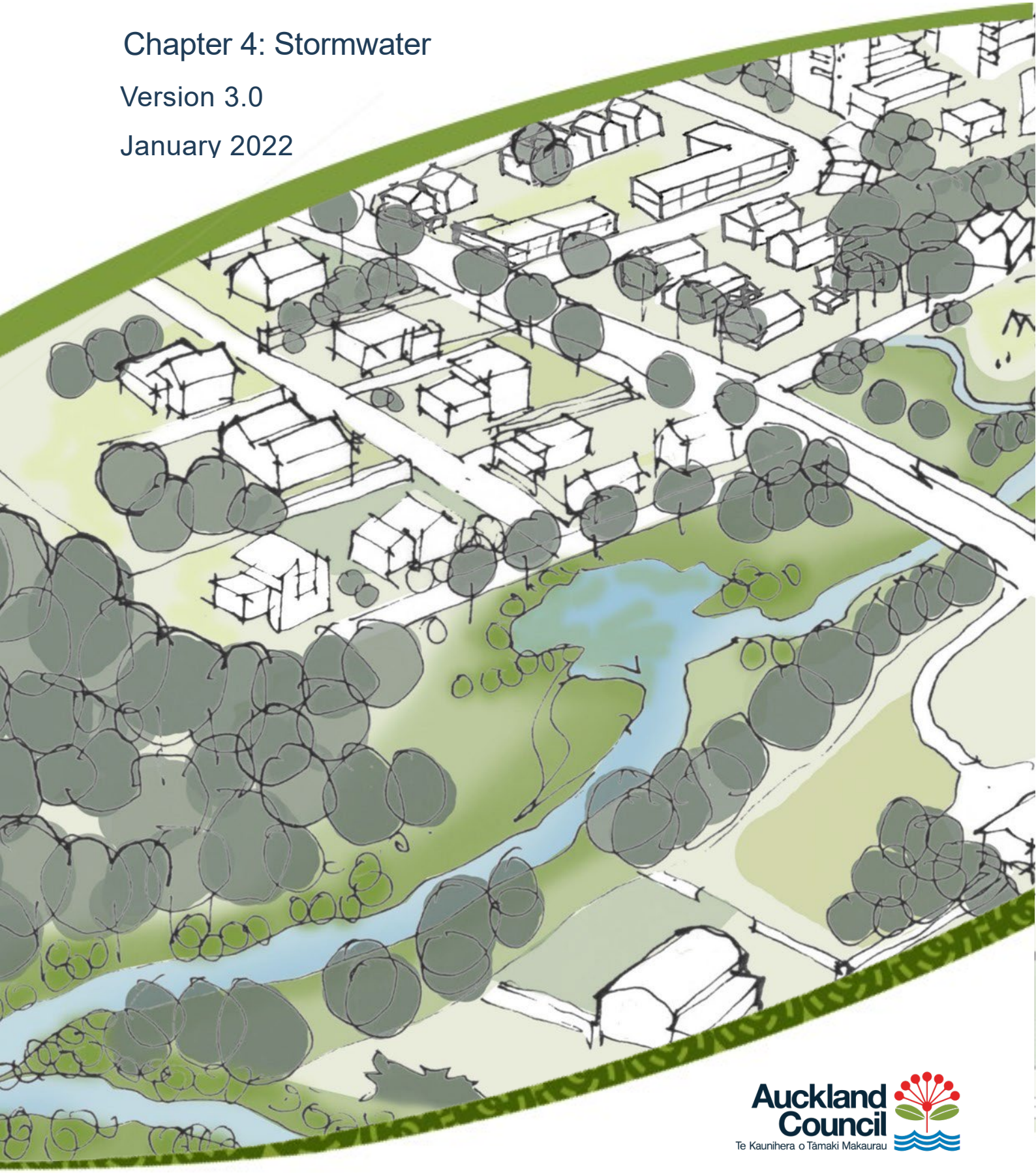
The Auckland Code of Practice for Land Development and Subdivision

Chapter 4: Stormwater

Version 3.0

January 2022



Auckland Council

Te Kaunihera o Tāmaki Makaurau

Document Control

Document name	Code of Practice for Land Development and Subdivision: Chapter 4 – Stormwater

Purpose	To provide minimum standards for the design and construction of new public stormwater assets and new assets which are to be vested in Auckland Council ownership Should the minimum standards not be achievable, developers shall discuss alternative approaches to development and ownership with Auckland Council

Version	Date
Version 3.0	January 2022

Approval for Version 3.0

Reviewed and recommended for publication	Branko Veljanovski, Head of Engineering Design and Asset Management
Approved for publication	Paul Klinac, General Manager Technical Services

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Thanks are also extended to Auckland Council staff, both past and present, who contributed to the development of the Stormwater Code of Practice.

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NZ Feedback

There is a feedback form available to download along with this document. Please send all feedback to SWCoP@aucklandcouncil.govt.nz

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4.0 Stormwater

4.1 Scope

The Stormwater Code of Practice (SWCoP) is Chapter 4 of Auckland Council's Code of Practice for Land Development and Subdivision. This January 2022 revision of the SWCoP supersedes the November 2015 edition.

The word 'shall' refers to practices which are mandatory for compliance with the SWCoP. The words 'should' or 'may' indicate a recommended practice. Any guidance given in the SWCoP, including references to technical publications and guideline documents, is provided to assist with meeting these minimum standards.

4.1.1 Purpose

The purpose of the SWCoP is to provide minimum standards for the design and construction of new public stormwater assets to be vested in Auckland Council ownership.

The SWCoP is intended to ensure that any vested assets are fit-for-purpose and are:

- Cost effective and durable components of the public stormwater system
- Able to provide effective and consistent service throughout their design life without onerous maintenance requirements or costs
- Safe to maintain, operate and ultimately, decommission.

Detailed design advice is available in a range of Auckland Council technical publications and other relevant industry best practice guidelines, rather than within this document.

4.1.1.1 Non-complying designs

Auckland Council recognises that in some cases, minimum standards may not be achievable, or alternative designs maybe deemed more desirable. Non-complying designs (or design components) may be considered by Auckland Council where no compliant alternatives exist. Approval shall be via the Engineering Approval Process (refer Section 4.2.4.1), and subject to proposed designs being demonstrated to meet all the objectives listed above, and providing an equivalent standard of service, durability and safety.

Approval for an alternative design, if given, may include a different ownership arrangement for the relevant asset(s).

4.1.2 Document context

Former local councils in the Auckland region had their own documents addressing compliance with development rules. The first version of the SWCoP was published in October 2013, creating a single set of stormwater minimum standards for Auckland, superseding the stormwater standards of previous legacy councils. It is noted that assets created prior to the October 2013 publication of the SWCoP shall remain in accordance with relevant legacy rules, codes of practices and standards (including with respect to ownership). The ownership rules in this version of the SWCoP will apply as described in Section 4.3.9.14. This is the second revision to the SWCoP and replaces the first revision of 2015.

The Auckland Plan sets the vision of Auckland becoming the 'world's most liveable city'. It emphasises that urban development undertaken to accommodate population growth should be sustainable, while ensuring that communities are safe and have healthy environments in which to work, live and play. For stormwater management, the significant issues are the protection of people, property, infrastructure, and the receiving environment. Auckland Council's approach to supporting Auckland Plan's vision includes encouraging integrated stormwater management, utilising an inter-disciplinary approach to promote balancing land development with the ecosystem services necessary to support it.

All stormwater assets to be vested in Auckland Transport shall be designed and constructed in accordance with the Auckland Transport Code of Practice, and Auckland Transport Design Manual. The SWCoP is to be used in conjunction with:

- Auckland Council Code of Practice for Land Development and Subdivision *Chapter 1: General Requirements*
- Auckland Council guideline document, GD2017/001 (GD01): *Stormwater Management Devices in the Auckland Region*
- Auckland Council guideline document, GD2015/004 (GD04): *Water Sensitive Design for Stormwater*
- Auckland Council guideline document, GD2021/007 (GD07): *Stormwater Soakage and Groundwater Recharge in the Auckland Region*
- Auckland Regional Council technical publication 131, (TP131): *Fish Passage Guidelines for the Auckland Region*
- Auckland Regional Council technical publication, 108 (TP108): *Guidelines for Stormwater Runoff Modelling in the Auckland Region*
- Auckland Council technical report, TR2013/018 (TR18): *Hydraulic Energy Management: Inlet and Outlet Design for Treatment Devices*
- Auckland Council, Regional Stormwater Network Discharge Consent.

Together, these publications provide best practice guidance for stormwater design.

4.1.3 Revisions

Auckland Council intends to revise the SWCoP periodically in response to changes in legislation, policies, technology and national standards, and industry feedback.

A feedback form is available to download along with this document. Please send all feedback to SWCoP@aucklandcouncil.govt.nz.

4.2 General

4.2.1 Objectives

The primary objective of a stormwater system is to manage stormwater runoff to minimise flood damage and adverse effects on both the built and natural environments.

Design of the stormwater system shall include provision for:

- Meeting all Auckland Council standards
- Compliance with environmental and Network Discharge Consent requirements
- Safety in design (refer to Section 4.2.5.4)
- Minimising flood risk to life and property
- Minimising adverse environmental and community impacts
- Minimising Health and Safety risk(s) for public and maintenance workers
- Minimising operational, maintenance and asset decommissioning risk(s)
- Protection of aquatic ecosystems from potential adverse effects
- Adequate system capacity to service the fully developed catchment
- Long service-life with consideration of maintenance and whole-of-life cost
- Application of an integrated stormwater management approach.

4.2.2 Legislation and policy

Legislation and policy controlling the planning, design, construction, operation and maintenance of Auckland Council's stormwater system includes the following documents:

4.2.2.1 National legislation, approved codes of practice, and standards

- Resource Management Act, 1991 (RMA)
- Local Government Acts, 1974 and 2002 (LGA)
- Public Works Act, 1981
- NZ Dam Safety Guideline, 2015
- Building Act, 2004; Building Regulations, 1992; Building Code and associated Compliance Documents (https://www.building.govt.nz/)
- Plumbers, Gasfitters, and Drain Layers Act, 2006
- Civil Defence Emergency Management Act, 2002
- Health and Safety at Work Act, 2015 and associated regulations
- Approved Code of Practice for Temporary Traffic Management (Version 4)
- Australian Standard AS 2865: Confined Spaces

- National Code of Practice for Utility Operators' Access to Transport Corridors, 2015
- Hauraki Gulf Marine Park Act, 2000.

4.2.2.2 National policy

- National Policy Statement for Freshwater Management
- New Zealand Coastal Policy Statement
- National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health
- National Environmental Standards for Freshwater.

4.2.2.3 Auckland Council policy

- Auckland Unitary Plan
- Auckland Council Bylaws.

4.2.3 Auckland Council technical publications and guidance documents

Auckland Council publishes numerous technical publications and guidance documents that are relevant to stormwater design. These can be found on the Auckland Design Manual website.

The SWCoP refers to existing guidance documents and technical publications. However, many of these publications are in the process of being revised and re-published. It is the responsibility of developers and designers to ensure that they are using the current version of the relevant publications. A list of many of the potentially relevant documents can be found in Appendix A.

4.2.4 Auckland Council requirements

4.2.4.1 Engineering Approval

Engineering Approval is required for works and assets that are to be vested in Auckland Council ownership. Infrastructure that does not meet the minimum engineering standards within this SWCoP shall require specific design and is subject to approval by the asset owner (refer to Section 4.1.1.1).

In general, any stormwater pipe shall become public immediately downstream of the point it crosses a boundary of a fee-simple lot. Minimum design requirements for public pipelines are provided in Section 4.3.9.5. Requirements for connecting into existing public stormwater systems are provided in Sections 4.3.9.11, 4.3.9.12 and 4.3.9.13. Vesting criteria for stormwater management devices are provided in Section 4.3.6.

Drawing SW24 in Appendix B provides public versus private demarcation definitions for a range of potential connection scenarios. Additional clarifications relating to pipeline and culvert ownership, and

cross-boundary ownership and maintenance responsibilities are provided in Sections 4.3.9.14 and 4.3.16 respectively.

Where there is a conflict between the requirements of this Code of Practice and any other infrastructure requirements or conditions, this shall be discussed and resolved with Auckland Council. In general, the most stringent requirement shall prevail.

The recommended first step for most land-development projects is a pre-application meeting with Auckland Council. Its purpose is to identify a range of consent requirement issues, including those relating to the Engineering Approval process. Potential non-compliance with the SWCoP should be presented at this stage, and possible alternative solutions explored.

4.2.4.2 Auckland Unitary Plan

All land development activities are subject to assessment against the statutory requirements set out in the Auckland Unitary Plan (AUP) and, until the sections of the Plan that are under appeal become fully operative, the relevant provisions in the legacy plans (City and District Council Plans to be superseded by the AUP). The AUP replaces the previous Regional Policy Statement and 13 legacy plans and provides the regulatory framework for the management of Auckland's natural and physical resources.

AUP provisions are implemented through the resource consent process. Some use and development activities are Permitted Activities under the Plan; however, other approvals may still be required, and Auckland Council should be consulted to ensure that all necessary approvals are identified and being sought.

The AUP sets out the requirements for every stage of development to promote sustainable management under the RMA through managing adverse effects on the environment, including:

- Setting the rural-urban boundary
- Requirements for planning and plan changes for greenfield and brownfield developments, including structure planning and framework planning requirements
- Controls on land use, subdivision and development (RMA, s9), including for sediment control, and managing flood risk and stormwater flow and quality
- Restrictions on use of the Coastal Marine Area (RMA, s12)
- Restrictions on the use of beds of lakes and rivers (RMA, s13), including placement and use of structures
- Restrictions on the use, damming and diversion of water (RMA, s14)
- Restrictions on discharges to the environment (RMA, s15), including discharge of stormwater.

As part of integrated land and water management planning, the requirements of this Code of Practice shall be taken into consideration at the development's early planning stages. This is to ensure that stormwater assets to be vested in Auckland Council meet its requirements as a stormwater network utility owner and operator. Note that the need to meet Network Utility Operator requirements, including complying with the Code of Practice, is specified in the subdivision and development sections of the AUP, as this is the time that detailed infrastructure planning occurs.

Any activities involving connection (including diversion and discharge) to, modification of, or creation of a new public stormwater network shall be approved by the Network Utility Operator (Auckland Council) prior to approval of survey plans under the RMA s224(c).

4.2.4.3 Stormwater Bylaw

The Auckland Council Stormwater Bylaw came into effect on 1st November 2015. The purpose of the bylaw is to:

- Manage the development and maintenance of the public stormwater network, and the land, structures, and infrastructure associated with that network
- Protect the public stormwater network, and the land, structures, and infrastructure associated with that network, from damage, misuse or loss
- Manage the use of the public stormwater network, and the land, structures, and infrastructure associated with that network, and provide for the conditions on which connections to the public stormwater network may be made or maintained
- Ensure that discharges into the public stormwater network do not damage the network or compromise the Auckland Council's ability to comply with any applicable network discharge consent
- Prevent interference with the public stormwater network, and the land, structures, and infrastructure associated with that network
- Manage the public stormwater network, and the land, structures, and infrastructure associated with that network, so as to protect the public from nuisance and promote and maintain public health and safety
- Provide measures to manage the ground soakage systems that form part of the stormwater network
- Ensure the maintenance and operation of private stormwater systems, the removal or de-commissioning of redundant stormwater systems on private land to prevent damage to the stormwater network, to protect the public from nuisance and promote and maintain public health and safety.

The bylaw regulates land drainage and provides a consistent regulatory approach for managing the public stormwater network across Auckland. It therefore also provides a legal basis for the implementation of this SWCoP. All design decisions for stormwater shall be in accordance with the Auckland Council Stormwater Bylaw.

4.2.4.4 Auckland Council region-wide stormwater network discharge consent

The network discharge consent is a single, region-wide consent to divert and discharge stormwater from the public stormwater network held by Auckland Council. It came into effect on 29 October 2019 and applies to:

- Existing diversion and discharges of stormwater from the public network
- Future diversion and discharges resulting from extending the public network to service intensification and growth
- New or modified diversion and discharges resulting from stormwater network upgrades.

Developers can come under Auckland Council's consent rather than obtaining a private stormwater diversion and discharge consent, provided they meet the requirements. Connection standards and stormwater management requirements are specified for different development types in Schedule 4. Compliance with the Network Discharge Consent will be assessed against connection standards, objectives and outcomes within the consent, and will require approval from the Network Discharge Consent Holder.

If designers make a private application, transfers of private stormwater diversion and discharge consents may not be accepted and may remain with the consent holder. Any assets not complying with minimum standards of the SWCoP will not be accepted into Auckland Council ownership unless approved as a "non-complying design" (refer to Section 4.1.1.1). Designers shall comply with the relevant consent (evidence of compliance will be required) or make a private application for a stormwater discharge/diversion consent. Discharges from private stormwater infrastructure that will not be vested in Auckland Council may also require a separate stormwater diversion and discharge consent. Land use consents related to stormwater flow (hydrology mitigation) and stormwater quality may still be required even if stormwater discharges and diversions from the proposed land development project are covered by a stormwater network discharge consent because these matters are in part addressed by a separate rule framework within the AUP.

4.2.5 Health and safety – access to Auckland Council's stormwater network

Stormwater assets represent a number of risks to people. For example, confined spaces may include the inherent dangers of entrapment, engulfment, asphyxiation and drowning. As such, Auckland Council acknowledges that under the Health and Safety at Work Act as a PCBU (Person Conducting a Business or Undertaking), it may have overlapping duties for any persons wishing to access an Auckland Council asset. In discharging those duties, Auckland Council shall make every effort to advise the public through the Engineering Approval or Asset Owner Approval Process. In doing so, Auckland Council may require the applicant to submit a safe work methodology for review with supporting training evidence and an applied risk assessment relating to the intended work.

Based on that review, Auckland Council may seek to monitor the work or may request that the applicant provides evidence to demonstrate that the work has been monitored and inspected to meet the intent of the safe work methodology. This may include ensuring that all workers participate in carrying out the

safe work methodology, that workers are ultimately free from potential of harm, and that all identified safety improvements are implemented at that time.

In addition, any confined spaces within the public stormwater network shall only be accessed by an authorised and trained person. Access to combined networks is managed by Watercare Services Limited (Watercare) and shall comply with Watercare's requirements, including health and safety.

4.2.5.1 Access granted by Engineering Approval

Prior to commencing any physical works on the public stormwater network involving physical access, all contractors shall be able to demonstrate appropriate safe systems of work, have a current, site-specific Safety Plan (or safe work methodology) for that project, and have gained Engineering Approval, as required.

Examples of works to be undertaken under Engineering Approval are:

- New connection to a pipeline or manhole
- Maintenance/repair of existing stormwater pipelines
- Construction of a new stormwater asset to be vested in Auckland Council.

4.2.5.2 Access granted by asset owner approval

Contractors requiring access to the public stormwater network for purposes other than physical works shall undertake such works under approval from Auckland Council. Approval can be applied for using Auckland Council's *Permit to Access the Stormwater Network for Non-Physical Work Activity* form. The form can be downloaded via Auckland Council's *Stormwater Forms and Guides* webpage.

Access to services within the road reserve also requires corridor access request approval from Auckland Transport. The contractor shall also obtain all necessary landowner approvals for access.

Examples of works for which approval is required from Auckland Council as the asset owner are:

- Closed circuit television (CCTV) inspection
- Jetting and other cleaning
- Visual inspection requiring physical entry to network
- Any other physical access to the network not involving physical works.

4.2.5.3 Non-man entry inspection

Opening of covers for short durations (e.g. to check depths) not involving physical access to the system is permitted, providing contractors use the appropriate tools, and follow appropriate health and safety procedures so that they meet their duties under the Health and Safety at Work Act 2015, and obtain all necessary approvals (e.g. for land access, working in the road [corridor access approval], etc.).

4.2.5.4 Safety in design

Design of all stormwater assets shall consider health and safety risk throughout the life of the asset and shall help promote the safety of Auckland Council employees, contractors, the public, property, and operating personnel. As PCBUs, designers, architects, engineers, manufacturers, and suppliers or installers of structures such as stormwater pipes, hold a duty of care under the Health and Safety at Work Act. PCBUs are required to consider all aspects of risk during all phases of the asset's life, including design, construction, operation and decommissioning. Operational risks shall be considered during both normal use and in extreme storm events.

Operation and maintenance activities often involve personnel working within live networks. Design engineers shall ensure that all practicable measures are included in the design to facilitate safe working conditions in and around the asset.

As these assets will generally be developed in urban areas, to ensure public safety, careful consideration is also needed in design and construction with respect to how the public may interact with them.

Where requested, the Safety in Design Register and documentation shall be provided to Auckland Council for review and shall also form part of any operational and maintenance manual required.

4.2.6 Catchment planning

Auckland Council undertakes stormwater management planning on a catchment-wide basis for urban areas. Rural catchments may not have developed specific management plans. Where a proposed development is in an area covered by an Auckland Council Stormwater Management Plan, designers shall comply with that plan. Access to these documents will be made available via a request to Auckland Council. If there is no Stormwater Management Plan for the proposed development area, a developer may be required to develop a Stormwater Management Plan as outlined by the Network Discharge Consent.

A Network Discharge Consent is not required where a proposed development is not covered by an Auckland Council Stormwater Management Plan. In this case, the designs shall utilise the best practicable option that will meet the provisions of relevant plans required by Auckland Council and/or objectives of this SWCoP.

Any implications of future development on adjoining land shall be assessed so that mitigation of negative hydrological effects both during and post-development can be implemented. Effects to be assessed include those due to higher flow rates and volumes of stormwater discharge and peak flood levels. Section 4.3.5.6 provides information on secondary flow-path design requirements.

Any stormwater management planning issues, including non-compliance with the Stormwater Management Plan, shall be discussed with Auckland Council.

4.2.7 System components

The stormwater system conveys surface runoff and shallow groundwater from the point of interception to soakage areas, attenuation areas, or the point of discharge to receiving waters.

The stormwater system consists of:

- Natural systems such as:
  - Streams (ephemeral, intermittent and permanent)
  - Wetlands
  - Ground aquifers
  - Overland flow paths.
- Built assets such as:
  - Roadside channels
  - Swales
  - Catchpits
  - Piped network
  - Manholes
  - Inlets and outlets
  - Constructed channels
  - Stormwater quality improvement devices (such as wetlands, ponds, rain gardens, etc.)
  - Soakage and groundwater recharge devices
  - Diversion devices
  - Control structures.

Acceptable design solutions of standard system components are set out on standard construction drawings contained in Appendix B. The drawings and guidelines can be used by anyone in accordance with Creative Commons' Licences and the NZ Government Open Access and Licensing Framework.

All stormwater assets to be vested in Auckland Transport shall be designed and constructed in accordance with the Auckland Transport Code of Practice, and Auckland Transport Design Manual.

4.2.8 Catchment and off-site effects

Proposed stormwater systems shall cater for stormwater runoff from within the land being developed together with any runoff received from upstream catchments. The upstream catchment shall be considered for the maximum probable development scenario. This means that it allows for the maximum impervious surface limits of the current zone or, if the land is zoned future urban in the AUP, the probable level of development arising from zone changes. If the upstream catchment includes areas outside the rural urban boundary, then the maximum probable development shall be agreed with Auckland Council.

The effects of climate change are assessed as per Section 4.2.10.

For a system to be considered for vesting in Auckland Council ownership, or for stormwater discharges to be authorised under Auckland Council's Network Discharge Consent (see Section 4.2.4.4), the system must be designed to cater for the maximum probable development scenario as defined in this section.

For a proposed land development (including projects involving changes in land use or coverage), the design of the stormwater system shall include evaluation of the effects on both upstream and downstream systems. This evaluation shall be required at resource consent stage and may be linked to a requirement for the hydrological regime to be altered for the benefit of the wider catchment.

Auckland Council will endeavour to provide guidance at an early stage in the resource consent application process as to whether a catchment-wide solution will be required.

Downstream effects could include (but are not limited to), changes in peak flows and patterns, flood water levels, contamination levels and erosion or silting effects, and effects on the existing stormwater system. Developers shall allow for any specific mitigation requirements for the development area. If the proposed development area is not covered by a specific Stormwater Management Plan or the Network Discharge Consent and the proposed development includes effects that are assessed by Auckland Council as being more than minor, mitigation measures such as peak flow attenuation and volume control shall be required. Also, where a proposal details effects that are assessed by Auckland Council as being less than minor, the developer may be required to implement mitigation measures as directed by Auckland Council, in particular, to mitigate any cumulative effects of similar developments within the catchment.

Where modification of a watercourse is required including but not limited to; culverts, weirs, fords, aprons, ramps and flap gates, fish passage shall be maintained (refer to relevant consent requirements and National Environmental Standards for Freshwater). Auckland Council will look for opportunities to enable fish passages in watercourses where these have been obstructed by historic man-made structures.

4.2.9 Water quality

Compliance with the Network Discharge Consent or a private resource consent may be required for the diversion and discharge of stormwater. The treatment of stormwater discharge may also be required in order to comply with permitted activity rules or as a consent condition. Compliance with the consent or a private resource consent may be required for a discharge even when it is not a direct discharge to land or receiving water, such as where runoff enters an existing network.

Stormwater management devices may be required to avoid any potential adverse water quality effects on receiving land or waters. The type of contaminants that could become entrained in the stormwater shall be identified during the stormwater system design phase and then a suitable treatment device(s) shall be considered to address them.

Guidance and criteria for the design of stormwater management devices is provided in GD01. This document supersedes Auckland Regional Council's Technical Publication TP10. Design of stormwater management devices to be vested in Auckland Transport shall be designed and constructed in accordance with Auckland Transport Code of Practice requirements and Auckland Transport Design Manual.

4.2.10 Climate change

Climate change is expected to alter the intensity and frequency of significant rainfall events. In general, an increased peak flow is expected. Hydrological calculations shall be carried out in accordance with GD01 with allowances for climate change effects in accordance with Table 5.2 of the Ministry for the Environment, 2008: *Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand*, using a temperature increase of 2.1° by 2090. This includes an increase to the 24-hour rainfall depth, as well as a change to the dimensionless TP108 rainfall profile as shown in Table 1 and Table 2. For hydraulic analysis, a minimum sea-level rise of 1 m shall be used as per the AUP (refer to Section 4.3.5.8 below).

Table 1: Percentage increase in TP108 24-hour design rainfall depth

Annual exceedance probability (AEP)	Percentage Increase in 24-hour design rainfall depth due to future climate change*
50%	9.0%
20%	11.3%
10%	13.2%
5%	15.1%
2%	16.8%
1%	16.8%

* Assuming 2.1°C increase in temperature

Table 2: TP108 Normalised 24-hour temporal rainfall intensity profile

Time (hrs: mins)	Time interval (min)	TP108 normalised rainfall intensity (I/I24)	
		Existing condition	Future climate change*
0:00 – 6:00	360	0.34	0.33
6:00 – 9:00	180	0.74	0.73
9:00 – 10:00	60	0.96	0.95
10:00 – 11:00	60	1.40	1.40
11:00 – 11:30	30	2.20	2.20
11:30 – 11:40	10	3.80	3.82
11:40 – 11:50	10	4.80	4.86
11:50 – 12:00	10	8.70	8.86
12:00 – 12:10	10	16.20	16.65
12:10 – 12:20	10	5.90	5.95
12:20 – 12:30	10	4.20	4.24
12:30 – 13:00	30	2.90	2.92
13:00 – 14:00	60	1.70	1.70
14:00 – 15:00	60	1.20	1.19
15:00 – 18:00	180	0.75	0.75
18:00 – 24:00	360	0.40	0.39

* Assuming 2.1°C increase in temperature

4.2.11 Access to relevant information

A range of information including a Geographic Information System (GIS) viewer, planning documentation and property information can be accessed at www.aucklandcouncil.govt.nz.

Developers are also advised to visit the Auckland Design Manual website at: www.aucklanddesignmanual.co.nz.

4.3 Design

4.3.1 Durability

Designers shall provide, where requested, whole-of-life costs including capital, maintenance and rehabilitation costs using a lifecycle of 100 years. It is recognised that the durability of individual components may vary, and this should be accounted for in the whole-of-life cost.

4.3.2 Future development

Any proposed development shall make provision for stormwater services to cater for the upstream catchment and shall extend the public stormwater network to the boundary with the adjacent upstream property in accordance with Section 4.3.11. Easements in lieu of this network extension shall be considered only in exceptional circumstances.

4.3.3 Integrated stormwater management

The integrated stormwater management approach (also known as water sensitive design) aims to rely on natural components such as vegetation and soil media to cater for stormwater management as well as enhancing urban environments. The main principles of integrated stormwater management are to:

- Promote inter-disciplinary planning and design
- Protect and enhance the values and functions of natural ecosystems
- Address stormwater effects as close to source as possible
- Mimic natural systems and processes for stormwater management.

The benefits of integrated stormwater management include protecting and enhancing natural waterways by limiting discharges of silt, suspended solids, and other pollutants into receiving waters.

All future development in Auckland should apply the principles of integrated stormwater management to minimise stormwater runoff volumes and peak flow rates and to improve the quality of stormwater runoff entering the receiving environment.

Integrated stormwater management principles shall be considered during the initial planning stage; developed during design; and implemented at the construction stage of the project. Good planning and design early in the development process maximises the cost effectiveness of integrated stormwater management.

Guidance on the implementation of integrated stormwater management is available in the following documents:

- Auckland Council guideline document GD2015/004: *Water Sensitive Design for Stormwater*, known as GD04
- SNZ HB44: *Subdivision for People and the Environment.*

The requirements of this Code of Practice take precedence over any guidance provided by the above documents.

4.3.4 Stormwater system design approach

Sections 4.3.4 and 4.3.5 aim to provide designers with a clear understanding of the approach Auckland Council requires for the design of stormwater systems. Auckland Council's preferred approach is to minimise any impact upon the receiving environment. All development should, in the first instance, be in accordance with the integrated stormwater management principles detailed in Section 4.3.3 above and in Auckland Council guideline document GD2015/004: *Water Sensitive Design for Stormwater*. The information provided in the following two sections focuses primarily on the minimum standards required for the design of both primary and secondary systems.

The stormwater system shall be designed for the maximum probable development (see Section 4.2.8) of the entire upstream catchment and in accordance with TP108, with allowances for climate change as described in Section 4.2.10 above. Effects on downstream systems shall be shown to be acceptable. The system shall be designed to collect surface water from all areas, including lots, roads, rights-of-way and reserves.

4.3.4.1 Primary stormwater system

Primary stormwater systems include both open and closed conduits and shall be designed to cater for the flows generated by the event specified in the design standards in Section 4.3.5.2. As far as possible, the location of primary systems should be aligned with natural flow paths.

4.3.4.2 Secondary stormwater system

A secondary stormwater system consists of ponding areas and overland flow paths with sufficient capacity to transfer the flows generated by the event is specified in the design standards in Section 4.3.5.2. As far as possible, the location of secondary systems should be aligned with natural flow paths. The existing constructed or natural flow paths shall be retained as far as practical. Any alteration of the existing stormwater system shall result in no detrimental impacts to either upstream or downstream properties.

Where possible, secondary systems shall be located on public land. However, creation of an overland flow path is not to be considered as justification for the land it passes through to be vested in Auckland Council. Overland flow paths on private property with catchments equal or greater than 4000 m^2 shall be protected by registered easements in favour of Auckland Council or by other encumbrances prohibiting earthworks, fences and other structures, as appropriate.

4.3.5 Design criteria

A Design and Model Report shall be provided when the design process requires hydrological or hydraulic modelling. The report shall include all underlying assumptions such as curve numbers, time of concentration, catchment areas, roughness coefficients and losses. These assumptions shall be clearly presented so that an appropriate check of all calculations is possible. A copy of the model and/or calculations will be required by Auckland Council for review and/or record keeping. Models developed in proprietary software shall be submitted with temporary licenses as required.

The designer shall undertake the required design and prepare design drawings compatible with Auckland Council's design and performance parameters. Designers shall ensure the following aspects have been considered and included in the design where appropriate:

- The size of pipes, ponds, swales, wetlands and other devices in the proposed stormwater management system
- How the roading stormwater design is integrated into the overall stormwater system (refer to the Auckland Transport Code of Practice and Auckland Transport Design Manual). For works within the road reserve, liaison with Auckland Transport is required to confirm design parameters. Where these are different to those of Auckland Council, the most stringent parameters shall apply
- The type and class of materials proposed to be used
- System layouts and alignments including:
    - Route selection
    - Topographical and environmental aspects
        - Consideration of topographical restrains in the pipe layout to minimise the need for deep pipe installation
        - Consideration to minimise the environmental impact of the pipe layout.
    - Easements
    - Clearances from underground services and structures (see Watercare's Code of Practice: W*ater and Wastewater*)
    - Provision for future extensions
    - Location of overland flow paths and checks against depth and flow criteria (see Section 4.3.5.6).
- Hydraulic adequacy (see Section 4.3.5.3)
- Property service connection locations and sizes (see Sections 4.3.9.5 and 4.3.11)
- Accessway, including vehicle access for future operation and maintenance activities
- Cost, including whole-of-life cost
- Other specific requirements such as specific geotechnical conditions, fish passage, debris loading/blockage as necessary.

Where necessary, the designer shall liaise with Auckland Council prior to commencement of design, to ensure that sufficient prerequisite information is available to undertake a robust design.

4.3.5.1 Hydrological design of stormwater systems

For most catchments, estimation of surface water runoff shall be calculated using TP108, adjusted for climate change as stated in Section 4.2.10. For larger catchments, or where significant storage elements (such as ponds) are incorporated, surface water runoff shall be determined using an appropriate hydrological and/or hydraulic model to the approval of Auckland Council.

Runoff factors are to be based on the underlying geology, as defined on the geological map for the Auckland region and confirmed by site inspections. Runoff factors will also be influenced by land use.

4.3.5.2 Design standard

All new public stormwater systems shall be designed to cater for design storms of at least the Annual Exceedance Probability (AEP) set out in Table 3 (adjusted for climate change – see Section 4.2.10), unless specific approval has been obtained from Auckland Council.

Table 3: Design standard

Function	Annual exceedance probability (AEP)
Primary systems	10%
Secondary systems	1%

Development is generally not permitted in areas with no secondary flow path.

Secondary systems shall be designed to accommodate the 1% AEP design storm event, assuming the conditions listed in Section 4.3.5.6.

4.3.5.3 Hydraulic design of stormwater systems

The primary piped system shall be designed to cater for the peak design flow, without surcharge (water surface to not exceed above the soffit of the lowest incoming pipe), determined by the water surface profile throughout the piped system. Secondary stormwater systems shall be designed as open channel flows.

The hydraulic design of stormwater pipelines shall be based on either the Colebrook-White formula or the Manning formula. The Colebrook-White and Manning formulae can be found in *Metrication: Hydraulic Data and Formulae* (Lamont, n.d.). The roughness coefficient used when determining system capacity shall consider the aged condition of the new and the existing stormwater network. Manufacturer's specifications shall also be referred to.

Examples of appropriate ranges for Manning's roughness values for pipe materials are provided in Table 4. Capacity assessments shall take into account losses within the overall system, and also allow for energy losses through inlets and access chambers, as described in Section 4.3.5.4.

Table 4: Manning's roughness values for closed conduits and overland flow path

Classification	Manning's Roughness Coefficient (n)
Plastic	0.011
Concrete	0.013
Overland flow paths along roadways	0.02
Overland flow path designed and grassed channels	0.03
Overland flow paths through properties/parcels	0.10

Any obstruction to flow in a pipeline, such as fish passage, shall require specific design to Auckland Council's approval.

Hydraulic design of precast concrete stormwater culverts shall be in accordance with the Concrete Pipe Association of Australia CPAA Design Manual *Hydraulics of Precast Concrete Conduits (Pipes and Box Culverts*). For other materials, use *Guide to Road Design: Part 5B – Open Channels, Culverts and Floodways* (Austroads, 2013). Also see Section 4.3.9.8. In any case, Table 4 provides the minimum roughness values that will be acceptable.

4.3.5.4 Energy loss through structures

Energy loss (also known as head loss) in a pipeline or an access chamber typically consists of entrance, exit and bend losses.

Energy loss is expressed as velocity head:

$$\text{Energy loss } H_e = KV^2/2g \text{ (m)}$$

Where:

K = Empirical entrance loss coefficient

V = Velocity (m/s)

g = Gravitational acceleration (m^2/s).

The *New Zealand Building Code* clause E1/VM1 provides an entrance loss coefficient table (Table 4) and energy loss coefficient graph (Figure 12) that includes appropriate K values for flow through inlets and access chambers respectively. Figure 1 below shows coefficients for energy loss due to bends through manholes.

The exit loss coefficient has a range of values from 0 to 1. A free discharge exit has a K value of 0 while an exit submerged in a pond has a K value of 1.

When modelling catchpits, either of the following scenarios may be used:

- Where catchpit grating losses are allowed for, water levels at design flow shall not exceed kerb level at catchpit positions
- Where catchpit grating losses are neglected, design water level shall not allow standing water above the catchpit grating.

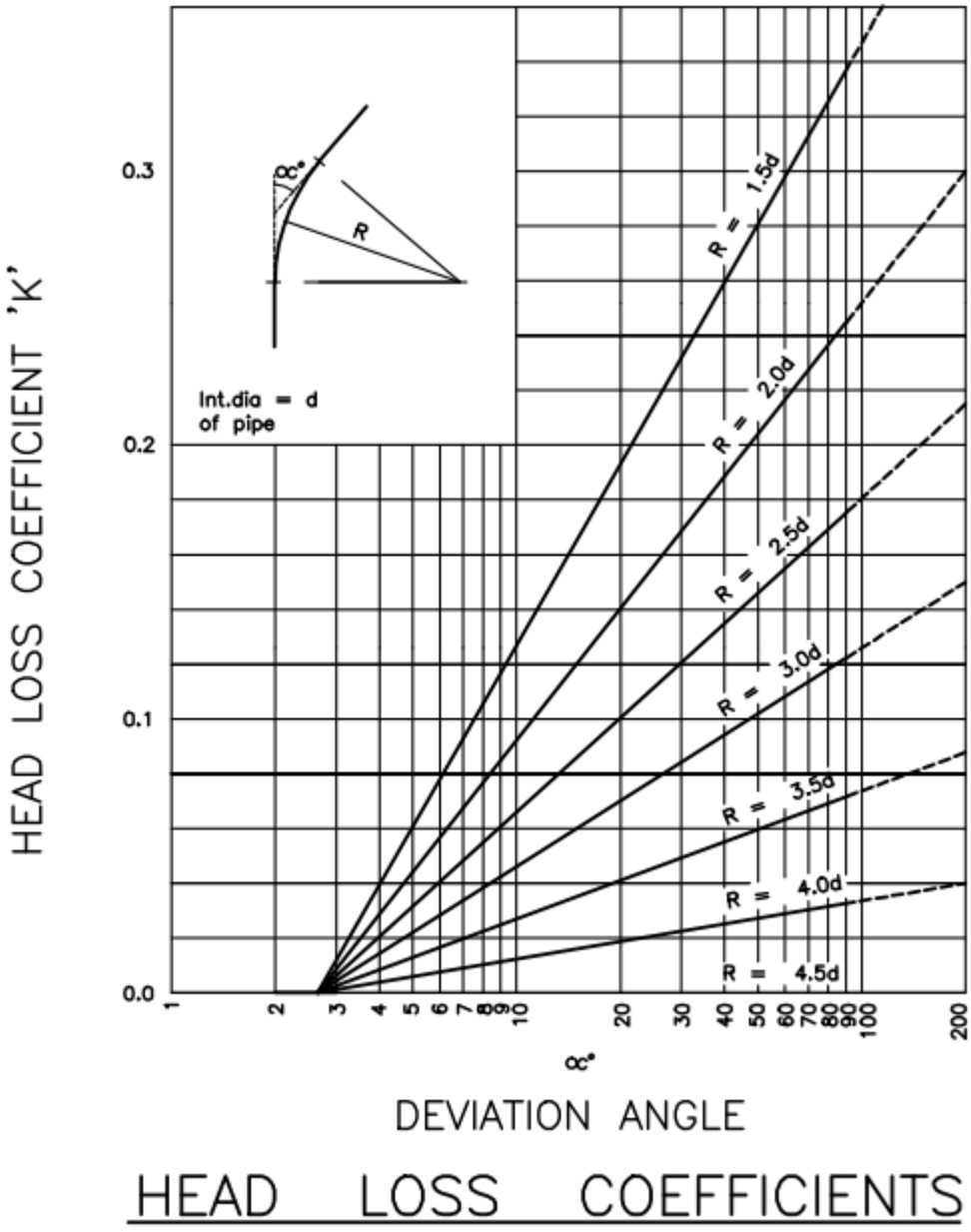

Figure 1: Head loss coefficients for bends through manholes

4.3.5.5 Determination of water surface profiles

Stormwater systems with a subcritical flow shall be designed by calculating backwater profiles along the pipe starting from an appropriate outfall water level. Where the system is complex, computer modelling shall be utilised. On steep gradients with supercritical flows, both inlet control and hydraulic grade line analyses shall be used, and the more severe relevant condition adopted for design purposes. At manholes and inlets, the water levels computed from the design flow shall be low enough to prevent overflow and to allow existing and future connections to function satisfactorily.

Requests shall be made to Auckland Council to provide outfall levels from the relevant hydraulic model when the discharge is to an existing stormwater network. If the discharge is to a river or other body of water, Auckland Council shall be consulted for relevant hydraulic model information; however, if this information is unavailable, the outfall water level shall be determined using the tailwater depth calculation in E1/VM1: *Compliance Document for New Zealand Building Code: Clause E1 Surface Water (Department of Building and Housing*, 2011). For areas with tidal outfalls (including tidal rivers), designs will need careful consideration in terms of the nominated receiving body water level which will be used for the backwater curve calculations. Each situation will need to be individually assessed by Auckland Council.

In principle, each step in determining a water surface profile involves calculating a water level upstream, i.e. reduced level of water surface (h_2) for a given value of discharge and a given start water surface level downstream (h_1).

This can be represented as:

$$h_2 + V_2^2/2\,g = h_1 + V_1^2/2\,g + H_f + H_e$$

where:

V	=	Velocity (m/s)
G	=	Gravitational acceleration (m^2/s)
h_1	=	Downstream water level
h_2	=	Upstream water level
H_f	=	Head loss (in metres) due to boundary resistance within the reach (for pipes, unit head loss is read from Manning's flow charts, for example)
H_e	=	Head loss (in metres) within the reach due to changes in cross-section and alignment (see Figure 1 for loss coefficients for bends through manholes).

4.3.5.6 Secondary flow paths

Secondary overland flow paths shall be designed with sufficient capacity to accommodate the 1% AEP storm event, assuming the following conditions for the primary network:

- For pipelines up to and including DN600, assume that the pipeline is 100% blocked
- For pipelines between DN600 and DN1,050, assume that the pipeline's capacity has been reduced by 50%
- For pipelines in excess of DN1,050, assume that the pipeline's capacity has been reduced by 10%.

The following matters need to be taken into account when considering the design of all secondary flow paths:

- Secondary flow paths shall not be obstructed in any way. Buildings or structures, including fences and retaining walls, shall not be built within a secondary flow path or form an obstruction to any part of a secondary flow path. This includes works which do not require a building consent.
- Any property owner is legally required to accept stormwater runoff that would naturally flow onto their property. The plotted secondary flow path entry point on the upstream boundary and the exit point on the downstream boundary shall not be altered by site development. However, it may be possible to relocate the flow path entry and/or exit point by mutual agreement with neighbouring properties.
- Where modification to a secondary flow path is required by a development, applicants shall submit a detailed design of the overland flow path when the catchment is equal or greater than 4000 m^2 and for smaller catchments at Auckland Council's discretion.
- Where the road reserve is to be used as the secondary flow path (or where flow paths traverse pedestrian or vehicular accessways or public carriageways), Auckland Transport shall be consulted at an early point in the design on a number of issues such as road and reserve width, road profile, lifelines access, and health and safety.
- Secondary systems shall be designed to avoid land instability and to reduce the significance of erosion during significant events. The design shall incorporate erosion protection measures as appropriate.
- Conveyance of secondary flows can often be integrated into other site requirements, such as driveways and landscaped areas. Consideration of this shall be undertaken throughout the design process. All applications potentially affecting secondary flow shall include design details showing the layout of the secondary flow path across the site including flow depth and velocity at critical locations.
- All modifications to secondary flow paths shall be documented on as-built plans.

4.3.5.7 Freeboard

The requirements for buildings and activities in relation to floodplains are set through rules in the AUP. Refer directly to the AUP to be certain of requirements.

The minimum freeboard for overland flow paths shall be as per Section 4.3.1 of E1/VM1 (Compliance Document for New Zealand Building Code: Clause E1 Surface Water, Department of Building and Housing, 2011), using the flow generated by the 1% AEP flood event, except where the flow is in excess of $2m^3/s$. Table 5 shows freeboard requirements for different scenarios.

Table 5: Freeboard requirements for the 1% AEP event flood plain and 1% AEP coastal storm inundation including 1 m sea-level rise

Scenario	Freeboard
More Vulnerable Activities* in floodplains	▪ 500 mm
Less Vulnerable Activities* in floodplains	▪ 300 mm
Overland flow paths where flow is less than $2m^3/s$	▪ 500 mm where surface water has a depth of 100 mm or more and extends from the building directly to a road or car park, other than a car park for a single dwelling ▪ 150 mm for all other cases
Overland flow paths, where flow is equal to or in excess of $2m^3/s$	▪ 500 mm for More Vulnerable Activities* ▪ 300 mm for Less Vulnerable Activities*
Coastal Storm Inundation Areas (1% AEP including 1m sea-level rise)	▪ 500 mm for dwellings and habitable rooms which are subject to wave action from the sea ▪ 150 mm for all other cases

* As defined in the AUP

The AUP requires new development proposals within the 1% AEP flood plain, coastal inundation areas and/or overland flow paths to be subject to a Resource Consent. In addition to the minimum freeboard requirements listed above, development proposals in such areas shall therefore also clearly demonstrate how adverse effects on public safety and property are to be avoided or mitigated, as per Section E36.9 of the AUP. Alternative freeboard levels may be required subject to site-specific risk assessment in accordance with E36.9 Special information requirements.

Alternative specific designs for freeboard within overland flow paths may be considered for approval at the Council's discretion. Freeboard shall be measured from the top water level to the finished floor level.

4.3.5.8 Coastal areas

In coastal areas, design criteria shall be discussed with Auckland Council at an early stage. Stormwater infrastructure shall align with the policies set out in the New Zealand Coastal Policy Statement (Department of Conservation, 2010) including avoiding locating infrastructure in the hazard zone where possible, discouraging hard protection structures and promoting alternatives including natural defences. Sea level rise allowances shall comply with the AUP (1 m sea level rise) as a minimum. In addition, it is recommended that sea level rise allowances align with the *Coastal hazards and climate change: Guidance for local government* (MfE, 2017), where MfE's sea level rise recommendations are greater. MfE's (2017) coastal hazards and climate change guidance provides updated sea level rise values based on more recent projections from the Intergovernmental Panel on Climate Change (IPCC, 2015). Other coastal processes including storm surge, coastal erosion and coastal instability need to be considered in accordance with the following technical reports and guidance documents:

- *Auckland's Exposure to Coastal Inundation by Storm-tides and Waves*, TR2020/024, Carpenter, N; R Roberts and P Klinac, (Auckland Council 2020)
- *Coastal Hazards and Climate Change: Guidance for Local Government* (Ministry for the Environment, 2017)
- *Predicting Auckland's Exposure to Coastal Instability and Erosion*, Roberts, R., N Carpenter and P Klinac (2020). Auckland Council, technical report, TR2020/021.

Where relevant, the worst case from any of the above documents shall be considered.

4.3.6 Stormwater quality and quantity control

Development can generate increased runoff rates and contaminants, with corresponding negative effects on receiving environments. Stormwater management devices can be used to reduce the effects of changes in stormwater quality and quantity.

For stormwater quality and quantity requirements that need to be met for new developments, refer to the relevant planning provisions. GD01 provides guidance for stormwater device design using a best-practicable option approach.

4.3.6.1 Stormwater management devices

There is a wide range of stormwater management devices available for managing the quality and quantity of stormwater. Each of these devices may be appropriate for varying sites with different land use types and other constraints. Readers should refer to GD01 for guidance on the appropriate selection and design of stormwater management devices. The final selection of any devices to be vested is subject to the approval of Auckland Council.

In addition to the devices outlined in GD01, proprietary devices may also be considered in areas where spatial constraints and practicality require their use. In these instances, only devices that have been

approved by Auckland Council may be used. In general, the use of proprietary devices in 'greenfield' development areas shall not be permitted for vesting in Auckland Council ownership.

4.3.6.2 Stormwater device ownership

New stormwater management devices may be vested in Auckland Council's ownership if it can be demonstrated that a significant flow from the public stormwater network discharges to that treatment system. Auckland Council may, at its discretion, approve public treatment systems where there is considerable public benefit, i.e. treatment is available for stormwater runoff from public land or from properties outside of the immediate development site. Stormwater management devices shall otherwise remain in private ownership.

The developer shall discuss and agree with Auckland Council any requirements for vesting stormwater management devices and/or infrastructure funding agreements early, as part of the pre-application process. As part of these discussions, the developer maybe asked to prepare and submit to Auckland Council, a comprehensive whole-of life cost analysis for the proposed device(s). The developer shall be responsible for providing suitable access for all future maintenance operations. Any financial burden, including costs associated with easements and/or land being vested in Auckland Council, shall fall on the developer (unless an alternative arrangement has been agreed as part of an infrastructure funding agreement).

Stormwater management devices either created by Auckland Council or by a developer, then vested in Auckland Council's ownership, shall satisfy a number of criteria, including the following:

- Public stormwater management devices shall be located on Auckland Council-owned land
- Any private stormwater diversion and discharge consent, or other relevant RMA consent (e.g. to dam water or for physical works associated with ongoing operation and maintenance) issued to the developer, shall be transferred to Auckland Council (in accordance with RMA s136) at the same time as the land and assets are vested in Auckland Council ownership
- In general, treatment devices should be constructed after the catchment is fully developed to ensure that no contaminants from construction works can enter the device
- Where the above is not possible, any devices constructed prior to a catchment being fully developed shall be reinstated to its as-new condition upon the completion of the maintenance period, once the catchment has been fully developed, prior to vesting. This is to ensure that the quality of the device vested to Auckland Council is not compromised by construction works during a latter phase of a development
- All devices shall be operated and maintained with the fully developed catchment for at least 12 months by the consent holder prior to vesting
- The device is vested to Auckland Council with no service contract
- The minimum maintenance periods for proprietary devices are 12 months

- For screen and gross pollutant traps, the following must be provided:
  - Safe access during storm events
  - Bypass for flows larger than the target flow
- Whole-of-life costs including capital, maintenance and rehabilitation costs using a lifecycle of 100 years are to be submitted to Auckland Council. Replacement costs associated with components with less than a 100-year life shall also be accounted for in the whole-of-life cost
- The Operation and Maintenance Plan and maintenance records must be submitted to Auckland Council prior to vesting.

For stormwater management devices (e.g. rain gardens) installed as part of a roading project, liaison with Auckland Transport will be required to confirm locations, connection requirements and design parameters. All stormwater management devices to be vested in Auckland Transport shall be designed and constructed in accordance with Auckland Transport Code of Practice requirements and the Auckland Transport Design Manual.

Catchpits and associated pipe systems located on private land shall remain private assets and will not be maintained by Auckland Council.

4.3.6.3 General design approach for stormwater management devices

The success and cost-effectiveness of stormwater management devices is improved by considering them in the very early stages of planning and design of a development. The developer shall enter into discussions with Auckland Council regarding the selection of these devices as early as practicable in the development's design, prior to sign-off by Auckland Council. The following key items shall be considered:

a) **Primary objective:** Having a clear understanding of the statutory requirements regarding water quality and quantity is crucial in identifying appropriate stormwater management devices. The devices chosen must match the water quality and quantity objectives.

b) **Secondary objective:** Stormwater management devices offer many opportunities to deliver multiple benefits in addition to their stormwater functionality.

c) **Integrated approach:** An integrated approach considers several aspects of stormwater design including the following:
   - Consideration of stormwater management requirements in the early stages of a project
   - Integration of stormwater management devices with other infrastructure such as parks, reserves, wastewater, water supply and buildings as part of the development's integrated stormwater management, e.g. a green roof may function as a quality device, roof and open space
   - Maintenance of stormwater management devices shall be considered early in the design process to facilitate the ease and efficiency of their on-going operation and maintenance. All maintenance requirements shall consider current resource consent requirements.

d) **Device selection:** The proper design and position of a device within the stormwater catchment is critical. Several devices are often used in series, in what is called a “treatment suite”. The respective position of the various components in the treatment suite is an important consideration in ensuring effectiveness of the system throughout its lifecycle. Treatment suites are needed where a single device does not meet all of the water quality and quantity objectives (refer to GD01 for further guidance on the treatment-suite approach). The whole-of-life cost of devices, including maintenance costs, shall be considered.

e) **Device location:** Stormwater management devices shall be located in a readily accessible location, preferably on public land or land to be vested with Auckland Council. Where this is not possible, and the device is located in private land, easements are to be provided for maintenance and access. Generally, the location of stormwater management devices in trafficked locations is not acceptable. Deviations from this approach may be considered by Auckland Council, e.g. where the device is in a very low traffic volume location, access is on the berm rather than the carriageway, and there is sufficient area. Device location, type, size and maintenance requirements are subject to Auckland Council’s approval.

- Refer to Section 4.3.6.5 for access requirements
- Devices located in high amenity open space areas require additional consideration to achieve a sympathetic and unobtrusive design for Auckland Council’s approval. Reference should be made to the Auckland Design Manual (www.aucklanddesignmanual.co.nz) for guidance with respect to design in high-amenity open space.

f) **Device quantity:** Applicants shall optimise the proposed number of devices in relation to treatment effects and whole-of-life costs. There are situations where fewer and larger facilities are preferable to many smaller ones; there are also situations where the opposite applies.

g) **Device replacement parts:** Applicants shall demonstrate that any spare parts anticipated being required for routine maintenance activities are commonly available on the open market and are not subject to any licences or other restrictions that would bind Auckland Council to purchase such items from a single supplier.

h) **Device design:** The device must be designed for a 100-year design life, and no contaminant leaching material can be used (e.g. uncoated treated timber). Generally, retaining walls shall be kept out of the permanent water pool.

i) **Design for safety:** Ensuring that the device is safe both for the public and operational and maintenance staff is critical. Devices involving open water storage such as wet ponds and wetlands require attention to water safety, including inlet and outlet location and levels. Pond fencing requirements will be subject to careful risk assessment which shall demonstrate to Auckland Council’s approval that risks to public safety, especially falls from height and drowning, have been appropriately addressed. If there is a potential risk of vehicles rolling or driving into stormwater infrastructure which has open water surfaces, sufficient barriers in accordance with Auckland Transport’s Code of Practice must be provided or an alternative design that is agreed and accepted by Auckland Council.

j) **Emergency spillways:** The requirement for, and the design (and consideration) of spillways to protect upstream and downstream receiving environments during extreme weather events (outside of the design storm) to ensure a safe and resilient community.

k) **Other issues:** Additional items that may need considering include aesthetics, biodiversity, site topography, underground devices and future decommissioning of the device.

4.3.6.4 Maintenance of stormwater management devices

The design and construction of any stormwater device shall take future ownership, access, maintenance requirements and whole-of-life costs into consideration and shall ensure that maintenance can be carried out with little or no disturbance to the surroundings or neighbouring properties.

Elements to consider in the design for the maintenance and operation of the device include:

a) Safety in design to enable safe operation and maintenance

b) Access arrangements for operation and maintenance purposes shall be in accordance with Section 4.3.6.5

c) Procedures for the removal and disposal of sediment, including the required frequency. This shall include any consenting issues that are considered likely to occur in the future associated with the removal and disposal of silt

d) Obtaining consent(s) for any maintenance activities for assets to be vested in Auckland Council

e) Where necessary, an appropriately sized and located drying/storage area shall be provided for any litter/silt/media etc. that is removed from the device

f) Wherever practical, it should be possible to drain the device and forebay by gravity flow

g) Maintenance requirements of mechanical parts

h) Vegetation maintenance requirements. Weeds shall be controlled and removed in accordance with Auckland Council's *Plant and Pest Management Strategy* (2007). Plant maintenance for vegetation shall be included in the Maintenance Plan.

An Operation and Maintenance Manual for all stormwater management devices, public or private, shall be submitted to Auckland Council for approval as part of the Engineering Approval process, and prior to the issue of certificates such as the Code Compliance Certificate or RMA s224(c) Certificate for Subdivision Consent. The manual shall include a detailed technical data sheet and shall state the methodology for the ongoing and long-term maintenance of the device, including:

- Inspections required and frequency
- Maintenance needs and frequency
- Recommended ongoing control methodology to eradicate established pests and invasive weeds from both terrestrial and aquatic areas.

Additional operation and maintenance information that is needed for detention ponds and wetlands (and their surrounding drainage reserve) are:

- Details for permanently wet areas
- Details for the surrounding planted area
- De-watering methodology for the main pond and the forebay
- De-silting methodology for the main pond and the forebay
- Consent(s) for operation and maintenance.

4.3.6.5 Access requirements for maintenance of devices

The following minimum criteria shall be met to allow anticipated future maintenance works for treatment devices:

a) To allow for access for maintenance, a Vehicle Manoeuvre Plan shall be provided with the Maintenance Plan. This must show that maintenance vehicles as required as per the Operation and Maintenance Plan, can access and exit the site safely, and that sufficient space is provided to manoeuvre the vehicle on site. General requirements are:
   - Minimum accessway width shall be 3.5 m
   - The maximum gradient of the accessway should be 1:8.

b) The minimum track specification including the design, construction and choice of surfacing for access tracks shall be discussed with Auckland Council. Requirements will vary according to device type and the use of the area in which the device is located.

c) Where necessary, provide a suitable platform for an excavator to undertake any maintenance work as required.

d) The approved access shall remain available at all times in perpetuity or until Auckland Council confirms in writing that the access is no longer required.

e) If the device is in a trafficked location, sufficient area shall be allowed to establish all necessary traffic management controls, or any other requirements of the Traffic Management Plan.

The suitability of the access and all other requirements listed above shall be demonstrated in the device's design and in the Operation and Maintenance Plan.

4.3.7 Watercourses, natural and constructed waterways

Watercourses are an important part of a stormwater system. Discharges to watercourses shall be designed to minimise erosion, water quality impacts and flood risk. Watercourse maintenance is the responsibility of the owners of the land through which they pass. In some situations, Auckland Council has control over the watercourse via covenants or easements. Where daylighting of existing piped watercourses occurs, the resulting watercourse shall be maintained by the landowner. In isolated instances where private land with watercourses maybe vested in Auckland Council or in its control, they

shall be provided with an easement-in-gross in favour of Auckland Council to access any such land for maintenance purposes.

Enhancement of watercourses is to be considered as part of a development, where appropriate. Enhancement may include, but is not limited to, the following:

- **Watercourse rehabilitation:**
  - Providing riparian margins and landscaping that takes into account ecological values as well as flood risk issues
  - Protection against scour and erosion of the watercourse
  - Removing obstacles for free fish passage
  - Restoring ripples and runs to provide habitat and mimic natural conditions
  - Weed removal.
- **Watercourse day-lighting:** In line with Auckland Council's integrated stormwater management principles, where practicable, Auckland Council may prefer the conversion of existing culverted watercourses to its natural pre-development status. Where such opportunities are identified, the developer shall discuss and agree such options and associated details with Auckland Council on a case-by-case basis.

4.3.8 Stormwater pumping

All modifications or extensions to the public network shall be designed as gravity systems. There shall be no stormwater pumping within the public network without explicit permission from Auckland Council. All private stormwater rising mains, backflow prevention devices and other fittings shall be owned by the landowner of the lot the rising main serves. This applies for the full length of the rising main, ending at a private discharge chamber, prior to discharging into a public chamber. Details for the connection of the private raising main to the public system can be found in Drawing SW11 in Appendix B.

4.3.9 Pipelines and culverts

4.3.9.1 Alignment of pipelines

The expectation is that the pipe will be located within the overland flow path. Stormwater pipes shall be located, where practicable, within the road reserve (but not the carriageway) or other public land. Only where this is not possible, shall the location of stormwater pipes within private property be considered. In such cases, the pipe shall be located so as to not reduce the building area available on the lot (i.e. located as close as possible to a boundary) or where it can be shown that a satisfactory house-location site is available clear of the pipe, and that access points have been allowed for, suitably placed so that access will be available post-development. Where stormwater pipes are installed adjacent to wastewater pipes within the berm or under the footpath, they shall preferably be installed on the carriageway side of the wastewater pipe.

The order of preference for the location of stormwater pipes is summarised as follows:

1) Within overland flow path
2) Road reserve (but not carriageway) and other public land
3) Shared accessway
4) As close to the property boundary as is practicable, and parallel to the boundary.

Auckland Council's preferred option is to have no pipelines in public road carriageways. Where a viable pipeline alignment away from the carriageway cannot be identified, approval from Auckland Council and Auckland Transport shall be obtained. A whole-of-life cost analysis must be provided, including operation, maintenance, replacement and associated traffic management costs.

Pipelines adjacent to boundaries, structures and foundations shall be located at least a distance equal to the depth to invert away from such boundaries and the edge of such structures and foundations with an absolute minimum clearance of 1 m in all cases (refer to Drawing SW22 in Appendix B).

The stormwater network layout shall ensure the following:

a) Access to all parts of the reticulation shall remain available for inspection and maintenance. Adequate spacing of manholes, access points and access chambers shall be provided for regular maintenance and inspections including CCTV inspection, water jetting, root cutting and grouting
b) The proposed pipe system shall comply with the design, construction and maintenance aspects of AS 2865 (Confined Spaces)
c) The potential for infiltration and exfiltration shall be minimised, e.g. by optimising the number of manholes and access points
d) Siphons and inverted siphons are generally not permitted; however, Auckland Council will exercise its discretion on a case-by-case basis. These shall require specific design and approval

e) In general, pipelines between access points shall be straight with manholes at a change in direction or grade. Horizontally or vertically curved pipelines shall require specific design and approval by Auckland Council. Pipelines with both horizontal and vertical curvature shall not be permitted.

4.3.9.2 Other services

For normal trenching and trenchless technology installation, clearance from other service utility assets shall generally be in accordance with those established in Auckland Council's *Code of Practice for Land Development and Subdivision* (Chapter 5: Wastewater & Chapter 6: Water)

Service crossings of open stormwater channels or watercourses shall be installed beneath the channel or watercourse. Minimum clearance between a pipe soffit and stream bed is 500 mm. However, in any case, a specific design is required to address potential future stream erosion and stream maintenance requirements. If it is impractical to install the service beneath the channel, specific design approval is required from Auckland Council.

4.3.9.3 Design for installation

All pipes shall be designed to support all existing and any predicted future dead loads. Design live loads shall be HN-HO-72 for motorways and arterial roads, HN for local streets and driveways, and 20 kN wheel load for non-trafficable areas. Reinforced concrete pipe installation design shall be in accordance with AS/NZS 3725 and CPAA Engineering Guideline: *Selecting Materials for Bedding Steel Reinforced Concrete Pipe*. The minimum acceptable support type shall be H2 as shown in Drawing SW03 in Appendix B. The use of higher support types to reduce pipe class shall be subject to specific design and Auckland Council approval.

All reinforced concrete pipes shall be designed to AS/NZS 4058 and AS/NZS 3725.

All flexible pipes shall be designed and constructed to AS/NZS 2566 Parts 1 and 2.

Installation of reinforced concrete pipes in road reserves shall require specific design to demonstrate that any possible heavy compaction of trench fill to achieve road subgrade and pavement stability requirements will not cause excessive cracking of the pipes. The use of free-flowing granular materials for pipe embedment (as shown in Drawings SW02 and SW03 in Appendix B), is recommended to reduce compaction stresses on pipes.

In areas with a high water table, it shall be demonstrated to Auckland Council's satisfaction that all pipelines are designed against floatation. This shall include consideration of the potential for post-construction ground conditions with saturated non-cohesive backfilling above the piping over the width of the trench. The factor of safety against floatation shall be at least 1.25.

4.3.9.4 Materials

The pipe types listed in Table 6 may be used for stormwater drainage work when appropriate, provided they are designed, manufactured and installed to the current New Zealand or Australian standards.

Wherever it may be reasonably anticipated that concentrations of chlorides, sulphates and acids may be elevated, and in industrial areas, the pipe material and grade shall be selected to resist attack from any chemicals that are identified through a suitable testing regime. In all cases where elevated chemical concentrations may exist, including in peat soils and the marine environment, the soil, groundwater, and stormwater shall be tested, and results provided with the design report. Where concrete pipe is specified, design shall be in accordance with this Code of Practice and other relevant standards, including NZS3101, and in particular the requirements relating to pipe design with respect to aggressive environments. Where other material is specified, design shall be in accordance with equivalent requirements of the relevant standard.

Table 6: Pipe materials

Pipe type	Standard	Conditions of use
Reinforced concrete (RC)	AS/NZS 4058 and AS/NZS 3725	All stormwater applications.
Polyvinyl chloride (PVC)	AS/NZS 1254 or AS/NZS 1260 – Minimum SN16	Generally, for up to DN375
Polyethylene (PE)	AS/NZS 4130 and 5065 – Minimum PE100 or base resin from which PE100 is compounded, with Standard Dimension Ratio (SDR) of 17 or superior including for thrust and drilled lines that are grouted.	Generally confined to trenchless applications or trenched applications where required by specific site conditions. Will be approved for use following demonstration of satisfactory specific design.
Polypropylene (PP) twin-walled pipe	AS/NZS 5065 – Minimum SN16	Will be approved for specific applications following demonstration of satisfactory specific design.

All other pipe materials are excluded from use without specific approval from Auckland Council.

All buried infrastructure (including tanks and manholes) which are made of plastic shall be manufactured from virgin material.

4.3.9.5 Minimum pipe sizes and connections to public systems

All public stormwater pipes that are built for, or vested to Auckland Council, shall meet the following requirements (Table 7). All pipe diameters are minimum sizes and shall be subject to capacity checks and design as per this SWCoP.

Table 7: Minimum connection/outlet requirements for stormwater networks

Private connection pipe	A private connection pipe is the section of pipe located upstream of the demarcation point as defined in Section 4.3.11(e): ▪ A private connection pipe can only serve one property ▪ Design and construction of a private connection pipe must be in accordance with the NZ Building Code ▪ Minimum diameter: 100 mm (DN).
Public connection pipe	A public connection pipe is the section of pipe located downstream of the demarcation point as defined in Section 4.3.11(e). A public connection pipe can only serve one property, and shall comply with the following: ▪ Minimum diameter: 100 mm DN (only if the maximum length is 3 m or less) ▪ Minimum diameter: 150 mm DN (where the length is longer than 3 m) ▪ Be designed to offer a minimum conveyance capacity in accordance with Sections 4.3.4 and 4.3.5 of this SWCoP ▪ The public connection pipe may terminate at an existing public main as per Section 4.3.12 of this SWCoP ▪ Where appropriate upstream access for CCTV inspection and maintenance is not provided, the point of connection shall be at a non-access chamber or manhole (in accordance with Table 9).
Public main	A public main is a pipe that serves more than one lot, and shall comply with the following: ▪ Minimum diameter: 150 mm DN ▪ Be vested in Auckland Council ▪ Be designed to offer a minimum conveyance capacity in accordance with Sections 4.3.4 and 4.3.5 of this SWCoP ▪ Consist of a non-access chamber or manhole (in accordance with Table 9) at the upstream end ▪ Consist of a maximum length between manholes as per Section 4.3.10 of this SWCoP ▪ All public mains shall connect to larger downstream public networks as per Section 4.3.12 of this SWCoP.
Upstream extensions	▪ If an extension into an upstream property with future development potential is required, the upstream end of the pipe shall consist of a non-access chamber or manhole (in accordance with Table 9) ▪ The downstream network shall be sized to also convey the upstream catchment serviced by the extension, in accordance with Sections 4.3.4 and 4.3.5 of this SWCoP.
Catchpit leads	Public connections from catchpits shall be designed and installed in accordance with Section 4.3.13 of this SWCoP.

Stream outlets	On private land: ▪ When possible, multiple outlets shall be consolidated to reduce the number of outlets and structures in the stream ▪ Outlet structures shall be provided with wing wall and energy dissipation measures to meet Auckland Council's TR2013/018 ▪ If an outlet serves only one lot, it shall remain in private ownership ▪ If an outlet serves more than one lot, or the pipe to the outlet has crossed the boundary of its private lot, the outlet and pipe from the point it crossed that boundary shall be vested in Auckland Council, with maintenance access provided. On public land: ▪ When possible, multiple outlets shall be consolidated to reduce the number of outlets and structures in the stream ▪ Outlet structures shall be provided with wing wall and energy dissipation measures to meet Auckland Council's TR2013/018 ▪ The outlet structure and pipe up to the boundary of the private property shall be public and shall be vested in Auckland Council ▪ Maintenance access shall be provided.

Refer to Drawing SW24 in Appendix B for examples of public/private boundaries for stormwater connections.

For further information regarding connections to the public system, refer to Section 4.3.11, and for information regarding connection to public mains, refer to Section 4.3.12.

4.3.9.6 Minimum cover

All pipelines shall be specifically designed to support all temporary, permanent and life loadings, in relation to the minimum cover to the top of pipe to be provided in accordance with the relevant standards. The cover shall be not less than 600 mm (including during the development of the site).

In the road reserve the cover shall be not less than 1,000 mm.

For pipes under private driveways and access ways, the cover shall be not less than 1,000 mm. A reduction to 600 mm cover can be made if the surface is constructed of reinforced concrete.

Where the reticulation pipelines are laid in the front yard of lots and the lots are elevated above the carriageway, the minimum cover on the pipelines within the lot area shall be 600 mm below the adjacent road level. This is to avoid damage when the lot is subsequently levelled out to make way for building platforms and/or driveways are subsequently excavated.

The requirements for minimum cover on pipelines are summarised in Table 8.

Table 8: Minimum cover on pipelines

Pipeline location	Min. cover
Location where specific design shows no additional cover is required	▪ 600 mm
Private driveways, surface finish made of:	
▪ Reinforced concrete	▪ 600 mm
▪ Other	▪ 1,000 mm
Front yard of lot where the lot is elevated above the carriageway	▪ 600 mm below finished surface level of carriageway
Road reserve	▪ 1,000 mm

For special cases, and with agreement from Auckland Council, cover can be reduced by using a higher class of pipe, special bedding, concrete protection or a combination of these. Reference shall be made to AS/NZS 3725: *Design for Installation of Buried Concrete Pipes*, and to AS/NZS 2566.2: *Buried Flexible Pipelines Part 2: Installation*, or to similar standards for pipes of other materials. The key issue is that pipes shall not be installed in situations where their design load capability is exceeded during construction or subsequent operation.

4.3.9.7 Minimum flow velocities and gradients

Pipe velocity limits

The velocity of stormwater in pipes shall be maintained within acceptable limits to ensure both self-cleaning of the pipe or box section and avoidance of scouring and erosion of the conduit.

The acceptable minimum flow velocities for all pipes of all materials for the 50% AEP design storm are an absolute minimum of 0.6 m/s and desired minimum of 1.0 m/s.

The maximum velocity for a 10% AEP design storm is 4 m/s. It is in Auckland Council's discretion to allow higher flow velocities up to 8 m/s if suitable measures are taken within the pipe catchment to prevent the entry of abrasive materials and the flow can be diverted through the manholes without surcharge.

Notwithstanding the above velocity limits, hydraulic considerations may well require the velocity to be controlled to well below the stated maximum and/or the pipe size increased to minimise structure losses and the slope of the hydraulic grade line.

Pipe grade limits

Pipeline gradients shall be designed to allow for the maximum and minimum velocities stated above. Within these limits, the maximum gradient shall not exceed 25% (1 in 4), and the minimum gradient shall not be less than 0.1% (1 in 1000) for all pipes.

In addition, designers shall consider the peak velocity in the pipe against the maximum design velocity provided by manufacturers and suppliers.

4.3.9.8 Culverts

For the purposes of this document, a culvert is defined as any conduit that transfers the flows of a watercourse or waterway across a road or embankment. The design of culverts shall comply with this SWCoP, and where relevant, Auckland Transport's Code of Practice and Auckland Transport Technical Design Manual. Where the requirements of the two documents differ, the most stringent parameters shall apply.

a) If the culvert embankment can be considered a dam under the dam safety regulations, the requirements of those regulations shall take precedence over those stated here. The following thresholds under the AUP apply:
    - Vertical height from the downstream toe of the embankment to the top is more than 4 m, or
    - The total stored volume of fluid is more than 20,000 m^3, or
    - The contributing upstream catchment is more than 20 ha.

b) The culvert shall be designed to cater for the flows and water levels generated by the 1% AEP event without adversely affecting upstream or downstream property.

c) The headwater pond created by the culvert during the 1% AEP event shall have a depth not exceeding 3.0 m above the invert of the pipe and shall provide 500 mm freeboard to the edge of the seal of the road (or similar feature) at the top of the embankment. For cases where the approach velocity is greater than 2 m/s, the freeboard shall be at least 1.5 times the velocity head at the entrance. The headwater pond created by the 10% AEP event shall not be higher than the soffit of the pipe.

d) Culverts shall be designed such that the maximum velocity within the culvert generated by the 1% AEP event does not exceed 6.0 m/s. Higher velocities in culverts require approval from Auckland Council. High outlet velocities are likely to cause scour and erosion of natural channels and reference shall be made to Auckland Council technical report TR2013/018. Note that energy dissipation shall be required at far lower velocities than the maximum allowed within the conduit stated above.

e) Culverts shall be designed such that for the 50% AEP design storm, an absolute minimum velocity of 0.6 m/s and desired minimum of 1.0 m/s is achieved.

f) Culverts shall have a minimum internal diameter of 375 mm (for vehicle crossing standards refer to the Auckland Transport Code of Practice and Auckland Transport Technical Design Manual).

g) A suitable transition structure is required at both the inlet and outlet to the proposed culvert which shall ensure that there is no scour or erosion in the watercourse, private property and/or the road formation (refer to the Auckland Transport Code of Practice and Auckland Transport Technical Design Manual for special requirements adjacent to roads).

h) A secondary flow path shall be kept unobstructed at all times. The secondary flow path design shall assume the total blockage of the culvert in cases where it is less than DN1,500, and 50% capacity reduction if the culvert is greater than or equal to DN1,500, unless demonstrated by specific design to Auckland Council's approval that a lower blockage factor can be applied.

i) Allowance for 100% blockage of pipes greater than DN1,500 may be necessary in some circumstances. The risk of blockage resulting from the contributing catchment shall be assessed on a case-by-case basis (this includes situations where a safety grille or debris screen is used) to determine if specific culvert design (including consideration of a secondary inlet) is required.

j) No obtrusive brand names on proprietary devices and other visible components of the stormwater system shall be visible once constructed.

k) For culverts whose inlets may be difficult to locate if submerged, green retro-reflective raised pavement markers shall be required to mark the presence of the culvert under the roadway. For all culverts associated with roads, markings shall be in accordance with Auckland Transport Code of Practice and Auckland Transport Technical Design Manual requirements.

l) Provision of safety measures may be required, e.g. a barrier along the culvert headwall (refer to the Auckland Transport Code of Practice and Auckland Transport Technical Design Manual for special requirements adjacent to roads).

m) Culverts under road fencing or barriers are to be designed to Auckland Transport requirements.

n) Adequate provision shall be made for maintenance. This shall include, but not be limited to, access to inlet and outlet for inspection, debris removal and scour protection maintenance, and any other activities stated in the operation and maintenance manual.

o) Fish passage shall be provided in accordance with Section 4.2.8.

p) The need for debris screens shall be subject to specific design, considering the likelihood of debris flowing from the upstream catchment and potential impact on the culvert.

q) Culverts shall be single-barrelled unless specific design is approved by Auckland Council.

All culverts transferring flow across the road reserve, roadside drains and water table are owned and maintained by Auckland Transport or the NZ Transport Agency. Note that culverts for private vehicle crossings (i.e. serving a private property) within the road reserve will be owned and maintained by the property owner.

4.3.9.9 Inlets and outlets

At any discharge point, consideration must be given to energy dissipation for erosion control and land stability. Guidance on design for inlets and outlets can be found in Auckland Council's technical report *Hydraulic Energy Management: Inlet and Outlet Design for Treatment Devices* (TR2013/018). Energy dissipation and erosion control is likely to be required in addition to the headwall structure and shall be specifically designed using guidance from GD01, and TP131 if fish passage is required.

An example standard design drawing for an inlet/outlet headwall is provided in Drawing SW19 in Appendix B.

Where inlets or outlets are located on or near natural waterways, their visual impact in the riparian landscape and likely impact on in-stream values shall be considered. Methods to reduce such impacts may include:

- Cutting off the pipe end at an oblique angle to match soil slope
- Constructing a headwall from local materials such as rock or boulders
- Planting close to the structure
- Locating outlets well back from the water's edge.

Design of inlet and outlet structures in high-amenity open space areas requires additional consideration to achieve a sympathetic and unobtrusive design. Auckland Council Community Facilities Department is to be consulted when the outlet is in public reserve land.

Inlet/outlet structures for pipe culverts shall be either a standard precast wingwall supplied by a certified precast manufacturer, or a specifically designed structure as approved by Auckland Council. Inlet/outlet structures require specific design and shall be subject to Auckland Council approval in the following situations:

- Pipe culverts larger than DN600
- Multiple barrelled culverts
- Culverts at complex natural soil locations
- Where special appearance and/or energy dissipaters are required.

Inlets and outlets adjacent to roads may require additional road-user safety considerations (refer to Auckland Transport Code of Practice).

With respect to health and safety, all inlets to the stormwater network greater than DN375 diameter shall be fitted with a safety grille. The inlet grille shall be specifically designed and requires Auckland Council approval. The spacing between bars shall not exceed 140 mm. Note that grilles are not required on manholes or generally, at the inlet to a culvert.

Scruffy domes on outlet structures in wetlands and ponds shall be hinged for easier access. The outlet must be located close enough to the embankment to allow for access during storm events for clearing and maintenance.

Culvert inlets are generally not screened for safety reasons. When designing inlets to culverts, debris screening may be required as discussed in Section 4.3.9.8 above. However, a risk assessment shall be undertaken on each culvert (and the surrounding catchment) to ascertain if a grille is required to prevent accidental entry to the culvert. If a grille is required, provision shall be made for the impact of debris build-up against that grille. There shall also be suitable access for maintenance personnel and for any mechanical plant required to remove debris build-up from the grille.

Fencing around inlet/outlet structures is required unless it can be demonstrated that human access to the inlet/outlet structure is unlikely and/or the height of the structure is less than 1.0 m. A standard detail for a safety fence for inlet/outlet structures is provided in Drawing SW20 in Appendix B.

4.3.9.10 Outfall water levels

Backwater profiles shall be considered such that the design is fully informed with respect to any likely adverse effects.

Similarly, for tidal outfalls, peak flow may or may not coincide with extreme high tide levels. A sensitivity analysis is required for tidal affected outlets and all adverse effects (sea-level rise, storm surge) must be considered as described in Sections 4.2.10 and 4.3.5.8 of this document. In circumstances where a flap valve or flood gate is necessary, specific design and approval from Auckland Council is required.

4.3.9.11 Subsoil drains

All subsoil drains to provide land stability are considered private and should be self-contained within the individual lot.

All subsoil drains shall be connected to a cleanable silt trap (e.g. catch pit with sump) before connecting to the public line via the private connection pipe.

4.3.9.12 Anchor blocks and waterstops

Steep gradients and anchor blocks

Where gradients of pipes are between 10% and 20%, pipelines shall be laid from downstream to upstream with sockets facing upstream and shall be bedded in low-strength concrete (7 MPa). Where gradients of pipes are in excess of 20%, anchoring shall be required to prevent movement. Anchor blocks also help to prevent:

- Bedding scour
- Migration of fine granular particles
- Separation of joints
- Transfer of groundwater through the backfill material surrounding the pipe.

In situations where anchor blocks are to be implemented, pipelines shall be laid from downstream to upstream with sockets facing upstream. A protective/compressible membrane shall be wrapped around the pipeline for the length of the anchor block at the concrete interface. Spacing between anchor blocks shall not exceed 6 m, measured centre to centre (see Drawing SW23 in Appendix B).

Manholes with flanged bases adequately installed against a trimmed excavation may be considered as an anchor block.

Specific anchor block design and arrangement is required for pipelines where:

- The gradient is greater than 30%, or
- High groundwater table or unstable ground conditions are apparent.

Waterstops

Where a pipeline is to be installed between an area with a high water table and an area with a lower water table or in tidally affected areas, transfer of groundwater through the backfill material in the reinstated trench is likely to occur. Transfer of groundwater through backfill materials may also occur due to the gradient of the pipeline/trench and the geotechnical conditions of the native soil.

A waterstop shall be used to prevent transfer of groundwater, where required. For pipelines up to DN750, an anchor block as shown in Drawing SW23 in Appendix B shall be used to provide a waterstop at a maximum spacing of 10 m. Waterstops for pipelines greater than DN750 are subject to specific design and approval, including spacing.

4.3.9.13 Trenchless technology

In general, open-cut trenching is the default stormwater pipe installation method. However trenchless technologies may be preferable or required by Auckland Council and should be assessed for practicality for deep installations or alignments passing through or under:

- Environmentally sensitive areas
- Built-up or congested areas
- Railway and road crossings
- Significant vegetation.

Trenchless installation may include:

- Horizontal directional drilling
- Uncased auger boring/pilot bore micro-tunnelling/guided boring
- Micro-tunnelling
- Pipe jacking
- Pipe ramming.

Trenchless pipe rehabilitation/renovation may include:

- Slip lining/grouting
- Close fit slip lining
- Static pipe bursting
- Reaming/pipe eating/inline removal
- Soil displacement/impact moling
- Cured in place pipe
- Spiral wound pipe.

Any trenchless technology and installation methodology shall be chosen to be compatible with achieving the required gravity pipe gradients.

For trenchless solutions, the following details shall be submitted to Auckland Council for approval:

- Clearances from services and obstructions
- A plan and long-section identifying surface levels, pipe invert levels, depths to invert and chainages
- Proposed pipe support
- Proposed pipe material and pipe class including supporting design calculations
- Factual and interpretative geotechnical reports
- How pipes will be protected from damage during construction
- Any assessed risk to services, surfaces and structures
- Location of pipe welding and laydown area
- Pipe pulling route
- Location of access pits, shafts and working spaces
- Specific proposals for risk mitigation when working close to or under watercourses
- Identification of high-risk areas for “frac-outs”
- Methodology for controlling “frac-outs”
- Methodology for controlling groundwater transmission through any annulus created by the installation method
- Anticipated settlement due to overcut, groundwater drawdown and excavation support deflection including supporting calculations.

Materials and gradient

The two types of pipe approved for trenchless installation are polyethylene and reinforced concrete. Reinforced concrete pipes shall be manufactured specifically for jacking operations. Pipe classes for each type are subject to specific design. The joints for all pipes are subject to specific approval by Auckland Council. The methodology used shall ensure that the design gradients are met along with hydraulic efficiency of the pipeline. Micro-tunnelling is recommended where gradients are less than

1.5%. For fusion welded polyethylene pipe, removal of internal weld beads (de-beading) is generally not required.

Acceptance

Where trenchless methods of construction are used, the resulting pipeline shall not be accepted if it contains sags or crests in the vertical plane which will retain flow and consequently lead to siltation in the pipeline. Horizontal deviation from alignment is acceptable without loss of vertical alignment provided that the maximum horizontal deviation is not more than one pipe diameter. Clear line or laser profiling shall be undertaken to meet the requirements of Table 5.6 of AS/NZS 2566.2. Profiling shall be undertaken 30 days after installation of the trenchless section. Note that where the annulus is grouted, this profiling shall be undertaken 30 days after grouting.

4.3.9.14 Pipeline and culvert ownership

The ownership rules in this SWCoP define the assets to be vested in developments lodged for Resource Consent and/or Engineering Approval after the publication date of this version of the SWCoP.

Where a pipe that is not on Auckland Council's asset register is discovered on a property, the pipe shall be deemed to be private unless the landowner can provide documentation of a completed vesting process that proves beyond doubt that the asset belongs to Auckland Council. See Section 4.3.16 for information on cross-boundary ownership.

Where approval has been gained for a watercourse in private land to be piped by private landowners, ownership and maintenance responsibility remains with the landowner. Where approval has been granted for a watercourse in private land to be piped and for the constructed pipe to be vested in Auckland Council, the pipe shall be deemed to be a public asset. In all other instances, whether the watercourse was piped through a consenting process or not, the pipe shall be considered private and is the responsibility of the owner(s) of the land through which it passes.

4.3.10 Manholes

Manholes or non-access chambers shall be provided at all changes of direction, gradient and pipe size, and as required under Section 4.3.9.5 of this SWCoP. Other suitable specifically designed structures may be used, subject to Auckland Council approval. Manholes shall be provided at a distance apart not exceeding:

- 25 m for pipelines with diameter less than DN225
- 90 m for pipelines with diameter DN225 to DN750
- 150 m apart for pipelines with diameter of DN750 and above.

Manholes shall be easily accessible and shall be located at least 1.0 m clear of any structure or boundary.

Table 9 shows the types of manholes that shall be used, and their reference drawing numbers. Drawings are in Appendix B.

Table 9: Manhole types

Type	Outlet pipe diameter (DN)	Depth range*	Drawing no.
Standard manhole	≤1050 mm	<4.0 m	SW05
Non-access chamber**	≤225 mm	<1.0 m	SW06
Manhole with in-situ base	500 – 1200 mm	<5.0 m	SW07
Stormwater manhole offtake***	>1200 mm	-	Specific design
Deep manhole	-	>4.0 m	Specific design

* Depth is defined as the distance from the manhole cover level to the invert of the outlet pipe.

** Maximum diameter of incoming pipes shall be DN100, with a maximum of two incoming pipes

*** For pipe diameters greater than DN1,200, a factory-produced pipeline section combined with an off-take riser may be an acceptable solution (with any change in flow direction achieved through lobster back bends) subject to specific design and Auckland Council approval.

Deep manholes (specific design)

Manholes deeper than 4.0 m to the pipe invert may be used in certain circumstances, subject to the approval of Auckland Council. The manholes need to be designed to meet the site-specific conditions. However, the following generic requirements apply:

- They shall be specifically designed with an emphasis on safety during installation, operation and maintenance
- The designer shall provide the proposed construction method with the design documentation
- Comment on how the renewal, upgrade or improvement of the manhole(s) can be safely undertaken in the future shall be provided
- A secure safety grille shall be provided beneath the manhole cover
- A clear warning visible when the access cover is closed that the manhole is deep.

High energy manholes

Specific analysis is required for manholes with:

- High energy inlets (e.g. with inlet/upstream velocities in excess of 4 m/s)
- Deflection angle between 75° to 90°
- A significant change in invert levels
- Significant side inlets.

This is to guard against the impact of any extraordinary head losses and the potential dislodgement of manhole covers.

4.3.10.1 Location of manholes

The selection of a suitable location for manholes may influence the pipe alignment. A minimum clearance of 1.0 m from the outside diameter of the manhole riser to any structures or boundaries shall be provided to facilitate maintenance and rescue. Auckland Council may determine other specific requirements, subject to the individual site characteristics.

Auckland Council's preferred option is to have no manholes in carriageways of public roads. Where connection to a public main located within a carriageway is the only viable option, approval from Auckland Council and Auckland Transport shall be obtained.

4.3.10.2 Manhole material

Manholes are to be constructed of reinforced concrete in accordance with Drawings SW05 to SW09 in Appendix B. Benching of the manhole shall be hard-finished concrete as opposed to a plaster finish. Benching shall be to the equivalent of the full height to the level of the inlet and outlet pipes as shown in Drawing SW05.

4.3.10.3 Manhole design

The following shall be considered and allowed for when designing and constructing manholes.

- A safe landing area for personnel shall be provided on benching, at the base of rungs or ladder
- Access to the manhole shall be clear of any incoming pipes
- Manhole covers shall be in accordance with requirements in Section 4.3.10.9
- For pipes less than DN450, all pre-cast manhole risers shall be a minimum 1050 mm diameter. However, should the deflection angle be between 75° to 90°, then specific design shall be required
- For pipes less than or equal to DN600, one flexible joint shall be provided within 600 mm of the riser wall. Pipes greater than DN600 may require flexible joints subject to site conditions
- Manholes shall be designed to require the minimum number of risers. The minimum riser height shall be 300 mm. No riser shall be cut down to height
- Refer Drawing SW09 for recessed rung details for manholes with channels/pipes greater than DN600
- Where half-round channels are not available, the channel shall be formed using 25 MPa concrete, vibrated and finished smooth. Plastering shall not be permitted
- All openings through manhole risers shall be cut using a concrete saw. Sledgehammers shall not be used
- Refer to Section 4.3.10.7 for requirements when connecting to manholes
- Manholes with a depth to invert of less than 1.5 m shall have the cover orientated over the outlet
- The inside of the manhole throat shall be painted blue

- Raised throats are permitted but shall be subject to specific design, and approval by Auckland Council
- All joints between risers shall be epoxied. Butyl mastic may be used only if specifically approved by Auckland Council
- Where a manhole is greater than 2.4 m in height above benching, a reducer slab and 1050 riser may be used from that point. Specific design shall be required
- Concrete manhole lids shall be sealed using a mastic seal, and not epoxy
- Cover/frame shall be bolted to lid slab with SS Dynabolts and sealed with epoxy mortar
- Refer to Section 4.3.10.9 for further requirements relating to manhole and chamber covers.

Structural design

Manholes shall be designed to be constructed as segmental, panel or one-unit structures, made of precast or cast in-situ reinforced concrete. The general shape of manholes may be circular, rectangular, or any other shape that satisfies all design requirements of this section. Manholes shall be designed so that structural integrity between its components is maintained during installation and normal service life. The effect of pipe entries on the structural integrity of the manhole risers shall be considered during design.

All manholes shall be designed to support all existing and any predicted future dead loads. Design live loads for reinforced concrete manholes and cast-iron covers shall be HN-HO-72 for motorways and arterial roads, HN for local streets and driveways, and 20 kN wheel load for non-trafficable areas. Manholes shall also be designed to support lateral earth pressure, hydrostatic pressure and any expected high eccentric lateral pressure due to live load or surcharge load. Manhole foundations shall be designed such that the bearing pressure does not exceed the safe bearing capacity of the soil.

Durability design

All components of manholes and access chambers shall be designed for an asset life of 100 years. Circular manhole risers shall be designed and manufactured to meet the 100-year design life requirements of AS/NZS 4058 for normal environment when designed for installation in such an environment, and for marine environment when designed to be installed in marine tidal locations or aggressive soils. The durability design of other reinforced concrete components shall be in accordance with the durability requirements of NZS 3101.1.

4.3.10.4 Size of manholes

The minimum internal diameter of manholes shall be 1050 mm. Manhole riser diameter is to allow for a minimum curve radius within the manhole of three times the internal diameter of the outlet pipe and to comply with the manufacturer's specification. Where the outlet pipe is less than DN450, all pre-cast manhole risers shall be 1050 mm dia. unless the deflection angle between inlet and outlet pipes is between 75° to 90°, where specific design shall be required.

4.3.10.5 Non-access chambers

Non-access chambers may only be used where the depth to invert is less than 1.0 m. The maximum outlet pipe diameter for a non-access chamber shall be DN225. Non-access chambers shall have a maximum of two inlets of no greater than DN100 pipe (as shown on Drawing SW06 in Appendix B). Additional connections may be allowed on approval from Auckland Council. Any chambers outside of these criteria shall require a standard manhole instead.

Non-access chambers shall be constructed in accordance with Drawing SW06 in Appendix B. Benching within non-access chambers is not mandatory.

4.3.10.6 Hydraulic flow in manholes

Internal falls through manholes

In addition to the normal pipeline gradient, all manholes on pipelines of less than 1.0 m diameter shall have a minimum fall through the base of the manhole of 50 mm. The maximum allowable fall through the base of the manhole between inlet and outlet pipes is 300 mm.

Manholes on pipelines greater than 1.0 m diameter shall have the fall through the base of the manhole designed to compensate for the energy lost due to the flow through the manhole at the design radius.

Where the outlet pipe diameter at a manhole is greater than the inlet diameter, the minimum fall through the manhole shall be not less than the difference in diameter of the two pipes, in which case the pipes shall be aligned soffit to soffit.

On pipes where the above criteria for internal fall across the base of the manhole is not achievable due to a large difference between the levels of incoming and outgoing pipes, then an open cascade may be appropriate (see Section 4.3.10.7). Manholes on steep grade lines and where a stormwater line changes direction or has a vertical drop shall be designed as an open channel flow, without surcharging (water surface profile to not exceed above the soffit of the lowest incoming pipe).

Change of direction within manholes

For deflections between 75° to 90°, specific design is required. The centreline bending radius of the channel inside the manhole is to be greater than three times the pipe diameter.

Effect of steep grades on manholes

To avoid excessively deep channels within manholes, steep grades (>7%) shall be designed out during the design phase where practicable. Where a pipe of grade >7% enters a manhole, the following precautions shall be taken if the topography and the connection pipes allow:

a) No change of grade is permitted at an inlet to a manhole

b) Steep grades are to be continuous through the manhole at the same grade

c) Depth of manhole is to exceed:

- 1.5 m to invert for DN225 diameter or smaller pipes
- 2.0 m to invert for DN300 diameter or larger pipes.

d) Change of direction at the manhole is not to exceed 45°

e) No open cascades are to be incorporated in a manhole where the entry pipe grade is >7%

f) The inside bending radius of the channel inside the manhole is to be greater than six times the pipe diameter

g) The hydraulic gradient at design peak within the manhole shall be contained without surcharging (water surface profile to not exceed above the soffit of the lowest incoming pipe).

4.3.10.7 Manhole connections

Connections to manholes shall be made following this order of priority depending upon practicability of the option:

- At the manhole invert, with the soffit of the inlet pipe matching the soffit of the outlet pipe
- At the top of manhole benching level, with a channel in that benching provided to direct the flow to the outlet
- Via an open cascade in accordance with the cascade conditions below
- In accordance with specific design to Auckland Council's approval.

Cascades are only permitted under the following conditions:

- Where the manhole is more than 2.0 m deep
- Where the cascade inlet pipe diameter is a maximum of DN300
- Where the cascade will not discharge on to any steps or ladders
- Where the drop height will not exceed 1.0 m (from the invert of the cascade inlet pipe to the top of the benching within the manhole).

Where any of the above conditions are not met, specific approval is required.

The base of all manholes shall be benched and haunched to a smooth finish to accommodate the inlet and outlet pipe. For manholes where there is more than one inlet pipe (excluding minor inlets), a specific design and detail drawing of the benching layout shall be provided and shall be subject to Auckland Council approval. The detail shall include the location of the manhole cover and frame and steps in relation to the benching.

New inlet pipes shall be cut back to the inside face of the manhole and provided with a smooth finish. All chambers are to be made watertight with epoxy mortar around all openings.

Minor pipelines (not the primary inlet and outlet pipes in a manhole) connecting to a manhole shall do so at an angle of not greater than 90° to the primary direction of inflow. Where the minor pipeline connects above the design water level only, a connection at an angle in excess of 90° may be permitted with Auckland Council's approval.

The total number of connections to a manhole (other than the primary inlet and outlet pipes) shall not exceed four without Auckland Council's approval. The designer shall however consider the impact of

cutting/drilling holes on the structural integrity of the manhole and specify any necessary provisions and/or details to adequately overcome any such issues.

Connections of polyethylene pipes to manholes shall be in accordance with Drawing SW10.

4.3.10.8 Floatation

In areas of high water table, it shall be demonstrated to Auckland Council's satisfaction that all manholes are designed against floatation.

The factor of safety against floatation shall be at least 1.25, excluding skin friction in the completed condition, with empty manhole and saturated ground. Where allowance is made for skin friction in the permanent condition, the factor of safety shall be at least 1.4. Both factors of safety in the respective conditions shall be met.

4.3.10.9 Manhole and chamber covers

Manhole covers shall be hinged and removable with a clear opening of at least 600 mm diameter, except for non-access chambers where a clear opening of 500 mm diameter is permissible.

Manhole covers shall be ductile iron. Note that Auckland Council approval is required for square and/or rectangular manhole covers.

The class of manhole cover and frame to be used shall be determined by the potential loading on the manhole in accordance with AS 3996. Limits are as follows:

- A minimum AS 3996 Class D, or better, heavy-duty manhole cover and frame shall be used in all areas
- In industrial areas, or for any application where abnormally high loads are likely to be transferred to the manhole cover, AS 3996 Class E or better shall be required at Auckland Council's discretion.

As described previously in this SWCoP, Auckland Council's preferred option is to have no manholes in carriageways of public roads. Where specific approval from Auckland Council and Auckland Transport has been obtained, manhole covers on roads shall be aligned so that a vehicle striking a hinged cover in a partially open position shall push that cover towards its closed position. Liaison with Auckland Transport is required for the location of all manhole covers in the carriageway.

Where a manhole is installed within a secondary flow path, the manhole cover shall be aligned to open with the direction of flow (hinge upstream). This will ensure that a cover opening under hydraulic surcharge will close again and will not be prevented from closing by trapped debris swept by the secondary flow.

Debris control screens (as per Drawing SW21 in Appendix B) should be used for manholes and manhole risers in stormwater ponds and stormwater management devices or in situations where

overland flow is to be directed into the stormwater pipe network. More aesthetic alternatives may be considered/required and approved at Auckland Council's discretion.

4.3.11 Connection to the public stormwater system

The following requirements shall be met for new connections of individual lots and developments to the public system:

a) Approval from Auckland Council is required for any stormwater connection to a public stormwater pipeline or discharge to a waterway, roadside kerb, swale or rainwater tank, or for on-site disposal via soakage.

b) Each individual lot shall be serviced by an approved stormwater connection that is either a pipeline that is ultimately connected to a consented discharge, or on-site disposal.

c) All discharges to the road kerb are subject to Auckland Transport approval as part of the building consent and shall remain in private ownership.

d) Only one new connection is permitted when subdividing a lot. Any existing connection shall be used where design confirms sufficient capacity.

e) The demarcation point is the interface between the public system and private system, where the design requirements (Building Code upstream, Code of Practice downstream) and ownership change. The pipeline downstream of the demarcation point to the manhole, public main or outlet shall be vested in Auckland Council:

   - Where the private connection pipe becomes public when crossing the boundary of a private lot, the demarcation point shall be at the private boundary
   - Where the private connection pipe connects to a public manhole or chamber within a private lot, the demarcation point shall be the wall of the receiving manhole or chamber
   - Where the private connection pipe joins directly to the public main within the lot served (in accordance with Section 4.3.12 of this SWCoP) the demarcation point shall be at the connection point to a fitting or saddle, or at the public pipe.

f) Where a private pipeline does not connect to the public network at a manhole or chamber, an after-construction CCTV inspection of all public parts of the connection (from the receiving public main to the demarcation point) shall be provided to Auckland Council.

g) No pipe downstream of a public pipe can be private.

h) Where a new public pipeline is proposed, the developer shall provide suitable access for all future maintenance operations. Any financial burden shall fall on the developer.

i) Duplication of small diameter pipelines on similar alignments (i.e. construction of a new pipeline within 10 m of an existing alignment) is not permitted. In some circumstances, avoiding duplication is best achieved through utilisation of an existing Auckland Transport pipeline (catchpit lead). The developer shall discuss and agree such options with Auckland Council.

   Where a public connection into an Auckland Transport pipeline is required due to it being the most practicable option, the pipeline shall become public from that connection point and a manhole shall

be required at the connection. Transfer of ownership from Auckland Transport to Auckland Council will be required and shall be arranged through Auckland Council's development engineers. An assessment of the pipeline to be transferred shall be required to demonstrate that the pipeline is sized appropriately, is in good condition and complies with this Code of Practice.

Where the existing Auckland Transport pipeline is of insufficient capacity or condition, the developer shall construct a new pipeline of sufficient capacity for that development and for the upstream Auckland Transport road network and reconnect the road drainage to this new pipeline.

j) Where phasing of the development requires a private connection pipe to be constructed at a later date, the pipeline shall terminate 1.0 m within the lot boundary and be sealed by a removable cap, with the cap and pipe painted blue. The location of this point of connection shall be marked by a blue 25 mm diameter uPVC tube sited over the end cap of the connection and extending well above the ground surface.

k) Where the catchment extends upstream of the proposed development, there shall be allowance for the stormwater pipeline to be extended through the lot to the upstream boundary. This pipe shall be sized to allow for the maximum probable development (in accordance with Section 4.2.8) and be a minimum DN150. In order of preference, the options are:

- Build the pipe and extend to a new manhole within the boundary of the upstream land, with permission from the landowner
- Build the pipe and connect to a new manhole within the boundary of the land being developed, and provide an easement for the upstream land to connect to this manhole
- Where neither of the above two options are feasible, an easement-in-gross (a minimum of 3.0 m in width) in favour of Auckland Council to allow a pipeline to serve the upstream catchment in the future maybe allowed (subject to approval from Auckland Council as part of the Engineering Approval process). An easement will not be appropriate if the pipe cannot be built cost-effectively in the future, e.g. where a driveway, building or retaining wall is to be constructed over or near the future pipe position.

l) In general, the alignment of all public lines constructed on private land shall be designed using the order of preference described in Section 4.3.9.1.

m) The depth of the point of connection should allow for 1.0 m of fall between the presumed floor level and the soffit of the pipe at the point of connection.

n) The point of connection shall be located so it can service the lowest practical point on the property and can serve the whole of the lot. Where part of the lot is not able to be served for topographical reasons, the area of the likely or proposed building footprint and paved surfaces shall drain by gravity to the point of connection as a minimum. The internal diameter of private connection pipes shall be sized based on lot size and anticipated flows, with minimum pipe sizes in accordance with Section 4.3.9.5.

o) The point of connection shall be indicated accurately on as-built plans, with coordinates provided. As-builts shall be in accordance with Auckland Council's document, D*evelopment Engineering – As-built Requirements* which is available on the Auckland Council website.

p) No new combined sewer connections will normally be approved (refer to Section 4.6.1.1).

4.3.12 Connection of pipelines to public mains

When the pipeline being connected to a public main is DN225 or larger, it shall be connected at a manhole (unless the pipe is a catchpit lead and conforms with all of the requirements listed under Section 4.3.13.2).

Factory-made swept tee or Y-junction fittings shall be used wherever possible for lateral connections less than DN225. The pipeline being connected shall be at least one size lower than the diameter of the public main.

Where saddle connections are proposed for lateral connections less than DN225, the pipeline being connected shall be less than or equal to half the diameter of the public main. Saddles shall be bonded to the exterior of the main pipe.

A direct connection of a lateral less than DN225 may be made via a drilled hole where the public main is DN1,200 or larger, subject to specific design and approval by Auckland Council.

Refer Drawing SW04 in Appendix B for further requirements with lateral connections.

There are significant lengths of older infrastructure in the more established parts of Auckland such as brick barrel pipelines and brick manholes. Some of these assets have compromised structural integrity, including very limited strength in tension and signs of significant decay. Making connections to older infrastructure requires careful consideration and may require specialist design input. Such connections shall be referred to Auckland Council for design guidance and approval. Any construction proposed within 10 m of a stormwater structure that is more than 50 years old is to be referred to Auckland Council for detailed evaluation and approval.

4.3.13 Catchpits

The sizing, selection and spacing of all catchpits (except for field catchpits) shall be in accordance with the Auckland Transport Code of Practice, and Auckland Transport Design Manual, and in general accordance with AS3996.

4.3.13.1 Catchpit positions

Catchpits shall be located to best capture ponding of surface water. This shall generally be at low points. Where possible, catchpits shall be located to reduce the flow of stormwater in the channel at pedestrian crossing points. However, catchpits shall not be placed in the direct path of pedestrian movement.

Catchpits are also required at changes in gradient or direction where water may leave the channel, e.g. kerb line tangent points at intersections.

4.3.13.2 Catchpit connections

Public connections from catchpits can only be made where the pipe exiting the catchpit has minimum diameters in accordance with Auckland Transport's Code of Practice as follows:

- Standard and field catchpits: minimum DN225
- Splay and street catchpits: minimum DN300.

Catchpits shall be connected directly to a manhole on the public stormwater network. The catchpit lead may be connected via a saddle or direct connection, subject to all of the following conditions being met:

- A manhole is not conveniently located for connection
- The catchpit lead is DN300 or less
- For saddles, the minimum public main diameter shall be DN900, and for direct connections, the minimum public main diameter shall be DN1,200
- The catchpit has no siphon.

4.3.14 Runoff and stormwater disposal

All system designers considering discharges shall refer to the current relevant Network Discharge Consent and Stormwater Management Plan (refer to Section 4.2.6 for more information on catchment planning).

4.3.14.1 Runoff

Stormwater runoff caused by an increase in impermeable area as a result of a development shall not be permitted to discharge across footpaths or berms, or from or to adjacent properties. Sheet flow from upstream lots or sub-catchments shall be intercepted by either the primary drainage system or the secondary overland flow paths, wherever such sheet flow may create a nuisance to downstream lots.

Natural intermittent streams and overland flow paths are generally the responsibility of landowners, and there is an obligation on downstream landowners to accept these natural flows from upstream properties. Therefore, where a development within these systems causes unacceptable effects on downstream properties or where the existing primary drainage system has failed, the landowner of that development property shall be responsible for rectifying the situation by mitigating any negative impacts, based on the pre-development condition.

Auckland Council has the ability, under Section 459 of the Local Government Act 1974, to require the landowner to execute, provide, and do generally any works, materials, and things which in the opinion of Auckland Council are necessary or expedient for the efficient drainage of the premises and every part thereof.

4.3.14.2 Stormwater disposal from development

The developer shall always discharge into the public stormwater network (subject to capacity assessment) at the point approved by Auckland Council. In designated soakage areas, discharge shall be to private soakage (subject to satisfactory percolation testing in accordance with Auckland Council guideline document GD2021/007: *Stormwater Soakage and Groundwater Recharge in the Auckland Region*).

If discharge to the public system is not possible, other site-specific discharge options may be discussed with Auckland Council and submitted for specific approval. The preferred solution shall be developed on a case-by-case basis in consultation with Auckland Council and/or Auckland Transport and/or Watercare.

In order of preference, options include:

1) Discharge to the public network, or to private soakage for designated soakage areas.
2) Discharge to a watercourse or coastal area.
3) A connection may be made to a catchpit lead, subject to the conditions specified in Section 4.3.11. Connection may not be made to a lead discharging to soakage.
4) Discharge to either:
    - The kerb (subject to compliance with requirements of this Code of Practice and Auckland Transport approval). Discharge of stormwater to the road kerb shall not be permitted in greenfield areas unless it forms part of an integrated stormwater management solution for the wider subdivision
    - A combined sewer line (subject to compliance with requirements of this SWCoP and Watercare approval).

In either case, an approved on-site mitigation device shall be required, and approval is solely at the discretion of Auckland Transport or Watercare. Approval will not be given simply on the basis that all three of the other options are unavailable.

4.3.14.3 Stormwater disposal from combined sewer areas

On-site mitigation devices are required when stormwater disposal is in an area which is both:

- Defined as a combined sewer area
- An area where Auckland Council's programme for sewer separation does not indicate a new stormwater network upgrade within 5 years of building consent application.

4.3.14.4 Disposal methods not permitted

Stormwater from any improvement shall never be discharged into the following:

- A wastewater-only system
- Footpaths, berms, or adjacent property
- An area with insufficient soakage (refer to Auckland Council guideline document GD2021/007: *Stormwater Soakage and Groundwater Recharge in the Auckland Region*).

4.3.15 On-site stormwater mitigation

On-site stormwater mitigation devices may be required to reduce the impact of stormwater runoff (quantity) on receiving systems. The installation of stormwater storage devices as part of a site's private drainage system can ensure that the rate of stormwater discharge does not increase when the site is developed.

All stormwater mitigation devices are subject to specific design and approval by Auckland Council, and shall be designed in accordance with the relevant Auckland Council technical guidelines.

Auckland Council requires devices to be provided in the following situations:

- Where required by either planning rules or conditions of resource consent
- All new developments in all combined sewer areas
- Instances of kerb discharge
- In catchments where there are known capacity issues with the downstream stormwater system
- Where soakage systems require reduced flow rates to match the available infiltration rate.

4.3.16 Cross-boundary ownership

4.3.16.1 Pipelines draining via private land

Where a lot must drain through another lot to connect to a public pipeline, this extent of the pipe shall be deemed public. The point of connection to the public system is defined in Section 4.3.11. It is the developer's responsibility to obtain permission from the affected landowner(s) to place the pipe.

4.3.16.2 Private pipelines in public land

Roads

- No new private pipelines shall be permitted in road reserves, except kerb discharges and other circumstances as per Section 4.3.11 above.
- Stormwater pipelines serving only Auckland Transport assets remain the responsibility of Auckland Transport. In cases where a public pipeline is to be connected to an Auckland Transport stormwater pipeline, ownership of the pipeline shall move from Auckland Transport to Auckland Council.
- Existing private pipelines within the road reserve are not covered by easement. Auckland Council may hold records of these private pipelines in the form of approved building consents and permits and associated as-built plans. If undertaking maintenance and repair work on these pipelines, a corridor access request shall be obtained from Auckland Transport.

Parks and reserves

- Developers should avoid laying multiple new pipelines across reserve land. Instead, stormwater from a development should be collected into a single pipe that crosses the reserve land.
- In general, no private pipelines shall be permitted in public reserve land. Guidance on connections is provided in Section 4.3.11 above.
- The applicant shall confirm that the reserve land is not a closed landfill. Generally, new pipelines are not permitted in closed landfills.
- Auckland Council Community Facilities is the asset owner for parks and reserves. Stormwater pipelines serving only Auckland Council Community Facilities' assets remain the responsibility of Community Facilities and no public pipeline shall be connected to them.
- Where a facility on parks' land (Community Facilities) has both stormwater and park functions, Community Services is to be consulted early in the design process and may have requirements additional to the Code of Practice standard.
- For all work on existing stormwater assets within parks and reserves, specific landowner approval shall be obtained from Auckland Council. This approval shall be obtained independent of the Engineering Approval process and shall be the responsibility of the applicant to negotiate and obtain.

Other land owned by Auckland Council

- Where Auckland Council is recorded as the owner of the land in question, queries related to existing easements shall be directed to the property department manager who acts as the landowner for this purpose.

Other land not owned by Auckland Council

- Any work on land outside of Auckland Council's control requires specific approval from the appropriate authority/landowner.

4.3.17 Inverted siphons

Siphons, as distinct from inverted siphons, are rarely used in stormwater infrastructure and are not acceptable.

Inverted siphon systems require specific approval by Auckland Council and shall only be considered when other alternatives have been exhausted.

Inverted siphons may sometimes be necessary to pass major obstacles such as large immoveable services or other underground structures. Generally, inverted siphons shall be avoided, and other options shall be considered first. Any design of an inverted siphon is to be submitted to Auckland Council for consideration and approval. Inverted siphons are potentially high maintenance devices as they are points where debris and silt can build up and block the flow of stormwater.

For marginal situations, specific head-loss calculations may be required to ensure flow rates can be achieved and to ensure water does not backflow out of the siphon and discharge out of the inlet (e.g. catchpit).

Where a direct connection to a stormwater network is made by way of an inverted siphon system, a gravity chamber shall be installed. The chamber shall be completed prior to connection to the public system to prevent backflow into the private system.

4.3.18 CCTV inspection

A CCTV survey provides a reliable indication of the quality of assets to be vested in Auckland Council ownership and shall be required for all new pipes that will form part of the public stormwater infrastructure. The CCTV survey of the pipe shall be undertaken by a suitably trained operator in accordance with the requirements in the current version of the *New Zealand Gravity Pipe Inspection Manual*, published by Water New Zealand. All costs involved in undertaking this CCTV work shall be borne by the developer, as will any remedial work required to be undertaken and a repeat CCTV, if required by Auckland Council. For new assets to be vested in Auckland Council, the CCTV work shall not be undertaken until the final earthworks have been completed and the CCTV inspection shall be less than three months old upon submittal.

CCTV inspections of stormwater assets shall be provided to Auckland Council which shall include the following information:

- Each pipe is to be assigned a temporary ID
- Sketch of the assets, showing the temporary IDs
- Inspection video and photo files
- A .CSV export of the inspection and observation data from the proprietary CCTV capture software (e.g. Cleanflow or WinCan).

Laser profile testing which tests pipe ovality, vertical and horizontal deflection, pipe measurements, cracking and pipe distortion may be required by Auckland Council.

4.3.19 Soakage areas

In defined soakage areas, where appropriate, each dwelling shall dispose of its own stormwater through a private in-ground soakage system, which shall be maintained by the property owner.

Soakage devices shall be designed to cater for at least the flows generated by the design standard for primary systems (refer to Section 4.3.5.2). For all soakage systems, an overland flow path shall also be provided which is capable of catering for the flows in accordance with the design standard for secondary systems, assuming complete blockage of the soakage device.

Auckland Council technical report Auckland Council guideline document GD2021/007: *Stormwater Soakage and Groundwater Recharge in the Auckland Region*, should be referred to for design guidance for all soakage systems and approval by Auckland Council shall be required. All treatment devices installed in soakage systems to service new developments, as specified by Auckland Council, are deemed to be private, and responsibility for maintenance lies with the individual property owners. Auckland Council declaring such devices public will be entirely at its discretion.

Pre-treatment (devices are structures that are designed to be installed upstream of soakage systems) is required to protect the soakage device from clogging and the aquifer from contaminants.

Groundwater recharge is necessary in areas with peat soils to maintain underlying aquifer water levels and geotechnical stability. Dewatered peat soils are subject to shrinking and ground surface settlement.

The requirement for groundwater recharge is to be considered and specific design and Auckland Council approval is required for any development in an area where peat soils can be anticipated. In particular, there is a significant area of peat and soils with high organic content in the Papakura area (refer to Auckland Council guideline document GD2021/007: *Stormwater Soakage and Groundwater Recharge in the Auckland Region*, for design guidance for all soakage systems). Refer to the AUP for other requirements regarding groundwater recharge in peat areas.

Pre-treatment (devices are structures that are designed to be installed upstream of groundwater recharge pit systems) is required to protect the groundwater recharge pit from clogging and the aquifer from contaminants.

4.3.20 Where access to adjacent land is required

Where access to adjacent land is required, the developer must obtain any required adjacent landowner entry agreements. In all cases, the developer is responsible for negotiating and coming to a satisfactory arrangement with affected landowners. This is a private negotiation between individuals and does not involve Auckland Council.

The Local Government Act 1974 (s 460, 461) and 2002 (s 181 (2-3)) contains various provisions relating to access by Auckland Council, or others, to private land in order to carry out required drainage works. In exceptional cases, these may be considered in relation to a specific development where it is necessary to obtain access to neighbouring private land for private drainage, or to construct public drainage. The developer should note that this is a costly and time-consuming process. A specific engineering local government act application shall be made to Regulatory Engineering (refer to the Auckland Council website for more information).

4.3.21 Extensions to the public system

Extensions and upgrades to the public system and diversions of existing systems may be required as part of a development. Engineering Approval for proposed extensions shall be obtained from Auckland Council before any physical works are commenced.

4.3.22 Works over and diversions of public pipes

Building over stormwater pipelines is not a recommended practice and will only be considered by Auckland Council in exceptional circumstances where no suitable alternative exists. Build-over guidelines also apply to cantilevered buildings. Approval from Auckland Council is required before undertaking any physical works activity over or within the zone of influence of the public stormwater network which may cause damage to the network. This includes removing existing cover material or placing additional material (refer to Drawing SW22 in Appendix B for construction clearance requirements and for definition of the zone of influence).

If a diversion will definitely be required in creating new lots, the developer of the original site shall implement the diversion at the time of initial development.

If building over a pipeline is proposed, then the following requirements shall be addressed:

a) Engineering Approval is required for ALL stormwater relay and diversion works.

b) Alternative options such as relocating the building or diverting the pipeline around the building shall be thoroughly investigated. Diversion of pipelines will not be considered where the diversion will result in more than one change of direction of 90^{o} or more, or significant loss of grade, either of which may reduce the hydraulic capacity of the pipeline. In such cases, it will be at Auckland Council's discretion as to whether building over is acceptable.

c) Stormwater pipes are frequently located beneath overland flow paths. Careful attention shall be paid to the consequences of building in such locations and the need to maintain overland flow paths

clear of obstructions. Applicants shall submit a detailed design of the overland flow path where the catchment exceeds 4000 m^2, or for smaller catchments at Auckland Council's discretion.

d) Accurate location of the existing pipelines shall be required. Pot holing may be required to prove pipe location prior to works. Adjacent services shall be adequately protected and supported during construction.

e) The pipeline shall be inspected using CCTV both before and after the works for the full length between the upstream and downstream manhole. To allow finding the works over area in the CCTV video, both manholes shall be surveyed to an accuracy of 0.2 m in the horizontal. The pre-construction CCTV inspection shall confirm the condition, pipe material, depth and location of the pipeline and shall be conducted not more than six months prior to construction. Note that Auckland Council's GIS information shall NOT be relied upon for any design or build-over decisions.

f) The CCTV footage and inspection report of the pre-construction condition of the existing pipelines shall be submitted together with detailed long-sections and cross-sections of the proposed build-over. The detailed long-sections and cross-sections shall clearly indicate the relationship between the proposed foundation works (including any piles), the pipeline, any other existing or proposed services and the proposed ground levels either side of the building footprint.

g) The post-construction CCTV and inspection report shall be completed immediately following construction of the foundation and prior to laying the floor slab to verify that the pipeline has not been damaged due to the construction works. An additional CCTV inspection and report may be required at the completion of construction.

h) If the pipeline is either not in satisfactory condition, not in compliance with Auckland Council's standards for public stormwater infrastructure or Auckland Council is in any doubt as to the functionality and condition of the pipe, then the pipeline shall be replaced by the developer at their cost to the required Auckland Council standard.

i) As-built records shall be provided in accordance with Auckland Council's document: *Regulatory Engineering – As-Built Requirements.*

j) Any existing earthenware/clay pipes, asbestos cement pipes and corrugated iron culverts shall be considered to be beyond their useful working life and shall be replaced at the cost of the developer, irrespective of existing condition.

k) For deep pipelines, where the existing pipe is found to be in a satisfactory condition with only minor defects, in-situ repair techniques may be considered for approval. All associated costs shall be met by the developer.

l) Auckland Council may require that an assessment is made to cater for anticipated future development or increased level of service, at the developer's cost.

m) Selection of the pipe material and the length of pipe to be relayed shall be at the discretion of Auckland Council.

n) No horizontal or vertical deflection of pipelines as a result of being built over is acceptable.

o) The support structure for the building shall be totally independent of the pipeline so no additional loading is applied to the pipeline.

p) Piles shall be constructed where there is a need to bridge the pipeline. Piles shall have a minimum separation distance of 1000 mm from the outside of the pipe to the edge of the pile (refer to Drawing SW22 in Appendix B).

q) For pipes greater than DN375, or depth to invert greater than 2.0 m, the separation distance shall be increased. This situation shall be subject to specific design.

r) For manholes with diameter ≤1,200 mm and depth ≤4 m, piles shall have a minimum separation distance of 1000 mm from the outside of the manhole to the edge of the pile (refer to Drawing SW22 in Appendix B). A minimum clearance of 5 m to any overhanging structure above the manhole shall also be maintained. Manholes larger than 1,200 mm diameter or deeper than 4.0 m shall be specifically designed, including specific design of required construction clearances.

s) Specific approval from Auckland Council is required for works within 10 m of a stormwater rising main.

Note that meeting the above criteria does not necessarily mean that a build-over will be approved.

Where pipelines are to be diverted, the following shall apply:

- Where a diversion is necessary, curvature in the pipeline will be considered to minimise the number of manholes required. Design will be subject to specific design and approval by Auckland Council
- The pipeline is to be on an even longitudinal grade
- Diversion pipelines shall be designed to the requirements of this SWCoP and in particular, Section 4.3.5.

Where construction works are proposed in the vicinity of existing public stormwater assets, the developer shall implement any necessary measures to protect such assets. Auckland Council may at its discretion require the developer to supply a construction management plan that adequately addresses any such risks, and/or supply pre- and post-construction CCTV of public pipes considered vulnerable to any proposed construction works.

4.3.23 Abandonment of assets

Abandonment of assets is to be undertaken with Auckland Council's approval and to Auckland Council standards. CCTV is required prior to abandonment of the asset to confirm that no connections are currently in use.

Abandonment can either be full removal of the assets or capping/disconnecting and grout filling pipes and cutting down and backfilling manholes. Where abandoned assets remain in the ground, they will be shown on Auckland Council's GIS as abandoned. For future development within the vicinity of these assets, a specific foundation design will be required to deal with weak ground conditions associated with the original installation of the abandoned asset (e.g. trenching). Where assets are fully removed, and the area is backfilled with engineered fill that is certified to result in competent bearing conditions for construction, the abandoned assets will be deleted from GIS and normal building design will be possible, subject to confirmation in a geotechnical report. Lack of certification of backfill will result in the assets still showing on GIS as abandoned and specific foundation design will be required.

4.4 Approval of proposed infrastructure

4.4.1 Approval process

As a guideline, any proposed works affecting stormwater require approval by Auckland Council, e.g.:

- New connections
- Re-laying existing stormwater pipelines
- Diverting existing pipelines
- Raising or lowering manhole lids
- New developments
- Subdivisions
- Building works to be vested in Auckland Council.

If the work involves existing or proposed public assets, an Engineering Approval is required. Building consent is required for all works relating to private drainage. In addition, a resource consent may be required.

4.4.2 Information required

Applications to Auckland Council shall include sufficient information to demonstrate that the proposed works meet the requirements of all relevant legislation and this Code of Practice, as appropriate. The requirements outlined in Chapter 1: *General Requirements and Procedures* shall also be met, including the following:

a) A plan showing the location of existing and proposed stormwater works and all existing services likely to affect or be affected by the proposed works. Suitable scales of drawings illustrating the location of all existing services at A3 size shall be used.

b) Detailed longitudinal sections showing the levels, grades, bedding type, installation methodology, pipe diameter, pipe-material class, capacity and flow velocity of proposed stormwater pipelines. Longitudinal sections and typical cross-sections shall also be provided for any modifications to secondary flow paths. Suitable drawing scales at A3 size shall be used.

c) Details and calculations prepared by persons experienced in stormwater catchment analysis, demonstrating that the proposed system is of adequate capacity and highlighting any impact on adjacent areas or catchments that the proposed works may have. The analysis shall also include remedies for any negative impacts.

d) A plan showing the location of any streams, ponds, or wetlands within the site or in close proximity to the site. The location in plan and level of the water's edge and shoulder of the banks shall be indicated as well as the proximity of proposed buildings to the water's edge and/or shoulder of the banks. Suitable drawing scales at A3 size shall be used.

e) Typical pre- and post-development cross-sections through any streams, ponds or wetlands. Suitable drawing scales at A3 size shall be used.

f) All applications to build within floodplains, or overland flow paths shall be supported by a detailed hydrological report and assessment of environmental effects in accordance with the RMA. The report shall include both internal and external effects, e.g. the effects on upstream, downstream and adjacent properties as a result of the proposal and the effects on the property itself and the proposed future land use as a result of its location within a floodplain, or overland flow path.

g) Where a new structure, e.g. an underground chamber, will create an atmosphere of “confined space” as defined in AS 2865: *Confined space*, the design engineer shall provide full details of how risk to personnel during construction and future maintenance shall be managed.

h) All levels are to be in terms of Local Vertical Datum Auckland 1946.

i) Draft operations and maintenance manuals for any water quantity and/or quality control devices shall be submitted to Auckland Council for design approval along with other documents. The manuals shall describe the device’s design objectives, describe all major features, explain operations such as recommended means of sediment removal and disposal, identify key design criteria, and identify on-going management and maintenance requirements such as plant establishment, vegetation control and nuisance control. Accurate design calculations shall be included in the manual.

4.5 Construction

Any redesign on site will be subject to SWCoP requirements and be agreed with Council either through an amendment to the EPA and/or via a written Field Amendment from Council's site inspection officer.

4.5.1 Pipeline construction

The construction of pipelines shall be carried out in accordance with the requirements of AS/NZS 2032 (PVC), AS/NZS 2033 (polyethylene), AS/NZS 2566 Parts 1 and 2 (all buried flexible pipelines), or AS/NZS 3725 (concrete pipes).

4.5.2 Trenching

Guidance on trenching and embedment design is provided in Drawings SW01, SW02 and SW03 in Appendix B.

Where a pipeline is to be constructed through areas with unsuitable foundations, such material shall be removed and replaced with approved material. Alternatively, other methods of construction may be carried out with approval from Auckland Council to ensure adequate foundation and side support is provided.

4.5.3 Reinstatement

Public areas where construction has taken place shall be reinstated to the pre-construction condition or better, as required by Auckland Council. If work has been done within the road corridor, all reinstatement shall be undertaken in accordance with the most up-to-date version of the *Auckland Transport Code of Practice*.

4.5.4 Inspection and acceptance

Completed works shall be approved by Auckland Council prior to placing them into service. This shall include the consideration and approval of as-built plans, testing of works, defects liability periods, consents issued by other parties, financial considerations and conditions of approval issued for the works originally.

Testing shall be undertaken in accordance with Auckland Council's requirements, and CCTV in accordance with Section 4.3.18 of this document, or on request from Auckland Council.

As-built documentation shall be submitted in accordance with Auckland Council's document: *Regulatory Engineering – As-built Requirements,* which is available on the Auckland Council website.

More information on Council's inspection protocols can be found in the Regulatory Engineering Quality Assurance Manual.

Acceptance will be on the basis of the quality of materials and the standard and accuracy of construction. Areas where works have taken place shall be reinstated to a condition not worse than before the works took place. Owners affected by the works shall give their written approval of the result of the reinstatement works. The certification of works, as provided by the developer's design professional, signifies that the same professional certifies that the works are constructed appropriately and to the provisions of this code.

4.6 Combined stormwater and wastewater network area

4.6.1 Public systems

No applications for new combined public pipelines will be considered or approved.

4.6.1.1 Connections to combined public sewers

No new combined sewer connections will normally be approved. However, dispensation may be granted in the event that the existing combined sewer is the only option for stormwater disposal. New stormwater connections must comply with Clause 14 (2) of the Water Supply and Wastewater Network Bylaw 2015. Where dispensation is given, the following conditions shall be met as a minimum:

- Approval is required by Watercare as owner of the combined system
- Each unit shall have an independent combined connection to the sewer
- The private wastewater and stormwater pipes shall join together as close as possible to the connection to the combined public sewer to allow for future separation
- On-site mitigation measures are generally required (refer to Section 4.3.15)
- New stormwater connections into the combined sewer network are treated as trade waste discharges and need to comply with the Trade Waste Bylaw.

4.6.1.2 Separation of public sewers

All development projects initiated within combined areas shall have separation considered as part of the proposal. A development proposal within a combined area where public sewer separation is in progress shall consider the proposed separation works as part of the proposal. Developers should contact Auckland Council for areas where public separation projects are programmed. Discharge and associated consents may be required for stormwater disposal and should be discussed with Auckland Council.

4.6.2 Private systems

Each site shall have separate private systems for wastewater and stormwater.

4.6.2.1 Separation of private combined pipelines

All existing combined private pipelines shall be separated in any of the following cases:

- Any additional development. Note that the removal of any existing structure will not contribute to reducing the area that is classed as impervious and therefore cannot offset the increase in impervious area resulting from the new development.
- Re-development of the site is proposed
- Any work is undertaken on private drainage (unless work is being done solely within a dwelling, i.e. plumbing only).

4.6.2.2 Site and drainage plans

A detailed Site and Drainage Plan (including all public and private pipelines) shall be supplied with all relevant consent applications. These plans shall include drainage details for all existing and proposed impervious areas.

4.6.2.3 New pipelines

Where separation of existing pipelines is required, the preferred option is to install new private stormwater and wastewater pipelines. However, if the existing private combined pipeline is structurally sound and has adequate capacity, it may be used for stormwater with a new pipeline installed for wastewater. A stormwater storage device is required for both options (see Section 4.3.15 for further information).

4.6.2.4 Extent of private separation

The site-separated pipeline shall be taken to approved outlets. Where the site must discharge stormwater into a combined pipeline, the separate pipelines shall join as close as possible to the connection to the combined public sewer (refer to Figure 2).

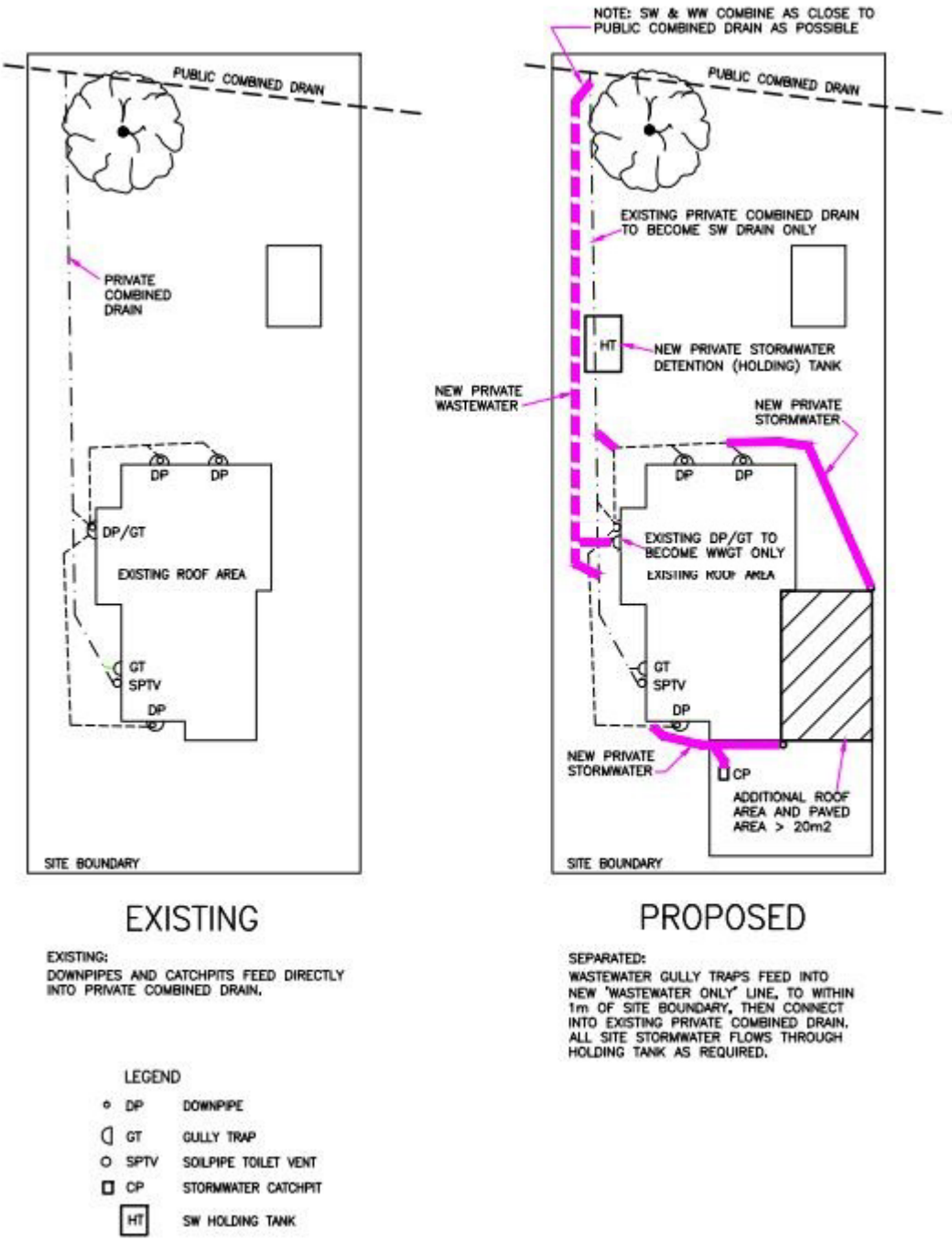

Figure 2: On-site separation of private combined pipelines

4.6.2.5 Costs

Costs of separating private pipelines are to be met by the property owner or developer.

Glossary

Term	Definition
Annual Exceedance Probability (AEP)	The probability of an event being equalled or exceeded in any year.
AT	Auckland Transport. A Council-controlled organisation responsible for transport, including some stormwater functions in the road corridor.
Auckland Design Manual	A best practice guide for designing the built environment. Available online at: http://www.aucklanddesignmanual.co.nz/.
AUP	Auckland Unitary Plan
Best Practicable Option (BPO)	In relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to: ▪ the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and ▪ the financial implications, and the effects on the environment, of that option when compared with other options; and ▪ the current state of technical knowledge and the likelihood that the option can be successfully applied.
Brownfield	Any already urbanised land to be redeveloped; often for more intensive or different land use.
CAR	Corridor Access Request. An authorisation for working in the road corridor, administered by Auckland Transport.
Catchment	The total surface area draining to a particular point of interest or discharge point. Note: in reticulated urban areas the piped catchment may not be identical to the overland flow catchment.
Code of Compliance Certificate	A certificate issued by Auckland Council at the end of a building project to demonstrate satisfaction that the completed building work complies with the original building consent.
CCTV	Closed Circuit Television. Used to inspect pipelines in order to determine the interior condition of the pipe.
Coastal marine area	Generally, the area below mean high water springs.
Community Facilities	The Auckland Council department which is the asset owner for public parks and reserve land.
CoP	Code of Practice. In legacy councils in the region these were also known as: 'Connection Standards', 'Quality Standards', 'Design Standards' or 'Development Code'.
Culvert	Any conduit that transfers the flows of a watercourse or waterway across a road or embankment.

Term	Definition
Design flows	The flows selected as a basis for the design of works in the system.
Design storm	The rainfall calculated from historical records that can be expected for a specific return period and duration.
Engineering Approval	Engineering Approval is required for works that are to be vested in Auckland Council's ownership. This includes public stormwater, wastewater, water supply, roading and park assets. Engineering Approval may also be required in other circumstances, such as a condition of an underlying resource or building consent.
Floodplain	The area of land that is inundated by water during a specific flood event. In the SWCoP, the 1% AEP flood event is used.
Frac-outs	The inadvertent loss of drilling fluid from the borehole annulus to the surrounding soil as a result of excess downhole fluid pressure. Also known as hydrofracture.
Freeboard	Additional clearance above estimated flood/inundation level (including 1m sea level rise for coastal inundation) to allow for uncertainties in flood/inundation level estimation, wave action and localised water level variations..
GD	Guideline Document. An Auckland Council publication which provides technical and/or design guidance.
Greenfield	Land identified for future urban development that has not been previously developed
HN-HO-72	Loading requirement as per NZTA Bridge Manual: http://www.nzta.govt.nz/resources/bridge-manual/bridge-manual/
Integrated Stormwater Management	Replaces the term "water sensitive design" in the Auckland Unitary Plan, defined in Section E1.3.10. In terms of stormwater the objectives are: ▪ Reducing stormwater flows and contaminants at source prior to the consideration of mitigation measures and the optimisation of on-site and larger communal devices where these are required; and ▪ The use and enhancement of natural hydrological features and green infrastructure for stormwater management where practicable.
Invert	The invert level is the base interior level of a pipe, or culvert, at a given location.
LGA	Local Government Acts 1974 and 2002.
Minor pipelines	Pipes connecting to a manhole that are not on the primary pipe alignment.
Maximum Probable Development (MPD)	Design case for consideration of future flows allowing for development within a catchment that takes into account the maximum impervious surface limits of the current zone or, if the land is zoned 'future urban' in the Auckland Unitary Plan, the probable level of development arising from zone changes.

Term	Definition
Network Discharge Consent (NDC).	A consent that authorises the diversion and discharge of stormwater, including associated contaminants, from existing and potential future public stormwater networks within urban areas and rural and coastal settlements.
Non-access chamber	An inspection chamber which does not allow a person to enter (refer to Appendix B, Drawing SW06 for a typical detail).
Overland flow path	The route taken by stormwater when flowing over land.
PCBU	Person conducting a business or undertaking
Peak flow	The maximum flow reached in a stormwater system during any storm (or at any time in other reticulation).
Primary system	The pipes, streams, open watercourses and other elements of built and natural drainage infrastructure that carry the flow of stormwater within the catchment during non-extreme storm events. Where designed they generally should have capacity for the 10% AEP flow.
Private Stormwater Network	Any component of the stormwater network that drains water from premises on private land to a receiving environment or up to the point of service connection with the public stormwater network and includes pipes, gutters, downpipes, catchpits, swales, subsoil drains, stormwater treatment devices, rainwater tanks and any stormwater management device or redundant stormwater system.
Public Stormwater Network	▪ Any stormwater pipe, drain, land drainage work or treatment facility, vested in or under the control of Auckland Council ▪ Any stormwater drain, drain, land drainage work or treatment facility declared by Auckland Council to be a public drain under Section 462 of the Local Government Act 1974 ▪ The stormwater assets of other public entities such as Auckland Transport, Auckland Council Community Facilities and the NZ Transport Agency are not considered “public” in the context of this document. They may be owned by a public entity but are not “public” assets that can be connected to.
RMA	Resource Management Act 1991. New Zealand's main piece of legislation that sets out how we should manage our environment.
Runoff	The portion of rainfall which runs off the land and into the drainage system and overland flow path.
Secondary flow path	The route taken by stormwater runoff when the primary system capacity has been exceeded or is blocked.
Soakage	Disposal of stormwater into the ground by way of specifically designed pits, trenches or bores.
Soffit	The highest point of the internal surface of a pipe or culvert at a given location. Sometimes called the obvert.
Stormwater Management Device	A device or facility used to reduce stormwater runoff volume, flow and/or contaminant loads prior to discharge. Examples are rain gardens, pervious paving and tree pits.

Term	Definition
Stormwater (SW)	Rainfall runoff from land, including constructed impervious areas such as roads, pavement, roofs and urban areas which may contain dissolved or entrained contaminants, and which is diverted and discharged to land and water.
SWCoP	Code of Practice for Land Development and Subdivision Chapter 4 – Stormwater.
Time of Concentration (ToC)	The time it takes for water to arrive from the top of the catchment to a location downstream.
TP	Technical publication. A former Auckland Regional Council technical document.
TR	Technical report. An Auckland Council technical report.
Watercare CoP	The Water and Wastewater Code of Practice for Land Development and Subdivision.
Zone of influence	See Drawing SW22 in Appendix B.

Appendix A – List of relevant documents

Auckland Council Publications

Auckland Council. (2012). *Development Engineering – As-built Requirements*.

Auckland Regional Council. (1999). *Guidelines for Stormwater Runoff Modelling in the Auckland Region.* Technical Publication TP108.

Auckland Regional Council. (2000). *Fish Passage Guidelines for the Auckland Region*. Technical Publication TP131.

Auckland Council guideline document GD2017/001: *Stormwater Management Devices in the Auckland Region.* Guideline Document GD01.

Auckland Council guideline document GD2015/004: *Water Sensitive Design for Stormwater*. Guideline Document GD04.

Auckland Council guideline document GD2016/005: *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*. Guideline Document GD05.

Auckland Council guideline document GD2021/007: *Stormwater Soakage and Groundwater Recharge in the Auckland Region*. Guideline Document GD07.

Auckland Council technical report TR2016/017: *Coastal Inundation by Storm-tides and Waves in the Auckland Region.* Technical Report TR17.

Auckland Council technical report TR2013/018: *Hydraulic Energy Management: Inlet and Outlet Design for Treatment Devices.* Technical Report TR18.

Auckland Regional Council. (2007). *Auckland Regional Pest Management Strategy 2007-2012*.

Auckland Council technical report TR2017/030-3. *Auckland Region Climate Change Projections and Impacts* (Revised September 2020). Technical Report TR30-3

Ministry of the Environment

Ministry for the Environment 2017: *Coastal Hazards and Climate Change: Guidance for Local Government*

Relevant Industry Standards

The latest published version of the below standards shall apply:

- AS 3996: Access covers and grates
- AS/NZS 1254: PVC-U pipes and fittings for stormwater and surface water applications
- AS/NZS 1260: PVC-U pipes and fittings for drain, waste and vent application
- AS/NZS 2032: Installation of PVC pipe systems
- AS/NZS 2033: Installation of polyethylene pipe systems
- AS 2865: Confined Spaces
- AS/NZS 2566.1 Buried flexible pipelines: Structural design
- AS/NZS 2566.2: Buried flexible pipelines: Installation

- AS/NZS 3500.2: Plumbing and drainage, Part 2: Sanitary plumbing and drainage
- AS/NZS 3725: Design for installation of buried concrete pipes
- AS/NZS 4058: Precast concrete pipes (pressure and non-pressure)
- AS/NZS 4130: Polyethylene (PE) pipes for pressure applications
- AS/NZS 4327: Metal-banded flexible couplings for low-pressure applications
- AS/NZS 5065: Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
- BS EN 295-1: Vitrified clay pipe systems for drains and sewers. Requirements for pipes, fittings and joints
- BS EN 295-4: Vitrified clay pipe systems for drains and sewers. Requirements for adaptors, connectors and flexible couplings
- NZS 3101.1&2: Concrete structures standard
- SNZ HB44: Subdivision for people and the environment

Legislation & Plans

- Approved Code of Practice for Temporary Traffic Management (Version 4)
- Auckland Council Bylaws
    - Trade Waste Bylaw (2013)
    - Stormwater Bylaw (2015)
    - Water Supply and Wastewater Network Bylaw (2015)
- Auckland Transport Design Manual
- Auckland Unitary Plan
- Building Act 2004
- Building Code and associated Compliance Documents. Retrieved from: https://www.building.govt.nz/building-code-compliance/
- Building Regulations 1992
- Civil Defence Emergency Management Act 2002
- Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment, 2nd Edition. Wellington: Ministry for the Environment. 2018.
- Hauraki Gulf Marine Park Act 2000
- Health and Safety at Work Act 2015 and associated regulations
- Local Government Act 1974
- Local Government Act 2002
- National Code of Practice for Utility Operators' Access to Transport Corridors (2015)
- National Policy Statement for Freshwater Management. (2014)
- NZ Dam Safety Guideline 2015
- Plumbers, Gasfitters, and Drain Layers Act 2006

- Public Works Act 1981
- Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2012
- Resource Management Act 1991

Appendix B – Drawings

DWG	Title
SW01	Embedment & Trenchfill
SW02	Pipe Embedments – Standard Embedment for Flexible Pipes
SW03	Pipe Embedments – Standard Embedment for Concrete Pipes
SW04	Stormwater Lateral Connections
SW05	Standard Stormwater Manhole
SW06	Stormwater Manholes – Non-Access Chamber
SW07	Stormwater Manhole with In Situ Concrete Base
SW09	Stormwater Manhole Access
SW10	Stormwater Manhole PE Pipe Joint
SW11	Stormwater Manhole – Rising Main Connection
SW19	Stormwater Inlet and Outlet Structures
SW20	Stormwater Inlet and Outlet Structures - Safety Fence Detail
SW21	Debris Control Screen
SW22	Stormwater Pipe and Manhole Construction Clearance Requirements
SW23	Stormwater Lines – Steep Gradients and Anchor Blocks
SW24	Stormwater Boundaries – Connections