGT pumps have the pressure cut out switch installed which will result in pumps ‘tripping out’ on a high pressure reading, which will result in pumps with lower head conditions pumping out first.
(b) Full pressure system with OGP pumps: The OGP pumps can operate at low flow/high head situations, which will result in all pumps operating but all at different flow rates.
(c) Hybrid pressure/gravity system: Pumps connected directly into a gravity sewer will have no restriction on pumping, whether an OGT or OGP is installed.

If the system is a hybrid system or full pressure and contains (OGP) pumps, then consideration needs to be given to the flows that may be experienced after a power outage and pipe diameters adjusted accordingly if required.

Gravity sewers will need to be assessed and sized for the worst-case scenario, either

(a) PWWF, or
(b) Post 24hr power outage flow.

In ‘smart’ pressure systems which utilise two-way telemetry communication between the property and a central control system, following a power outage, the operation of the individual pump units will be controlled via algorithms to ‘smooth’ the flow.

This flow ‘smoothing’ allows for a reduction in the size of the pressure network infrastructure.

The minimum required pump rate for an individual property shall be calculated based on the requirements detailed in Clause 4.4.3 of WSA07.

6.4. MATERIALS

All pressure sewers and approved fittings must be constructed using fully welded polyethylene (PE), utilising a Minimum Pipe Class - PE100 (SDR11) PN16 (Black with cream stripe).

All on-property pump units (including storage tank, control system, and pumps) must be supplied by Yarra Valley Water approved supplier ‘Aquatec’ as per requirements under Section 6.2.

All approved products and materials are specified on the MRWA Portal.

6.5. PIPE SIZES

The minimum allowable pipe diameters for pressure sewers shall be as per Table 6-3.

Table 6-3 - Minimum Pressure Sewer Diameters

PIPE TYPE	MINIMUM PIPE DIAMETER (DN)
House Service Line	40mm (ID = 32mm)

Pressure Sewer	50mm (ID = 40mm) [1]

[1] DN40mm pipe can be specified when there is a minimal number of property connections (i.e., end of line) in order to achieve minimum velocity requirements.

Selection of pipe size shall consider to keep friction loss to minimum whilst remaining within the required velocity ranges as per Section 6.9 and Section 6.10.

6.6. MULTI-UNIT RESIDENTIAL DEVELOPMENTS

6.6.1. Community Sewerage Areas

Yarra Valley Water requirements are noted below:

(a) Multi-unit residential developments managed by an Owner's Corporation can be serviced by a common pump unit of the appropriate capacity, rather than individual pump units for each property. However, this is only applicable where:
  I. Common power supply is available, and.
  II. Gravity connection from the residential units to the common pump is feasible.
(b) The pump unit shall include SCADA alarms with backup battery.
(c) A minimum 4.0m wide easement will be required for permanent access over the property discharge line as detailed in Section 6.16.
(d) The pump unit shall be located within a common property.
(e) Multi residential development up to 40EP shall use a 2-Pump unit using Aquatec's Duplex pump chambers (refer Section 7.2).
(f) Multi residential developments from 40 EP to 60EP shall use a 3-Pump unit using Aquatec's Triplex pump chambers (refer Section 7.2).
(g) Multi residential developments greater than 60EP shall implement Yarra Valley Water's requirements for a Sewage Pumping Station as per Section 8. Alternatively, it is possible to use multiple duplex or triplex units to service large Owner Corporation developments.

6.6.2. Developments outside of Community Sewerage Areas

For multi-unit residential developments outside of Community Sewerage Areas, YVWCD-2-7954 Servicing Properties with Privately Owned Sewage Pumping Stations shall be applied.

6.7. INDUSTRIAL/COMMERCIAL PROPERTY DEVELOPMENTS

Yarra Valley Water requirements are noted below:

(a) Maximum discharge flow shall be 40,000 L/day.
(b) Refer to Table 6-1 for details on pump chambers that shall be used for different development types.
(c) Minimum 5000 L of Emergency Storage. The storage shall be sized as detailed in Section 6.8.
(d) The pump unit shall include SCADA alarms with backup battery.
(e) A minimum 4.0m wide easement will be required for permanent access over the property discharge line as detailed in Section 6.16.
(f) Customers with emergency generators on site will be requested to provide power to the pump unit in the event of a power outage.

Industrial/commercial developments greater than 40,000 L/day shall implement Yarra Valley Water's requirements for a Sewage Pumping Station as per Section 8.

6.8. EMERGENCY STORAGE REQUIREMENTS

Pump chambers for residential properties shall have at least 24 hours of storage assuming a typical daily of 514 L/hh/day discharging to sewer (Note: 514 L/hh/day only applies to residential Community Sewerage Areas).

All pump units for Multi-Unit Developments and Industrial/Commercial Developments shall have a minimum of 3 hours' emergency storage, either wholly contained within the pump unit or in combination with an additional storage tank.

The required volume of the emergency storage shall be the maximum theoretical inflow volume generated during any continuous 3-hour period during dry weather flow.

Calculation of the emergency storage volume is based on the volume above the alarm level for the pump unit.

The calculation of the emergency storage volume shall be determined via any of the following methods:

(a) Hydraulic modelling (preferred).
(b) Volume calculation shall be based on EP from WSA 02 Appendix B Estimation of Equivalent Population or proposed flows provided by Developer.

6.9. MINIMUM VELOCITY

All pressure sewers must achieve a self-cleansing velocity of 0.6m/s (based on PDWF) at least once per day. This will ensure that any grit or debris, which may build up within the pipe, can be flushed out without the need for manual cleaning.

6.10. MAXIMUM VELOCITY

The maximum velocity allowable in pressure sewers during PWWF is 3.0m/s. This will avoid scouring of the pipe and ultimately increase its serviceable life.

6.11. SYSTEM HEAD

All pressure sewers must be designed such that the following pressures are not exceeded at any of the pump units:

(a) Multistage Centrifugal Pump (OGP) total system head (normal operation) – 45m.
(b) Single Stage Centrifugal Pump (OGT) total system head (normal operation) – 48m.

In areas of the pressure sewer network where pressure at the pump units are expected to exceed the above pressures, a booster pump station may be required to serve as a hydraulic break. Booster pump stations are typically installed in public land, like a road reserve, and comprise a duplex or triplex multi-pump unit described in Section 6.2.2.

A total system head of greater than 60m is permissible post a 24-hour power outage scenario, provided no pressure sewer units (via hydraulic modelling assessment) are predicted to spill.

Pressure reticulation sewers should only discharge into a gravity sewer at the highest point of the pressure sewer. This is in order to prevent sections of the pressure sewer draining under no flow conditions.

6.12. TELEMETRY

Telemetry that links the unit to the Yarra Valley Water SCADA system shall be provided for all Duplex and Triplex systems.

There is no requirement for telemetry for standard Simplex installations. Designers can elect to nominate telemetry for these installations if there are significant advantages to controlling a section of the system (e.g., directly upstream of an SPS, to minimise the SPS storage requirements).

6.13. PUMP CONTROL PHILOSOPHY

The pressure sewer working group have classified the control system into three types.

(a) Type 1 - No telemetry.
(b) Type 2 - Alarms.
(c) Type 3 - Alarms and set point control.

All Duplex and Triples systems will be Type 3. Domestic simplex systems will be either Type 1,2 or 3 depending on the outcome of a risk assessment.

Yarra Valley Water requirements are noted below:

(a) Pressure sewer pumps operate by a cut-in, cut-out philosophy.
(b) High-level alarms for Duplex and Triplex systems shall be triggered by an alarm in SCADA.
(c) High-level alarms for Simplex systems (not on SCADA) shall be triggered by an audible and visual alarm at the control panel of the unit. Customers are encouraged to call Yarra Valley Water if the alarm activates, and a Yarra Valley Water representative will attend the site.
(d) Duplex units shall operate on a Duty/Assist philosophy, whilst Triplex units shall operate on a Duty/Assist/Assist philosophy.

6.14. VALVES

The purpose and requirements of valves in a pressure sewer system are described in Table 6-2.

Table 6-2 - Pressure Sewer Valves

VALVE TYPE	PURPOSE	REQUIREMENTS
Isolation (shut) valve	Isolate sections of the pressure sewer in the event of a system failure or planned maintenance	• Must be clockwise closing • Must be fitted with a pressure sewer spindle to distinguish them from water valves • Must be located a interval of less than 500m or 30 service connections, whichever is the least • If located on same side of road as water main, a minimum of 2.5m spacing between water and sewer valves shall be maintained. • Surface box shall be labelled ‘sewer’ as per MRWA pressure sewer standard drawing PSS-101-M

		• Valves must be located within an even surface to allow for safe operation. • Must be located on either side of bridge crossings or unstable ground • Must have a minimum pressure rating of PN16 • All valves $\geq$ DN80 must be resilient seated valves and flanged
Scour (flushing point) valve	Flush flows out of the pressure sewer either for cleaning or maintenance purposes	• Must be located at the dead end of pressure sewers • In line flushing points shall be provided downstream of isolating valves, except where there is a downstream flushing point within 100m • In line flushing points shall be provided where there is more than one upstream connecting line. • Flushing points shall be provided at intervals not exceeding 500m • If located on same side of road as water main, a minimum of 2.5m spacing between water and sewer valves are to be maintained. • Surface box shall be labelled 'sewer' as per MRWA pressure sewer standard drawing PSS-101-M • Scour valves must be located within an even surface to allow for safe operation. • Flushing points shall be designed to allow for scouring/flushing with flow initiation from the end flushing points and progressively downstream via in line flushing points to the discharge end of the network • Where there is more than one connecting pressure sewer at a tee junction, a flushing point must be provided downstream of the junction
Air Valve	Release air which accumulates in the system which may potentially cause operational problems or enable the formation of a vacuum within the system	• Air valves must be located at all high points where a negative pressure of 10m can occur • Air valves must be dual action air valve • Air valves must have an isolating valve
Boundary Valve Kits	Isolate individual pumping units from the pressure sewer in the road reserve as well as preventing flows passing from the pressure sewer in the road reserve back into the customers property	• Boundary valve kits must be located on every property between the pumping unit and the pressure sewer in the road reserve • Boundary valve kits must be located along the front property boundary (unless approved by Yarra Valley Water)

6.15. AIR MANAGEMENT

When air accumulates at high points within the pressure sewer network and velocities are not sufficient to move the air downstream, the upstream pumps will operate under greater pressure due to the effects of the entrapped air.

Pressure sewer networks should be designed such that entrapped air is transported downstream from high points and eventually out of the system, although this is only likely to occur when the flow velocity within the pipe is sufficient (i.e., peak flow periods). However due to diurnal flow within the system, the required flow velocities will not always be achieved, and air will accumulate at high points during periods of low flow velocity. The Walski equation is generally used to determine whether a pocket of air is likely to be swept downstream. If it is determined that the air pocket will not be swept downstream then an air valve will be required.

Refer to WSA 07 Appendix A for Walski equation and more details on air management in pressure sewer systems.

Sewage air release valves should only be installed where the effect of the entrapped air causes a significant negative impact on the hydraulic performance of the system. At design stage, it should be assessed whether the pipeline grade can be adjusted to avoid the need for an air release valve and replacement of carbon. OPEX cost for the maintenance of the air release valves should be taken into consideration for the NPV assessments.

The air that accumulates in a pressure sewer system will be a mixture of air and sewage gases and release will likely be odorous and hazardous.

There is a risk of H_2S posing a safety risk in these systems and the Designer shall assess the location as per requirements under Section 5.1.1 of this document.

Yarra Valley Water's preference for managing odour on air valves is via Green Dome Filters.

6.16. EASEMENTS

6.16.1. Reticulation Pressure Sewers

Reticulation pressure sewers preferably should be constructed in the dedicated road reserve and public open space. Where a pressure reticulation sewer cannot be located in a dedicated public road reserve or public open space, it shall be located within an appropriately sized and registered easement, subject to the approval of Yarra Valley Water.

The location of a pipeline within an easement shall be centrally placed.

Yarra Valley Water requirements for easements for reticulation pressure sewer is as per Table 6-3.

Table 6-3 - Pressure Sewer Easement Requirements

LAND USE	PIPE SIZE	PREFERRED LAND TENURE ACTION
Municipal Reserve	< DN 100	Minimum 2.0m easement.
	> DN 100 and < DN 200	Minimum 4.0m easement.
	≥ DN 200	Minimum 6.0m easement.
Private Property	All sizes	Reticulation pressure sewers shall not be located within private property
	Temporary reticulation	Temporary reticulation pressure sewers may be located within private property and within an easement. Minimum 4 m easement subject to Yarra Valley Water approval

	pressure sewers ≤DN 160	
Body Corporate Common Property	All sizes	Minimum 4 m easement in common land used for roadway

6.16.2. On-Property Components

The location of the on-property components (property connection, pump unit, house service line, boundary valve kit and control panel) shall be determined on-site by Yarra Valley Water's approved pressure sewer contractor, in conjunction with the property owner.

The location of the on-property components within an easement shall be centrally placed.

Yarra Valley Water requirements for easements for on-property pressure sewer components is as per Table 6-4.

Table 6-4 - On-Property Components Easement Requirements

LAND USE	PIPE SIZE	PREFERRED LAND TENURE ACTION
Private Property (Individual Property)	DN 40	Easements not required
Private Property (New sub-division)	> DN 40	In a new sub-division with vacant blocks, the Developer must create a 1m wide easement down the side of each block. The easement is required to facilitate the installation of on-property pressure sewer components and must be located on the side of the property, which the household plumbing will drain.
Private Property (Multi-Unit Residential)	> DN 40	Minimum 4.0m easement.
Private Property (industrial/commercial properties service lines and pumping units)	> DN 40	Minimum 4.0m easement.

7. SEWER RISING MAINS

7.1. GENERAL

The following principles for the planning and design of sewer rising mains (SRM) must be read in conjunction with the Yarra Valley Water Pressure Main Technical Standard.

Both this document and the Technical Standard outline the design requirements for SRM.

Pressure mains are pipes along which sewage is pumped. They typically rise from a sewage pumping station and discharge into a gravity sewer. Pressure mains are very similar in design to gravity sewers except the pipe flows full. The main aspects to consider when designing rising mains are noted below:

- Capacity.
- Design pressure.
- Minimum velocity.
- Maximum velocity.
- Discharge maintenance hole arrangement.
- Customer connections.
- Valves.
- Materials.
- Easements.
- Odour control.
- Cost estimation.
- Fatigue.

7.2. CAPACITY

The required capacity of the pressure main is the ultimate design flow generated by the upstream pump station, and as a minimum must be equal to the pump rate.

7.3. DESIGN PRESSURE

The pressure main must be designed for the peak pressure generated by the pump station. This is defined as:

Design Pressure = Static Pressure + Friction Loss + Water Hammer

Refer to Section 7 and Section 8 of the Pressure Main Technical Standards for more detail.

The pipe class selected for the pressure main must have a peak allowable pressure, which is at least equal to the peak pressure, and be a minimum of PN16.

For the calculation of friction loss along the pressure main the following typical Colebrook White 'k_s' friction factors can be used.

Table 7-1 - Friction Factors

VELOCITY	SUITABLE VALUES OF K_S (mm)

	Good	Normal	Poor
Mean velocity 1.0 m/s	0.15	0.3	0.6
Mean velocity 1.5 m/s	0.06	0.15	0.30
Mean velocity 2.0 m/s	0.03	0.06	0.15

7.4. FATIGUE

For thermoplastic pipes (PVC or PE), a fatigue de-rating factor shall be applied to the operating pressure as per WSA03 Section 3.6.4 'Fatigue de-rating of plastic pipes and fittings'.

For other pipe material (other than thermoplastics), the nominal pressure rating shall be increased by one-step.

7.5. MINIMUM VELOCITY

The pressure main must meet a minimum slime shearing velocity at the ultimate design flow to achieve a shear stress of 3.85kPa.

The minimum slime stripping velocity varies with the internal diameter of the pressure main. Figure 7-1 and Figure 7-2 details the minimum velocities for slime control, along with the critical flows for slime control and self-cleansing for various pipe diameters. These graphs were developed based on the formulas in Section 4.4.

Refer to Section 6 of Yarra Valley Water Pressure Main Technical Standard for more details.

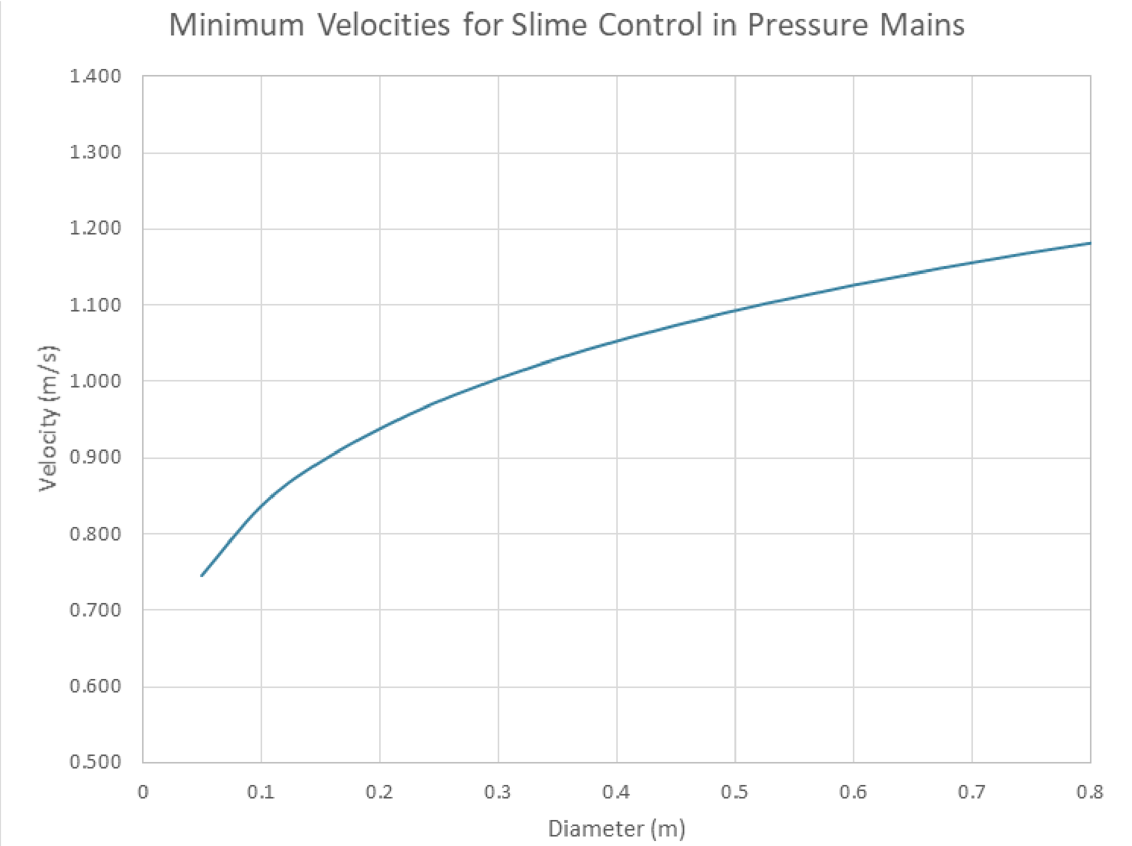


Figure 7-1 - Minimum Velocities for Slime Control in Pressure Mains (Manning's 'n' 0.01278)

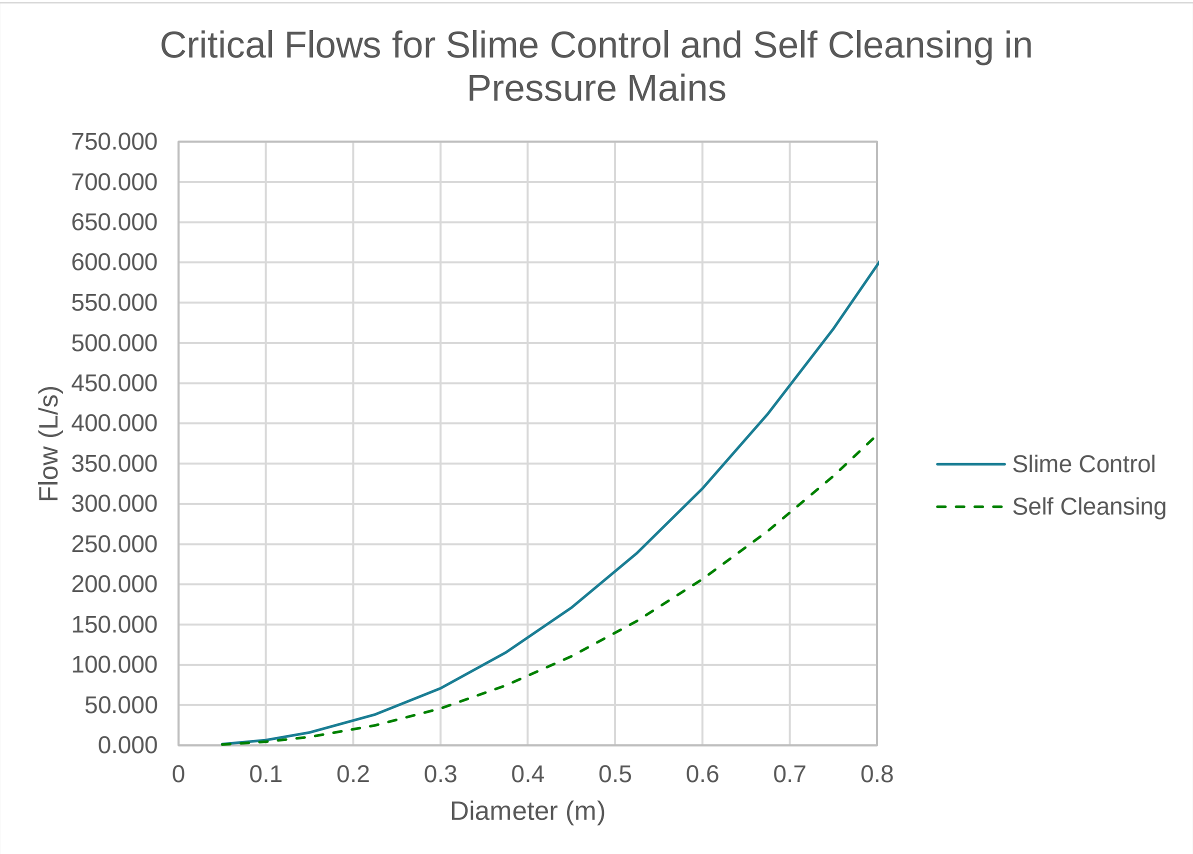


Figure 7-2 - Critical Flows for Slime Control and Self Cleansing in Pressure Mains

7.6. MAXIMUM VELOCITY

The maximum allowable velocity in pressure mains at ultimate design flow is 3.0m/s, to prevent the erosion of pipes and fittings.

7.7. DISCHARGE MAINTENANCE HOLE

In addition to the requirements for the discharge maintenance hole detailed in the Yarra Valley Water Pressure Main Technical Standard and MRWA Drawings, the following points should be considered.

(a) Diameter of gravity sewer discharge pipe in relation to rising main diameter and flow rate. The first section of gravity sewer shall be upsized to reduce likelihood of surcharge in the discharge maintenance hole.
(b) Potential for air displacement within the discharge maintenance hole or along the gravity sewer discharge line to cause boundary traps on property connections to be 'sucked' out.
(c) Provision for the maintenance hole to be vented to allow for air to be drawn in or out of the system. This venting may be via a traditional vent stack or via a filtered vent.
(d) Corrosion control protection shall be provided to maintenance holes located downstream of the discharge maintenance hole, if warranted by H_2S levels.

7.8. CUSTOMER CONNECTIONS

The connection of customers into pressure (rising) mains is not generally permitted.

Yarra Valley Water in exceptional circumstances will consider allowing customer connections when no alternative options are available.

7.9. VALVES

Refer to Section 11 of Yarra Valley Water Pressure Main Technical Standard for details.

7.10. MATERIALS

There are several different suitable materials available to be used for pressure sewerage pipes. Determination of the most suitable material is based on, but not limited to, the following criteria:

(a) Required pipe diameter.
(b) Required pressure class.
(c) Ground conditions.
(d) Depth.
(e) Construction method.
(f) Catchment type (i.e., residential, or industrial/commercial).

All approved products and materials are specified on the MRWA Portal.

A summary of the advantages and disadvantages, along with the range of sizes available for the various pipe materials is detailed in Appendix E.

7.11. EASEMENTS

The Yarra Valley Water easement requirements for pressure mains based on land zoning are noted in Table 7-2.

Table 7-2 - Easements

Land use	Pipe size	Preferred land tenure action
1. Private Property	All pipes	**Redesign – Not Acceptable in private property under any circumstances**
2. Municipal Reserve	< 200mm	Minimum 4.0m easement. Pipe to be located centrally within easement [1]
	≥ 200mm	Minimum 6.0m easement. Pipe to be located centrally within easement [1]

[1] If future duplication of the pressure main is proposed the initial pressure main shall be located within the easement to allow for the duplication pipe.

7.12. ODOUR CONTROL

Refer to Section 19 of Yarra Valley Water Pressure Main Technical Standard for details.

8. SEWAGE PUMPING STATIONS

8.1. GENERAL

The following principles for the planning and design of sewage pumping stations (SPS) must be read in conjunction with the Yarra Valley Water Sewage Pumping Station Technical Standard.

Both this document and the Technical Standard outline the design requirements for Sewage Pumping Stations.

Sewage pumping stations are used to transfer sewage from a low point to a high point. The main aspects to consider when designing sewage pumping stations are noted below:

- Capacity.
- Wet Well Dimensions.
- Wet Well Levels.
- Emergency Storage Provision.
- Emergency Relief Structure.
- Ventilation.
- Odour Control.
- Buffer Distances.
- Cost Estimations.

8.2. PUMP STATION CAPACITY

Pump stations will generally be designed to pump either:

(a) Peak Wet Weather Flow (PWWF) from the upstream catchment, or
(b) At a rate equivalent to the available excess capacity within the receiving downstream sewerage system (generally associated with sewerage flow control facilities).

Any new pump station designed should be checked and integrated with the system to which it is connecting. This should ideally be completed via the use of a hydraulic model.

Refer to Section 3.1 of Yarra Valley Water SPS Technical Standards for more details.

8.3. WET WELL DIMENSIONS

The minimum diameter of wet wells shall be:

(a) Small Duplex / Tri-set / Triplex – 3.2 m.
(b) Large Duplex – 4.1 m.
(c) Large Tri-set / Triplex – 5.0 m.

Yarra Valley Water's preference is that all wet wells are circular, however square, or rectangular wet wells will be accepted in some circumstances (i.e., multiple linked wet wells).

Refer to Section 2.6 of Yarra Valley Water SPS Technical Standards for more details.

8.4. WET WELL LEVELS

8.4.1. Wet Well Surface Level

Flood levels for the project site shall be obtained from Melbourne Water (where available). If the wet well cannot be located above the flood level, the access covers must be sealed, and a vent installed to above the flood level.

8.4.2. Pump Control Levels

The control levels for the wet-well shall be in accordance with the requirements provided in the Table 8-1. The pump control levels shown for Duplex pump station only. Refer to YVWCD-2-6885 Sewer Pump Station System Control Philosophy.

Table 8-1 - Pump Control Levels

PARAMETER	DESCRIPTION	REQUIREMENT
Wet Well High-High (Float) Alarm	Alarm to indicate imminent overflow (i.e., ERS spill)	Set at 100mm below ERS spill level
Emergency Storage Tank Filling (Analogue) Alarm	Alarm to indicate overflow into the emergency storage (if a separate emergency storage tank is provided)	Set at the level at which the emergency storage starts filling (Optional alarm setting)
Wet Well High (Float) Alarm	Alarm on sewage level. Required Emergency Storage Volume is above this level. Note: The float must be set below the Emergency Storage level to increase time available to respond	To be set above Emergency Backup Pumping Float 2, and be the greater of: 200mm, or 1 minute of height increase at PDWF conditions
Emergency Back-up Pumping – Pump 2 (Float)		To be set above Emergency Backup Pumping Float 1, and be the greater of: 200mm, or 1 minute of height increase at PDWF conditions
Emergency Back-up Pumping – Pump 1 (Float)		To be set above Standby Cut In and be the greater of: 200mm, or 1 minute of height increase at PDWF conditions
Standby Pump Cut in Level (Analogue)	The wet well level at which the standby pump is programmed to start	Set to be greater of: 100mm above the duty cut-in level, or 1 minute of height increase at PDWF conditions
Inflow Pipe Level	The level of the incoming sewer invert level	Refer to Sewage Pump Station Technical Standards for details on

		minimum height above Duty Pump Cut in level
Duty Pump Cut in Level	The level at which the duty pump is requested to start	Set at a level which gives: Maximum 12 starts/hr ($\leq$ 15kW) Maximum 8 starts/hour (> 15kW)
Duty pump Cut Out Level	The level at which the duty pump is requested to stop	Set in accordance with the heights corresponding to the cut-in/cut-out volumes and being not lower than the minimum submergence levels of the pumps
Low Level	Set as low as possible to eliminate dead storage, but still provide enough submergence of the pump to prevent ventilation at the pump inlet and allow for motor cooling	Set as per pump suppliers' recommendations (Note: some pumps without cooling jackets need to be fully submerged, whereas some pumps with cooling jackets can be run at 'snort' level)

8.4.3. Live Leak Detection

In addition to the standard levels for pump control detailed in Table 8-1 above, an additional setting is required to monitor pressure drop within the pressure (rising) main.

The pressure transducer at the pump station shall be linked via SCADA for pressure monitoring. Pressure readings are taken during 'pump off' conditions and when the pressure drops below the expected head, an alarm shall be triggered.

The pressure drop method of live leak detection is only possible when the rising main has a continuously rising profile.

Rising mains that have undulating or falling profiles will require alternate methods of leak detection, such as

(a) Multiple pressure monitors located at low points, or
(b) Flow totalisation (i.e., flow meters at each end).

8.5. EMERGENCY STORAGE

All Sewage Pump Stations must be provided emergency storage to reduce the likelihood that spills will occur following either a mechanical or a power outage, allowing maintenance crews sufficient time to respond and arrange for management of flows from the wet well.

8.5.1. General

Yarra Valley Water requirements on emergency storages at Sewage Pumping Stations are as follows:

(a) All Sewage Pump Stations having an ADWF <= 5 L/s must be provided with a minimum emergency storage volume equal to the lesser of either:
   I. The maximum theoretical inflow volume generated during any continuous 3-hour period during dry weather flow, determined by a hydraulic model; or

    II. 3 hours at PDWF, using WSAA method for small catchments.
(b) Where the storage is provided in the wet well, an additional storage equivalent to 60 minutes at PDWF shall be available in the maintenance holes and sewers upstream of the wet well.
(c) For Sewage Pump Stations having an ADWF exceeding 5 L/s a more detailed assessment of the emergency storage volume is required. This will need to consider the following factors:
    I. Travel time to site for initial response.
    II. Travel time to site for other equipment (e.g., eductor truck, or by-pass pumps and equipment, or temporary generator).
    III. Site specific constraints that limit the efficiency of eduction (e.g., suction heights > 6m, proximity to discharge point to the site).
    IV. Time taken to set up equipment to manage flows in the event of mechanical or electrical failure on site (e.g., by-pass pump, temporary generator).
(d) This storage volume must be provided above the high-level alarm level and may be provided in one or more of the following (in order of preference):
    I. Offline storage tank or pipe.
    II. Upstream gravity pipe network.
    III. Wet well.
(e) For Sewage Flow Control (SFC) facilities, the storage within these sites is considered to account for the emergency storage volume required for the wet well. As such, no separate emergency storage is required for a wet well forming part of a Sewage Flow Control facility.
(f) For pump stations located in sensitive environmental areas that are interlocked, it needs to be taken into consideration as to whether the downstream pump station storage needs to be sized accordingly in the event of an interlock failure.

Refer to Section 2.9.1 of Yarra Valley Water Sewage Pump Station Technical Standard for more details.

8.5.2. Failure Analysis

The required storage volume will be calculated in consideration of the factors under Section 8.5.1 (c) and will need to cater for a range of scenarios where the pump station has no pumps available.

Scenarios shall include mechanical failure of all pumps, failure of equipment within the wet well (e.g., pump pedestals or pump risers), switchboard failure, or prolonged power outages.

The designer shall consider the risk and consequences of the various modes of failure and incorporate contingencies accordingly based on an environmental risk assessment. The contingency plan shall include provision of:

(a) Standard connections for emergency by-pass pumping.
(b) Standard connections on the electrical cubicle for a mobile generator.
(c) Stand-by pumping equipment and associated controls.
(d) Spare pump(s); and
(e) Easy all-weather access for maintenance and emergency activities.

8.6. EMERGENCY RELIEF STRUCTURE

Refer to Section 2.9.2 of Yarra Valley Water Sewage Pumping Station Technical Standard and the Yarra Valley Water Emergency Relief Structure Technical Standard for details.

8.7. VENTILATION

All Sewage Pump Stations must be equipped with ventilation.

Provision may be required on larger Sewage Pump Stations to install further odour-control measures (i.e., carbon scrubbers etc.).

Refer to Section 2.8 of Yarra Valley Water Sewage Pump Station Technical Standard for more details.

8.8. ODOUR CONTROL

Refer to Section 7.8 of Yarra Valley Water Sewage Pump Station Technical Standard for details.

8.9. BUFFER DISTANCES

There should be a buffer distance of at least 50 metres to the nearest residential allotment (measured from the centre point of the pump wet well and any other significant noise or odour sources) to minimise potential odour and noise issues. Any variation to this buffer distance must be approved by Yarra Valley Water.

8.10. POWER RELIABILITY

Refer to YVWCD-2-6719 Standard and requirements for Portable and Fixed Plant Generators. Additional Requirements noted below:

(a) Sewage Pumping Stations must be installed with fixed plant power generators.
(b) A minimum back up power of 8 hours must be supplied.
(c) All electrical equipment should be designed to withstand extreme heat days (temperatures higher than 40°C) by using shade, heat resistant switchboards and similar.

8.11. CRITICAL SPARES

During the design phase, the Designer shall identify critical spares for items with long lead times with considerations given to warranty periods.

9. SEWAGE FLOW CONTROL FACILITIES

9.1. GENERAL

The following principles for the planning and design of Sewage Flow Control facilities (SFC) must be read in conjunction with the Yarra Valley Water Sewage Flow Control Facilities Technical Standard.

Both this document and the Technical Standard outline the design requirements for Sewage Flow Control Facilities.

Flow Control Facilities are designed to store wet weather flows for release into the downstream system when capacity is available, enabling downstream upgrades and augmentations to be avoided whilst preventing overflows.

The design for each Sewage Flow Control facility will vary greatly due to the physical extent of the civil works and the differing operational requirements.

The main aspects that should be considered when designing a flow control facility are:

- Capacity.
- Fill and Drain Method.
- Flushing Method.
- Provision for by-pass pumping.
- Odour Control.
- Buffer Distances.
- Cost Estimation.

9.2. CAPACITY

As a minimum, a SFC shall:

(a) Be sized using hydraulic models.
(b) Accommodate for future growth in the catchment both upstream and downstream of the Sewage Flow Control facility.
(c) Have a discharge rate less than or equal to the available excess capacity in the downstream sewer allowing for ultimate infill development, where excess capacity is equal to the total capacity minus the current or ultimate flows through the system.

It should be noted that the critical design storm used to size the Sewage Flow Control volume may not correspond with the critical design storm for the rest of the sewerage system.

The design philosophy for wet wells at Sewage Flow Control facilities shall be same as for Sewage Pump Stations with some minor exceptions:

(a) Wet wells can be square or rectangular if required.
(b) Wet well shall spill to the flow control facility, then into the Emergency Relief Structure.

Refer to the Yarra Valley Water Sewage Flow Control Facilities Technical Standard for more details.

9.3. FLUSHING METHOD

Within a SFC, sediment and debris are deposited following each operation.

These solids must be removed immediately following operation and there are several different methods for doing so, with Yarra Valley Water's preferences outlined in the Yarra Valley Water Sewage Flow Control Facilities Technical Standard.

9.4. BUFFER DISTANCES

There should be a buffer distance of at least 50m between the nearest developable lot and the perimeter boundary of the Sewage Flow Control facility.

9.5. POWER RELIABILITY

Refer to YVWCD-2-6719 Standard and requirements for Portable and Fixed Plant Generators. Additional Requirements noted below:

(a) Sewage Flow Control Facilities must be installed with fixed plant power generators.
(b) A minimum back up power of 8 hours must be supplied.
(c) All electrical equipment should be designed to withstand extreme heat days (temperatures higher than 40°C) by using shade, heat resistant switchboards and similar.

10. ASSET DECOMMISSIONING

10.1. GENERAL

Decommissioning of assets can be required as part of upgrade works within the sewerage network. Assets that require decommissioning must be identified at the design phase and work must be completed almost immediately after implementation of the proposed augmentation. Asset decommissioning costs must be allowed for as part of the project.

For all decommissioning works the following definitions apply:

(a) Flowable Fill - Flowable fill shall be controlled low strength material consisting of fluid mixture of cement, fly ash, fine aggregates, and additives (e.g., Hanson Liquifill).
(b) Grout - Cement based dry-pack grout (e.g., Parchem Conbextra Deep Pour).

10.2. GRAVITY SEWERS

The methodology to be used to abandon gravity sewers will depend on the depth and location of the sewer:

(a) Sewer Cover < 1.5m: All sewers which have a cover depth to the pipe obvert of < 1.5m, and which are not located under structures, obstructions, waterways, roads, railway tracks, right of ways or similar surface obstructions shall be removed and the excavation backfilled as per the MRWA Backfill Specification 04-03.2.
(b) Sewer Cover > 1.5m: All sewers which have a cover depth to the pipe obvert of > 1.5m, and which are not located under structures, obstructions, waterways, roads, railway tracks, right of ways or similar surface obstructions shall have 'grout' plugs placed at either end. The grout plug is to be installed a minimum of 300mm into the pipe. A temporary plug will need to be placed inside the pipe to facilitate installation of the grout plug.
(c) Sewers located under structures, obstructions, waterways, roads, railway tracks, right of ways or similar surface obstructions shall be completely filled with 'flowable fill' from maintenance structure to maintenance structure.

10.3. SEWER RISING MAINS

The methodology to be used to abandon rising mains is as detailed above in Section 10.2 for Gravity Sewers, based on the depth and location of the rising main. In addition to these requirements the following additional works are required to be completed.

(a) Appurtenances: All appurtenances (shut valves, air valves, scour valves etc.) are to be removed from the pipeline and the resulting sections of pipe be sealed via the installation of a grout plug.
(b) Location/Distance: When grout plugs are being installed to abandon rising mains, they shall be installed at all high and low points along the alignment. In addition to these locations, grout plugs are to be installed at a maximum spacing of 250m.

10.4. MAINTENANCE STRUCTURES/VALVE PITS/SCOUR PITS/AIR VALVE PITS

The methodology to be used to abandon maintenance structures, valve pits, scour pits and air valve pits is as follows:

(a) Maintenance Structures: For concrete maintenance holes, the maintenance hole frames, and cover are to be removed and the concrete structure broken down to a minimum of 1m from surface level. The structure can be broken down to a greater depth, but not deeper than 0.5m above the obvert of the abandoned sewer. The pipe exits from the maintenance hole are to be sealed with a grout plug and the maintenance hole filled with ‘flowable fill’ to a depth of 0.5m below the finished surface level. The remaining depth is to be backfilled with the appropriate material based on the maintenance hole location. For GRP maintenance holes, the structure is to be totally removed and the pipes sealed with grout plugs.

(b) Maintenance chamber or shaft: The structure is to be totally removed and the pipes sealed with grout plugs.

(c) Valve Pits/Scours Pits/Air Valve Pits: The pit frames and covers are to be removed and the pit structure broken down to a minimum of 1m from the surface level. The structure can be broken down to a greater depth, but not deeper than 0.5m above the obvert of the abandoned sewer. The pipe exits from the pit are to be sealed with a grout plug and the maintenance hole filled with ‘flowable fill’ to a depth of 0.5m below the finished surface level. The remaining depth is to be backfilled with the appropriate material based on the pit location.

10.5. SEWAGE PUMP STATIONS

The methodology to be used to abandon sewage pump stations is as follows:

(a) The cover and any surrounding concrete surrounds, plinths etc. are to be removed and the wet well structure broken down to a minimum of 1m from surface level. Any pipe entries into the wet well are to be sealed with grout plugs and the wet well is to be filled with flowable fill to a depth of 0.5m below the finished surface level. The remaining depth is to be backfilled with the appropriate material based on the sewage pump station location.

(b) Refer to Decommissioning a Sewer Asset Guide for details relating to decommissioning assets related to sewer pump stations.

(c) Designer shall consider decommissioning activities as part of design.

11. Appendices

Appendix A – Design Default Assumptions Reticulation Sewers

PARAMETER	VALUE	COMMENT
Rainfall Intensity	1 hour	
k	1.5mm	Colebrook-White roughness coefficient
d/D	0.7	A proportional depth ration of 0.7 provides for 30% air gap at design flow
EP/ET	3	Design ratio of equivalent persons per equivalent tenement
ADWF	150 L/d/EP	Refer to WSA02-2014
Median Lot Area	450m^2	Refer to WSA02-2014
Net/Gross lot area	70%	Yarra Valley Water Default
Sewer below water table	35% $Portion_{Wet}$	Yarra Valley Water Default
Soil aspect	0.8 S_{aspect}	Yarra Valley Water Default
Network defects aspect	0.6 N_{aspect}	Yarra Valley Water Default
Leakage severity, C	1.4. $S_{aspect} + N_{aspect}$	Yarra Valley Water Default
AEP	0.181 (ARI 5 years)	Yarra Valley Water Default

Appendix B – Liquid Phase Chemical Odour Control Methods

The Table below lists the benefits and disbenefits of the different types of chemical dosing methods, approved for use on Yarra Valley Water's sewer network

TECHNOLOGY	BENEFITS	DISBENEFITS	TRADE/COMMON NAME
Alkalis	• Can be dosed in conjunction with iron salts to improve efficiency	• Dosing with two chemicals may be economically unviable	
Lime	• Cheap readily available, simple to dose, quick to buffer pH up and reduce evolution of H_2S • Non-dangerous good	• High pH which can adversely impact on STP • Can have handling and dosing issues • Hazardous substance	Lime
Magnesium Hydroxide (Refer to YSGD0521 Design Guidelines for Magnesium Hydroxide Dosing Facilities)	• Buffers at pH of 9.5, no risk of excessive pH • Non-dangerous good (transport)	• Expensive and correct dosing equipment needs to be used to prevent blockages •	SulfaLock
Sodium Hydroxide	• Usually added as a slug does to remove slime layer and sulphate reducing bacteria from pipes • Quick results are achievable	• Dangerous good • Hazardous substance • Overdosing may affect STPs. This is a short-term solution as bacteria and slime may return after a few months	Sodium hydroxide, Caustic soda
Biological Additives	• Relatively new, no adverse effects on sewerage network or plants and may improve STP performance • Simple dosing method	• Slow response time • Takes time to re-establish biology if a problem occurs	Liquid nutrient brew Organic concentrate
Calcium Nitrate	• Established technology, simple dosing method • Non-dangerous good (transport) • Generates no additional solids	• Optimum results occur in a relatively narrow pH band • Hazardous substance	Calcium Nitrate
Calcium Nitrate/Ferric Blend	• Non dangerous good (transport) • Benefits from the iron and nitrate addition, low maintenance requirements	• Acidic substance with a pH of 4, direct exposure to metals or concrete can result in corrosion • Hazardous substance	Ferrox
Hydrogen Peroxide	• Established technology, simple dosing method • Quick reaction time and unused H_2O_2 decomposes to increase dissolved oxygen levels	• Dangerous good (transport) • Hazardous substance • After dissolved oxygen is consumed generation of H_2S can recommence • Optimum efficiency at pH less than 7.0	Solvay Interlox
Iron Salts (ferric & ferric chloride, ferrous sulphate)	• Established technology • Reaction is irreversible • Simple dosing method and low maintenance requirements • Can discharge into high pressure systems, and suitable for pressurised systems • Up to 95% odour reduction •	• Acidic pH < 2, direct exposure to metals or concrete can result in corrosion • Dangerous good • Hazardous substance • Optimum pH level > 7.0 • Requires supervised delivery • Requires tanker delivery • Extensive risk assessment is required prior to use • Should not be used upstream of other SPS sites • Not recommended for use in residential areas	Ferric Sulphate, OdourLock (ferric chloride)
Oxygen Gas (O2)	• Established technology, no adverse effects at STP if overdosing concerns	• Limited by solubility of oxygen and residence times • Can result in high capital outlay to achieve effective dissolution of oxygen • Difficult to provide residual for long detention times	Primox, Oxygen

		• Dangerous good (transport)	
Ozone (O3)	• Does not require delivery and storage of chemicals to site • Can potentially be more cost effective than traditional chemical dosing setups • Small footprint • Lower storage risks than other chemical dosing setups • No impact on downstream STPs and No residue in wet wells or pipes	• Localised treatment only (i.e., immediate vicinity of pump station) • Could notionally lead to explosive environment in wet well • Could notionally damage wet well components (i.e., especially some rubber components) • Notional health and safety risk	Phantom

Appendix C – Gaseous Phase Odour Treatment and Ventilation Methods

The Table below lists the different types of Gas Phase Treatment Facilities, as possible technologies for Yarra Valley Water consideration for use on sewer network.

TREATMENT	DESCRIPTION
Activated Carbon (Yarra Valley Water Preferred)	Acts as an adsorbent and catalyst. Absorbs organic odours and oxidises the H_2S to disulphide, which is then physically absorbed. Can deal with intermittent loads
Scrubbers (Sodium Hypochlorite gas)	Odorous air passes through a porous material over which a chemical solution is sprayed. This encourages the removal of odorous gas
Odorgaurd	Variation to sodium hypochlorite system. Employs catalyst to improve the efficiency of the standard scrubber
Biofilters	Require a constant stream. Environmentally friendly, no dangerous goods and minimal maintenance
Ultraviolet	Generate ozone and allowing mixing with foul air, oxidising the H2S. Energy intensive and need to allow for adequate mixing. Can be economically viable in long term
Ionised Air (Terminodour System)	Generates ionised air which when passed into the chamber with foul air oxides the H_2S. High upfront capital but no dangerous goods and low maintenance requirements
Thermal Oxidation	Generally used at STPs. Air or oxygen at high temperatures are used to remove odours and kill other compounds. These include VOCs and ammonia-based odours

Refer to YSGD0522 Design Guidelines for Gas Phase Treatment Facilities for more details.

Appendix D – Gravity Sewer Pipe Materials

The Table below lists the benefits and disbenefits of the different types of pipe materials, approved for use on Yarra Valley Water's sewer network

MATERIAL	SIZES AVAILABLE	BENEFITS	DISBENEFITS	SUITABILITY
Vitrified Clay (VC)	DN100-1200 Jacking Pipe DN150-1200	• Resistant to chemical corrosion • Not affected by organic contaminants • Suitable for all types of sewage • Resistant to H_2S attacks • Not degraded by UV radiation	• Greater slime build up, difficult to wash off • May fracture under differential settlement • Not totally impervious to ground water infiltration	• Not recommended where there is ground contamination by certain chemicals • Not suitable for above ground installation • Not suitable for use as pressure main
Polyvinyl Chloride (PVC)	Plain wall and sandwich construction: DN100-375	• Immune to H_2S attacks • Slow build-up of slime which is easy to wash off • Resistant to corrosive soils • Abrasion resistant • Light weight • Allows for flatter grades or smaller diameter pipes	• Support required to prevent excessive distortion • If unshielded for more than 12 months will become degraded by UV • May become damaged by certain pipe cleaning and locating methods • May become degraded by some solvents	• Not recommended for areas that have extreme ground movement • Not recommended for areas where future contamination is likely by incompatible chemicals • Not suitable for above ground installation • Not suitable for some industrial discharges. • •
Polypropylene (PP)	DN150-900	• Immune to H_2S attacks • Slow build-up of slime which is easy to wash off • Resistant to corrosive soils • Abrasion resistant • Light weight • Allows for flatter grades or smaller diameter pipes	• Support required to prevent excessive distortion • May become damaged by certain pipe cleaning and locating methods • May become degraded by some solvents	• Not recommended for areas that have extreme ground movement • Not recommended for areas where future contamination is likely by PP harmful chemicals • Not suitable for above ground installation • Not suitable for use as pressure main
Polyethylene (PE)	DN100-600	• Allows for flatter grades or smaller diameter pipes • Resistant to corrosive soils • More flexible than PVC • Allows for narrow trench • Resistant to UV • Will bend to conform to subsidence under pipe	• Embedment support required to prevent excessive pipe flexure • Pipes distort in hot weather • Higher thermal coefficient than other plastics	• Not suitable in ground contaminated with chemicals that degrade PE • Not suitable where future works may disturb side supports •
Glass Reinforced Plastic (GRP)	Centrifugally Cast DN300-1200 (larger on request) Filament Wound DN300-1200 (larger on request)	• Immune to H_2S attacks • Allows for flatter grades or smaller diameter pipes • Greater internal diameter than other pipes of same size and class • Resin liner can be changed to suit chemical resistance required	• Embedment support required to prevent excessive pipe flexure • Easily damaged by impact from hard objects • Damaged pipe is difficult to repair • Come-a-longs, which are required for jointing in shielded trenches, are more time consuming and difficult than bar and block	• Unsuitable for some industrial discharges • Unsuitable in ground contaminated with chemicals that degrade GRP • Not recommended where there is high possibility of third-party intrusion along the pipeline • Unsuitable for large ground movements or subsidence •

	Jacking Pipe DN220-2100 (larger on request)			
Ductile Iron (DI)	DN80-700	• High beam and ring strength • Not effected by UV • Small changes in length with temperature • Can have very shallow cover • Not subject to damage from large loads and differential settlement	• Heavy, requires mechanical lifting • For uncoated or bitumen coated pipes external PE sleeving is required • Steeper grades or larger diameter pipes required for CL pipes • Cement mortar lining is subject to abrasion	• Preferred for above ground installations, but not marine environments • Favoured where minimum pipe covers are not possible • Suitable for superimposed loadings too large for other materials
Fibre Reinforced Concrete	DN100-DN300	• Not degraded by solvents • Performance not effected by disturbance of side supports • Not effected by UV • Negligible variation in shape with temperature change	• Product appraisal not completed • Rough bore requires steeper grades or larger diameter • Susceptible to corrosion and abrasion • Not resistant to impact damage	• Not recommended for long term use • Not suitable for use as pressure main • Requires Yarra Valley Water approval to be used
Steel	Cement lined for DN100-DN225 PE line for DN300 and larger	• External coating provides corrosion resistance in aggressive soils • High beam strength, pressure rating and loading capacity • Low coefficient of expansion	• Corrosion may occur when coating damaged • Fittings usually require fabrication to order • Cement lining is corroded by sulphuric acid	• Preferred for above ground installation. • Requires Yarra Valley Water approval to be used

Refer to the MRWA Products Portal for the latest approved products and materials.

Appendix E – Sewer Rising Main Pipe Material

The Table below lists the benefits and disbenefits of the different types of pipe materials, approved for use on Yarra Valley Water's sewer network

MATERIAL	SIZES AVAILABLE	LIKELY FAILURE	BENEFITS	DISBENEFITS
Ductile Iron Cement (mortar) Lined (DICL)	DN100-600 (DN750 available on order)	• Corrosion as a result of coating system damage and/or • Galvanic corrosion associated with copper property service connections	• Withstands higher external loading than UPVC and PE for equivalent support conditions • Withstands higher internal pressures • Good for ground subject to large movement • Easily traced • Not affected by UV • Slight change in length due to temperature variations	• Heavier than UPVC • External PE sleeve required • PE sleeve easily damaged and may result in corrosion to the DI pipe
Polyvinyl Chloride (PVC) No distinction between PVC-U, PVC-M or PVC-O	DN100 - 450	• Fails in brittle manner	• Lighter than DICL • Corrosion resistant • External sleeving of pipe not required • Can accommodate minor ground movements • Easy to repair	• Sensitive to impact damage • Degraded by UV after 12 months • Not as flexible as PE • Pipes not readily located without tracer tapes or wire
Polyethylene (PE)	DN16-630 (>DN630 subject to Yarra Valley Water approval)	• Most failures associated with weld failure at pipe joints and fittings	• Lighter than DICL, MSCL and GRP • Greater flexibility than UPVC • Tolerant of extreme ground movement • Resistant to UV where carbon black stabiliser used • Suitable for use in trenchless construction (Horizontal Directional Drilling) • Yarra Valley Water preferred material	• Support from embedment required to prevent excessive pipe failure • Less stiff than UPVC solid wall pipe • Significant length changes with temperature changes • Smaller bore than UPVC pipe in same pressure class • Difficult to repair

Refer to the MRWA Products Portal for the latest approved products and materials.

Appendix F – Corrosion Protection of Maintenance holes: Yarra Valley Water Supplement to MRWA Table 307-E

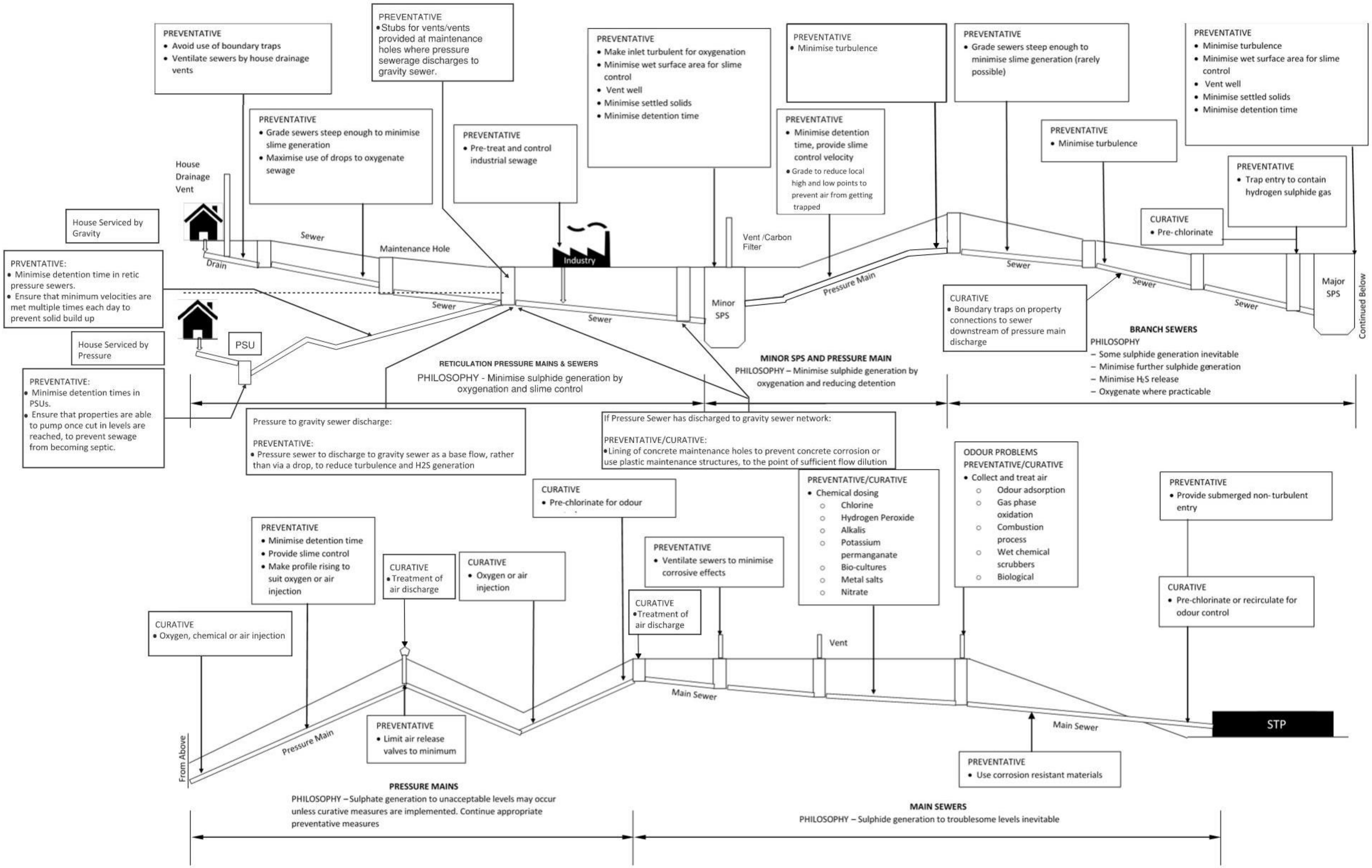
The purpose of this Appendix is to provide a guide for selection of corrosion protection of maintenance hole s. It expands on MRWA Table 307-E and provides further detail to aid in decision making.

		GRP MAINTENANCE HOLES OR SHAFTS	PVC/HDPE LINING OF MAINTENANCE HOLE (PRECAST OR CAST IN SITU)	HDPE LINER UNDERNEATH TOP SLABS AND LANDINGS. EPOXY COATING REMAINDER OF THE MAINTENANCE HOLE *	HDPE LINER UNDER TOP SLABS AND LANDINGS	EPOXY COATING MAINTENANCE HOLE *	SPECIAL CLASS CONCRETE MAINTENANCE HOLE (N40 SPECIAL CLASS CONCRETE AS PER CONCRETE NOTE 3 – MRWA-S-309)
Implemented when:	H2S Risk Assessment Score (as calculated using MRWA-S-401)	>6	>6	Between 3 and 6	Between 3 and 6	Between 3 and 6	Between 3 and 6
	Situational/Risk factors	• Modelled corrosion rate exceeds 1mm/yr' (highly corrosive) • Access to the asset in the future to repair / renew less robust liner is likely to be difficult • There are long detention times in the upstream pipeline	• Modelled corrosion rate exceeds 1mm/yr' (highly corrosive) • Maintenance hole walls are likely to deteriorate • It is too difficult to or costly to install a GRP maintenance hole	• Modelled corrosion rate exceeds 0.5mm/yr' (corrosive) • Maintenance hole walls or chase are likely to deteriorate	• Modelled corrosion rate exceeds 0.5mm/yr' (corrosive)	• Modelled corrosion rate exceeds 0.5mm/yr' (corrosive)	• Modelled corrosion rate exceeds 0.5mm/yr' (corrosive)
Advantages:		• Are designed to last for 100 years in highly corrosive environments • Reduced probability of having to do future rehabilitation • Complex shapes can be made off site • Generally offsite construction improves likely QC of final product	•	• Easy to cast HDPE liners into precast maintenance hole top slabs • More cost effective to construct than GRP manholes (generally)	• Easy to cast HDPE liners into precast maintenance hole top slabs and landings •	•	• As easy to construct as a normal concrete maintenance hole • Greater concrete density reduces the rate of possible corrosion
Disadvantages:		• Usually the most expensive option • If >3m in diameter (varies depending on supplier), the supplier will need to design the entire maintenance hole (instead of just supplying the product)	• Can be difficult to pour concrete whilst keeping the HDPE sheets in the right position • Doesn't have long term resilience of GRP so may have greater whole of life cost	• If both the HDPE liner and the epoxy coating are not correctly applied, the maintenance hole could require rehabilitation in the future • Doesn't have long term resilience of GRP so may have greater whole of life cost	• Does not protect maintenance hole walls	• If there are holes in the epoxy coating, this can significantly reduce its effectiveness • Success is dependent on thorough quality control during construction	• Not as effective as other means of protection
General considerations:		• Installation is critical to long term success • GRP manholes need to be designed considering the installation method and backfill	• Welding of HDPE sheets are required • ITP's and construction methodology must be sited prior to commencement.	• Concrete must cure for a minimum of 28 days before application of epoxy coating • The epoxy coating must be installed in strict accordance with the manufacturer's instructions, paying particular attention to surface	•	• Concrete must cure for a minimum of 28 days before application of epoxy coating • The epoxy coating must be installed in strict accordance with the manufacturer's instructions, paying particular attention to surface	• Concrete shall be in accordance with WSA114- 2002 • Ensure concrete supplier specifies that their product is MRWA approved • Higher strength concrete usually has higher hydration heat (higher

	• Transport limits may restrict the maximum dimensions of the GRP product, which would only be an issue for rare instances.	• Transport of plastic lined precast concrete must comply with WSA02 MRWA edition.	preparation of the concrete and temperatures at the time of application		preparation of the concrete and temperatures at the time of application	cement content) and increased risk of early age cracking. If that isn't considered during construction this can cause problems

* Epoxy coating not preferred for use on new assets and is subject to approval by Yarra Valley Water on a case-by-case basis.

Appendix G – Hydrogen Sulphide Odour and Corrosion Control Measures



HYDROGEN SULPHIDE ODOUR AND CORROSION CONTROL MEASURES FOR SEWERAGE SYSTEMS

Yarra Valley Water proudly acknowledges the Traditional Custodians and Owners of the land and water on which we rely and operate. We pay our deepest respects to their Elders past, present, and emerging. We acknowledge the continued cultural, social and spiritual connections that Aboriginal and Torres Strait Islander Peoples have with the lands and waterways, and recognise and value their care and protection for thousands of generations.

At Yarra Valley Water we are also proud to celebrate, value and include people of all backgrounds, genders, sexualities, cultures, and abilities.