Unitywater

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Pr11462 - Specification for Trunk Gravity Sewerage Design and Construction

Addendum to SEQ Service Providers Edition of the WSAA Gravity Sewerage Code Version 2.1 (July 2021)

Read this document in conjunction with SEQ Gravity Sewerage Code

Document Sponsor	Infrastructure Standards and Products Approval Committee
Document Owner	Head of Asset Management
Subject Matter Expert	Infrastructure Standards and Assurance Team
References	Refer to Appendix B – References of this document

Version review

Revision	Reviewed by	Approved by	Date approved	Revision type/summary
1	Unitywater Infrastructure Standards and Assurance Team with key stakeholders	Head of Asset Management	16/04/2026	New

Contents

Introduction

This Trunk Gravity Sewer Main Design and Construction Code (TGSM Code) is an Unitywater addendum to the SEQ Gravity Sewerage Code of Australia (SEQ Gravity Sewerage Code) and is intended to assist engineering consultants prepare design documentation for proposed trunk gravity sewer mains to be owned and operated by Unitywater.

This document must be read in conjunction with the current version of the SEQ Gravity Sewerage Code [which at the time of writing this document is the SEQ Service Providers Edition of the WSAA Gravity Sewerage Code of Australia – Version 2.1 (September 2021)].

For information on abbreviations, acronyms and definitions used within this document, please refer to the current SEQ Gravity Sewerage Code.

Unitywater will update this document as Unitywater' technical requirements for trunk gravity sewer mains evolve over time, or until such time that the scope of the SEQ Gravity Sewerage Code is broadened to include trunk gravity sewer main requirements.

Unitywater reserves the right to specify or approve other trunk gravity sewer main design and/or construction requirements for projects and/or developments. Before commencement of any construction, Unitywater's approval shall be obtained for any design and/or installation that does not comply with this document.

Background

Currently the WSA 02 Gravity Sewerage Code provides planning, design and construction requirements for sewer mains up to and including DN1200, with the SEQ edition scope limited to sewer mains up to and including DN300 Unitywater.

The intent of this Unitywater TGSM Code is to provide greater clarity regarding Unitywater requirements for the design and construction trunk gravity sewer mains greater than DN300 built on behalf of (or donated to) Unitywater.

Scope and limitations

This TGSM Code is only applicable for the design and construction of trunk gravity sewer mains to be owned and operated by Unitywater. For information regarding design and construction requirements for trunk gravity sewer mains (to be) owned and operated by other agencies (e.g. City of Gold Coast, Logan City Council, Redland City Council, Urban Utilities, etc.) please contact them directly.

The Project Proponent is responsible for obtaining all third-party approvals relating to the design and construction of Unitywater trunk sewer main infrastructure. All third-party approvals shall be obtained by the Project Proponent and submitted to Unitywater during the trunk sewer main design phase. It is the Project Proponent's responsibility to prepare the design in accordance with the requirements of all relevant stakeholders.

Please note, any endorsement of the design documentation by Unitywater does not infer that any other agency has endorsed/approved the design.

The Project Proponent (and their consultants/agents) are responsible for ensuring that all works are executed in accordance with Unitywater requirements, as well as sound engineering principles and practices.

All designs shall be prepared and certified by a Registered Professional Engineer of Queensland (RPEQ) considering all relevant construction, operational, maintenance, repair and demolition aspects of the proposed works. As-constructed works shall be certified by a Registered Professional Engineer of Queensland (RPEQ).

Approval for requirements that do not comply with this TGSM Code shall be via Unitywater's procedure for deviation from technical standards.

Document hierarchy

If there is a discrepancy between this document and the SEQ Water Supply & Sewerage Design Criteria (SEQ WS&S Design Criteria), the SEQ WS&S Design Criteria shall take precedence.

If there is a discrepancy between the TGSM Code and the SEQ Service Providers Edition of the Gravity Sewerage Code (SEQ Water Code), the TGSM Code shall take precedence for all matters relating to Trunk Gravity Sewer Mains.

Where the underlying SEQ Sewerage Code requirements are not shown in this document, the SEQ Gravity Sewerage Code requirements shall apply.

If there is a discrepancy between the TGSM Code text and the TGSM Code Appendices, the TGSM Code text shall take precedence.

Where a discrepancy exists between the TGSM Code and any other relevant document (including Unitywater documents/specifications/requirements), please consult with Unitywater to seek advice regarding which requirement takes precedence.

Feedback and information

Please direct all comments and suggestions regarding this document by email to: seqcode@unitywater.com

For further information on the South East Queensland Water Supply and Sewerage Design Construction Code (SEQ Code), or to provide comments and suggestions, visit www.seqcode.com.au.

Conditions of supply of the Unitywater TGSM Code

The TGSM Code is supplied subject to the following understandings and conditions:

- The TGSM Code is copyright and apart from any use as permitted under the *Copyright Act 1968*, no parts of the documents may be sold, reproduced, stored in a retrieval system or transmitted in any form or by any means without the prior permission in writing of Unitywater.
- The TGSM Code is intended for use in connection with Unitywater related projects only. Unitywater does not warrant the applicability of the TGSM Code and SEQ Water Supply & Sewerage Design & Construction Code to climates, topography, soil types, water characteristics and other local conditions and factors that may be encountered outside Unitywater area of operation.
- The holder of the TGSM Code acknowledges that they may contain errors and/or omissions. Unitywater accepts no responsibility for the incorrect application of the TGSM Code by the holder or any other party.

Any details not currently denoted in the TGSM Code shall be referred to Unitywater.

UNITYWATER TRUNK GRAVITY SEWERAGE MAIN DESIGN AND CONSTRUCTION CODE - ADDENDUM TO SEQ SERVICE PROVIDERS EDITION OF THE WSAA GRAVITY SEWERAGE CODE OF AUSTRALIA V2.1 (SEP 2021)

USING THE TGSM CODE ADDENDUM

- This TGSM Code addendum shall be read in conjunction with the SEQ Gravity Sewerage Code text.
- Unitywater trunk gravity sewer main requirements consist of the requirements within the TGSM Code, as well as the SEQ Gravity Sewerage Supply Code text.

  NOTE: the entire SEQ Gravity Sewerage Supply Code text has not been duplicated within this document
- Where an SEQ Gravity Sewerage Code clause is not detailed within the TGSM Code addendum, refer back to the SEQ Water Supply Code for the requirements.

TGSM CODE CLAUSE NUMBERING

- Clause numbering and clause headings used in the TGSM Code addendum correspond with the same clause numbering & headings used in the SEQ Gravity Sewerage Code text.
- Not all clauses from the SEQ Gravity Sewerage Code are shown in this TGSM Code. As a result, the clause numbering within the TGSM Code is not always sequential – this is not an error.
- Generally, only Clauses which contain amendments to the SEQ Gravity Sewerage Code text, specifically for the design and construction of Unitywater trunk sewer mains, are shown in this document.

TGSM CODE TEXT COLOURING

Black Text: SEQ Service Providers Edition of the WSAA Gravity Sewerage Code

Green Text: Amendments to the SEQ Service Providers Edition of the WSAA Gravity Sewerage Code text, specifically relating to the design and construction of Unitywater trunk gravity sewer mains.

PART 1: PLANNING AND DESIGN

1. General

1.1 Scope

This Trunk Gravity Sewerage Code shall apply to gravity sewer mains greater than DN300. The SEQ Service Providers Edition of the WSAA Gravity Sewerage Code of Australia – Version 2.1 (September 2021)] shall apply to gravity sewer mains less than or equal to DN300. This code will normally apply to Trunk Gravity sewers and Branch sewers as defined in Clause 2.2.3.

This TGSM Code definition of Trunk (greater than DN300) is distinct and separate to the definition and criteria provided by the *South-East Queensland Water (Distribution and Retail Restructuring) Act 2009* and those specified in Unitywater's Netserv Plan which, amongst other criteria, generally defines Trunk Sewer Mains as greater than DN225.

The DN within this code addendum refers to the nominal size. Where the code does not specify pipe material, DN shall be taken as nominal bore. For example, DN 300 may refer to DN 300 uPVC or DN 315 PE.

At the highest level, the planning and design requirements of the SEQ-SPs in respect of gravity sewerage are specified in the SEQ Water Supply and Sewerage Design and Construction Code's Design Criteria (SEQ Design Criteria) and the Queensland Department of Local Government, water and Volunteers Planning Guidelines for Water Supply and Sewerage Schemes. The SEQ Design Criteria precedes all other planning advice relating to water and sewerage infrastructure within the SEQ-SPs' service areas.

The Reader should be aware that:

(a) Specific design parameters relevant to this document are contained within the SEQ WS&S Design Criteria.

(b) Where there is conflict between this Code and the SEQ WS&S Design Criteria, the SEQ WS&S Design Criteria shall take precedence.

1.2 Planning and design

1.2.2 Scope and requirements

Project Managers of the delivery of services to land developers and/or Water Agencies should read this TGSM Code in conjunction with the procedures, instructions, quality plans, variations and other relevant documentation provided by Unitywater, which will ultimately own the asset.

The requirements contained in this TGSM Code are applicable to the majority of situations. However, variations may be necessary to meet special circumstances or to overcome other problems not addressed. Departures from any requirement of this code shall be identified and submitted for review via F10996 - Deviation to Unitywater Technical Specification. Unitywater requires enough information to assess dispensation requests and their potential impact. The onus is therefore on the proponent to justify deviation request submissions and provide suitable evidence to support them. The Designer shall not proceed to document/incorporate the non-conforming work before the Unitywater has assessed and accepted the proposed action in writing via F10996.

In conjunction with empirical flow estimation methodologies, commonly adopted for "greenfield" sewer systems, Unitywater may require calculation of dry and wet weather loading rates from gauged network points for inclusion in the design basis and subsequent hydraulic modelling software utilised for planning and design.

Environmental pollution has emerged as a new driver for overflow containment, based not only on the overflow frequency but also the ability of the waterway to assimilate the various constituent mass load inputs. Unitywater will determine both the frequency and total volume of environmental discharges (overflows) permissible from a catchment and subject TGSM. A modified empirical approach set out in the Code adopts the traditional "factor DWF" approach, but varies it with frequency of incidence or design flow containment standard. Alternative Criteria relating to environmental release shall be provided by Unitywater where relevant.

In Queensland, the design of the works described by this code addendum must be carried out under the direction of, and certified by, a Registered Professional Engineer of Queensland (RPEQ) in accordance with the requirements of the *Professional Engineers Act 2002*.

1.2.3 Servicing strategies

Servicing strategies shall consider the least community cost and ensure all community, environmental, cultural, heritage and statutory requirements are complied with. Gravity sewers are the preferred means for providing sewerage service and the adoption of any other options require the explicit approval of Unitywater.

Smart Sewers are mandatory in the form adopted by Unitywater except for in-fill areas where other materials and construction types may be used where explicit approval to do so has been obtained from Unitywater.

The evolution of planning future growth and sewer network management has evolved on the basis of realising current performance of existing assets and providing affordable and practicable asset management. The 5 x ADWF approach has evolved to the latest SEQ Design Criteria acknowledging additional complexity of wet weather response.

Existing networks that have been calibrated using measured data provide an insight into actual performance. Acknowledging actual performance and other issues in the network, allowing for an improved assessment of capacity when assessing the impact of future growth. Using a frequency of overflow based assessment to provide a reasonable and practicable level of protection for customers and the environment.

The risk based assessment provides an opportunity to challenge the frequency based performance, this utilises knowledge of both the sewer and environment, to identify a higher or lower standard for that particular asset. This is based on acknowledging one size does not fit all.

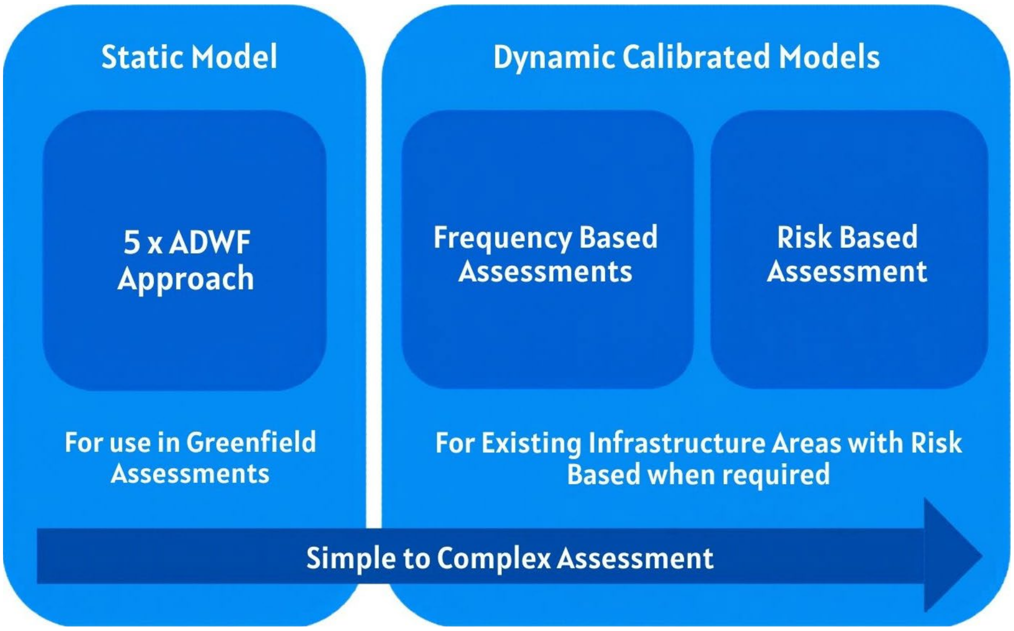

Figure 1 – Sewer Planning Evolution

1.2.5 Concept Plan Format

A concept plan shall be developed for each project.

The concept plan shall:

a) satisfy requirements of relevant WHS, environmental, cultural, heritage and security legislation, act and/or regulations;

b) provide the network analysis including:

  i. Key to network analysis e.g. node points, elevation, design flows

  ii. Design parameters – number of lots, number of Equivalent Persons (EP), design flows (average and peak, dry and wet weather)

  iii. Legend of Domain types (residential, Industrial etc.)

  iv. Limit of the sewer catchment serviced by the mains.

c) address route and/or layout of the sewer system including but not limited to:

  i. Size and type of mains indicated graphically and distinguished by colour and/or line type

  ii. Proposed contours for the entire development at a minimum of 5 m intervals, and

  iii. Reticulation and branch connections points and design Hydraulic Grade Line (HGL) as supplied by Unitywater

  iv. Infrastructure location e.g. pumps, dosing systems, emergency relief overflow structures (EROS), appurtenance features etc., and a listing of proposed easements and land to be dedicated to Unitywater

  v. Consideration of existing and proposed infrastructure (e.g. roads, road improvements, proximity of drainage infrastructure, etc.) when determining location of maintenance holes and ancillary structures including EROS.

d) address the operational and maintenance needs including but not limited to;

   i. operational and maintenance access, e.g. flow control and isolation, bypass contingency, human and remote operating vehicle (ROV) access

   ii. system performance monitoring requirements, e.g. flow level, flow rate, liquid and gaseous phase sampling and monitoring (refer to Section 8.8)

   iii. septicity and odour control systems e.g. chemical dosing, ventilation, monitoring and control systems

   iv. failure, renewal and replacement strategy.

e) minimise the likelihood of pipe, fitting and structure failures especially in the case of critical sewers;

f) identify special Unitywater requirements including, but not limited to:

   i. provision for future expansion of the system and/or required augmentation of the existing system; and

   ii. critical infrastructure protection (Refer 1.2.6 Critical infrastructure protection).

The plan shall also consider and address as necessary:

Site Access, Tenure, Environment and Environment (STEP) as well as land use planning requirements covering *(Refer to Unitywater Documents Pr8856 - Project Control Environmental Procedure and Pr11074 - CIPM - Site Assessment Procedure):*

   i. Cultural, heritage and archaeological aspects;

   ii. and ownership and planning requirements;

   iii. Impacts on the community, and;

   iv. Impacts on the environment.

1.2.6 Critical infrastructure protection

1.2.6.3 All hazards – infrastructure protection

Following risk assessment, an appropriate and cost effective level of protection shall be determined for each asset category of the sewerage systems being designed. These appropriate protection components or required design features shall in turn be incorporated into the final design of the sewerage system.

Refer to Pr10731 - Risk Assessment and Scoring Criteria Tool.

1.2.7 Detailed design

1.2.7.1 Designer's needs and responsibilities

The design of the works shall be carried out under the direction of and certified by a Registered Professional Engineer of Queensland (RPEQ) as defined by the *Professionals Engineers Act (Qld)*.

The Designer shall obtain the written approval from Unitywater delegate for any variations to the requirements of the latest TGSM Code, as amended by Unitywater prior to the submission of the final design.

1.2.7.2 Requirements to be addressed

The Designer shall use Unitywater Template F8586 - Design Report for the proposed trunk gravity sewer works, which shall address, inter alia, the:

(a) Unitywater policies, customer charters and contracts;
(b) Unitywater standards not otherwise contained or referenced by this Code;
(c) Critical infrastructure protection measures;
(d) Climate change impacts;
(e) Minimisation of life cycle costs to Unitywater and the community in terms of operations and maintenance, future upgrading costs, future condition assessment, rehabilitation, renewal, replacement, decommissioning, etc.
(f) Minimising adverse environmental, cultural, heritage and community impacts.
(g) Compliance with environmental, cultural and heritage requirements.
(h) Compliance with WHS requirements including the Queensland WH&S Act 2011 (or otherwise as current).
(i) Providing sufficient hydraulic capacity to service the full catchment.
(j) Control of septicity.
(k) Reducing the likelihood of blockages through entry of tree roots etc.
(l) Resistance to internal and external corrosion and chemical degradation.
(m) Resistance to applied loads and structural adequacy of system components for the design life.
(n) No service connections to the trunk mains without specific written approval from Unitywater.
(o) Easement requirements.
(p) Ensuring no infiltration/exfiltration at commissioning and minimal infiltration/exfiltration over the life of the system.
(q) Physically confirmed locations and alignments of Unitywater and other Utilities (or agencies) infrastructure which may be impacted by the proposed works in accordance with *AS 5488.1 Classification of subsurface utility information Part 1: Subsurface utility information* Quality Level A requirements.
(r) Scope of work, including all sewer connections, disconnections and diversions to enable the proposed infrastructure to be successfully constructed. (Prior consultation with Unitywater is required to determine whether there are any existing network limitations/constraints that will influence how, when and where network connection, disconnection, augmentation and/or diversion arrangements are to be designed).
(s) All work associated with the potholing and survey of services shall ensure that service locations and alignments are accurately reflected in the design drawings.
(t) That proposed sewer infrastructure terminates at a location and in a way that facilitates ease of future connection to the network, whilst minimising disruption to the community and the need to obtain private landowner's consent.
(u) Factors that will impact the design of the infrastructure – including customer and trade waste discharge requirements and associated sewage physical and chemical characteristics, ground conditions (e.g. acid sulphate soils, low bearing capacity and shrink/swell characteristics, areas with known mining subsidence, ground containing hydrocarbons etc.).
(v) Impacts to Stakeholders, customers, community, Local Authority, Road Authorities and service providers (e.g. Rail Authority).
(w) Extents and location of mechanical protection (i.e. pipe enveloper or concrete encasement) on existing services.
(x) Extents, location and status of existing sewer network pipeline anti-corrosion measures

(e.g. cathodic protection systems).

(y) Existing and proposed sewer network upsizing / augmentation works.

In addressing the above requirements, the Design Report shall be developed in accordance with relevant Queensland legislation and regulations, Codes of Practice, Australian Standards and Unitywater technical standards.

1.2.7.3 Design outputs

Design Digital Information (drawings, models, data) and Specifications for construction purposes shall clearly address the issues of a project. The design output shall be in accordance with:

- Pr8701 - Specification for Asset Information
- SEQ Water Supply and Sewerage Design and Construction Code Asset Information
- Pr8843 - Specification for Drawing, Document and Equipment Tag Numbering
- Pr10360 - Project Information Requirements
- Pr11446 - Infrastructure Design Development and Review Guide (SPS, SRM, SGM).

Design output requirements are provided in Section 5.1 Detail Design Process.

1.2.7.4 Safety in design

The design process and outputs shall satisfy requirements of the relevant WHS legislation/act and/or regulations.

All design work shall consider safety in design and be risk assessed without exception.

SiD risk workshops are to be organised and chaired by an independent facilitator nominated by the Designer and accepted by Unitywater. The workshops are to include key Unitywater stakeholders representing operations and maintenance and other functions and shall identify all risks which can impact design or be designed out.

Planning, design, construction, commissioning and handover activities shall include the requirements specified in Pr8187 - Safety in Design Procedure and Pr10883 - Safety in Design Guidelines.

1.3 Consultation with other parties

1.3.1 Design life

Buried sewer systems shall be designed for a nominal asset life of at least 100 years without rehabilitation. Some components such as pumps, valves, flow metering and control equipment may require earlier renovation or replacement.

Asset Design Lives shall be in accordance with **Table 1-1** below:

Table 1-1 Typical Asset Design Life

ASSET DESCRIPTION	DESIGN LIFE
Trunk Gravity Sewer Mains (and all appurtenances including wet/dry wells, storages, valve pits/chambers)	100 years
Maintenance Structures	100 years
Pumps	25 years
Valves	30 years
SCADA	15 years
Buildings / Structures	Refer to Unitywater for requirements, Pr9903 - Specification for Building and Structural Works and/or Pr9693 - Specification for Mechanical Installations

1.3.2 Instrumentation and control systems

The designer shall liaise with Unitywater and incorporate sewer instrumentation, monitoring and control systems into the planning and design of the sewer system.

These systems may include, water level, flowrate, water quality and air quality instrumentation and control systems.

Monitoring locations may include Trunk Junction Maintenance Holes, grit chambers and EROS.

All designs incorporating monitoring and control equipment shall comply with Unitywater requirements.

*Refer to **Appendix TGSM-B** for list of relevant Unitywater Documents.*

2. Systems planning

2.1 General

Sewerage System Planning shall be undertaken within and in accordance with Unitywater's Pr9660 - Water Netserv Plan Part A. The Netserv Plan will define the catchment and network risks, service value and outcomes required of the sewerage system. Netserv Plan will outline and guide the servicing strategy for the subject area.

2.2 Sewer system philosophy and definition

2.2.3 Level 2 transportation subsystems

This addendum defines the various functional sewers as trunk, branch and reticulation generically as follows:

a) Reticulation sewers are a network of pipes including property connection sewers nominally up to and including DN 300 that receives sewage and/or trade waste from customer properties (residential, commercial and industrial).

b) Branch sewers are a network of pipes nominally DN 375 to DN 600 that connect the reticulation pipes within a reticulation area or a group of reticulation areas. Property connection sewers are not generally connected directly to branch sewers.

c) Trunk sewers are a network of pipes nominally DN 750 and greater that connect the branch sewers and transport sewage to a treatment facility.

These descriptions are generally applicable to larger sewer systems. In smaller systems, DN 150—DN 300 pipes may be defined as branch or trunk sewers.

The transport subsystem may also include SPSs and storage facilities.

The scope of the SEQ Service Providers Edition of the WSAA Gravity Sewerage Code Version 2.1 (July 2021) is restricted to sewers up to and including DN 300. This Code Addendum covers the requirements for gravity sewers above DN300. The requirements of this code may apply to Branch and Trunk sewers as described above.

2.2.4 Level 3 operating units

2.2.4.1 Sewers

Each sewer comprises pipes as well as any fittings, maintenance structures and ventilation facilities used in association with such pipes. These components are generically defined as follows:

a) Maintenance holes that allow trunk sewer pipes to be inspected and maintained, and which are usually installed at changes of level, sewer line direction, sewer pipe size or otherwise a minimum spacing interval. Maintenance Structures may include peripheral or appurtenant equipment including but not limited to:

- human or equipment access provisions
- monitoring and communications provisions
- flow control elements (gates, valves)
- quality elements (screens)
- septicity control (chemical dosing, air management).

Refer also to Chapter 7 Maintenance Holes.

b) Vent shafts that are typically above ground structures and that have a dual purpose of admitting air to the sewer system to reduce the likelihood of sewage turning septic or corrosive and causing offensive odours, and allowing odours to be dispersed.

c) Overflow or emergency relief overflow structures (EROSs) that are used to provide controlled overflow from the sewer system so as to protect public health by reducing the risk of sewage being discharged from maintenance holes, customer gully traps and internal fittings such as floor wastes, sinks and toilets.

2.3 Planning principles

2.3.1 Planning horizon

The planning horizons addressed in the system planning shall align with the Servicing Strategy of the catchment, the relevant Unitywater Integrated Plan and reviewed and referenced against the published Sewer Netserv Plan.

Planning shall be undertaken for horizons up to and including the ultimate projected population under the Planning Scheme for the relevant Council Area that the works are being provided within, unless otherwise agreed or directed by Unitywater.

2.3.2 Concept plan

A Concept Plan shall be prepared and submitted for Unitywater Review. The concept plan should incorporate outcomes of a catchment /system analysis, staging requirements and the renewal and replacement strategy. Refer to Section 1.2.5 for further details of the Concept Plan.

2.3.3 Catchment analysis

A catchment analysis, the principal input to the concept plan, should involve analysing options for servicing sub-catchments and options for integrating them to develop feasible options for draining the total catchment; this requires assessing, inter alia:

a) Hydraulic loading of the proposed development (design flows), including likely future development and potential inflows and infiltration (Refer to section 3 FLOW ESTIMATION and the estimated population as per SEQ design Criteria)

b) Pipe sizing, pipe grade, sewage velocity and shear stress (Refer to 5.5 PIPE SIZING AND GRADING).

c) Controlled overflows (Refer to 8.7 EMERGENCY RELIEF STRUCTURES) including assessment of receiving environment impact.

d) Septicity assessment, management and control (Refer to 2.5.1 Septicity).

e) Horizontal and vertical alignment (Refer to 5.3 HORIZONTAL ALIGNMENT OF SEWERS and 5.6 VERTICAL ALIGNMENT OF SEWERS).

f) Obstructions and clearances (Refer to 5.4 OBSTRUCTIONS AND CLEARANCES).

g) Not in use.

h) Not in use.

i) Maintenance structures (Refer to 7 MAINTENANCE STRUCTURES).

j) ventilation, syphons, overflows and storage (Refer to section 8 ANCILLIARY STRUCTURES)

k) Structural and civil engineering (Refer to section 9 STRUCTURAL DESIGN).

l) Products and materials (Refer to section 4 PRODUCTS AND MATERIALS).

m) Resource and financial estimates in accordance with Water Agency requirements.

n) Not in use.

o) Environmental, cultural and heritage considerations.

2.3.4 Provision for future gauging needs

The concept plan shall include:

a) Clear explanation of the purpose of the gauging and what the captured data is to be used for

b) provision for flow rate, level and rain gauging, and

c) calibration check points for the initial and the ongoing calibration of all proposed gauging facilities. Gauging sites could include but not be limited to:
   i. overflow points - EROS or uncontrolled
   ii. pumping stations and gravity subsystem outlets
   iii. locations with other known issues such as chokes and breaks
   iv. downstream of major development locations
   v. bifurcations or other significant flow control structures.

2.4 Planning parameters

2.4.1 Loading per serviced lot

The loading rates and associated land-use categories in the SEQ Design Criteria shall be used as the basis for future load assessments. Unitywater shall be consulted with regard to any proposal to depart from the values in the SEQ Design Criteria or to assess future loads differently.

Alternative loading rates may be applied to the assessment based on the current Servicing Strategy for that area. These alternative loading rates may be based on actual network performance/flows and the significance of existing brownfield development within the system and the relevant Servicing Strategy for growth related augmentations and staging.

Refer also to Section 3 Flow Estimation.

2.4.2 Estimating future catchment loads

Average daily loading shall be calculated as the product of the estimated EP draining to the point of design interest, and the residential loading rate in the SEQ Design Criteria (Refer to 2.4.1 Loading per serviced lot). Alternatively, Unitywater may instruct specific catchment based loads for the purposes of Planning Assessments.

Equivalent future population shall be calculated for each land use type to be developed by identifying the number of units to be developed from the categories in the SEQ Design Criteria (or Unitywater supplementary advice) or from the developers or local or planning authorities. For residential areas without density classifications or areas where future changes to residential zonings are anticipated, a most likely density consistent with town planning policies shall be determined. In summary:

a) Use the EP loadings per unit type listed in the SEQ Design Criteria or otherwise as specified by Unitywater

b) Calculate EP as the sum of the products of unit numbers multiplied by EP/unit rates.

2.4.3 Estimating existing system loads

Where existing system loads are likely to limit the spare hydraulic capacity available for new development, the existing system loads shall be determined by gauging unless otherwise instructed by Unitywater. Where not practicable, the area or number of lots per land-use serviced shall be determined by one or more of the following:

(a) Zoning maps and planning instruments.

(b) A field house count.

(c) Interrogation of census data.

(d) Interrogation of GIS system data.

Existing loads on ungauged areas shall be estimated as the sum of the products of unit numbers multiplied by EP/unit rates. Refer also Section 3.2 Flow Estimation.

If catchment development is likely to be spread over a long time frame, planning and design of transport, pumping and treatment facilities shall be suitably phased /staged.

2.4.4 Climate change impacts

Climate change impacts including less frequent and more intense rainfall events shall be included in a planning risk assessment. The changing weather patterns may impact on inflow and infiltration, wet weather flows, groundwater levels and flood levels. Unitywater shall advise the parameters to be applied to account for long term, extreme weather event related climate change.

Additionally, the embodied carbon of the planned system shall be quantified as part of the planning assessment.

2.4.5 Environmental, cultural and heritage impacts

The concept plan shall consider the environmental, cultural and heritage impacts of the project for design, construction and operational phases in the light of Federal, state and territory environmental, cultural and heritage laws and regulations and Unitywater policies, instructions and guidelines. Legal requirements and Unitywater policies require the Planner to consider the environmental, cultural and heritage impacts to the fullest extent possible.

An assessment of Site Access, Tenure, Environment and Planning (Refer to Unitywater Documents Pr8856 - Project Control Environmental Procedure and Pr11074 - CIPM - Site Assessment Procedure) aspects shall be undertaken at the planning stage and updated during design and construction phases of the project. Refer also to Section 5.2.7.

2.4.6 Geotechnical investigations

The concept plan shall, as necessary, consider the nature of the ground, with respect to instability and groundwater infiltration (GWI).

Detailed geotechnical investigations are addressed further in Section 9.6.

The impact of a sewer trench on potential draining of the water table may require the installation of bulkheads (Refer to 9.10 BULKHEADS AND TRENCHSTOPS).

2.4.8 Operations and maintenance considerations

The Planner and the Designer shall consider operations and maintenance requirements in the Concept Plan. Further requirements for detailed design are provided in Section 5.2.

The Concept Plan will include:

a) Provision of safe and easy access for maintenance, condition assessment, repair and/or rehabilitation and bypass equipment. Layout plans shall show anticipated safe work areas and offsets to adjacent land uses and activities.

b) Location of sewers clear of other services and adjoining structures, particularly with deep sewers under structures /facilities, heavy structural foundation loadings and adverse trench /foundation conditions.

c) Control of gas generation, passive and forced ventilation and odour treatment, to enhance asset life, the safety of maintenance workers, prevention of gas flows from sewers to sanitary drains, minimise odour release and to comply with licence requirements and workplace exposure limits for airborne contaminants.

d) Requirements, including frequency of visits, isolation locations, methods (valves, gates, plugs, etc) and durations (set-up, overflow), for bypassing of flows to allow maintenance and asset condition assessment, repair and/or rehabilitation.

e) The impact of unstable or water charged ground.

f) Storage and EROS and their cleansing and odour control.

g) Confined space assessment.

h) Compilation of these assessments and provisions into an Operations, Maintenance, Replacement and Decommissioning Strategy.

i) Assessment of the likelihood of potentially explosive atmospheres forming within the sewer system, considering catchment-specific factors such as hydraulic retention times, trade waste contributions, stormwater infiltration, local ground conditions, security of access, and abnormal operational scenarios to inform hazardous area classification. Refer to WSAA Guidelines for Potentially Explosive Atmospheres.

2.5 Sewage quality

2.5.1 Septicity

To avoid excessive septicity, the Concept Design shall:

a) provide adequate grades for self-cleansing (Refer to clause 5.5.7 Minimum grades);

b) minimise detention periods by avoiding use of SPSs and long rising mains wherever practicable and provide staging of storage and pumping capacity where appropriate (Refer to SEQ Code edition of WSA 04);

c) avoid any unnecessary turbulence at junctions and changes in grades, particularly where pressure mains enter the gravity system, at drop junctions and at vortex drops;

d) where deemed necessary, provide passive and/or forced ventilation refer to Unitywater Pr10999- Specification for Odour Control Unit Design and Construction (Network);

e) where deemed necessary, provide chemical dosing as required refer to Unitywater Pr10852 - Specification for Design and Construction of MHL Dosing Systems, and;

f) Undertake a septicity assessment with reference to the Hydrogen Sulphide Control Manual, Septicity, Corrosion and Odour Control in Sewerage Systems, Technological

Standing Committee on Hydrogen Sulphide Corrosion in Sewerage Works, Volumes 1 and 2, Melbourne Metropolitan Board of Works, Dec 1989.

2.6 Planning review

Once the system has been planned and a layout established, a review shall be undertaken to demonstrate compliance with Unitywater requirements. The review should include at least the following:

a) All existing and likely licence and customer contract requirements for all existing and future customers (unless this is part of a future augmentation project) can be met.

b) All appropriate geotechnical considerations have been included.

c) Service capability is provided at the lowest lot connection in each catchment.

d) Maximum and minimum flow estimates have been made in accordance with Unitywater requirements.

e) Sewer capacities and any storage capacity and/or overflow structures satisfy system requirements.

f) Potential for future septicity problems and odour and corrosion are minimised at the various stages of development or as an inherent outcome of the design.

g) Ventilation measures are adequate within individual catchments.

h) Sewer layout and alignment meet Unitywater requirements.

i) All environmental, cultural and heritage requirements have been identified and addressed.

j) All asset life cycle costs shall be considered for each project.

k) Operations Maintenance, Replacement and Decommissioning Strategy meets Unitywater requirements.

3. Flow estimation

3.1 General

Unitywater shall direct the methodology to be applied to the estimation of flows. These methodologies will include empirical methods based on rates and factors from Table 10 of the SEQ WS&S D&C Code, Design Criteria and also catchment performance, either direct or indirect and supported by field monitoring and performance data. Flow estimation methodologies shall also be informed by the respective Integrated Catchment Plan and Servicing Strategy. These catchment specific methodologies shall take precedence over the SEQ WS&S D&C Code, Design Criteria.

3.2 Design flow estimation

The flow in a sewer comprises domestic sewage, industrial wastes, groundwater infiltration and storm inflows and rainfall dependent infiltration.

Flow (in L/s) is composed of the three components, illustrated in the pipe cross section in Figure 3.1, where the overall design flow is represented by the equation:

$$\text{PDWF} = \text{C2 X ADWF where C2} = 4.7 \text{ X } (\text{EP})^{-0.105}$$

Design flow = PDWF + RDI

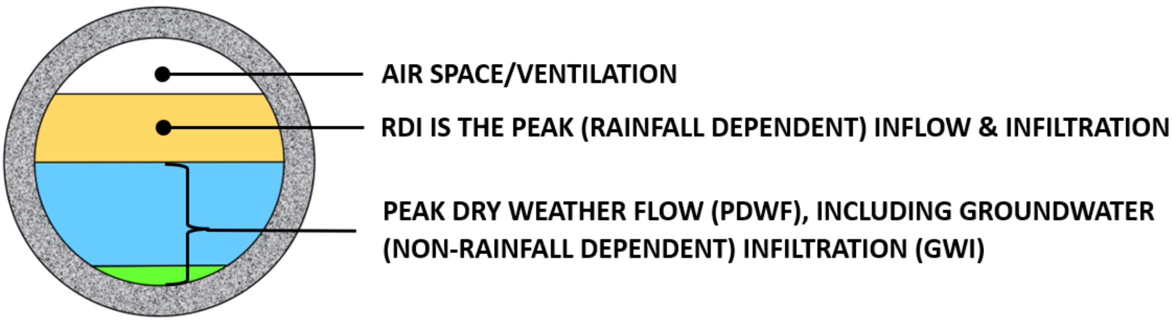

Figure 0-2 FLOW COMPONENTS IN A GRAVITY SYSTEM

New green-field developments shall design for an Air Space at the Design Flow.

Brown-field developments shall be subject to upstream and downstream boundary conditions as provided by Unitywater or otherwise determined from network monitoring. Unitywater shall provide additional operational requirements should there be planned changes in downstream boundary conditions or alternatively upstream inflows.

Where practicable, gravity sewers shall maintain air space under Peak Dry Weather Flow (PDWF) conditions.

Design of constrained brown-field developments that operates in a surcharged condition shall adopt the following a containment and spill performance outcome:

1. No spills from a sewer system (MH or EROS) up to an Average Recurrence Interval of six months
2. Spilling only from EROS but not from MH up to an Average Recurrence Interval of two years.

3.3 Design flow estimation method

3.3.1 General

Unitywater shall be consulted in respect of the hydraulic design of all branch and trunk sewers. Design Flow shall be estimated using the methodology, design criteria, and indicative loadings, which are based on land use, specified in the SEQ Design Criteria.

Unitywater may allow departures from the SEQ Code on site and project specific basis. These departures may include any of the parameters listed above in Section 3.1, Table 10 of the SEQ WS&S Design Criteria or any other design basis variable.

3.3.2 Traditional design flow estimation method

Where a calibrated model applicable to the system under consideration is not available e.g. "greenfield" development sewers that will not receive upstream flows from an existing system, the method for determining the design flow shall be in accordance with the SEQ WS&S Design Criteria and as specified by Unitywater.

For trunk gravity sewers the design parameters shall be provided by or agreed by Unitywater where the parameters are proposed by others.

3.3.3 Design flow estimation incorporating existing systems

For sewers that will connect to an existing upstream system, the method for determining the design flow shall be in accordance with the methodology, including computer models and design inputs, specified by Unitywater.

Design of Composite (brownfield, infill development with or without a green field component) development sewerage systems shall utilise Unitywater' calibrated model where available.

Infill development shall apply revised population loads. However, GWI and RDI should remain as determined by a calibrated model.

3.3.5 Flow schedule

A schedule of all flows into the sewer shall be documented in a format nominated by Unitywater. The flow schedule shall be included in the Concept and Detailed design reports.

4. Products and materials

4.1 General

Design Drawings and specifications shall state requirements for pipeline component products and other construction items and materials such as embedment, trench fill, marking tapes etc. and the corresponding product specifications.

Unless otherwise permitted by Unitywater, only "approved" products and materials as listed in shall be used.

Materials accepted by Unitywater for sewerage pipes and fittings are listed in the SEQ Water Supply and Sewerage Design and Construction Code Accepted Civil Infrastructure Products and Materials (IPAM) list. In addition, the following limitations apply:

(a) The SEQ Accepted Civil IPAM list is intended for use for reticulation infrastructure, and only guidance for trunk infrastructure.
(b) Accepted pipe material for trunk gravity sewer mains shall be in accordance with **Table 4a.**
(c) All pipes and fittings require Unitywater approval.

Unitywater have a strong preference for gravity sewer systems with reduced GWI potential (i.e. welded systems) and for inert systems that can operate in low pH environments (i.e. plastic systems).

Smart Sewers shall be used for all new developments. Smart sewers are the preferred solution for in-fill developments. Smart Sewers shall be constructed as:

Either RIGSS or NuSewers are accepted for Unitywater. RIGSS Reduced Infiltration Gravity Sewerage Systems are a type of Smart Sewer which comprises rubber-ring jointed pipes, and NuSewers shall be HDPE.

Products for which inadequate performance or premature failure may jeopardise the meeting of Unitywater “Standards of Service” or the economic life of the TGSM system, require authorisation for use by Unitywater prior to incorporation into the works. Designers should include:

a) Product Specifications to ensure that constructors purchase and install the correct products.
b) Product Specifications should nominate Unitywater requirements.
c) All products and materials shall be in accordance with the relevant WSAA and Australian Standards.

Any pipe materials that are not listed in **Table 4a** are not accepted by Unitywater for trunk gravity sewer mains.

Table 4a – ACCEPTABLE PIPE MATERIALS FOR TRUNK GRAVITY (NON PRESSURE) SEWER MAINS

CHARACTERISTIC	**TRUNK GRAVITY SEWER MAIN PIPE MATERIAL SUITABILITY**				
	Mild Steel	**Ductile Iron**	**Polyethylene (PE100)**	**Glass Reinforced Plastic**	**PP**
Acceptable to Unitywater	YES	YES	Yes	Conditional[1]	Yes
Minimum Pipe Pressure Class: (CONSIDER DELETING or renaming	PN16	PN35	PN8	PN1 (SN10000 N/m/m)	SN10 & SN20
Accepted Sizes:	OD406, 457, 508, 610, 762, 914, 1016 and 1290	DN375, 450, 500, 600 and DN750 (ISO Sized DI pipes shall not be used, and require prior written approval by Unitywater)	DN400, 500, 630, 800, 1000, 1200	DN300-3000 (DN300-3600 for GRP Jacking Pipe)	Up to DN600 for SN10 Up to DN525 for SN20
Accepted Internal Pipe Lining:	Fusion Bonded Polyethylene lining	Factory applied Polyurethane lining	n/a	n/a	n/a
Accepted External Pipe Protection	Fusion Bonded Polyethylene Coating Cathodic Protection	Zinc-Aluminium 400 g/m^2 with Red oxide epoxy paint coating with gray PE sleeving	n/a	n/a	n/a
Acceptable Installation Techniques	Open Trench Trenchless[1,2]	Open Trench Trenchless[1,2]	Open Trench Trenchless[2]	Open Trench Trenchless[1,2]	Open Trench Trenchless [1,2]
	RRJ[1]	RRJ[1]	Butt Welded	Coupling	RRJ

CHARACTERISTIC	**TRUNK GRAVITY SEWER MAIN PIPE MATERIAL SUITABILITY**				
	Mild Steel	**Ductile Iron**	**Polyethylene (PE100)**	**Glass Reinforced Plastic**	**PP**
Acceptable Jointing where mechanical protection (i.e. pipe enveloper or concrete encasement) of trunk gravity sewer main pipework is not required	Flanged Welded	Flanged	Flanged E-F[1] Mechanical (Gripper)[1]	Sleeve (special for GRP Jacking Pipe)	
Acceptable Jointing where mechanical protection (i.e. pipe enveloper or concrete encasement) of trunk gravity sewer main pipework is required	Welded joints	Conditional[1]	Butt welded joints only	Conditional[1]	Conditional[1]

1. Subject to the acceptance of Unitywater Proposed jointing products and systems require prior written approval from Unitywater with the design to include, but not limited to, design calculations for fittings and system thrust restraint and design life compatibility between individual system components.
2. Pipeline systems for trenchless installation are covered by other Unitywater Technical Specifications, Refer to Pr9787 - Specification for Microtunneling and Pipejacking and Pr9789 - Specification for Auger Boring.

Guidance on pipe material selection shall consider site and pipe protection characteristics, as summarised in Table 4b.

Table 4b – PIPE MATERIAL SELECTION CONSIDERATIONS FOR TRUNK GRAVITY SEWER MAINS

SITE & PIPE PROTECTION CHARACTERISTICS	TRUNK GRAVITY SEWER MAIN PIPE MATERIAL SUITABILITY				
	Mild Steel	Ductile Iron	Polyethylene (PE100)	**GRP**	**PP**
Pipework located within corrosive or acid sulphate soils	Preferably not (unless cathodic protection is considered)	Preferably not (Zinc-aluminum and epoxy coated Pipes may be considered)	Yes	Yes	Yes
Pipework located in contaminated ground (i.e. ground contaminated by organic compounds, such as hydrocarbons and chlorinated hydrocarbons)	Yes – with welded joints	Preferably not	No	Yes	No
Pipework located in reactive soils (i.e. typically clay-type soils that swell when wet and shrink when dry)	Yes – with welded joints	Yes - RRJ	Yes	Yes	Yes
Pipework located in areas prone to mining subsidence and ground movement	Yes – RRJ or welded joints	Yes - RRJ	Yes	Yes	Yes
Pipework located near overhead power lines and transmission towers (refer Cl 5.4.3)	Preferably not (unless surge diverters or cathodic protection is installed)	Preferably not	Yes	Yes	Yes
Cathodic Protection (CP) Requirements	CP shall be considered where pipework: crosses creeks; is installed within corrosive / acid sulphate soils, is susceptible to stray current corrosion	Unitywater does not typically install cathodic protection on DI mains	n/a	n/a	n/a

Pipeline materials selection should be carefully considered to ensure adequate strength to enable the asset to behave in the manner for which it is designed for the duration of it specified service life without being uneconomical. Materials selection process shall consider the following factors: sewage aggressiveness, internal liner integrity and failure risk, pressure rating, structural behaviour, environmental setting, installation methods (e.g. construction loading) and asset criticality.

Assets that have a consequence of failure of **High Significance** or **Most Significance** are considered critical assets.

The asset criticality assessment of the proposed installation shall be assessed in conjunction with Unitywater and shall consider a range of consequence of failure factors including as a minimum: repair duration, safety, service area (number of customers and Key Customer Account's), setting (major transportation corridors, receiving environment) and others in accordance with Unitywater Document Pr9306 - Risk Management Procedure.

For illustration, a trunk gravity sewer serving 2,500 customers conveying sewage across a major transportation route, where failure could result in widespread conveyance disruption for more than 48 hours third-party damage and reputational damage would likely be considered as having an asset consequence of failure of 'High Significance'. Unitywater would expect to see a higher standard of design (lower factors of safety) for critical trunk sewers. The material selection for such an asset may be a fully welded mild steel pipeline.

4.2 Identification of sewer systems

Unless otherwise approved by Unitywater, colour identification for trunk gravity sewers shall be as per Table 4c below.

Table 4c – Colour Identification of Components in Trunk Sewer Systems

Pipe Material	Identification – colour, markings
Mild Steel Pipe/Fittings	Black fusion bonded polyethylene and cathodic protection
Ductile Iron Pipe/Fittings	Red epoxy paint external coating with grey polyethylene sleeving
Polyethylene Pipe/Fittings	Grey or cream, or black with cream stripes or jackets with a co-extruded internal white, light grey, orange, yellow or green liner.
Glass Reinforced Plastic Pipe/Fittings	Beige
Polypropylene (Twin Wall)	Grey
Marking Tape	Grey
Surface Fittings and Surrounds	As per SEQ Gravity Sewer Code
Signage (marker posts, plates)	As per SEQ Gravity Sewer Code

4.3 Serviceability of sewer systems

Products and materials used to construct sewer systems should be selected and configured so as to provide:

a) sufficient access and working space (personnel and equipment) for operations and maintenance with an emphasis on facilitating non-personnel entry operations and maintenance

b) where confined space entry is required, the necessary means to manage safety risks. This shall include provisions for monitoring of conditions (flow level and rate, gas concentrations), flow isolation and bypass, gas management and exposure (e.g. ventilation, SCBA), entry and egress. Serviceability shall be informed by an Operations and Maintenance Strategy and reference Workplace Exposure Standards for Airbourne Contaminants and Potentially Explosive Atmospheres Standards.

c) ease of internal inspection and condition assessment using remote controlled equipment e.g. ROV and CCTV including the use of suitably coloured materials so as not to inhibit inspection processes e.g. internal surfaces thermoplastic pipes should not be black and preferably coloured white or other light shaded colours, i.e. yellow, white, grey.

4.4 Protection against degradation

The protection against internal and external corrosion and material degradation of sewer system components shall be addressed as part of the detail design (refer also to Products and Materials Information and Guidance downloaded from www.wsaa.asn.au).

Protection shall include:

a) protection against internal corrosion due to hydrogen sulphide attacks;

b) protection against external aggressive environments such as acidic soils, high salinity soils, sulphate bearing groundwater and soils;

c) protection against external contaminated ground with contaminants such as hydrocarbons; and

d) protection against direct exposure to sunlight.

4.4.1 Protection against internal hydrogen sulphide attack

A septicity and corrosivity assessment as per clause 2.5.1 shall be undertaken by a suitably qualified independent consultant and shall:

(a) Undertake a septicity assessment with reference to the Hydrogen Sulphide Control Manual. This assessment shall consider the various methods available to reduce sewage age, optimize velocity and shear for biofilm control, minimise turbulence and facilitate ventilation.

(b) Recommend suitable pipe material/s to be used for trunk sewer mains exposed to high corrosivity risks that shall be submitted to Unitywater for consideration and approval. Specific multi-barrier measures to address high risk areas, e.g. ‘high points’ where air pockets develop and air valves/vent pole are provided and high turbulence zones, shall be provided. This might include air primary management systems and secondary acid-resistant internal lining systems.

4.4.2 Protection against external aggressive environments and contaminated land

Desk-top assessments and geotechnical investigations shall determine the physio-chemical condition of the installation location and necessary pipe material selection criteria. This shall include acid sulphate soils and other natural or man-made factors leading to low pH soils.

Where determined by a desk-top assessment, a contaminated ground investigation shall be included as part of the geotechnical investigation and carried out by a suitably qualified independent consultant and shall:

- Recommend suitable pipe material/s to be used for trunk gravity sewer mains located within contaminated land that shall be submitted to Unitywater for consideration and approval.

Plastic pipes shall not be used in ground, such as former landfill sites, likely to be contaminated with hydrocarbons or other chemicals that may adversely affect the pipe material. Where hydrocarbons are known to occur or are likely to be encountered approval of the pipe material to be used shall be sought from Unitywater.

4.4.3 Protection against damage to coatings

Double thickness of PE sleeving shall be specified for insertion between coated fittings, valves and other appurtenances, and thrust and anchor blocks. PE sleeving shall be 200 ± 20 µm, in accordance with AS 3680: Polyethylene sleeving for ductile iron pipe.

Constructors shall be required to repair any damaged sleeving in accordance with the pipe and/or fitting manufacturer's instructions.

4.4.4 Cathodic protection

Any mild steel or ductile iron pipe systems will be assessed in accordance with AS 2832.1 and AS/NZS 4853, with the resulting technical report referred to Unitywater for a decision on the requirement for cathodic protection. *Typically, Unitywater only requires cathodic protection on mild steel pipework. Refer to* ***Table 4b*** *for pipe material selection considerations.*

Cathodic Protection shall be considered as part of an overall system / asset-specific philosophy for the trunk gravity sewerage main and interconnecting assets. In addition, consideration of the existing CP system is required when determining if and how CP is to be installed for the new steel trunk gravity sewerage main works.

Mild steel trunk gravity sewer mains shall be designed to enable connection to adjacent or future Unitywater cathodic protection systems (if required). *This may be achieved by installing bonding at the ends of the steel pipework.*

Cathodic Protection is typically required where mild steel mains are:

(a) crossing a river
(b) crossing a railway
(c) fully or partially located within reactive soils (based on soil testing)
(d) fully or partially located within corrosive soils (based on soil testing)

Electrical isolation of fittings shall be provided at the flanges, where required, to prevent electrical current continuing along the pipeline (e.g. at valves in pits, etc.).

Isolation of cathodic protection is preferred at all offtakes.

All scour valves and air valves including equipment in direct contact with the ground are to be electrically isolated from the trunk main with the use of approved insulated bolt sets and gaskets, or isolating flanges.

When steel mains are laid in proximity to power lines, e.g. high voltage transmission lines and railway overhead power lines, the design of cathodic protection systems shall consider Low Frequency Induction (LFI) and Earth Potential Rise (EPR). *Earth mats may be required for fittings in these locations.*

Third party CP systems may also cause damage to Unitywater pipework. As such, the Designer is responsible for investigating and mitigating any adverse impacts on Unitywater assets from third party CP systems.

The cathodic protection Designer shall have a minimum of five years' experience in design, installing and servicing the types of systems required in the design.

Please note, ongoing maintenance costs of impressed current CP systems in Queensland are high, as these systems must be (re)registered/ every 5 (five) years. Consideration of whole of lifecycle cost shall be used to inform appropriate selection of trunk gravity sewerage main pipe material and arrangement.

4.4.5 Protection against direct exposure to sunlight

Polyethylene and glass reinforced plastic pipes and externally protected steel and ductile iron pipes and fittings shall be protected from pipe and coating degradation caused by exposure to sunlight and UV. Consideration shall be given to pipe strength derating and compensatory measures like provision of higher class/thickness pipes and/or additional external coating protection.

4.5 Ductile iron gravity sewers

4.5.1 Product specifications

WSA 402 Product and Material Information and Guidance Supplement to the Gravity Sewerage Code of Australia, WSA02-2014, Water Services Association of Australia, 2024.

4.5.2 Sizes and configurations

To mitigate against corrosion potential, DI pipe class shall be PN35. DI fittings shall be minimum PN16.

Ductile Iron Pipe (Cast Iron Outside Diameter – CIOD) shall be used unless otherwise agreed by Unitywater.

4.5.3 Cement mortar lining

Application of cement mortar lining systems are not accepted for sewer applications. Thermal boned polyurethane lining as per AS/NZS 2280 EN 15655-1 is the accepted internal lining.

Ductile Iron pipes for gravity sewers with internal lining of a Calium Aluminate Cement (with seal coat) as per AS/NZS 2280 EN14647 or other cement mortars (AS 3972 Type General Purpose, General Blended or Sulphate Resisting) are not permitted.

The standard internal lining for Ductile Iron pipes for gravity sewers to be "Min 1300 micron Polyurethane internal Lining" Refer to table 4.a.

4.5.3.1 Fitting lining systems

The standard internal lining for AS/NZS 2280 fittings is thermal bonded polymeric lining to AS/NZS 4158.

4.5.4 Sleeving

PE sleeving shall be specified on all DI pipes and fittings (including those with zinc-aluminium alloy coatings) applied in accordance with AS 3681, unless following a comprehensive soil testing and risk assessment the pipe supplier or manufacturer provides a written guarantee to the satisfaction of Unitywater that PE sleeving is unnecessary.

Constructors shall be required to repair any damaged sleeving in accordance with the pipe and/or fitting manufacturer's instructions.

Double thickness of PE sleeving shall be specified for insertion between coated fittings, valves and other appurtenances, and thrust and anchor blocks. PE sleeving shall be 200 ± 20 µm, in accordance with AS 3680 Polyethylene sleeving for ductile iron pipe.

4.5.6 Flanged joints

PN16 flange dimensions and associated bolting details shall be in accordance with Figure B5 of AS/NZS 4087.

Flanged joints (including screw-on flanges) shall not be subject to moment forces and shall not to be used underground unless special provision is made to either fully support the pipe or incorporate flexible joints.

All buried bolted connections to be protected with a petrolatum system (such as Denso tape or equivalent).

Refer to SEQ Code Standard Drawing SEQ-WAT-1313-1 for guidance on bolted connection requirements.

4.5.7 Coatings

Ductile Iron pipe coatings shall be Zinc-Aluminium 400 g/m^2 with Red oxide epoxy paint coating and polyethylene sleeving.

Alternative coatings include Polyurethane coating to EN 15189 and Fusion bonded epoxy or liquid 2-pack epoxy to EN 14901.

Application of alternative lining systems are subject to approval by Unitywater

Subject to compliance with Clause 4.5.4, DI pipes with an enhanced zinc alloy coating with 400 g/m^2 thickness and min 100mm thick finishing layer can be buried without sleeving except:

a. acidic peaty or acid-sulphate soils
b. soils containing refuse, cinders, slag or polluted by wastes or industrial effluents
c. soils below the marine water table with a resistivity lower than 500 Ω cm
d. areas where there is stray current
e. or as otherwise determined from a comprehensive soil testing and risk assessment.

4.5.8 Diametral deflection

DI pipes are to be designed to limit diametral deflection of the pipe to 2% of the pipe diameter.

For pipes with a flexible lining system, design shall limit diametral deflection of the pipe to 4% of the pipe diameter.

Refer also INFORMATION AND GUIDANCE NOTE (IGN) WSA TN 3, Ring bending stiffness, allowable deflection and embedment design of ductile iron and steel pipe.

4.6 PVC gravity sewers

PVC pipes and fittings shall not be used for trunk gravity sewer mains.

4.7 Polyethylene gravity sewers

Polyethylene pipe is Unitywater preferred trunk sewer pipeline material due to its resistance to low pH environments.

4.7.1 Product specifications

WSA 402 Product and Material Information and Guidance Supplement to the Gravity Sewerage Code of Australia, WSA02-2014, Water Services Association of Australia, 2024.

PE pipes and fittings shall comply with AS/NZS 4129 and AS/NZS 4130. PE pipes shall be polyethylene grade PE100 with minimum class of SDR21. Higher pipe classes (that is lower values of SDR than SDR21) may be used as necessary to suit soil and loading conditions.

Pipe colour shall be:

(a) External light grey—solid or striped.

(b) Internal white or light colour to facilitate CCTV inspection.

Internal white or light colour is mandatory as CCTV inspection forms part of the gravity sewer asset acceptance requirements.

All PE to PE connections in PE sewer systems (including NuSewer) shall be welded. Welding shall be in accordance with the following:

Factory welds:

(i) butt welding preferred;

(ii) electro-fusion welding is subject to Unitywater approval.

Site welding:

(i) butt welding preferred;

(ii) electro-fusion welding is subject to Unitywater approval.

Only approved fittings that comply with AS/NZS 4130 and AS/NZS 4129 shall be used.

All site and factory welding shall be carried out by persons who has completed the Nationally Accredited Training Courses for Butt welding or Electro-fusion and must hold a valid welding certificate as per AS/NZS 2033. Refer to PIPA website for the training course details. PE pipe and fittings shall be provided by a single supplier. Welding equipment shall include Quality and Assurance monitoring and recording software, so that all records relating to the PE welds are provided to Unitywater at no cost, and in accordance with the product manufacturers requirements.

Jointing the PE pipes and fittings shall be as per Pr9875 - Specification for Non-Pressure Pipeline Construction clause 6.5.

The manufacturer's printed instructions on the electro-fusion welding procedure, especially the surface preparation requirements, are to be strictly adhered to.

Joint preparation shall include the removal of oxidised layers with a mechanical rotational Peeler. The use of hand scrapers is not permitted.

De-beading is not to be carried out for butt welded joints (internal or external) unless specified otherwise by Unitywater.

4.7.3 Flanged pipe joints

PN16 flange dimensions and associated bolting details shall be in accordance with Figure B5 of AS 4087.

Flanged joints shall not be subject to moment forces and shall not to be used underground unless special provision is made to either fully support the pipe or incorporate flexible joints.

All buried bolted connections to be protected with a petrolatum system (such as Denso tape or equivalent).

Refer to SEQ Code Standard Drawing SEQ-WAT-1313-1 for guidance on bolted connection requirements.

Only full-face full-bore PE flanges with stainless steel (SS 316) backing rings shall be permitted for flange connections. *This is because PE stub flanges which are not full face may rotate due to relaxation of the PE stub flange material. requirements.*

4.7.4 Deflection

PE Pipes are to be designed to limit the diametral deflection of the pipe to 4% of the pipe diameter.

4.8 Polypropylene gravity sewers

Polypropylene pipes and fittings are accepted for trunk gravity sewer mains. Refer to the latest civil IPAM list for the accepted products and size ranges. The design shall include supportive documents submitted by RPEQ to demonstrate the selected pipe material is appropriate for the purpose and complies with WSA PS-240 and AS/NZS 2566.1.

4.9 GRP gravity sewers

Glass Reinforced Plastic pipe is subject to acceptance by Unitywater for trunk sewer applications due to its resistance to low pH environments and a preference over polyethylene for 'grade controlled' trenchless pipe jacking (thrust or auger bored) applications.

Supporting documentation shall be submitted by RPEQ to demonstrate the selected pipe material and jointing system are appropriate for the purpose and comply with the AS/NZS 2566.1 & AS 3571.1.

The design shall confirm the requirements for embedment and backfill immediately surrounding the pipes, specifying the required degree of compaction and defining the following:

- Particle size limits and restrictions on embedment and backfill materials.
- Trench management requirements, including minimum trench width, dewatering methods, trench wall support, and procedures for leaving trenches open.
- Bedding and foundation requirements, including approved compaction methods and embedment depth below the pipe.

Hydraulic calculations shall verify that the minimum self-cleansing shear stress in accordance with SEQ Design Criteria.

Pipeline and maintenance hole Buoyancy & Flotation shall be checked to ensure compliance with the required factor of safety, as specified in Clause 9.4.5 & clause 9.4.6.

For trenchless sections, the design shall confirm the suitability of the installation methodology for the ground conditions and pipe material, and verify compliance with line, level, tolerances, jacking forces, and post-installation alignment and deformation.

4.9.1 Product specifications

WSA 402 Product and Material Information and Guidance Supplement to the Gravity Sewerage Code of Australia, WSA02-2014, Water Services Association of Australia, 2024.

4.9.2 Sizes and configurations

Permissible pipe sizes range from DN300 to DN3000. GRP pipe size shall be determined by the hydraulic design sizing, manufacturing method (filament wound or centrifugally cast), construction method (trenched or trenchless) and performance requirement (carrier or enveloper).

4.9.3 Stiffness class

Minimum stiffness of GRP shall be 10,000 N/m/m. Structural design shall determine the requisite stiffness for the design application.

4.10 Plastics-lined concrete gravity sewers

Plastics-Lined Concrete pipes and fittings shall not be used for trunk gravity sewer mains unless under specific circumstances, upon application and subject to approval by Unitywater.

Reinforced concrete class 4 Butt jointed pipes with steel locating bands are suitable as enveloper pipes only installed by trenched or trenchless techniques.

4.11 Vitrified clay sewers

Vitrified Clay pipes and fittings shall not be used for trunk gravity sewer mains.

GRP pipe manufactured to ISO 25780 is Unitywater preferred material for jacking pipe. Vitrified clay pipes mains are not preferred as jacking or enveloper pipes unless under specific circumstances, upon application and subject to approval by Unitywater.

4.12 Steel gravity sewers

4.12.2 Sizes and configurations

Steel pipe and fittings shall be minimum Grade 250, minimum yield strength 250 MPa and conform to the requirements of AS 1579.

To mitigate against corrosion potential, all steel pipes and fittings shall have a minimum wall thickness of 6 mm.

4.12.3 Joints

Refer to SEQ Code Standard Drawings SEQ-WAT-1313-1, SEQ-WAT-1400-1, SEQ-WAT-1401-1, SEQ-WAT-1402-1, SEQ-WAT-1403-1 and SEQ-WAT-1405-1 for guidance regarding jointing of steel pipework.

4.12.5 Flanged joints

All buried bolted connections to be protected with a petrolatum system (such as Denso tape or equivalent).

Refer to SEQ Code Standard Drawings SEQ-WAT-1313-1, SEQ-WAT-1403-1, SEQ-WAT-1404-1 and SEQ-WAT-1405-1 for guidance regarding flanged joints.

4.12.6 Closing joints

2% Provision is to be made for a collar closing joint where the trunk gravity sewerage main runs between two anchored points. The construction procedure shall be to construct a bend and anchor block with one full pipe on each side and then lay the intermediate pipes. The closing pipe is cut to suit and collared into the trunk gravity sewerage main. The gap between pipes at a closing joint shall be minimised as much as practicable.

Collars are to be noted on the drawings as providing a gap no greater than 10 mm on pipes < DN750 and 20 mm on pipes > DN 750.

On pipes < DN750, seal welds are required on collar joints to enable testing of the joint.

4.12.7 Steel fittings

Steel fittings shall be factory fabricated and shall be manufactured from pipe produced by a manufacturer that is certified to AS 1579.

Fittings shall be manufactured with sufficient strength and stiffness to withstand all hydraulic, earth and surface loads. Where the pipeline is operating at or near design maximum pressures, fitting strength shall be considered in the design calculations for the approved detailed design. *Depending on the situation, additional reinforcement of the steel fitting may be required by increasing the localised thickness of the pipe. Steel tees, crotch plate reinforcement (also known as compensating rings) may be required.* Where required, reinforcing plates, compensating rings or crotch plate reinforcement shall be designed and detailed on the Design Drawings.

4.12.8 Diametral deflection

Welded steel pipes are to be designed to limit diametral deflection of the pipe to 3% of the pipe diameter and RRJ pipes designed to limit diametral deflection of the pipe to 2% of the pipe diameter.

For pipes with a flexible lining system, design shall limit diametral deflection of the pipe to 4% of the pipe diameter.

Refer also INFORMATION AND GUIDANCE NOTE (IGN) WSA TN 3, Ring bending stiffness, allowable deflection and embedment design of ductile iron and steel pipe.

4.13 Maintenance structures

4.13.1 Product specifications

Only Maintenance Holes (MH) are permitted for Trunk Gravity Sewer Systems.

WSA 402 Product and Material Information and Guidance Supplement to the Gravity Sewerage Code of Australia, WSA02-2014, Water Services Association of Australia, 2024.

4.15 Access covers and frames

4.15.6 Size and configuration

Only DN600 Round solid top covers with standard lifting key. Covers with another Service Provider's name not accepted.

Bolt down for Surcharge and overland flow areas, 4 x M12 (min) SS 316 Bolts.

4.17 Polyethelyene (PE) Plain and twin wall pipes

PE twin wall sewer pipes complying with AS/NZS 5065 shall not be used for trunk gravity sewer mains.

5. Detail design

5.1 Detail design process

Following the definition of the servicing strategy for a catchment and its functional design requirements, detail design of the major infrastructure for the area and the individual reticulation and property connection sewers shall be carried out.

Detail design shall ensure that the following principal requirements are met:

(a) the design reflects Unitywater's servicing strategy, concept plan and/or other brief for the subject catchment;

(b) Unitywater has been consulted and has approved downstream impacts of flows from the proposed development;

(c) the design incorporates the most appropriate location, size, depth and grade of sewers;

(d) the design takes account of any physical features (buildings, planned or existing underground utilities/services, creeks etc) previously identified in the field;

(e) projected life cycle costs are minimised;

(f) Not in use

(g) Not in use

(h) the design identifies and incorporates access, lifting and maintenance needs as provided by the Concept Design Report or otherwise determined as required in Sections 1.2.5 and 2.4.8.

(i) the design identifies and incorporates hazardous areas classification risks and mitigation and management measures.

(j) the design identifies and incorporates requirements for Septicity control as provided by Section 2.5.1.

5.1.1 Detailed design outputs

In addition to clause 1.2.7.3, the design outputs shall include, but not limited to:

(a) Product, construction and other relevant technical Specifications;

(b) Design PWWFs, pipe capacities, pipe size(s) and grades of sewers throughout the relevant portion of the proposed trunk /branch /reticulation system to meet concept plan requirements;

(c) appropriate products including reference to relevant product specifications (including structural, electrical, mechanical, control system, process logic, civil and hydraulic design) and specific project requirements such as material type(s), stiffness class(es), jointing system etc., in accordance with concept plan;

(d) Basis of Design Report

(e) sewer layouts and alignments including:

- route selection;
- Plan and elevation design drawings of all sewers and appurtenant structures and facilities and all necessary construction drawings;
- topographical and environmental, cultural and heritage aspects;

- easements;
- foundation and geotechnical aspects;
- provisions for future extensions;
- types and locations of maintenance structures, overflows and vents;
- locations and details of bulkheads;
- location of all relevant obstructions;
- property service connection locations; and
- special construction requirements, e.g. trenchless.

(f) site investigation, excavation/trench details and other technical matters;

(g) documentation of all design assumptions, constraints and issues relevant to the design and not otherwise noted in the concept plan or Design Drawings or Specification, including any written approvals from Unitywater to deviate from the provisions of the Code.

(h) Detailed construction drawings showing, as appropriate, location of pipelines, pipe materials, size, pressure class, jointing methods maintenance structures, valves (including penstocks), EROS, pump stations, corrosion protection measures, chemical dosing systems, odour control and buildings.

(i) Detailed construction drawings and models showing the location of all relevant obstructions, as well as all existing services within and around the vicinity of the works areas, that have been accurately located using non-destructive methods (e.g. pot-holing). *Refer to Pr11231- Unitywater Technical Specification Reference Guide.*

(j) Any variations to this TGSM Code, and the reason for the variation, shall be highlighted in a boxed note on the design drawings

(k) Design Report inclusive of but not limited to:
- Basis of Design;
- Design calculations;
- geotechnical report including criteria in relation to geotechnical and imposed load assumptions;
- hydraulic analysis including transient analysis (if required);
- septicity and corrosivity assessment (to check corrosivity of the water being conveyed if a Calcium Aluminate Cement-lined pipe is proposed);
- survey;
- electrical investigations;
- environmental and cultural heritage reports.

(l) Safety in Design Report (refer to Section 1.2.7.4)

(m) Plans detailing any additional easement requirements where the trunk main is to be temporarily located within private property as part of the works;

In addition, refer to SEQ Sewerage Standard Drawings that may also be used for guidance only, even though these drawings are not intended for use in trunk gravity sewer main designs.

The SEQ Code Standard Drawings are not suitable for construction without further engineering design.

5.2 Detail design considerations

5.2.1 Catchment Design

Trunk Gravity Sewers may be required in new 'greenfield' development areas or otherwise retro-fitted into existing catchments.

Sewers within any project area shall be designed to drain the specified catchment and provide any additional conveyance and performance improvements as outlined in the Concept Design and/or Unitywater Servicing Strategy and relevant Integrated Catchment Plans.

5.2.2 Design accuracy

The location and final design elevations of the sewer(s) and appurtenant features shall be determined to the following levels of design accuracy and specified in the Design Drawings:

(a) in plan, to 0.01 m.

(b) in level where grade is < 0.5% (1:200) to the nearest 0.005 m.

(c) in level where grade is > 0.5% (1:200) to the nearest 0.01 m.

Levels shall be referenced to the Australian Height Datum (AHD). Location in plan shall be referenced either to the local cadastral boundaries, or to the Geodetic Datum of Australia (GDA 2020).

Asset geospatial referencing and associate accuracy shall be in accordance with the SEQ Water Supply and Sewerage Design and Construction Code Asset Information Specification, and where possible, to local property boundaries.

5.2.3 Sewer layout

Unitywater preferred location for sewers is within the service allocation in the road reserve. Where Unitywater agrees this is impractical, the following alternatives may be considered:

- another service allocation, subject to the service owner's approval;
- along drainage reserves subject to the provision of vehicular access to sewer maintenance points; and
- in the road carriageway.

As a gravity sewer system design is generally preferred to other options, the sewer layout shall conform to the natural fall of the land as far as practicable. The design shall address the following factors in determining the location of sewers:

(a) Road reserve size and layout;

(b) Topography and geotechnical considerations;

(c) Not in use

(d) Not in use

(e) Underground services;

(f) Maintenance structure locations and associated safe operations and maintenance requirements including; support vehicle parking, laydown and temporary site occupation areas (if required);

(g) Existing / proposed building alignments;

(h) Proposed zoning / land use;

(i) Planning information regarding proposed or possible future development on the site e.g. road re-alignments, landscaping;

(j) Easements, with existing sewerage easements being used where possible;

(k) Physical surface obstructions;

(l) System security;

(m) Construction methods e.g. normal excavation or trenchless methods;

(n) Historical information regarding previous use of the site;

(o) Environmental, cultural and heritage considerations;

(p) Preference for sewer location in accordance with Unitywater requirements;

(q) Preferences expressed by lot Owners;

(r) Preferences of municipal councils and other authorities;

(s) Future development plans and the need to avoid unnecessarily reducing the development potential of adjoining lands;

(t) The siting and associated overflow paths of overflow structures and maintenance holes designated to overflow;

(u) Contaminated soil;

(v) Aggressive soil, e.g. acid sulphate soils;

(w) Sites that have previously been disturbed or filled; and

(x) Structural design integrity/stability.

(y) Proximity to mains power supply to enable monitoring instrumentation deployment;

(z) Radio or mobile communications coverage to enable monitoring instrumentation;

(aa) Ventilation and odour management systems;

(bb) Operation and maintenance methods, including isolation and bypass methods, human and ROV access.

Taking all the above factors into consideration, the following list is indicative of where sewers should be positioned (no particular order):

1) Within the street reserve according to the locally applicable utilities' allocation code; in the absence of a code, a location clear of carriageways is preferred.

2) Within public land with the permission of the controlling authority.

3) Within drainage reserves outside 1 in 5 year flood area.

4) Within private lots parallel to front and/or side lot boundaries adjacent to street reserve or public land.

5) Within private lots parallel to rear and/or side lot boundaries.

The final sewer alignment shall comply with Unitywater requirements, any local space allocation code and applicable statutory requirements.

5.2.4 Location of sewers

5.2.4.1 General

Trunk Gravity Sewers shall be located on public property provided there is sufficient access for operations and maintenance. For the purposes of this clause, public property includes parks, reserves and land administered by a government authority. A pre-design meeting between the Designer and the Unitywater will ensure the location criteria for each case is satisfactorily identified and understood.

Refer also to Section 5.3 Horizontal Alignment of Sewers

Public and private land

Where sewers are designed to traverse any vacant or occupied public or private lots, the design shall, as far as practicable, allow for possible future building plans, preclude maintenance structures and specify physical protection of the sewer within or adjacent to the normal building areas and all engineering features (existing or likely) on the site, e.g. retaining walls.

Trunk Gravity Sewers shall not be located in private property (lots) without prior Unitywater approval.

Where a new trunk gravity sewer is to be located on private or public property:

(a) the designer will provide to the Unitywater written approval from the property owner and submit this with the design when an application is lodged for design approval;

(b) the sewer shall be sited closer to the dwelling than the stormwater drainage system;

(c) easements shall be provided in accordance with 5.2.8 Easements and;

(d) the designer shall ensure maintenance structures and property connections are located clear of structures in locations with unimpeded access.

When designing a sewer through private lots in developed areas obstructions such as sheds, brick walls, swimming pools, garages and large trees shall be avoided, where possible, when determining the route of the sewer. This route selection criteria will apply in principle to trenched and trenchless construction methodologies albeit with differing design considerations that shall be addressed in detail design.

Where sewers are designed to traverse lots containing existing structures, e.g. retaining walls, buildings and swimming pools, the current and future stability of the structure shall be assessed through structural design. Sewers adjacent to existing buildings and structures shall be structurally independent (located clear of the "zone of influence") of adjacent structures and foundations. If this is not possible, protection of the sewer and associated structures shall be specified for evaluation and approval by Unitywater in consultation with the property owner and relevant authorities. Geotechnical and structural investigations and detail design shall be undertaken to determine specific requirements and apply to trenched and trenchless construction methodologies.

The design shall allow access for all equipment required for construction and future operations and maintenance. Except where obstructions and/or topography dictate otherwise, sewers shall run parallel to boundaries or as specified by Unitywater.

Offsets from property boundaries, structures and corresponding easement geometry shall be assessed in accordance with Section 2.4.8 and reference the Operations, Maintenance, Replacement and Decommissioning Strategy for the proposed trunk gravity sewer. Deeper sewers will generally require larger offsets and easements in order to excavate and access for repair/decommissioning. The requirement for surface access and associated surface easements may not exist for deep and trenchless constructed sewer systems. However, a subsurface 'volumetric easement' will be required to protect the asset from adjacent development and associated structural impacts (refer also to Section 5.2.8 Easements).

The location and orientation of maintenance structures shall permit the removal of covers without being restricted by existing or proposed fences, retaining walls or other structures or adjacent land uses and activities. Easements for access to maintenance structures shall be proved over private property or otherwise as required to secure operational access (refer also to Section 5.2.8 Easements).

5.2.4.6 Branch and trunk sewers

The preferred location of branch and trunk sewers is outside private property (lots), where these assets can be operated and maintained. A pre-design meeting between the Designer and Unitywater will ensure the location criteria for each case is satisfactorily identified and understood.

5.2.5 Trenchless techniques for pipe installation

All forms of trenchless construction are acceptable to Unitywater including Auger/thrust boring and micro-tunnelling. Trenchless pipelines including the use of enveloper pipes shall be subject to detailed design which will be subject to review and approval by Unitywater prior to adoption.

Where a PE trunk sewer main is installed using trenchless technology, only butt-weld pipe joints are accepted. Butt welding shall have internal beads and burrs removed with cutting and grinding tools (refer Section 16.17). Stress analysis shall be undertaken to verify pipe material performance under installation loading.

Where a mild steel trunk gravity sewer main is installed using trenchless technology, only welded pipe joints are accepted.

Where GRP is installed using trenchless (thrust/auger-bore, micro-tunnelling) technology, only stainless steel sleeves with integrated rubber seals are accepted.

Pipework with rubber ring joints (RRJ), flanged joints (FL), electrofusion (EF) joints or mechanical joints shall not be installed using trenchless techniques or within mechanical protection (i.e. pipe enveloper or concrete encasement).

Design requirements relating to pipe grade and design elevations shall be addressed in the design of the trenchless installation. Additional pre-construction geotechnical investigations will be required along with suitable quality control and assurance to verify the construction has achieved the required design.

5.2.5.1 Requirements for enveloper pipe installations

In the design of trenched or trenchless installation utilising enveloper pipes, the following issues shall be addressed:

a) Whether the enveloper pipe is considered temporary or permanent works.

b) Assessment of enveloper durability including sacrificial pipe wall thickness and cathodic protection.

c) Design of spacers between the product pipe and the enveloper pipe.

d) The use of grout is required in either the outer or inner annulus. In general, grouting of the inner annulus is normally required if the enveloper pipe is designed as temporary works, however, if the enveloper is designed as permanent works then grouting may not be required.

Refer to Unitywater specifications Pr9787 - Microtunnelling and Pipejacking Specification and Pr9789 - Specification for Auger Boring.

Refer to Standard Drawings SEQ-SEW-1401-1, SEQ-SEW-1402-1 and SEQ-SEW-1403-1 for guidance only on typical arrangements

5.2.6 Near-horizontal boreholes and tunnels

5.2.6.1 General

Near-horizontal boreholes (directional drilling, thrust/auger-bore) and tunnels may be used to facilitate the economic installation of sewers, usually in difficult areas as described in Section 5.2.5 Trenchless techniques for pipe installation.

Advice shall be obtained from specialists regarding construction tolerances and other requirements for boreholes and tunnels.

All near-horizontal boreholes and tunnels require consultation and approval from Unitywater prior to planning, concept and detailed design, construction and commissioning.

Refer to Unitywater specifications Pr9787 - Microtunnelling and Pipejacking Specification and Pr9789 - Specification for Auger Boring.

In determining requirements for boreholes and tunnels, refer to ASTT Guidelines Standards Specifications, http://www.astt.com.au/.

Specific and appropriate geotechnical site investigation shall be undertaken (Refer to 9.6 GEOTECHNICAL CONSIDERATIONS).

Methods of construction include manned and unmanned and steerable and non-steerable techniques. The choice of method will depend on such factors as:

(a) Accuracy required in line and level.

(b) Proximity of other services.

(c) Diameter of bore.

(d) Length to be driven.

(e) Ground conditions.

(f) Minimum depth of cover.

(g) Access for equipment.

(h) Pipe lengths.

(i) Disposal of excavated materials.

(j) Mobilisation and construction costs.

5.2.6.2 Design requirements

The design of trunk gravity sewers constructed by trenchless techniques have a number of design criteria that require consideration in the planning, concept and detailed design process. Factors, preferences and requirements to be addressed include but are not limited to the following:

(a) Trunk size determined by following the requirements of Chapter 3 Flow Estimation and Chapter 5 Detailed Design. Unitywater preference is to provide additional pipe diameter equivalent to 'the next pipe size' or otherwise 20% whichever is the greater.

(b) Minimum trunk grade as required from the SEQ Design Criteria. Unitywater preference is to provide an additional pipe grade of 0.5% more than the appropriate minimum grade.

(c) Requirements of the Operations, Maintenance, Replacement and Decommissioning Strategy which might dictate size to achieve the required operator and equipment access requirements.

(d) Structural design to resist temporary and permanent loading and forces (static and dynamic). These include, for example, future permanent ground loading changes, installation conditions (PE pipe stresses during swage-lining) amongst others.

(e) Where plastic pipes are installed using boring or pipe pulling methods, Unitywater preference is that the pipe class or stiffness required shall be the higher of

- The class required to resist the installation forces.
- The class that is two classes stronger than the class or stiffness, that calculations show is required to resist the static forces and loads detailed in Section 9.3 Structural Considerations and Section 9.4 Loadings.

Construction methods shall be capable of achieving an installed grade that will ensure efficient hydraulic performance of the sewer. The design grade shall make allowance for construction tolerances appropriate to the particular method. Tolerances may be additional to those specified in Table 22.1. The hydraulic performance of the sewer at the design grade (inclusive of tolerances) shall be verified against the requirements of 5.5 PIPE SIZING AND GRADING.

The following factors shall be considered in the design phase before selecting the most appropriate pipeline system:

(a) Sewer inside diameter.

(b) Sewer outside diameter.

(c) Sewer length.

(d) Tolerances on dimensions.

(e) Safe jacking load or pulling force.

(f) Type and performance of joints.

(g) Type of sewer pipe to be used.

(h) Grouting method to be used where the sewer is laid inside a borehole liner pipe.

(i) External loadings such as overburden, live loads, groundwater pressure.

The pipeline system and/or encasement pipe shall be structurally designed by a suitably qualified and experienced professional engineer (Refer to 9 STRUCTURAL DESIGN).

As appropriate, Design Drawings shall show the location, type, materials and all necessary construction details for near-horizontal boreholes and tunnels, including any additional structures, features, equipment and protection measures.

The maximum limits of deviation from line and level shall be specified in the Design Drawings taking into account:

(i) requirements of function and maintenance

(ii) grade of sewer

(iii) possible installation methods to be used

(iv) existing structures and obstructions, and

(v) ground conditions.

The maximum limits of deviation from level (vertical) and from line (horizontal) measured in millimeters shall not exceed the greater of:

(1) the numerical value of the design grade in percent multiplied by 100, providing no backfall greater than the figures given in Table 5.1 occurs at any point; or

(2) the values in Table 5.1.

Table 5.1 MAXIMUM LIMIT OF DEVIATION IN LEVEL AND LINE OF BOREHOLES AND TUNNELS

Sewer size DN	Limit of vertical deviation mm/100 m length	Limit of horizontal deviation mm/100 m length
≤ 1000	± 30 (±0.03%)	± 50 (±0.05%)
> 1000	± 50 (±0.05%)	± 100 (±0.1%)

5.2.6.3 Silt traps

Silt and solids management shall be considered in the design of trunk sewer mains sizing and grade requirements and incorporated into the Operations, Maintenance, Replacement and Decommissioning Strategy. This assessment shall determine whether a particular sewer requires silt management and how that shall be provided by operations staff or otherwise conveyed to an alternative management location.

Before undertaking a design that includes silt traps, the Designer shall consult with Unitywater to discuss alternative options that can be adopted to eliminate the need for silt traps. For example, the lining of boreholes and tunnels may minimise the likelihood of solids catching on protrusions in the tunnel.

Where silt traps are needed, the Designer shall also address other maintenance requirements in consultation with Unitywater, such as providing all weather access to the silt trap for maintenance vehicles.

5.2.7 Environmental, cultural and heritage considerations

5.2.7.1 General

Full details of the environmental management plan and mitigation works shall be shown on the Design Drawings and submitted to relevant Authority for approval.

A Site Assessment including access, tenure, environment and planning requirement shall be completed as part of the design process. (Refer Pr8856 - Project Control Environmental Procedure and Pr11074 - CIPM - Site Assessment Procedure).

5.2.8 Easements

Where sewers cannot be located in a dedicated public road reserve or otherwise where required by Unitywater, easements shall be created that provide access for future operations and maintenance activities and prohibit any construction over, or immediately adjacent to, the sewer. The easement registration shall provide for rights of occupation and access by Unitywater and its contractors and ensure suitable conditions for sewer operation, maintenance and appropriate indemnities.

Unless otherwise specified by Unitywater, Easement widths and placement of the sewer and associated structures within the easement shall be as per Table 5.1A.

Easements shall be provided along the full alignment of gravity sewers located on land other than road reserve or land owned by Unitywater (or stakeholder).

Normally, easements shall be wholly contained within the property in which the sewer is located and located centrally over the sewer. Where these criteria conflict, Unitywater may permit the easement to be placed eccentrically over the sewer or the sewer to be placed centrally within a pair of parallel easements created over two adjoining lots.

Where a sewer maintenance structure is located on private property, a minimum 1 m wide easement along the side boundary from the front boundary to the rear boundary, for sewerage purposes, is to be provided to facilitate access to the structure. The minimum 1 m wide easement required for facilitating access to maintenance structures is to be provided for all maintenance structures on private property, irrespective of the diameter of the associated sewer, and is to contain the maintenance structure.

Notwithstanding legislation that may confer rights to the sharing and co-location of services within Unitywater easements, e.g. Telecommunications Legislation Amendment (National Broadband Network Measures No. 1) Bill 2009, the exception that may be permitted is where a sewer easement is shared with a stormwater drain, in which case the Council/Developer shall obtain its own stormwater easement from the land Owner. Where a stormwater easement has been granted, it may overlap a portion or the whole width of a sewer easement, in which case it shall be located on the side of the easement away from any buildings to minimise the potential for damage to buildings and improvements adjacent to the sewer.

Specific requirements for the use of an easement shall be obtained in writing from Unitywater prior to design and registration of the easement and shall at least include:

(a) The zone-of-influence of the trench for the sewer.

(b) Sufficient width for access for construction/maintenance (refer to Section 2.4.8 Operations and Maintenance Considerations).

(c) Additional access to allow for future upsizing, if appropriate.

5.3 Horizontal alignment of sewers

5.3.1 General

Horizontal alignment shall be referenced in accordance with the SEQ D&C Asset Information Specification requirements, and where possible, to local property boundaries. Levels shall be referenced to AHD.

Subsequent to determining the preliminary location of the sewer, the following more detailed aspects shall be incorporated into the final detail design, as appropriate.

5.3.2 Roads, reserves and open space

5.3.2.1 General

Unitywater preferred location for trunk gravity sewers is in the road shoulder or alternatively within the service allocation in the road reserve. Where this is not possible, Trunk gravity sewers may be installed in the verge, footpath or the road carriageway. For the purpose of this clause road carriageways includes trafficable driveways into commercial and industrial premises.

Alignment of the trunk gravity sewerage mains within Council or State road reserves requires the prior approval of the relevant Road Authority/ies, before Unitywater will consider accepting the design. Trunk Sewer alignment shall avoid Local Council and State road water main service corridors.

The designer shall obtain the details of the sewer-corridor allocation with the relevant road authority. Where there is an appreciable cross-fall across a road reserve the sewers shall, unless it is impractical to do so, be located in the sewer corridor allocation on the high side of the road reserve.

Where a sewer is to be placed in another utility's allocation, which should not be contemplated unless it provides significant advantage, written approval shall be obtained by the designer from the relevant utility before this allocation is used.

Sewers laid in the road carriageway shall be located in accordance with the relevant authorities' alignments/corridor allocations. The designer shall provide Unitywater with written approval for the horizontal and vertical alignment from the relevant road authority.

Wherever practicable, sewers in drainage reserves shall be laid parallel and adjacent to the drainage system and clear of grassed waterways to minimise the effect of pipe bedding material on ground water movement.

The use of pipeline aqueducts across waterways shall be avoided where possible as they can impede stream flow and incur additional maintenance costs.

Refer to SEQ Code Standard Drawing s SEQ–SEW-1400-1, SEQ–SEW-1401-1, SEQ–SEW-1402-1, SEQ–SEW-1403-1 and SEQ–SEW-1404-1 for guidance only regarding typical buried sewer mains crossings.

5.3.2.2 Location and clearances

For trunk gravity sewer mains located in road reserves, clearances from other utility services, such as electricity and telecommunication cables, gas mains, stormwater drains and sewers shall be specified.

Where applicable, trunk gravity sewer mains shall be laid straight through roundabouts.

Where possible, a trunk gravity sewer main shall be located on the alternate side of the street to the water mains.

Where a trunk gravity sewer main is to be located in the road shoulder, the spacing between the centerline of the main and the kerb shall be sufficient to enable a tracked vehicle to undertake trunk sewer main repair/replacement works without damaging the kerb and channel.

5.3.2.3 Installation

Trunk gravity sewer mains shall have mechanical protection (i.e. be installed within a pipe enveloper or concrete encasement) where they are located under bikeways and/or roadways constructed of concrete.

Where a trunk gravity sewer main was originally laid in the road reserve, but due to proposed road works (e.g. road widening) is now proposed to be located in a different relative location (e.g. trunk main was originally located in the road shoulder, but is now proposed to be located in the road carriageway), the trunk gravity sewer main shall be relocated to an appropriate alignment and constructed in an appropriate material for the location.

Where a proposed road crosses an existing AC trunk gravity sewer main of any other material no longer approved by Unitywater, the trunk main shall be replaced/relocated to an appropriate alignment and constructed in an appropriate and approved material for the location.

Where a trunk gravity sewer main is required to be relocated, consult with Unitywater regarding the preferred and acceptable alignment.

Where an existing trunk gravity sewer main has mechanical protection (pipe enveloper or concrete encasement), and the proposed works require extension of the mechanical protection, consult with Unitywater regarding whether mechanical protection on the existing main is acceptable, or whether relocation of the main is required.

Refer to Section 4 for information regarding appropriate/approved materials.

5.3.2.4 Operation and Maintenance

All trunk gravity sewer main appurtenances shall be able to be accessible to maintenance vehicles and shall not be restricted by any proposed road upgrades or other improvements. In addition, trunk gravity sewer main appurtenances shall be able to be accessed and operated from the finished surface level.

Minimising traffic impacts and the need for traffic control when operational and maintenance activities are undertaken shall be considered when determining the location of trunk gravity sewer main appurtenances.

Appurtenances shall not be located in the trafficable section of the road carriageway.

Refer also to Section 2.4.8 Operations and Maintenance Considerations.

5.3.2.5 Crossings

Crossings of all roads, waterways creeks, drains and underground services shall, as far as practicable, be at right angles.

Where sewers cross freeways, arterial roads and other designated major road reserves, the following design criteria shall be considered after consultation with and approval of Unitywater:

(a) Size the sewer to ‘the next pipe size’ or otherwise 20% whichever is the greater to cater for future growth; or

(b) Specify dual/redundant pipelines to avoid operational problems at a later date;

(c) Accommodate expansion of major roads, and;

(d) Encase the sewer in a bored or jacked enveloper pipe or culvert.

The design of trunk gravity sewer main crossings of controlled access roads (e.g. freeways and major arterials), railways and waterways shall include mechanical protection of the main. The installation of pre-cast reinforced concrete slabs over the trunk gravity sewer main as a means of providing mechanical protection is not permitted.

Mechanical protection shall preferably be provided by installing a pipe enveloper (encasing pipe). Where this is not practical, concrete encasement of a trenched/excavated trunk gravity sewer main may be considered and is subject to acceptance by Unitywater (refer also to Section 9.7 Special Embedment Concrete and Stabilised Supports).

Maintenance Structures shall be positioned outside the controlled road reserve, rail corridor/land or waterway embankments.

The design shall include drawings showing the reinstatement of road layers for open cut crossings. These details must be approved by the relevant corridor owner/Authority.

Trunk Gravity sewer main crossings shall be designed as buried pipelines using trenchless techniques unless approved otherwise by Unitywater.

The Designer shall consult with the relevant reserve/corridor Authority to ensure Unitywater requirements as well as those of the relevant reserve/corridor Authority are satisfied as part of the design process.

The design of crossings shall consider:

- the ultimate width of the corridor/reserve being crossed, as well as the associated enveloper/concrete encasement extents.
- specific requirements of the reserve/corridor authority.
- public utility plant crossings and clearances.
- impact of proposed road pavement design over newly constructed main (where relevant).
- the temporary works requirements associated with the various construction methods.

Refer to Section 5.2.5 Trenchless Techniques for Pipe Installation.

5.3.3 Railway reserves

Where a trunk Gravity sewer main crosses a railway reserve/corridor or rail land, agreement on terms and conditions which is acceptable to Unitywater and the Railway Manager is required.

The location of all underground sewer crossings of railway reserves shall be clearly identified with suitable marker posts with contact details of Unitywater and in accordance with requirements of the rail reserve Owner.

Marker posts and signs allow easy identification by contractors, utility service providers and operation and maintenance personnel and mitigate the risk of damage and interference to sewers by maintenance activities.

5.3.4 Waterways

Should a crossing of a watercourse be needed, the project proponent must obtain the approval in principle, and approval for both the design and construction of the crossing from the Unitywater , the relevant authority responsible for management of the watercourse, and where the sewer is to be fixed to a bridge or similar existing structure, the owner of the existing structure.

The location of all underground sewer crossings of waterways shall be clearly identified with suitable marker posts with contact details of Unitywater and in accordance with requirements of the waterway Owner.

Marker posts and signs allow easy identification by contractors, utility service providers and operation and maintenance personnel and mitigate the risk of damage and interference to sewers by waterway dredging and other works.

Marker posts shall be located at right angles to the sewer with markings facing towards the sewer or maintenance structure covers. Posts shall extend at least 1 m above FSL in open areas and 1.5 m above FSL in grass or cropped areas. Where marker plates are fixed to existing structures, e.g. buildings, poles, posts etc. they shall be at least 1.5 m above FSL.

5.3.5 Maintenance structures and vent shafts

Maintenance Holes, vent shafts and ancillary structures shall be located to fulfill the operation and maintenance requirements of the trunk sewer (refer Chapters 7 and 8) plus allow free and unencumbered access by the required maintenance vehicles, equipment, safety and laydown areas.

5.3.6 Changes in direction using MH

The maximum allowable deflection of a sewer through an MH, excluding horizontal bends external to the MH, shall be in accordance with Table 5.2.

Table 5.2 - Table 5.2 MAXIMUM ALLOWABLE DEFLECTIONS THROUGH AN MH[1,5]

Trunk Sewer Size (DN)	Maximum deflection[2] (degrees)
375 - 600	Up to 90° where there is no large fall or drop with MH[3] Up to 120° where there is a large fall at MH using an internal designed to Unitywater requirements[4]
>600	By design and as approved by Unitywater

Notes:

1 - Refer to 7.6.3 Design parameters for MHs for design parameters for MHs and 5.6.6 Grading through MHs for grading through MHs.

2 - Table 5.2 does not address requirements for external horizontal bends associated with an MH – Refer to 5.3.8 Horizontal curves in sewers for external horizontal bend requirements.

3 - No compensation for head loss due to friction through bends incorporated in the MH base is required for MHs located on branch and trunk sewers unless required by Unitywater.

4 - Where a larger than 90° deflection is required and it is not practicable to provide a drop in the sewer levels, the Designer may consider using two MHs, each with a deflection less than 90°, or a combination of an MH and long radius bend, to achieve hydraulic efficiency.

5 - Refer to Standard Drawings SE Q–SEW-1305-1, SEQ–SEW-1306-1, SEQ–SEW-1309-1 and SEQ–SEW-1310-1 as applicable.

Change of angles > 90 deg shall be checked by using CFD modelling or similar analysis for prevention of excessive turbulent flow, hydraulic jumps, head losses, odour and corrosion potential.

5.3.8 Horizontal curves in sewers

5.3.8.1 General

Straight sewers are preferred because they are generally less costly to set out, construct, locate and maintain. However, straight sewers are not always practicable due to bends or curves in streets, obstructions and proximity of other services. Under these circumstances, horizontal curves may be used to achieve changes of direction.

Horizontal curves shall be achieved by using on or more of the following methods:

(a) Deflecting consecutive flexible joints provided no individual joint deflection exceeds 80% of the manufacturer's recommended maximum joint deflection.

(b) Manual cold bending of PE pipe where curves are part of the engineering design with a minimum horizontal and vertical curvature radius (m) as per PIPA POP202.

(c) Using a manufactured bend (or pipe welding for Mild Steel) is subject to acceptance by Unitywater.

Where trunk network layouts include curved alignments, the Designer shall determine the most appropriate pipeline material and/or combination of components to achieve the required alignments.

5.3.8.3 Cumulative deflection using pipe joints

Cumulative deflections shall not exceed 90 degrees between Maintenance Holes. There shall be no change of direction of a curved alignment between Maintenance Holes

The minimum radii for curved shall be as specified in Section 5.3.8.1.

The Designer shall verify that for a project using pipes with deflection joints, the maximum allowable angle of deflection nominated by the manufacturer is sufficient to achieve the minimum curved sewer radius.

Curves shall not commence any closer than 1.5 m from the centre of an MH; however, where an MH has an external type drop structure, the curve shall commence clear of the drop structure.

5.3.8.4 Pipe Socket Direction

Trunk sewer pipework with socket connections shall be designed and detailed with sockets facing up grade. This is particularly important in the case of pipes > DN900 or on grades > 1.5%.

Subject to be approved by Unitywater, Sockets may be laid facing grade down on grades < 1.5% for short distances to avoid the necessity and cost of manufacturing a double socket transition piece.

5.4 Obstructions and clearances

5.4.1 General

All underground obstructions and services, surface obstructions and structures along the route of the proposed sewer shall be determined and shown in the Design Drawings. Easement geometry (in addition to Registered Survey Plans), shall be included in the Design Drawings including allowances for access, laydown, temporary works or offset requirements. The Design Drawings shall address the detail of avoiding any obstruction or service or structure in accordance with Clauses 5.4.2 to 5.4.5 inclusive.

5.4.2 Surface obstructions

If at the time of preparing a trunk gravity sewer design it is known or reasonably expected that landscaping, footpath or road embellishments or other development will take place over the installed main, then the design shall address the following:

(a) Structural design – provision of a structural slab over the trunk Gravity sewer main as a means of providing mechanical protection is not acceptable.

(b) Building over or near assets considerations - where practicable, trunk Gravity sewer mains shall be clear of landscaping and/or other development. Conformance with AS4970 Protection of trees on development sites shall be considered with respect to the proximity, stability and health of trees in proximity to the sewer main. Where it is not practicable, consult with Unitywater to obtain approval for any proposed landscaping and/or development.

The minimum horizontal clearance between a sewer maintenance structure and any other maintenance structure shall be 600mm.

5.4.5 Underground obstructions and services

5.4.5.2 Clearance requirements

Trunk gravity sewer main will generally be located vertically below other services due to accumulating grade, cover requirements and the requirement to be vertically offset below water services.

Sewer mains shall be located with sufficient clearance to structures to allow for maintenance and operation activities and provide protection against damage from pipeline failure.

For trenched and trenchless installations, clearances from other service utility assets shall not be less than the minimum vertical and horizontal clearances shown in Table 5.4. Written agreement on reduced clearances and clearances for shared trenching shall be obtained from Unitywater and, as necessary, the relevant service Owner. The clearance shall be measured between the two closest parts of sewer and the other underground service e.g. collar to socket.

The minimum horizontal clearance between a trunk sewer gravity main joint and an adjacent enveloper/encasement service extents shall be 600 mm.

Differential settlement shall be assessed and accommodated in the design of any enveloper installations.

Where services, including kerbs and footpaths, fall within the zone of influence of the sewer excavation they shall be adequately supported, e.g. by appropriate compacted sewer trench fill.

Table 5.4 CLEARANCES BETWEEN UNITYWATER TRUNK GRAVITY SEWER MAINS AND OTHER UNDERGROUND SERVICES

Utility (Existing or proposed service)	**Minimum Horizontal Clearance to new Unitywater Trunk Sewer Main (mm)**	**Minimum Vertical Clearance[1] to new Unitywater Trunk Sewer Main (mm)**
Gravity Sewers (all sizes)	600	300
Sewer Rising Mains, Pressure Sewers and Vacuum Sewers	600	500
Gas Mains	600	300
Telecommunication conduits and cables	600	300
Electrical conduits and cables	1000	300
Electrical and communication poles	1000	N/A
Stormwater drains[2]	600	300[3]
Water Mains[4] ≤ 375 NB	1000[5]/600	500[3]
Water Mains[4] > 375 NB	1000	500[3]
QBWSA[6] Water Mains ≤ 375 NB	1000[5]/600	500[3, 7, 8, 9]
QBWSA[6] Water Mains > 375 NB	1000	500[3, 7, 8, 9]
Kerbs	600[10]	900

Notes:

1. Vertical clearances only apply when sewers cross utility services, except in the case of water mains when a vertical separation shall always be maintained, even when the sewer and water main are parallel. The sewer should always be located below the water main to minimise the possibility of backflow contamination in the event of a water main break.
2. A sewer to be constructed under an existing or proposed stormwater pipe or channel ≥DN 375 shall be concrete encased to reduce structural risks to both services. Concrete encase sewers crossing under brick barrel drains or unlined open drain or channel. The concrete encasement shall extend at least 1 m each side of the stormwater pipe or channel. Clearances between the sewer and other services shall be measured from the outer surface of the concrete encasement.
3. Sewers should always cross under water mains and stormwater drains. For cases where there is no alternative and the trunk sewer main must cross over other services, the design shall nominate an appropriate protection treatment (e.g. welded mild steel main within pipe enveloper or concrete encasement, which is effectively joint-free in the vicinity of other services) or alternatives such as adjusting the water main or stormwater drain. Refer to Standard Drawing SEQ-WAT-1211-1 of the Water Supply Code.
4. Water mains includes mains supplying drinking water and non-drinking water.
5. When the sewer is at the minimum vertical clearance below the water main (500 mm) maintain a minimum horizontal clearance of 1000 mm. This minimum horizontal clearance can be progressively reduced to 600 mm as the vertical clearance increases to 750 mm.
6. QBWSA is the Queensland Bulk Water Supply Authority trading as Seqwater, established under the South East Queensland Water (Restructuring) Act 2007 (Qld). *For further information and requirements refer to: https://www.seqwater.com.au/working-near-water-infrastructure*

7. Sewers should always cross underneath QBWSA water mains. Where there is no alternative, then the sewer crossing over the water main shall be joint free and continuous between access chambers. Depending on circumstances and a risk assessment to be undertaken by Seqwater, it may also be necessary to concrete encase the Seqwater water main in accordance with Seqwater requirements.
8. Where a QBWSA main is concrete encased, a minimum vertical clearance of 150 mm is required between the sewer and the concrete encasement.
9. If a sewer cannot be maintained at the minimum vertical clearance below a QBWSA water main, then the horizontal clearance must be amended in accordance with an assessment of the associated risks to water quality
10. Clearance from kerbs shall be measured from the nearest point of the kerb.

5.5 Pipe sizing and grading

5.5.1 General

Pipe sizing and grading are important design parameters for the conveyance of sewage to meet the required service standards and meet the objectives of the Integrated Plan for the catchment. Trunk Main size and grade will dictate the conveyance capacity and consequent frequency of surcharge and overflow. Additionally, trunk main size and grade will influence the biochemical characteristics of the sewer and sewage environment, specifically, sewage age, septicity, biological/biofilm condition, corrosivity and odour characteristics.

Trunk Gravity Sewer sizing and grading will be dependent on a number of critical factors requiring considering during the planning, concept and detailed design. These include:

(a) Brownfield or Greenfield setting
(b) Integration with existing networks – pipe size and elevation
(c) Network hydraulic condition and hydraulic control – downstream backwater and surcharged conditions
(d) Future development allowances.

Design flow (sanitary, groundwater inflows and wet weather flows) shall be calculated by the method nominated by Unitywater (Refer to Section 2.2.3 Catchment Analysis and Chapter 3 Flow Estimation).

Pipe size and grade shall be such as to contain the design flow without exceeding the specified maximum velocity and to achieve a self-cleansing velocity at peak dry weather flow at least once per day. Refer to Section 5.5.7

Gravity sewer design needs to consider the following:

- Self-cleansing velocity – pipes should be sized to achieve self-cleansing velocities as least once a day Refer to Section 5.5.7 for recommended grades and velocities for different sewer sizes.
- Slime control velocity – in sewers with a diameter of 300mm and above, self-cleansing velocities may not be sufficient to prevent build-up of slime and therefore higher velocities are required for slime control.
- Sewers ≥ DN300 shall have minimum self-cleansing shear stress of 1.6 Pa to be achieved at least once per day by ultimate planning horizon.
- Optimise grades in branch and trunk sewers to minimise turbulence and H_2S release when dissolved sulphide levels are elevated and the location includes sensitive receptors. This is

a balancing act to achieve adequate reaeration and scour velocities while minimising sulphide release and should be assessed on a case by case basis. If sulphides are low, then turbulence is less of an issue. Minimum scour velocities should also be achieved at least once a day to prevent solids deposition.

Adoption of a slope commensurate with slime control usually allows selection of a smaller diameter pipe. Whether slime control slopes are warranted will depend on several factors including:

- The ratio of average dry and peak wet weather flows
- Natural surface slopes
- Age and composition of sewage
- Availability of other methods for increasing the level of DO in the sewage.

Absolute minimum grades shall comply with the SEQ Design Criteria Table 10.

5.5.2 Environmental protection requirements

The design of trunk gravity sewers shall align with the catchments integrated catchment plan.

For green field developments, the grade shall be at least steep enough to ensure design flow containment, i.e. without sewage levels exceeding the pipe soffit. Hydraulic analysis shall use either the Colebrook-White or Manning equation as directed by Unitywater.

For trunk sewer augmentation within existing networks where upstream or downstream conditions enforce level conditions, pipe size and grade shall fulfil other self-cleansing, biofilm shearing, storage and overflow requirements.

5.5.3 Minimum air space

At design flow (PDWF+RDI) the depth of flow shall not exceed 75% of the pipe internal diameter so as to provide a minimum air space depth of 25% of pipe internal diameter under design flow.

5.5.4 Minimum pipe sizes for maintenance purposes

Trunk sewer mains shall be sized to permit the access and operation of Unitywater personnel, equipment, ROV, CCTV and other proprietary maintenance and repair equipment. Pipe size shall satisfy the requirements of the applicable Operations, Maintenance, Replacement and Decommissioning Strategy (refer Sections 1.2.5 and 2.4.8).

5.5.5 Maximum ET for reticulation sewers

Determination of upstream reticulation sewer ET is not required for Unitywater trunk gravity sewer mains. Trunk sewer flows shall be determined in accordance with Chapter 3 Flow Estimation and the SEQ WS&S Design Criteria.

5.5.6 Limitation on sewer size reduction

Except where a sewer has been upsized in accordance with the requirements of 5.3.2 Roads, reserves and open space, the size of any trunk sewer shall not be reduced on any downstream section.

Additional exceptions will occur in existing networks where the size of a new sewer section is required to be larger than the existing downstream segment.

5.5.7 Minimum grades

Detailed sizing and grading trunk sewers (>DN 300) shall be determined in consultation with Unitywater and be based on Chapter 3 Flow Estimation.

Minimum self-cleansing shear stress requirements for sewers >DN 300 = Minimum 1.6 Pa achieved at least once per day by ultimate planning horizon

The minimum grades required to achieve self-cleansing shall be calculated using either the Colebrook-White equation for k = 1.5 mm or the Manning equation for nM equivalent to k = 1.5 mm (Refer to Table 5.6).

Table 5.6 Manning Coefficient

Pipe Size DN	Manning friction coefficient, nM — equivalent to Colebrook-White roughness ks = 1.5 mm
> 300	0.0128
≥ 600	0.0130
≥ 1000	0.0132
≥ 2000	0.0134

Irrespective of outcomes using the self-cleansing velocity methodology, grades shall not be less than those specified in Table 5.7

Table 5.7 Absolute Minimum Grades

Pipe Size DN	Absolute minimum grade %
> 300	0.19
≥ 450	0.15
≥ 525	0.13
≥ 600	0.11
≥ 750	0.09

5.5.8 Minimum grades for slime control

For sewers >DN 300, the minimum self-cleansing velocity may not be sufficient to prevent the build-up of slimes. However, increased grades may not be economical and alternative hydrogen sulphide control measures may be necessary.

The minimum grade shall ensure that a slime stripping velocity is achieved (Refer to Section 5.5.1 and Hydrogen Sulphide Control Manual Volume 1, Monograph 5.1). The Designer, in consultation with Unitywater shall address minimum grades and velocities and any other requirements necessary to effectively control slime build-up and hydrogen sulphide generation.

5.5.9 Maximum grades

5.5.9.1 Branch and trunk sewers

The maximum grade shall be that for which the velocity of flow is 3.0 m/s when the pipe is at PDWF. The maximum grade shall be determined using the Colebrook-White equations for a roughness coefficient (k) of 1.5 mm, or equivalent Manning "n_M" value from the SEQ Design Criteria or as otherwise agreed with Unitywater.

In special circumstances where the grade of a branch or trunk sewer will result in a flow velocity greater than 3 m/s, Unitywater approval shall be obtained (Refer to 5.6.6.6 Avoiding hydraulic jumps due to steep grades for general precautions for steep sewers).

Where Unitywater agrees that the generation of hydrogen sulphide cannot be avoided, the Designer shall include odour control measures (to be approved by Unitywater) and is required to protect the system using methods approved by Unitywater, e.g. energy dissipating devices, special pipe materials, protective coatings, ventilation and odour control etc. Consider additional requirements address slime control

5.5.10 Grade and velocity methodologies

The design shall demonstrate compliance with the minimum shear stress requirements for self-cleansing specified in Clause 5.5.1. Table 5.8 below shows the recommended sewer velocities for reference in gravity sewers. Figure 5-1 and Figure 5-2 are referred to in the table and respectively show the critical sewer slopes and minimum sewer velocities for slime control.

Table 5.8 Trunk Gravity Sewer Design Methods

Criteria	Recommended Velocity (m/s)	Notes
Minimum velocity during average flow conditions	>0.6	• Prevent deposition of solids • Maintain a self-cleaning action in sewers
Desirable velocity	>0.9	• Where practical
PWWF velocity	>1.1	• Avoid sulphide problems Provide adequate cleansing velocity • Prevent sulphide and odour generation
For trunk and branch sewers, wetted cross section average velocity at PDWF	0.7	• To achieve self-cleansing of grit and debris
Maximum velocity in branch and trunk sewers when sewer flowing full	<3	• To minimise turbulence and H_2S generation

Criteria	Recommended Velocity (m/s)	Notes
Critical sewer slopes for slime control	-	See Figure 5-1 below
Minimum sewer velocities for slime control	-	See Figure 5-2 below
Critical average wall shear stress of 3.35 Pa	-	• For slime control

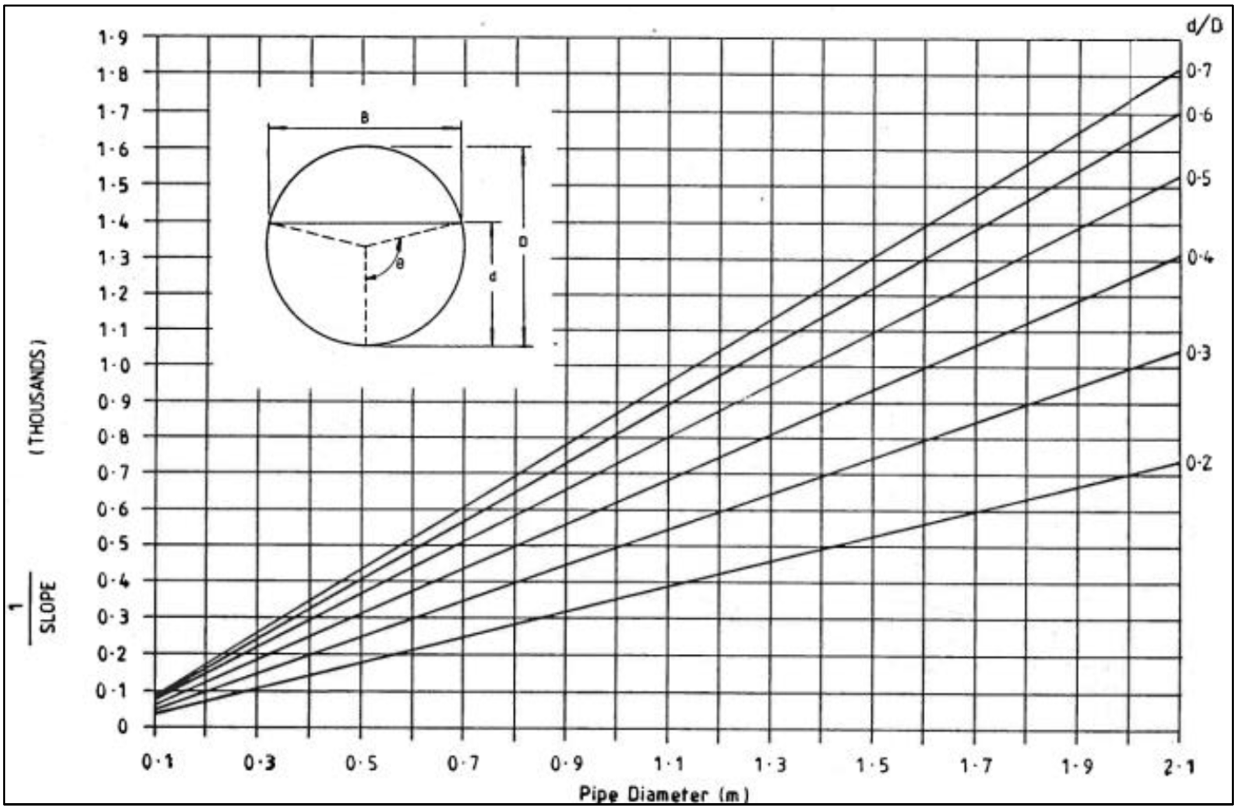

Figure 5.1 – Critical Sewer Slopes for Slime Control

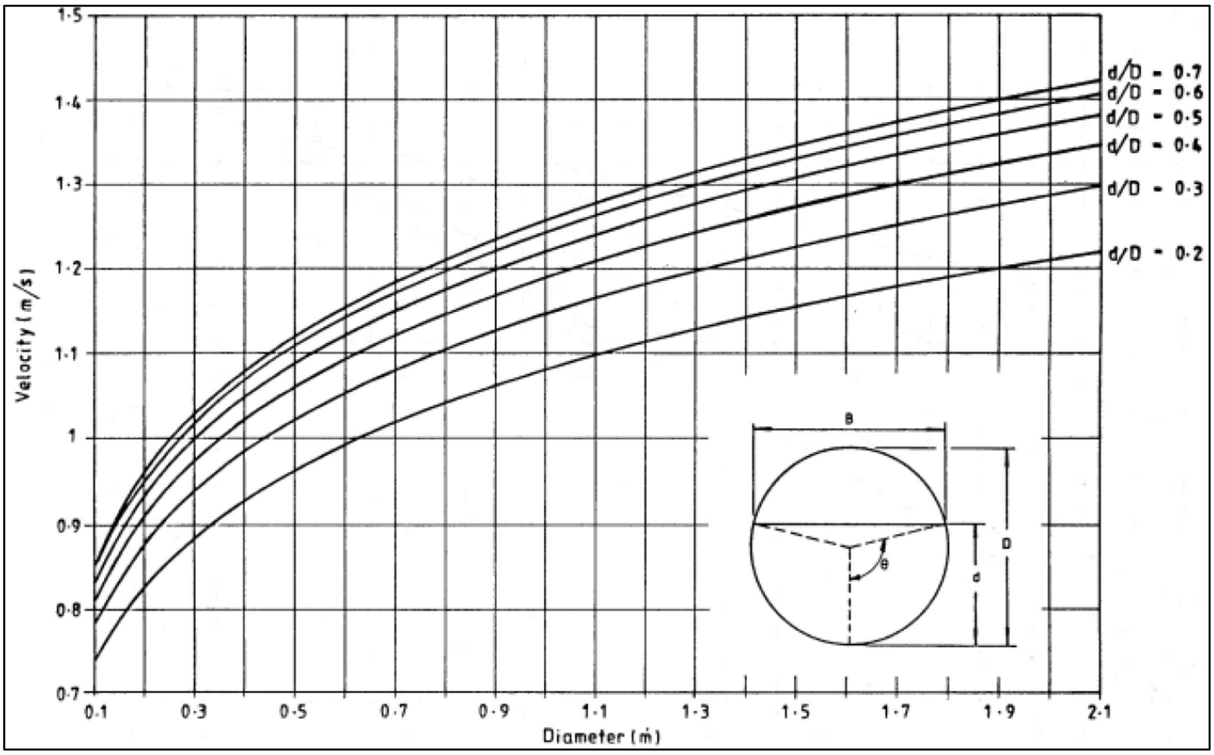

Figure 5.2 – Minimum Sewer Velocities for Slime Control

An alternative approach to design of gravity sewers based on gradient and velocity to achieve slime control is to maintain a minimum boundary shear stress to prevent suspended particles from settling out on the invert. As indicated in Table 5.8, the recommended design criterion to adopt for slime control is a critical average wall shear stress of 3.35 Pa. For sewers with Manning's n = 0.013 or less, a design boundary shear stress in the range of 0.1 5 to 0.20 kg/m^2 will likely keep self-cleaning sewer systems free from sulphide problems. For sewers with n = 0.015 or greater, a design shear stress of 0.2 kg/m2 should be used.

Under certain conditions, sulphide generation may be unavoidable. Sulphide build-up and rates of corrosion can be estimated using Figure 5.3 or using more sophisticated sulphide models that are available. Where sulphide generation is anticipated, corrosion resistant materials can be selected or the alkalinity and thickness of concrete pipe can be specified to help reduce the effects of hydrogen sulphide corrosion.

In addition to modelling sulphide generation within the trunk gravity main, designers shall consider upstream sulphide sources such as rising mains with extended hydraulic retention times and trade waste inflows, which may significantly exceed in-pipe generation.

For brownfield or staged developments, the Designer shall consult with Unitywater to identify any existing or anticipated upstream sulphide conditions that may influence material selection, corrosion mitigation requirements, or ventilation strategies.

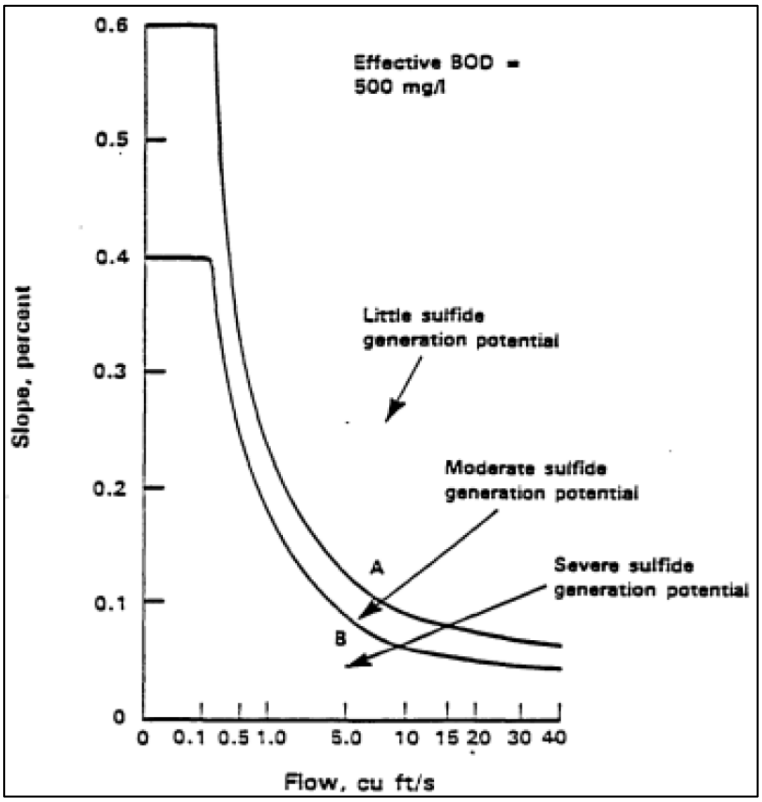

Figure 5.3 – Guide for Estimating Suphide Generation Potential

5.6 Vertical alignment of sewers

5.6.2 Long section design plan

Detailed Designs shall include enveloper/concrete encasement extents.

Volumetric easement geometry (in addition to Registered Survey Plans) shall be included in the Design Drawings including allowances for access, laydown, temporary works or offset requirements.

5.6.6 Grading through MHs

5.6.6.2 Internal fall through MHs joining sewers of same diameter

Minimum grade through an MH shall be the design grade of either the upstream or downstream sewers, whichever is the flatter.

For MHs located on branch and trunk sewers, no compensation for friction head loss through bends incorporated in the MH base is required.

5.6.6.4 Major sewer junctions

For junctions in Trunk Gravity Mains, the design of the MH junction angles shall incorporate hydraulic principles to limit turbulence and hydrogen sulphide emissions.

For guidance to design a major sewer junction to minimise turbulence, refer to the 'Hydrogen Sulphide Control Manual Volume 1' Monograph 5.3 Design of Special Structures Associated with Sewers.

Concept and Detailed Design of Trunk Maintenance Holes and Junctions shall be reviewed and approved by Unitywater.

5.6.6.6 Avoiding Hydraulic Jumps Due to Steep Grades

5.6.6.6.1 General

In an open channel, such as the sewer channel within an MH or a pipe flowing part full, an hydraulic jump occurs in the transition from supercritical flow (Froude number, Fr >1) to subcritical flow (Fr <1). An hydraulic jump may occur if a "steeply" graded sewer changes to a flatter grade, especially during peak or other flows or when a pressure main discharges into a gravity sewer.

Detrimental effects of an hydraulic jump may include:

(a) turbulence that will liberate gases and reduce or block air flow along the sewer;

(b) increased water levels in the MH that may impede flow from incoming sewers;

(c) increased rate of corrosion and erosion damages to the MH and sewers; and

(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 explosions and impact on the health and safety of the occupants, not to mention an increase in odour complaints.

Estimating the location of any hydraulic jump is difficult. Its location depends on flow velocity and volume, channel geometry, surface roughness and grades and other factors and is often difficult to predict. Feedback from field experience is most useful.

Where it is not practical to eliminate hydraulic jumps from the sewer design, appropriate measures as specified in 5.6.6.6.2 BRANCH AND TRUNK SEWERS shall be taken to design the hydraulic jumps to occur at MHs whereby:

i. there is less impact on air flow along the sewer and

ii. damage from corrosion and erosion can be readily inspected, monitored and repaired by providing easy access.

It should also be noted that MHs are generally stronger in withstanding corrosion and erosion compared with pipes and MHs can easily be lined to provide additional protection.

If there is to be a hydraulic jump in the sewer, it should be located in the pipe downstream from a maintenance hole. A major junction may be constructed within a vault or chamber entered by a maintenance hole at its upstream end and designed so that air that has been exposed to the high turbulence of the junction will be carried downstream and not exhaled from the maintenance hole (shown diagrammatically in Figure 5.4). As the sewage will contain sulphides, the junction structure will need to be protected by a lining, and the sewer pipe will need to be protected or constructed of non-corrodible material. The distance downstream that abnormal sulphide concentration will prevail will depend upon the turbulence of the air stream, its velocity and the sewer size.

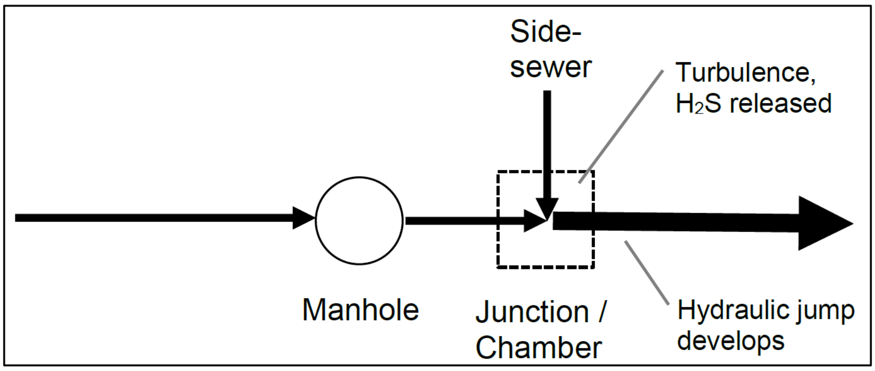

Figure 5.4 – Sewer Design to Avoid Hydraulic Jumps

5.6.6.6.2 Branch and Trunk Sewers

For trunk sewers of grades > (1000/DN) %, the Designer shall review the hydraulic performance of the sewer entering an MH. The Designer shall incorporate measures, such as (a) to (d) that will avoid a hydraulic jump occurring in an MH:

(a) Adequate educt / induct ventilation on either side of the possible hydraulic jump; and

(b) Prevent the jump from occurring in an MH by providing horizontal and/or vertical curves in the sewer at changes of grade and/or direction. The curve should be located at sufficient distance from an MH such that the jump will not occur in the MH. The radius of curvature should not be less than approximately 8 x the pipe diameter.

(c) Provision of a drop structure at the end of steep inlet sewer;

(d) Provision of an energy dissipating device, submerged inlet or drop structure at the discharge of a pressure main.

5.6.6.6.3 Not in use

5.6.6.6.4 Design Standards

To minimise the impact of odour generation from hydraulic jumps, the following design standards should be followed:

- Incorporate a transition to a flatter grade in sewers to absorb some of the momentum slowly and reduce the surge in water levels resulting from grade changes. This could also include using a larger pipe downstream. The design objective is to reduce the water level rise so that the restriction of air movement in the sewer headspace is minimal. Some suggested standards are minimising the pressure differential between the upstream and downstream ends of the pipe (e.g. to less than 5 Pa), or ensuring that at least 30% of the sewer pipe is open for air movement.
- Avoid flows from branch sewers dropping into trunk sewers; instead aim to have branch sewers enter the trunk pipe below the lowest level of the sewage surface in the trunk sewer, with the incoming branch sewer facing the downstream direction rather than entering the trunk at 90 degrees. See Figure 5.5 and Figure 5.7 for examples of this.
- If a branch sewer joins a trunk with a significant difference in invert levels, consider having the branch sewer end in a maintenance hole which drains into the trunk. This will provide an even transfer of the flow the trunk. Elements of this are illustrated in Figure 5.5, where flow from a branch sewer drops into side chamber which then drains into the trunk sewer at the trunk invert level.

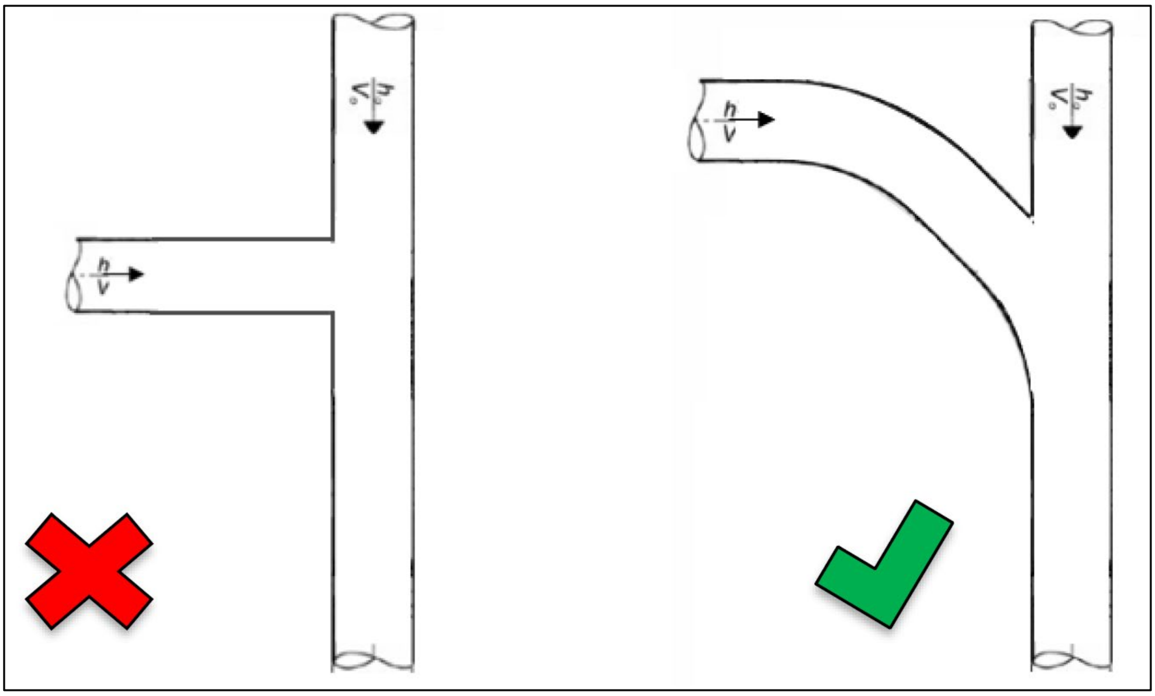

Figure 5.5 – Streamlining branch sewer connections on trunk mains

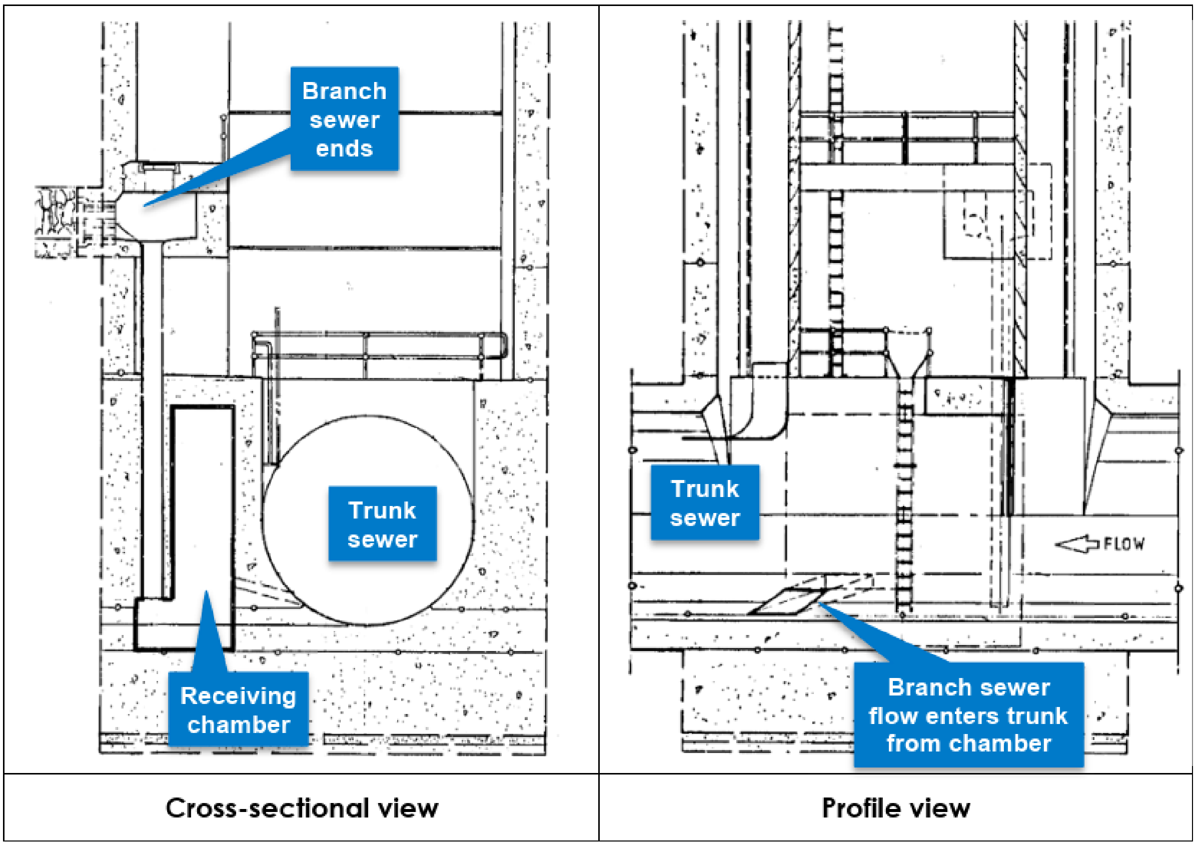

Figure 5.6 – Side chamber for merging flow from branch sewer

- Avoid abrupt changes in grade between upstream and downstream sewer lines.
- Avoid large differences in velocity between two or more upstream sewer lines entering the same maintenance hole.
- Make sure the downstream receiving sewer is sized to ensure an air-gap as follows:
  - For gravity sewers > DN 300, design for 30% of headspace availability during PDWF.
- This is particularly important near rising main release points.
- Avoid acute angles between upstream and downstream lines.
- Avoid large changes in upstream flow, particularly when there is more than one stream that could have significant variation. This can be achieved by minimising intermittent pumping using VSDs on SPSs.
- Energy loss through transitions should be minimised by streamlining junctions, as illustrated in Figure 5.7, by meeting the following conditions:
  - The angle of convergence of the channels within the junction zone (1 and 2) is as small as possible.
  - The channels are constructed so that the lateral momentum (Q1V1 sin 1 and Q2V2 sin 2) of each of the incoming lines is reduced by the channel geometry before convergence of the two streams.
  - Velocity changes at the junction should occur gradually.

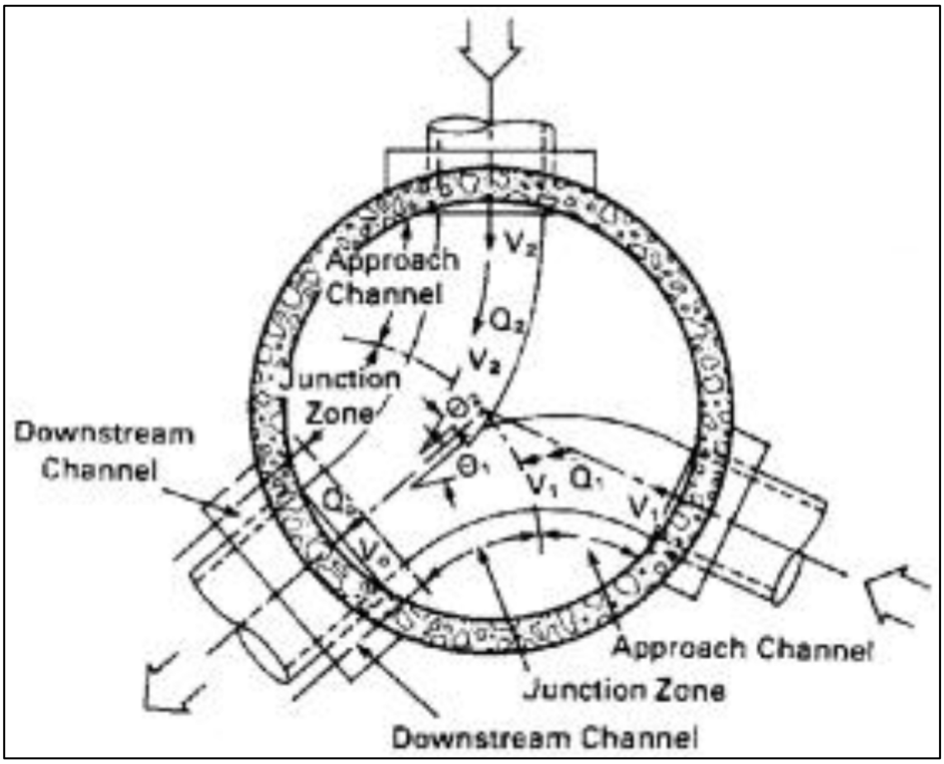

Figure 5.7 – Streamlined Junction

5.6.7 Vertical curves in sewers

Vertical curves are not preferred in trunk sewers, where a vertical curve is deemed unavoidable, it shall be discussed with Unitywater and approved at an early stage of the design process. Vertical curves may be incorporated where they form part of a hydraulic jump control measure or otherwise as part of a vertical transition from one elevations and with associated air and odour control. Refer further to Chapter 7 Maintenance Structures and 8 Ancillary Structures.

5.6.8 Compound curves

Compound curves are not permitted in trunk sewers, where compound curves are deemed unavoidable, it shall be discussed with Unitywater and approved at an early stage of the design process. Vertical curves may be incorporated where they form part of a hydraulic jump control measure or otherwise as part of a vertical transition from one elevations and with associated air and odour control. Refer further to Chapter 7 Maintenance Structures and 8 Ancillary Structures.

5.6.9 Deep sewers

Approval shall be obtained from Unitywater and specialist design carried out for any section of sewer that is deeper than 5 meters to invert. This will include at the planning concept and detailed design stages of the design development.

Unitywater require a structural design report be submitted with the design, which may include, but not be limited to:

(a) Geotechnical boreholes and analysis of native soil modulus;
(b) Soils testing – Contaminated soils, acid sulphate soils etc.;
(c) Groundwater level and testing;
(d) Detailed cross sections;
(e) Calculations on pipeline material and class selection, and;
(f) Operations and maintenance management requirements.

6. Property connection

6.1 General

Property Connections to trunk sewers are not permitted due to high volumes/flowrates of sewage flow and gas movement to/from property connections and associated risks of loss of water seals and air release into property connections.

7. Maintenance structures

7.1 Types of maintenance structures

Maintenance Holes are the only Maintenance Structures permitted for use on Trunk Gravity Sewer Mains.

7.2 Locations of maintenance structures

The design shall include maintenance structures at the following locations as minimum, subject to detailed design:

(a) Intersection of sewers.

(b) Changes of sewer size.
(c) Changes of sewer direction, except where a horizontal curve is applied (refer Section 5.3.8 Horizontal Curves in Sewers)
(d) Changes of sewer grade greater than the allowable sewer joint deflection,
(e) Combined changes of sewer direction and grade except where a Compound Curve is applied (refer Section 5.6.8 Compound Curves).
(f) Changes of sewer invert level.
(g) Changes of pipe material, except for repair / maintenance locations. This includes going from pipes of the same material but a different profile or ID, e.g. going from profile wall pipes to solid wall or jacking pipes.
(i) Discharge of a pressure main into a gravity sewer (A vent shall be provided, appropriately selected and located to avoid odour complaints) refer to Pr10999 - Specification for Odour Control Unit Design and Construction (Network).
(j) Either side of railway lines or boundaries, major roads, waterways etc.
(k) At maximum spacings referred to in 7.3.3 Maintenance Structure Spacing Branch and Trunk Sewers.
(l) Not in use
(m) Discharge of a gravity sewer into a pumping station, which shall be via a single inlet MH into which all gravity inlets discharge. At a pumping station all flows into the pumping station shall be through a single inlet MH.
(n) Maintenance holes shall also be positioned at the lowest feasible elevation where a future reticulation sewer may be required to connect into it to service future developable land, and the land is not otherwise able to be serviced by another reticulation sewer.

Maintenance structures other than MHs are not permitted on trunk gravity sewers. Trunk sewer maintenance structures shall not be located within private properties, easements shall be acquired if this is not feasible. Refer to Section 5.2.8 Easements.

Under no circumstances shall maintenance structures be located either side of a lot boundary, under an existing fence or wall, or on the alignment of an existing or proposed kerb or surface drain. In the road reserves, maintenance structures shall be located clear of driveways and as far as practicable clear from bikeways, footpaths and other surface improvements.

Where a sewer is to be located within the carriageway of the road reserve, the centre of the lid shall be located within the centre of the traffic lane to minimise tyre travel over the structure cover and frame.

Wherever practicable, maintenance structures shall not be located within any drainage swales, table drains, channels, overland flow paths, detention and retention basins.

Land areas with potential instability, steep slopes and erosion potential shall be avoided or if not, specific structural design shall address sewer and maintenance hole stability in such locations.

7.3 Spacing of maintenance structures

7.3.1 General

The spacing of maintenance structures is governed by site conditions, sewer layout and future extension and operations and maintenance access requirements. Where sewers are located within easements or reserves and remote from public access roads, a dedicated all weather maintenance access road is essential for 24 hours access to the maintenance structures.

It is mandatory that Operators and Maintainers have 24 hours access to trunk sewer networks to repair failures and carry our refurbishment, attend planned and scheduled maintenance works, to ensure the assets are in good and serviceable condition.

These works involve but not limited to sewer flushing, CCTV inspection, drone/ROV inspection, repairs, relining, replacements and new extensions. Generally maintenance structures which are designed as access points are required to be located within the sewer network where there is a change (vertical or horizontal) in sewer flow direction, diameter, at minimum intervals and at connection between rising main and a gravity main. It is a safety requirement that physical entry by operators to maintenance structures are minimized due to Confined Space Hazards within the sewer network. Refer also Section 2.4.8 Operations and Maintenance Considerations.

The design shall ensure that access to every part of a sewer is achievable using equipment installed on a service vehicle legally parked on the nearest boundary of the nearest road or readily accessible public property. The measured access route distance between the service vehicle and the maintenance structure shall be the slope distance in steep terrain, together with an allowance for the vertical drop from ground level to sewer invert inside the maintenance structure. Where these criteria cannot be met, the design shall include appropriate provisions for maintenance access. Unitywater are able to access service vehicles that are fitted with jet-rodding and equipment with pressure hoses and CCTV equipment up to 150 metres in length.

Taking into account access requirements, the available positions for maintenance structures may influence the sewer alignment design.

7.3.3 Maintenance structure spacing – branch and trunk sewers

The maximum distance between any two branch or trunk sewer MHs shall be as approved by Unitywater. Generally, the maximum spacing between MHs shall not exceed 180 m.

Maintenance Hole spacing, particularly for large and trenchless installation may be varied due to cost and surface access factors. An Operations, Maintenance, Replacement and Decommissioning Strategy shall be developed to support the design of surface maintenance hole spacing.

7.4 Special considerations for location of maintenance structures

When maintenance structures are located adjacent to existing structures. refer to 5.4 Obstructions and Clearances for clearance from structures. The following locations for maintenance structures shall be avoided:

(a) Where the location conflicts with future services, kerbs, lot boundaries, fences and/or other structures.

(b) Where the slope of the ground is excessive (Refer to 7.9.2 Cross-fall on MH covers).

The following locations for maintenance structures shall be avoided as far as practicable:

i. Within major road reserves.

ii. Within railway reserves.

iii. In floodways below 1:5 year flood levels and below high tide. Bolt-down lids and top slabs shall be provided on maintenance holes where the top of the lid level is below 1 in 100 year ARI[1] (Q100); flood level, (refer to Section 7.9.1).

iv. In coastal zones and below maximum high tide levels (Refer to 5.2.7.5 Coastal zones).

v. Where access to the structure is likely to be severely restricted e.g. foreshores.

vi. Within areas designated for a car parking, whether existing or future.

vii. Where disruption to residents may occur due to noise, sewage overflows and odour.

viii. Where access to the structure is extremely hazardous for maintenance employees (fall from heights, overhead and buried electrical services, poor ground conditions).

ix. Unstable ground. Where MHs have potential for erosion, erosion protection work shall be provided.

Under very limited cases sewers may terminate without a maintenance hole if the sewer is to be extended in the near future on the same alignment. The option to not design and construct a maintenance hole in such a situation shall require approval of Unitywater (Refer to 7.8.5.1 of SEQ-WSA 02 Temporary ends of pipe and 7.8.5.2 of SEQ-WSA 02 Permanent ends of pipe).

7.5 Special considerations for connection of new sewers to existing sewers

The most appropriate method of connecting a new sewer to an existing sewer shall be determined at the design stage and approved by Unitywater. Instructions for the connection, including isolation of non-commissioned assets from commissioned assets, shall be noted on the approved Design Drawings.
A new sewer, or the extension of an end-of-line sewer, shall be connected to an existing sewer using an existing or new maintenance hole.
Connection options may include construction of:

(a) A direct inlet at sewer soffit level via a formed channel through the bench of an existing MH.
(b) An internal drop in an existing MH.
(c) A new MH over the existing sewer

Sewer Flow monitoring may be required at trunk sewer junctions and grit chambers. Refer to the Clause 1.3.2. Rising main discharge maintenance holes require PE lining and vents. (Refer to Drawing SEQ-SPS-1406-1). The immediate downstream maintenance hole internal surface shall include an internal corrosion protection or PE lining. An assessment of subsequent downstream maintenance structures shall be undertaken to determine the potential for corrosion, and where a risk is identified, appropriate internal corrosion protection or PE lining shall be provided.

Where specified by Unitywater, water seals shall be installed upstream of the junction of sewers and/or at other locations, as necessary, so as to prevent back venting of gases (liberated by turbulence at sewer junctions) into upstream sewers and/or sanitary drains (Refer to 8.2 Water Seals, Boundary Traps, Water-sealed MHs and Gas Check MHs).

The Designer shall nominate the method of connection in the Design Drawings, together with other necessary construction details.

Property connections to trunk sewers are not permitted due to the risk associated with sewage surcharges to private properties. In exceptional circumstances property connections may be permitted as temporary connections until new sewer extensions are provided this arrangement requires prior Unitywater written approval.

In areas of high water table where MHs are subject to submergence, all MHs shall be designed to provide a factor of safety against flotation of 1.25.

7.6 Maintenance Holes (MHs)

7.6.1 General

MHs are sized to provide personnel entry down to the level of the sewer although person entry is not preferred due to the hazards associated with confined Space Entry. Use of modern technology using CCTV, Drones, Robots shall be considered in preference to person entries for operation and maintenance activities. Spacing of MHs is detailed in 7.3 Spacing of Maintenance Structures.

For MHs other than Sulphide Control MHs, depth shall be taken as the distance from the top of the MH access cover/frame to the invert level of the MH outlet.

The MH depth shall be taken as the distance from the top of the MH access cover/frame to the floor of the MH.

Internal back drops shall be used where depth between inlet invert and the invert of the maintenance holes >1.0 m.

For MHs located on branch and trunk sewers, no compensation for friction head loss through bends incorporated in the MH base is required. Minimum grade through an MH shall be the design grade of either the upstream or downstream sewers, whichever is the flatter.

For particularly flat or deep sewers, the fall through MHs may be reduced with the approval of Unitywater.

Project specific design of maintenance holes shall be undertaken for installation depths greater than six metres.

Refer to Pr11051 - Maintenance Holes Selection Guidance Technical Note for the limits for each type of MHs.

7.6.2 Types of MH construction and corrosion protection

Common materials of MH construction include cast in-situ concrete, pre-cast concrete, GRP, PP and PE. Concrete MHs shall also be lined with a Polyethylene internal liner to protect against corrosion.

Standard MH construction options shall be a poured in-situ concrete MH comprising a poured base, channels and walls with a pre-cast concrete cover slab.

Where a pumping station rising main discharges into a receiving maintenance structure, internal corrosion protection shall be provided in accordance with the standard drawings considering potential corrosion hazards to drop pipes, maintenance structures, steel pipes, cement-based pipes and pipes with cement-based linings and any other network components likely to be affected.

Unitywater permit only PE lining systems.

Concrete for MH construction that require shall be special class to WSA PS-358 with requirement of calcareous aggregates. MH construction details shall be shown on Design Drawings.

Special MH construction options may be permitted by Unitywater. These include combinations of concrete and other corrosion-resistant materials such as PE, PVC and GRP, either as formwork or as the corrosion barrier, in conjunction with non-standard construction techniques that may offer lower life cycle costs.

MH construction details for large diameter sewers and special situations are shown on Standard Drawings SEQ-SEW-1309-1, SEQ-SEW-1310-1, SEQ-SEW-1311-1 and SEQ-SEW-1312-1.

7.6.3 Design parameters for MHs

MHs shall be used at the design locations detailed in 7.2 Locations Of Maintenance Structures.

In areas subject to surcharge or water charged ground and where MHs are specified, only cast in-situ concrete MHs shall be used.

Unless otherwise approved by a project specific design, cast in-situ concrete MHs shall be provided.

Refer to Section 5.3.6 for horizontal changes of direction through a MH.

The maximum depth of a MH shall be 15m unless otherwise specifically designed and approved by Unitywater.

The use of pre-cast concrete, GRP, PP or PE MHs, including in water charged ground, requires Unitywater approval.

7.6.4 Design requirements for connection of sewers to MHs

Determination of the means of sewer connection to MHs shall be made at the design stage.

The means of connection, requirements and instructions for connection shall be detailed on the Design Drawings and/or in the Specification.

Property connection sewers are not permitted to be connected to MHs unless approved in an exceptional situations.

7.6.4.1 Pre-Cast Concrete MH Base Units

Unitywater does not permit precast MHs for trunk sewer mains.

7.6.4.2 Cast In-Situ Concrete MH Base Units

Refer to Section 7.6.4.2 of SEQ-WSA 02 for Unitywater requirements. Calcareous aggregate size of concrete shall be 10mm minimum and admixtures used for concrete mix shall be non-chloride type except where MHs include PE liners. PP or PE pipes and/or fittings, which are to be cast directly into the in-situ concrete MH base, shall incorporate a hydrophilic seal around the pipe or fitting in at least two positions to provide a watertight seal.

7.6.5 Connection of property connection sewers into MHs

Property connections to MHs are not permitted. Under exceptional circumstances SP may allow as a temporary connection until a sewer extension is provided to service the private properties.

The risk of private property surcharging and potential for odour shall be considered and suitable design should be done to prevent odour complaints and private property surcharging (i.e. use a “private ownership” non-return valve on the house drain)

7.6.6 MH drops

Internal drops to MHs is the preferred option. Refer to clause 5.6.6.5 and Table 5.13.

External drops shall not be used without the approval of Unitywater.

MH drops including the details shall be shown on the Design Drawings.

7.6.7 Diameters of MHs

On TGSM the minimum diameter of the MHs are 1200 mm for Unitywater.

7.6.9 Ladders, step irons and landings

Ladders, step irons or landings shall not be provided in MHs.

7.6.10 Flow gauging maintenance holes

Where specified by Unitywater, a designated flow gauging MH shall be provided for each catchment in a development with size 50-100 Ha, or having an 8-15 km total length of sewer pipes. Locations nominated by Designers shall be reviewed and approved by Unitywater prior to adoption.

The location of the flow gauging MH shall satisfy the following requirements:

(a) Flow depth shall not be affected by downstream backwater effects.

(b) Upstream and downstream sewers shall be straight, with no change in horizontal or vertical alignment for 50 m upstream and 10 m downstream of the MH.

(c) Upstream and downstream sewers shall have equal and constant grade, with grade greater than 0.5% and less than 1.5%.

(d) The MH shall have one inlet only.

(e) When near an emergency relief structure, the flow gauging MH is to be immediately upstream of the structure.

Flow gauging MHs shall be DN 1200 and their design shall allow for the installation, operation, maintenance and removal of the flow gauging system.

7.7 Maintenance Shafts (MSs) / Maintenance Chambers (MCs)

Maintenance Shafts and Maintenance Chambers are not permitted for Trunk Gravity Sewers.

7.8 Inspection Shafts (ISs)

Inspection Shafts are not permitted for Trunk Gravity Sewers.

8. Ancillary structures

8.2 Water seals, boundary traps, water-sealed MHs and gas check MHs

8.2.2 Water seals, water-sealed MHs and gas check MHs

8.2.2.1 General

An odour assessment conducted as part of the concept design (refer Section 2.4.8) shall determine whether a water seal, water-sealed or gas-check MH is required on a trunk gravity sewer or as otherwise directed and approved by Unitywater.

Water seals, water-sealed MHs and gas check MHs shall be located in road reserves or other public reserves to allow easy access for operations and maintenance, as they require more maintenance than standard maintenance structures.

8.2.2.3 Water seals on branch sewers entering trunk sewers

Water seals on trunk gravity sewers are not preferred by Unitywater and shall not be adopted as a standard design solution. Installation of a water seal will only be considered where demonstrated to be necessary to mitigate a specific trunk ventilation issue, and shall be subject to prior written approval Unitywater.

8.2.3 Water-sealed MHs and gas check MHs

Water-sealed and Gas Check MH’s (referred to as Sulphide Control MHs) are not used by Unitywater and may only be reviewed and approved under specific circumstances.

Where specified, the Sulphide Control MH shall be located adjacent to and upstream of the junction MH with the main sewer.

Where specified, a sewer door shall be installed on the inlet to a Trunk sewer Sulphide Control MH.

Where the connection is below the normal operating level of the trunk sewer, sewer doors shall be provide on the outlet of the Sulphide Control MH.

8.3 Vertical and Near Vertical Sewers

Vertical Sewers are not permitted by Unitywater unless as part of a siphon type waterway or other crossing. Refer to Section 8.6.

8.4 Ventilation

8.4.1 General

This Trunk Gravity Sewer Code addresses natural ventilation. Forced Ventilation may be required in sewer zones with high hydrogen sulphide concentrations and turbulence to address corrosivity and odour impacts on receptors.

Requirements for a particular project, including selection, design and location of induct and educt vents, shall be determined in consultation with Unitywater.

Ventilation criteria set out in the Hydrogen Sulphide Control Manual, Volume 1 shall be adopted in the design of branch and trunk sewers of size ≥DN 450.

The concept and detailed design of the trunk gravity sewer and associated ventilation systems shall be informed by a Septicity and Corrosivity Assessment (ref Section 4.4.1).

Design Drawings shall show the location, type, materials and all necessary construction details for vents, cowls, base blocks including any additional structures, equipment and protection measures.

8.4.2 Design parameters for ventilation and location of vent shafts

Ventilation of trunk gravity sewers shall be assessed as part of the sewer design. Vent shafts (including induct and/or educt vents) shall only be provided where demonstrated, through a ventilation assessment, to be necessary to maintain adequate air movement and pressure control within the sewer system.

On extended trunk sewer reaches where sufficient air exchange cannot be achieved via connected reticulation networks or existing system openings, induct and/or educt venting may be required. The type, spacing and location of any vent shafts shall be determined based on the ventilation assessment and subject to approval by Unitywater.

Trunk sewers shall also be vented in the following situations:

(a) immediately upstream of syphons

(b) on steep grades, as required under 5.6.6.6 Avoiding hydraulic jumps due to steep grades

(c) at SPSs (Refer to SEQ Code edition of WSA 04), and

(d) at MHs where pressure mains discharge to a gravity sewer (Refer to WSA 04).

The following additional ventilation requirements apply:

i. vents to be located above the 1:20 year flood level or else the base to be built up to flood level

ii. vents to be located outside the zone of influence of future sewer inlets

iii. vents not to be constructed on sewer dead ends

iv. vent shafts should be located on high ground above the level of adjacent inhabited areas

v. when high ground is not available, vents should be located at the most exposed sites, or in places where full advantage can be taken of high wind velocities, and

vi. vents should be located as far as practicable from houses and other habitable areas, especially where buildings are likely to be more than one story high.

Vent shaft sizing shall be determined based on the outcomes of an odour dispersion modelling study, undertaken in accordance with the requirements of the Guideline – Odour Impact Assessment from Developments.

8.5 Vortex inlets and water cushions

Requirements for vortex inlets and water cushions used for very large drops in branch and trunk sewers shall be in accordance with Table 8.1. Vortex drops shall have one inlet only, which shall be to the access chamber at the top.

Design of vortex inlets and water cushions shall be undertaken by an hydraulic specialist in consultation with Unitywater.

Table 8.1 Requirements for Vortex Inlets and Water Cushions

Sewer Size DN	Drop depth m	Requirements
375 to 525	< 6	Drop inlet
	6 – 20	Drop inlet with water cushion at bottom of drop
	> 20	Vortex inlet with water cushion at bottom of drop
≥ 600	< 3	Drop inlet
	3 – 10	Drop inlet with water cushion at bottom of drop
	> 10	Vortex inlet with water cushion at bottom of drop

Vortex drops shall have one inlet only, which shall be to the access chamber at the top.

Bore inlets and vortex drops provide suitable flow conditions for an inlet to a tunnel or very deep sewer. The receiving sewer shall be traversable so as to enable connection. Ventilation shall be provided at both the top and bottom of a dropshaft. Construction materials must be selected based on anticipated corrosion problems.

As appropriate, Design Drawings shall show the location, type, materials and all necessary construction details for vortex inlets and water cushions, including any additional structures, equipment and protection measures.

Drop and vortex inlets shall be hydraulically assessed and incorporate air management (induct, educt and odour management).

The design of drop, water cushion and vortex structures shall be undertaken by specialist hydraulic design and include the following assessments:

(a) Detailed design informed by computational fluid dynamics modelling or equivalent to determine the critical design parameters.

(b) Incorporation of air management systems, venting and odour control.

(c) Operations and Maintenance strategy including isolations, power supply, ROV enablement, confined space measures and others as required by Unitywater.

8.6 Inverted syphons

8.6.1 General

Inverted syphons may be used to cross under waterways, drains, roads, rail lines, utility services or other obstacles where the sewer grade cannot be maintained for practical and/or economic reasons. Inverted syphons have high maintenance requirements and generally are used only where alternative designs result in a severe and unacceptable deepening of the downstream sewer.

Inverted syphons may be constructed as a trenched pipeline installation with vertical changes in alignment predominately by vertical or compound manufactured bends, trenchless methods incorporating a curved vertical alignment or otherwise straight horizontal or near horizontal alignments with vertical maintenance holes or otherwise shaft and tunnel structures with an internal carrier sewer trunk main.

8.6.2 Design parameters for inverted syphons

An inverted syphon shall be used only with the approval of the Water Agency. Design of inverted syphons shall be undertaken in consultation with the Water Agency. F10996 - Deviation to Unitywater Technical Specification, in accordance with Clause 1.2.2, shall be submitted to Unitywater and approval obtained prior to proceeding with the design process.

Before commencing design of any syphon, the Water Agency shall be consulted regarding the need for such (or an alternative) and to determine specific requirements for design, construction and testing, as well as operation and maintenance needs. Where a syphon is required, an hydraulic grade line (HGL) analysis of the syphon shall be conducted to ensure surcharge will not occur. The HGL shall be shown on the Design Drawings. (Refer to Figure 8.11 and Figure 8.12.)

The profile and geometry of the syphon must be carefully planned and designed, since the soffit of the syphon will be below the HGL.

The design of inverted syphons shall:

(a) at least match the hydraulic capacity of the sewer; and
(b) provide sufficient driving head across the syphon.

Additionally:

(i) The flow velocity in the syphon shall be capable of transporting solids against gravity. The flow velocity should be ≥0.75 m/s during ADWF and ≥1.0 m/s during design flow. Design assumptions shall be recorded on the Design Drawings (Refer to 10.2.5 Sewers).

(ii) The syphon shall incorporate an inlet and outlet structure, which facilitates maintenance and inspection.

  Where lack of upstream storage volume and time is available to take the syphon system offline for maintenance, isolation and access will be provided to individual mains to enable them to be taken offline independently. This may involve the incorporation of additional maintenance holes for isolation and access.

(iii) The minimum difference in level between the inverts of the upstream and downstream sewers shall be equivalent to the calculated head loss through the syphon plus 600 mm.

(iv) A minimum of two pipes in parallel shall be used for every syphon; in some cases three may provide better performance and higher velocities.

(v) Pipe diameters within the syphon may be smaller than those of the sewer to achieve self-cleansing velocities. However, the combined hydraulic capacities of the syphon pipes shall not be less than that of the incoming sewer.

(vi) The minimum pipe diameter in the syphon shall be as per design.

(vii) The vertical section of pipework within the inlet structure shall extend below the invert level of the outlet structure to ensure pipe full flow conditions occur.

(viii) Transitions between falling grades, horizontal sections and rising grades shall not be abrupt to ensure laminar flow. Nominal falling grade shall be 1:1 (45°) and maximum rising grade shall be 1:1.7 (30°).

(ix) The inlet structure shall be designed so that up to PDWF only one of the parallel syphons (primary barrel) comes into operation, and at increased flows additional pipes are brought into service progressively until PWWF is reached.

(x) The outlet level of the secondary barrel(s) of the syphon shall be arranged at a higher level(s) than the primary barrel (1/2 pipe diameter minimum) to prevent reverse eddies from carrying solids back into the secondary syphon pipes.

(xi) The syphon (or carrier pipe with a shaft and tunnel syphon) shall be constructed from fully welded PE pipe and fittings. Where butt welding is used, the welds shall be internally debeaded and de-burred.

(xii) The pressure class (PN) of the syphon pipework shall include an allowance for high-pressure jet cleaning of the pipe during clearance of blockages.

(xiii) The HGL shall be calculated taking into consideration all losses in the syphon and associated structures including inlet losses and internal friction losses and shall be shown on the Design Drawings.

(xiv) Where required, thrust blocks shall be included to ensure the integrity of the syphon during testing, operation and maintenance.

(xv) Dispersion and/or treatment of trapped sewage gases from the inlet structure.

(xvi) Syphon pipework shall be designed to resist the effects of buoyancy (flotation). The Design Drawings shall specify the method to resist the effects of buoyancy when the syphon is emptied (Refer to 9.4.5 Buoyancy).

(xvii) Where the risk of erosion is high (such as through watercourses), and where trenchless construction techniques are impractical and open trench construction methods are employed, concrete encasement shall be considered.

(xviii) For public safety, bolt down covers shall be specified on the syphon inlet structure.

(xix) The design shall include an allowance for augmentation and/or replacement of carrier mains due to growth or otherwise renewals.

(xx) Odour control measures shall be provided to all syphons. The specific measures shall be determined by an odour assessment.

(xxi) An upstream emergency relief overflow structure shall be designed and included in the design of the syphon.

8.7 Emergency relief overflow structures

8.7.1 General

Catchment Planning and concept design (Sections 2.3.2 and 1.2.5 respectively) shall determine whether a trunk sewer system requires an emergency relief overflow structure (EROS). Unitywater shall provide network design criteria to inform on the performance requirements of any EROS including but not limited to:

(a) location,

(b) design spill frequency, and

(c) hydraulic capacity.

The designer shall liaise with Unitywater and Owner or authority responsible for the watercourse or drain to obtain any discharge licence and incorporate any conditions into the design of the EROS.

An EROS shall not be incorporated into a design without Unitywater approval and the approval of relevant Owner or authority responsible for the watercourse or drain. New sewers shall be of an appropriate size and grade to contain the design flow. Unitywater shall be consulted where calculation shows that the receiving sewer does not have adequate capacity to contain the additional loading from the new sewer.

As appropriate, an EROS shall be provided:

(a) On incoming sewers to a pumping station to enable controlled overflow during shutdown or facility failure. Unitywater shall be engaged in the determination of the hydraulic characteristics of EROS associated with Sewage Pump Stations.

(b) On detention tanks, designed to provide emergency storage for a pumping station.

(c) Along branch and trunk sewers to allow overflow of excessive inflow /infiltration during and following rainfall events.

Unitywater shall decide whether an EROS 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 EROS is proposed, the Designer shall submit a report to Unitywater that addresses, as a minimum, the following issues:

(i) The risk of harm to public health, environment or property if the proposed EROS is not constructed.

(ii) The risk of harm to public health and the receiving environment if an overflow from the EROS occurred.

(iii) The systems to be used to monitor overflows, power failures or mechanical failures of pumping or electrical equipment relating to or affecting the proposed EROS (refer to Section 8.8 and consult with Unitywater).

(iv) Details of the proposed methodology for responding to overflows (consult with Unitywater).

In selecting the EROS location, a compromise needs to be made between maximising in-line storage capacity of the sewer system and selecting a suitable point where the impact of any discharge will be minimised. It is necessary to ensure that sufficient storage is available to provide adequate response time prior to overflow occurring from the EROS. These storage requirements are discussed in the SEQ Code Edition of WSA 04.

8.7.2 Design parameters for EROSs

8.7.2.1 General

The size of the EROS shall be based on the hydraulic requirements of the overflow and required capacity and upstream sewer hydraulic grade line.

When an EROS is specified by Unitywater, the Design Drawings shall show the location and construction detail (Refer to Figure 8.13, Figure 8.14 and Figure 8.15 for typical details). Refer to Standard Drawing sets SEQ–SEW-1413-1 & SEQ-SEW-1413-2 and consult with Unitywater for the actual site-specific requirements.

8.7.2.2 Configuration

An EROS shall consist of:

(a) A relief MH linked to the sewer via a connecting pipe (upstream) and outlet pipe (downstream) discharging into a watercourse or stormwater drain. The connecting pipe and the outlet pipe shall be provided with adequate capacity to cater for the overflows.

(b) Unitywater approved non-return device (Refer to the SEQ Civil IPAM list) installed on the outlet pipe to prevent backflow of water from the watercourse into the sewer system.

(c) Adequate facilities to prevent gross solids entering the watercourse and to enable collection and removal from the structure. These may include bar/mesh screening and continuous deflection separation and collection systems based on solid density.

(d) Baffle systems to minimise surface floating scum from entering the watercourse.

(e) Monitoring systems to measure flowrate and remotely communicate with Unitywater Internet of Things (IoT) network monitoring systems (ref also Section 8.8 Flow Monitoring Devices) to alert when overflows do occur and complying with Unitywater requirements.

(f) Safe access for maintenance - the designer shall seek instruction from UW on the nature of gross solid capture and maintenance requirements' for settled solids, floating solids and scum.

8.7.2.3 Overflow pipe

Catchment planning and concept design (Sections 2.3.2 and 1.2.5 respectively) shall determine the hydraulic requirements of the EROS outlet size and conveyance capacity.

An overflow pipe shall satisfy the following conditions:

(a) Its outlet shall be made at an angle of between 45° and 90° to the direction of flow in the channel or watercourse to which it discharges, or otherwise designed to ensure satisfactory mixing with the receiving water body.

(b) Where discharge is to a formed channel, the invert of the overflow pipe outlet shall not be lower than 0.15 m above the toe of the channel wall.

(c) Where discharge is to a pipe drain, the overflow pipe outlet shall, if practicable, be designed centre to centre with the stormwater pipe. Where this is not practicable, the design shall ensure the structural integrity of the stormwater pipe will be preserved.

(d) MHs shall be used at changes in direction of overflow pipes.

(e) The minimum grade for overflow pipes shall be 1.0% towards the receiving water body so it is self-draining.

8.7.2.4 Overflow level

Catchment Planning and concept design (Sections 2.3.2 and 1.2.5 respectively) shall determine the level, activation and upstream surcharge and spill frequency characteristics.

A detailed hydraulic analysis of the discharge system shall be conducted and include appropriate head loss allowances for the EROS, including non-return devices and screens. The discharge system shall be designed to convey the nominated design flow without causing surcharge or overflow of upstream maintenance holes under design operating conditions, and shall maintain an appropriate freeboard. The designer shall liaise with UW to determine these design parameters.

When designing the EROS and associated pipework, the HGL shall be used to determine the level of surcharge in the sewers and MHs upstream. The Designer shall ensure there is no possibility of overflow upstream at MHs, sanitary drains and overflow relief gullies, etc.

Unless otherwise determined by the hydraulic analysis, the overflow level shall be not lower than:

(a) the mid-height of the receiving stormwater drain or waterway at the point of connection;

(b) 0.5 X diameter of the outlet sewer above the soffit level of the outlet sewer or 150 mm whichever is higher;

(c) the maximum tide level or 1 in 100 year flood level, whichever is the higher.

8.8 Flow measuring devices

8.8.1 General

Flow measuring devices shall be incorporated into the design of trunk sewer systems as required by Unitywater. The requirement shall be informed by Catchment Planning and concept design (Sections 2.3.2 and 1.2.5 respectively). Refer also Section 7.6.10 Flow gauging Maintenance Holes.

Unitywater shall be consulted on the determination of instruments, power supply communications and operations and maintenance requirements.

Design of flow monitoring systems shall include measures to eliminate or reduce the need for confined space entry and exposure to hazardous gas. Safe isolation and ventilation measures shall be provided where confined space entry is required for instrument operations and maintenance. A safety in design assessment shall be conducted on flow measuring installations and safety risks shall be

As appropriate, Design Drawings shall show the location, type, materials and all necessary equipment details for installation and testing of flow measuring devices and ancillary equipment, including any additional measures related to recording the transmission of data.

8.8.2 Within the sewer system

The Designer shall engage with Unitywater on the requirements for instrument integration into the new or existing trunk Sewer. This will include allowances for future instrument deployment and retro-fitting.

The Designer shall consider the following requirements when designing for flow measuring devices:

i. Approved technology, products and materials shall be used.
ii. Target monitoring parameter – dry or wet weather flows, open channel or pipe full flow, sewer or overflow (EROS).
iii. Timing of the installation – new sewer or future retro-fit.
iv. Power supply and communication inputs and outputs.
v. A straight section of sewer without connecting sewers.
vi. Grade flatter than 1 in 50.
vii. No change of pipe size or material.
viii. Located with minimal risk of being subject to back-watering i.e. not immediately upstream of a reduction in grade or major sewer junction.
ix. Located to provide easy and safe access for operation and maintenance. Reference to the Concept Plan (Section 1.2.5) shall be made.
x. A shallow MH.
xi. No pump discharges upstream (consider monitoring flows at the pumping station instead).

8.8.3 At Sewerage Pumping Station

Unless otherwise specified by Unitywater where alternative equivalent monitoring is available, at a sewage pumping station, the device shall be installed on the incoming gravity sewer taking into consideration the design requirements detailed in 8.8.2 Within the sewer system.

8.9 Network storage

8.9.1 General

Network Storage shall be incorporated into the design of trunk sewer systems as required by Unitywater. The requirement for network storage shall be informed by Catchment Planning and concept design (Sections 2.3.2 and 1.2.5 respectively).

Wet weather storage may take the form of inline storage comprising of oversize upstream sewer sections or otherwise off-line storage which fills once a certain water level or surcharge in the sewer has been achieved.

8.9.2 Design considerations

Any proposal by the Designer to incorporate wet weather storage in the design of a network shall be supported by the following:

(a) A comprehensive hydraulic analysis based on network hydraulic modelling that clearly shows:
   a. The proposed maximum capacity requirement based on the critical duration storm event.
   b. The degree of activation of the storage for storm events of duration different to that of the critical event. Storm events of 6 month and 2 year frequency shall be assessed as a minimum.
   c. Dry weather performance characteristics.
   d. The benefit provided by the storage on the performance of the downstream system.

(b) A cost benefit analysis that clearly shows that a wet weather storage is the best solution.

(c) Proposed method of filling and emptying the storage.

(d) Proposed cleaning and washing arrangements.

(e) Proposed odour management arrangements.

(f) Proposed site access arrangements for maintenance vehicles.

(g) Proposed storage access arrangements for maintenance personnel and equipment.

(h) Proposed alarm devices for linkage to the monitoring system (IoT or SCADA) system to alert when flow into the storage facility occurs.

(i) The need for pumping stations or other storages where operational interlocking of the facility with the sewer system is required.

(j) Corrosion protection measures for of internal walls and ceilings.

(k) EROS overflow path following power failure during pumped emptying or extra wet weather events.

(l) Site security and public safety.

8.10 Pump Station Inlet Maintenance Holes

These MHs are essentially located within pumpstation premises, therefore are covered in the SEQ code edition of the Sewage Pump Station Code WSA04.

9. Structural design

9.1 General

The sewer system shall be designed to resist long term structural failure or excessive settlement for its design life under all service conditions.

In Queensland, the design of the works described by this Code must be carried out under the direction of, and certified by, a Registered Professional Engineer of Queensland (RPEQ) in accordance with the requirements of the *Professional Engineers Act 2002*. Structural works or geotechnical works that go beyond the scope of the SEQ Standard Drawings, must be certified by an RPEQ competent to certify such specialist structural or geotechnical works.

Details of the final design requirements shall be shown in the Design Drawings and Specification.

Relevant Unitywater Specifications shall be addressed in the Design. These include but are not limited to:

i. Pr9787 - Specification for Microtunnelling and Pipejacking
ii. Pr9789 - Specification for Auger Boring
iii. Pr9790 - Specification for Pipe Ramming
iv. Pr9825 - Specification for Shafts
v. Pr9902 - Specification for Civil and Earthworks
vi. Pr9903 - Specification for Building and Structural Works

9.4 Loadings

9.4.2 Native soil strength

Ground and geotechnical investigations shall determine soil modulus and assess deformation characteristics of the ground.

The native soil deformation modulus is difficult to measure in the field, so it is considered reasonable to use a conservative value from established correlation with other soil parameters. An appropriate conversion of Standard Penetration Test (STP) blow counts to native soil deformation modulus or allowable foundation bearing pressure to native soil deformation modulus is given in Table 3.2 of AS/NZS 2566.1.

9.5 Foundation design and groundwater control

9.5.1 Migration of fines

Unless otherwise determined through geotechnical and structural design of the pipe/ground system, a Type 4 embedment support plus a separation geotextile shall be applied to trunk gravity sewer pipeline construction to avoid the migration of fines and subsequent deformation of the pipe support.

9.6 Geotechnical considerations

A geotechnical investigation including field testing is required to determine ground conditions before detailed design of Unitywater infrastructure is undertaken.

As a minimum, field testing shall determine the presence of mining subsidence and acid sulphate soils (where relevant), as well as soil grading, soil bearing strength and Emerson Class to check dispersion.

Embedment support shall be suitable for the location and constraints encountered on site. Pipe/embedment support utilising hardwood piles is not permitted.

Geotechnical investigation along the trunk gravity sewer main route is required to justify the trench design. Filter fabric wrapped around the pipe embedment is required if the native soil is migratory. Migratory clay can be identified using the Emerson Dispersion Index test or the Pinhole test. Both tests shall be carried out if the soil bearing strength is < 50 kPa. Where soil bearing strength is ≥ 50 kPa, either the Dispersion Index test or Pinhole test shall be undertaken, as nominated by the Designer.

If the native soil is non-cohesive, filter fabric around the pipe embedment is required if the grading analysis confirms the soil is classified as 'sand', in accordance with AS1726:2017 Geotechnical Site Investigations.

The bearing strength test requirement is not only related to whether the native material is migratory. It is used to determine whether a more onerous trench design is required. If the native soil is a very weak cohesive material, it can migrate into the trench and/or cause settlement of the pipe in the trench – a dispersion test does not identify this issue.

Table 7.2a provides guidance for designers regarding embedment support requirements.

Table 7.2a EMBEDMENT SUPPORT TYPE BASED ON NATA-CERTIFIED GEOTECHNICAL DATA

EMBEDMENT SUPPORT TYPE SHALL BE BASED ON REPRESENTATIVE NATA-CERTIFIED GEOTECHNICAL DATA FROM THE PROPOSED TRENCH DEPTH				
DISPERSION		Soil Bearing Strength (kPa) Note 3	Embedment support type	Requirement
Emerson Class Note 1	Pinhole Test Note 2			
Not 1, 2 or 3	Not ND1 or ND2	> 50	Type 3/C is acceptable	NATA-certified test results only
1, 2 or 3	ND1 or ND2	> 50	Type 4/D minimum	NATA-certified test results only
Any value	Any valve	< 50	Specific Design	Interpretive report

Note:

1. AS 1289.3.8.1:2017 Methods of testing soils for engineering purposes - Soil classification tests - Dispersion - Determination of Emerson class number of a soil
2. AS1289.3.8.3:2014 Soil classification tests – Dispersion – Determination of pinhole dispersion classification of a soil
3. As specified on Drawing SEQ-SEW-1200-1 and SEQ-WAT-1200-1, a special geotechnical assessment is required when soil bearing strength is less than 50 kPa. The resultant interpretive report must recommend design parameter values to be adopted for the design.

The Designer shall provide an interpretive report when native soil is identified as having less than 50 kPa bearing strength. The certifying Design RPEQ shall address the report's finding in the design:

(a) justifying that a more onerous design is not required; or
(b) justifying whether one of the details shown on SEQ Code standard drawings (such as SEQ-SEW-1204-1) would be adequate; or
(c) providing a specific design, including whether structural support and/or filter fabric would be appropriate and if so, the type(s) required.

Note that SEQ-SEW-1204-1 also requires filter fabric to fully wrap the embedment.

It is incumbent upon the certifying design RPEQ to ensure that the correct filter fabric is specified.

Geotextile filter failures are grouped into four categories: inadequate design, atypical soils, unusual permeants, and improper installation, as follows:

- *poor fabric selection, poor fabric design, socked drainage pipe and reversing flow conditions*
- *fine grained soils, gap-graded soils, dispersive clays and ochre*
- *sludges, turbid water, alkaline water, leachates and agricultural waste liquids*
- *intimate contact and completely adhesive clogging of surfaces.*

Refer to SEQ Code Standard Drawings SEQ-SEW-1200-1, SEQ-SEW1201-1, SEQ-SEW-1202-1, SEQ-SEW-1203-1, SEQ-SEW-1204-1 and SEQ-SEW-1205-1 for guidance on embedment types 1 to 17.

9.6.1 General

Where reasonable doubts exist regarding the suitability of the ground to provide adequate support to the pipeline and for all trunk gravity sewer mains pipelines >DN300, a specialist geotechnical assessment shall be made of the proposed route.

All gravity sewer manis proposed to be located within unstable ground, slip areas and mine subsidence areas shall as part of the design process and prior to commencing the detailed design:

(a) Have a geotechnical stability investigation and report prepared and certified by an appropriately qualified RPEQ.
(b) Require a risk assessment to be undertaken following the geotechnical stability investigation in collaboration with Unitywater. The risk assessment shall specifically consider the appropriate pipe material and jointing to be used.

Risk mitigation measures may include continuous ground and pipework monitoring to be used to determine ground movement, as well as impacts to Unitywater infrastructure.

9.6.5 Mine subsidence

Specialist geotechnical assessment and engagement with the Mine Subsidence Board is required for design of pipelines and associated structures within mine subsidence areas.

Grade allowances for ground subsidence due to ground strain and differential settlement shall be provided as outlines in Section 9.6.5 of the SEQ Gravity Sewerage Code.

9.6.8 Corrosive and contaminated ground conditions and cathodic protection

Geotechnical investigations shall determine the physio-chemical corrosivity of the ground conditions. This shall encompass:

(a) Acid Sulfate Soils.

(b) Other acidic conditions.

(c) Contaminated ground assessment.

(d) Corrosivity assessment (e.g. Linear Polarisation Resistance or equivalent techniques).

(e) Cathodic Protection Risk Assessment.

9.7 Special embedment concrete and stabilised supports

9.7.1 General

Where mechanical protection of a trunk gravity sewer main is required, using a pipe enveloper rather than concrete encasement is the preferred approach. Concrete encasement of trunk gravity sewer mains requires prior Unitywater written approval.

For major roadways and railways, mechanical protection shall extend at least 2000 mm horizontally beyond the property boundaries (where practicable). For water ways, mechanical protection shall extend at least 2000 mm horizontally beyond the riparian zone.

Non-flexible pavements (i.e. rigid concrete pavements) over the top of the water main will not be acceptable as mechanical protection.

Where approved in writing by Unitywater, concrete encasement/surrounding works shall be carried out in one continuous pour without horizontal joints. Concrete shall be poured on only one side of the pipe until the concrete has risen at least 25% of the pipe diameter on the opposite side.

Where it is necessary to concrete encase a section of plastic pipe material, a heavy duty 3 mm thick polyethylene material shall be placed between the concrete and the PE pipe to minimise imposed loadings, particularly where the pipe emerges from the concrete block. In addition, plastic pipework installed within 1m of the concrete encasement limits, shall have cement stabilised sand pipe embedment to prevent potential pipe movement and settlement.

Only the following pipe material and jointing method shall be used where a trunk gravity sewer main is concrete encased:

- Mild steel – welded joints
- PE – butt- welded joints
- Ductile iron – no joints (i.e. no RRJ, flanged or mechanical joints) shall be located within the concrete encasement).

No pipe joints shall be installed within 600mm of the concrete encasement.

Rocker pipes (typically 600mm or 2 x NB long, whichever is larger) may be required:

- at each end of the transition from the concrete encased pipe to the natural trenched section
- of the main at each end where a trunk gravity sewerage main crosses over a rigid structure (e.g. a reinforced concrete box culvert).

Refer to SEQ Code Standard Drawing SEQ-SEW-1203-1 for guidance regarding concrete encasement (Type 9) embedment.

Refer to SEQ Code Standard Drawing SEQ-SEW-1401-1, SEQ-SEW-1402-2-1and SEQ-SEW-1403-1 for the requirements regarding encasing pipe methods.

9.8 Above ground crossings

Prior approval for above ground crossings is required from Unitywater. The design of the above ground crossings shall take into account:

(a) pipeline supports;

(b) maintenance;

(c) access and exclusion requirements;

(d) the impact of flooding on the crossing;

(e) exposure conditions;

(f) protection against:

  i. external corrosion;

  ii. UV degradation;

  iii. vandalism;

  iv. bushfires; and

  v. temperature fluctuations.

Where a section of the sewer is to be laid above ground e.g. on an aqueduct, in a bridge duct, suspended from bridge etc. the pipe materials, support and restraint for the pipes and fittings shall be detailed in the Design Drawings and/or Specification. Refer to Standard Drawings SEQ–SEW-1404-1, SEQ–SEW-1405-1 and SEQ–SEW-1406-1 and clause 5.3.4 Waterways.

Only Mild Steel and Ductile Iron pipe materials shall be used for trunk Gravity sewers occurring above ground.

Where above ground Gravity Sewer mains are unavoidable, the following shall be satisfied:

(a) Pipes are to be supported on piles, cradles or alignment blocks as appropriate with detail designs addressing potential settlement and corrosion at supports.

(b) Retaining walls shall be provided where the pipe enters and leaves the trench.

(c) The position of the pipe shall be approved by the relevant Authorities where the pipe crosses creeks and other areas subject to flooding. Flood and debris loads on the pipeline structural support and associated afflux and backwater impacts on the water course shall be determined.

Where relevant, the design shall incorporate allowance for expansion at bridge expansion joints and at ends of the bridge.

Above ground trunk gravity sewerage mains crossings creeks and waterways shall be designed to satisfy impact and debris loading requirements within AS5100 Bridge Design.

9.9 Pipe cover

The design of the sewer shall take account of loading from the passage of construction plant as well as normal design loading (Refer to 9.4 LOADINGS and Standard Drawing SEQ–SEW-1200-2).

Trunk gravity sewer mains shall have sufficient cover to:

(a) ensure any vehicular loading that is in excess of the loading capability of the pipe, is transferred to the soil strata beyond the pipe

(b) meet the requirements of the road Owner (for sewer mains in road reserves), and

(c) meet any special requirements of Unitywater.

Structural design shall determine maximum pipe cover. Appendix I of the Gravity Sewer Code provides guidance on default trench dimensions. The designer shall apply the design requirements of AS/NZS2566.1 Buried Flexible Pipelines and determine whether a particular design relates to the conditions provided in Appendix I.

9.10 Bulkheads and trenchstops

Bulkheads shall be provided for pipelines designed to be laid at abnormal grades in accordance with the SEQ Gravity Sewerage Code **Table 9.1**. Road crossing bulkheads shall be constructed adjacent to kerb and gutter where the road formation requires support due to pipe gradient or ground conditions (Refer Standard Drawing SEQ–SEW-1206-1).

In addition to the grade of the sewer main, when determining the use of bulkheads and trenchstops, trench location, annual rainfall, native soil permeability, natural water table, the occurrence of underground streams and other Unitywater nominated criteria shall also be taken into consideration. Unitywater' consent in writing is required for the use of bulkheads and trenchstops. Where wide trenching with step batters is used, trenchstops and bulkheads should not extend above the lowest un-stepped trench section.

Where required, bulkheads and trenchstops shall be designed in accordance with AS/NZS 2566.2 and Table 9.1 of the SEQ Gravity Sewerage Code.

Where the grade is ≥30%, a fully welded (PE or MS) pipeline shall be designed.

Trench drainage shall not cause bolted fittings to become submerged for long periods of time. Trench drainage shall not affect land use of property owners

Refer to SEQ Code Standard Drawings SEQ-SEW-1206-1 and SEQ-SEW-1207-1 for guidance only regarding typical trench bulkheads, trenchstop and trench drainage arrangements.

10. Design review and drawings

10.2 Design drawings

10.2.1 General

All design drawings shall be clear, uncluttered, without conflicting/illegible text/linework; at a scale that achieves these objectives and in accordance with the SEQ D&C Asset Information Specification (AIS) and Pr8701 - Specification for Asset Information.

10.2.3 Scale

All drawings shall comply with scale requirements in the SEQ D&C Asset Information Specification and Pr8701 - Specification for Asset Information.

10.2.10 Tabulations

The following tabulations and its details shall, as a minimum, be shown on the drawings:

Asset register:

(a) name of Subdivision or Development
(b) Development site address
(c) application numbers from relevant Unitywater delegate
(d) Unitywater delegate approval date
(e) material and total length of each diameter of main
(f) date works complete, and
(g) Drawing or Detail Plan numbers.

Unitywater Connections and Substitutions:

(a) street name and location
(b) length, diameter and material of each main, and
(c) commencement and completion date.

Disused Sewers:

(a) street name
(b) length, diameter and material of each main
(c) “As constructed” folio and year.

10.5 Recording of Work as Constructed Information

The design drawings shall be prepared so that the as-constructed information can be readily incorporated and comply with Unitywater ADAC requirements contained within the current SEQ D&C Asset Information Specification and Pr8701 - Specification for Asset Information.

All Operations and Maintenance (O&M) Manuals provided to Unitywater at Asset Handover shall be reflective of the as-constructed information. O&M manuals that include the strategy and methods on how the sewer is to be operated and maintained.

Appendices

Please find on following pages.

Appendix A – TGSM – Relevant SEQ Code Standard Drawings

Below is a list of relevant SEQ Code Standard Drawings that may be used for guidance only when designing trunk gravity sewer mains.

Please note that the below drawings are generally not suitable for construction without further engineering design detail.

The current version of the below drawings can be obtained from the SEQ Code website at: https://www.seqcode.com.au/seq-sewerage-code

Appendix B – TGSM – Relevant Unitywater Documents

Below is a list of relevant Unitywater Documents relating to the design and construction of trunk water mains to be owned and operated by Unitywater.

Table B1 – Planning Documents

Document ID	Document Title	Document Type
Pr9660	Netserv Plan Part A	Public
	SEQ Code Design Criteria	Public
Pr11057	CIPM - Capital Infrastructure Project Manual	Internal

Table B2 – Development Services Documents

Document ID	Document Title	Document Type
Pr9660	Netserv Plan Part A	Public

Table B3 – Risk Management Documents

Document ID	Document Title	Document Type
Pr9306	Risk Management Procedure	Available on Request
Pr8187	Safety in Design Procedure	
Pr10883	Safety in Design Guidelines	
F11016	UW HAZID Electronic Recording Template	
F11017	UW HAZOP Electronic Recording Template	
F11018	UW CHAZOP Electronic Recording Template	
F11019	UW CHAIR Electronic Recording Template	
F10682	Risk Register Template	

Table B4 – General Engineering Documents

Document ID	Document Title	Document Type
Pr8843	Specification for Drawings, Document and Equipment Tag Numbering	Public
Pr9080	Specification for CAD/BIM Drafting and Modelling Standards	Available on Request
Pr1146	Infrastructure Design Development and Review Guide (SPS, SRM, SGM)	Public
Pr11231	Unitywater Technical Specification Reference Guide	Public
F10996	Deviation to Unitywater Technical Specification or Standard	Available on Request

Table B5 – Civil & Structural Engineering Documents

Document ID	Document Title	Document Type
Pr9902	Specification for Civil and Earthworks	Public
Pr9769	Specification for Concrete Surface Protection	Public
Pr9875	Specification for Non-Pressure Pipeline Construction	Public
Pr9787	Specification for Microtunnelling and Pipejacking	Public
Pr9789	Specification for Augur Boring	Public
Pr9790	Specification for Pipe Ramming	Public
Pr9825	Specification for Shafts	Public
	CHECKLISTS, SCHEDULES & DATA SHEETS	
Pr8843	Specification for Drawings, Document and Equipment Tag Numbering	Public
Pr9903	Specification for Building and Structural Works	Public
Pr10360	Project Information Requirements	Public
F8614	Project Design Brief	Available on Request
Pr8701	Specification for Asset Information	Public
Pr11211	Specification for Commissioning of Active and Passive Assets	Public
Pr9032	Procedure for Managing Water Quality during Mains Commissioning	Public

Table B6 – Mechanical Engineering Documents

Document ID	Document Title	Document Type
Pr9693	Specifications for Mechanical Installations	Public
Pr10932	Mechanical and Electrical Major Service Manual	Internal

Table B7 – Electrical Engineering Documents

Document ID	Document Title	Document Type
F10678	Preferred Equipment List (Electrical and Instrumentation)	Public
	CHECKLISTS, SCHEDULES & DATA SHEETS	
F10678	Accepted Electrical Equipment List	Public
Pr9380	Specification for Electrical Installations at Network Sites	Public
Pr9743	Electrical Safety Procedure	Internal
Pr9911	Restricted Electrical Licence Procedure	Internal
SWMS9386	Work On or Near Energised Electrical Installations or Services Safe Work Method Statement	Internal

Document ID	Document Title	Document Type
Pr8780	Delivery of Planned Capital Works Electrical Projects Procedure	Internal
Pr10618	Specification for Power Systems Analysis and Arc Flash Studies	Public

Table B8 – Control System Documents

Document ID	Document Title	Document Type
Pr8320	Change Management Procedure	Available on Request
Pr9834	Specification for SCADA Standard	
Pr9845	SCADA and PLC Implementation Specification	

Table B9 – Environment Requirements Documents

Document ID	Document Title	Document Type
Pr8196	Health, Safety and Environment Consultation and Communication Procedure	Available on Request
Pr8856	Project Control Environmental Procedure	

Appendix C – TGSM – Relevant Code and Industry Documents

Below is a list of relevant SEQ Code. WSAA and PIPA documents relating to the design and construction of trunk gravity sewer mains to be owned and operated by Unitywater.

SEQ Code Documents

To purchase a copy of the SEQ Service Providers Edition of the Water Supply Code of Australia, refer to https://www.wsaa.asn.au/shop

For more details regarding the SEQ Water Supply and Sewerage Design and Construction Code, refer to: www.seqcode.com.au.

Table C1 – Relevant SEQ Code Documents

Document Title	Document Type
SEQ Service Providers Edition of the WSAA Gravity Sewerage Code of Australia, Version 2.1 (March 2021)	For Purchase
SEQ Code Standard Drawings	Public
SEQ Code Water Supply and Sewerage Design Criteria	Public
SEQ Accepted Civil Infrastructure Products & Materials List	Public
SEQ Accepted Mechanical Products & Materials List (IPAM)	Public
SEQ Code Asset Information Specification	Public

WSAA Documents

To purchase relevant WSAA Code, refer to: https://www.wsaa.asn.au/shop

To obtain the latest version of the WSAA Product Specifications, refer to:
https://wsaa.asn.au/Web/web/shop/ShopSearch.aspx?category=PRODSPECS

Table C2 – Relevant WSAA Documents

Document Title	Document Type
SEQ Service Providers Edition of the WSAA Gravity Sewerage Code of Australia, Version 2.1 (March 2021)	For Purchase
WSA 02-2014 Gravity Sewerage Code of Australia, Version 3.3	For Purchase
WSA 01-2004 Polyethylene Pipeline Code, Version 3.1	For Purchase
WSA 402 Product and Material Information and Guidance Supplement to the Gravity Sewerage Code of Australia	For Purchase
WSAA Product Specifications	Public

PIPA Guideline Documents

To obtain the latest PIPA Technical Guidelines, refer to: https://pipa.com.au/technical/pop-guidelines/

Table C3 – Relevant Plastics Industry Pipe Association of Australia (PIPA) Technical Guideline Documents

Document ID	Document Title	Document Type
POP001	Electrofusion Jointing of PE Pipe and Fittings for Pressure Applications	Public
POP003	Butt Fusion Jointing of PE Pipes and Fittings – Recommended Parameters	
POP004	Packaging, Handling and Storage of Polyethylene Pipes and Fittings	
POP004A	Supplementary List – Materials Specific to Electrofusion and Moulded Fittings	
POP005	Packaging, Handling and Storage of Polyethylene Pipes and Fittings	
POP006	Derating Requirements for Fittings	
POP007	Metal Backing Flanges for Use with Polyethylene (PE) Pipe Flange Adaptors	
POP010A	Part 1: Polyethylene Pressure Pipes Design for Dynamic Stresses	
POP010B	Part 2: Fusion Fittings for Use with Polyethylene Pressure Pipes Design for Dynamic Stresses	
POP013	Temperature Rerating of PE Pipes	
POP014	Assessment of Polyethylene Welds	
POP202	PVC, PP and PE Pipe Installation on Curved Alignments	