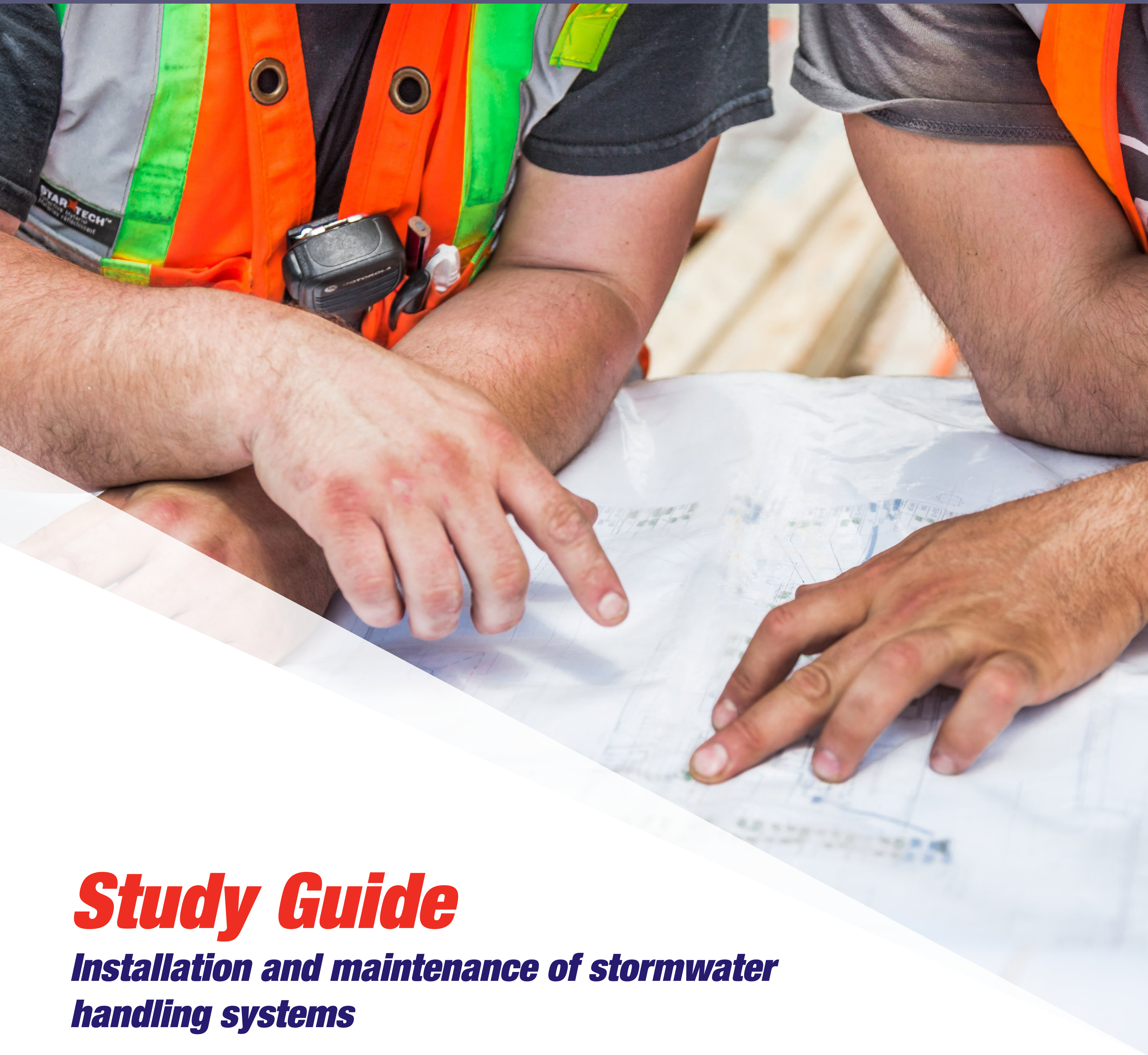

Study Guide

Installation and maintenance of stormwater handling systems

30577 (Version 1, Level 4, Credits 9) | 30578 (Version 1, Level 4, Credits 4) | 30579 (Version 1, Level 4, Credits 2)

Trainee Name

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Unit Standards

Unit Standard 30577

People credited with this unit standard are able to:

- demonstrate knowledge of concepts and principles underpinning the installation and maintenance of stormwater handling systems
- describe positioning for installation of stormwater handling systems
- describe the installation of stormwater handling systems
- describe the maintenance of stormwater handling systems.

Unit Standard 30578

People credited with this unit standard are able to:

- determine position for the installation of stormwater handling systems
- select, install, and complete surface water handling systems
- maintain stormwater handling systems.

Unit Standard 30579

People credited with this unit standard are able to install and complete wingwall structures for stormwater handling systems.

The best way to use this Study Guide is:

1. Read through the following information step by step.
2. Where other resources are mentioned (such as websites), find and read them as well.

Skills acknowledges the content and images provided by the Ministry of Business, Innovation and Employment (MBIE) to aid in the development of this resource.

Contents

Introduction

Stormwater is the runoff of water from urban surfaces, like roofs and driveways, from rainfall or melting snow or any area that can catch rainfall. It needs to be managed because it can cause:

- flooding
- erosion
- pollution of waterways.

Stormwater drains and handling systems are designed to control the flow of stormwater and prevent damage to buildings and property. Uncontrolled stormwater can undermine buildings, cause dampness, as well as waterlog and erode properties.

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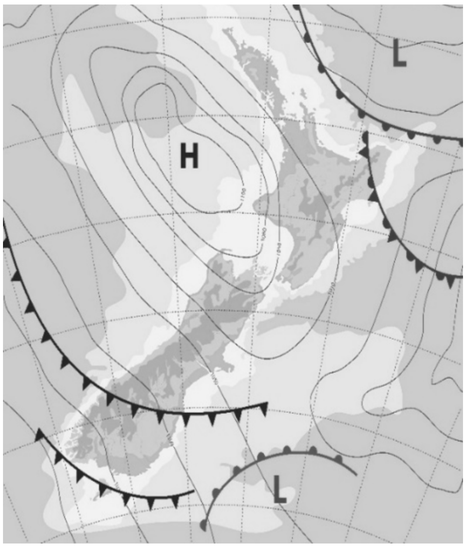
In New Zealand, stormwater is not always treated before it is discharged into the sea/lakes/rivers. This means it can cause pollution if it is not handled within effective stormwater systems before being released into the waterways.

Stormwater handling systems

Buildings and site work (including drainage systems) need to be designed and installed in a way that protects people and property from the effects of stormwater. This also includes the effect that building and drainage work may have on neighbouring properties.

Even a well-designed drainage system may not always cope with exceptional levels of rainfall. However, even in these situations it is important that stormwater does not enter foul water sewers, as this can cause them to become overloaded. If overloaded with stormwater, the foul water sewer will become pressurised and start to overflow at the areas where there is the highest pressure, such as low-lying properties and manhole covers.



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Our stormwater and surface water control systems need to be designed according to the rainfall in each area of New Zealand as it varies.

Stormwater drains can also be used to control underground water and seepage. This is called sub-soil drainage.

The *New Zealand Building Code E1/AS1* requires every property owner to provide stormwater drains to convey stormwater to an approved outfall.

Inadequate stormwater collection may result in a poorly drained or waterlogged site. Ineffective drains that leak may create unstable ground conditions, which in turn may cause foundations, paths or driveways to subside and water to seep into underground basement areas.

A stormwater drainage system should be installed to:

- convey surface water to an appropriate outfall
- allow reasonable access for maintenance and blockage-clearing procedures
- avoid blockages
- avoid leaks and root penetration
- avoid damage to any outfall
- avoid damage from loads or normal ground movement.

Legislation, Standards and Codes

Legislation relating to stormwater drainage

Plumbers, gasfitters, and drainlayers need to comply with relevant legislation when installing and maintaining stormwater handling systems.

This section will look at some of them:

- Building Act 2004
- Health and Safety at Work Act 2015
- Plumbers, Gasfitters, and Drainlayers Act 2006
- Plumbers, Gasfitters, and Drainlayers Regulations 2010
- Resource Management Act 1991
- AS/NZS 3500.3:2015 Plumbing and drainage – stormwater
- New Zealand Building Code Clause E1 Surface Water

You are not expected to memorise all the specifications detailed in the Codes and Standards, but you should know where to find them if they are referenced in job details or on plans and drawings. As you work in the trade, you will become familiar with them.

Building Act 2004

The purpose of this Act is to provide for the regulation of building work, the establishment of a licensing regime for building practitioners, and the setting of performance standards for buildings. It aims to ensure that:

- people who use buildings can do so safely, without endangering their health
- buildings have attributes that contribute appropriately to the health, physical independence and well-being of the people who use them
- people who use a building can escape from the building if it is on fire
- buildings are designed, constructed and able to be used in ways that promote sustainable development.

Health and Safety at Work Act 2015

The Health and Safety at Work Act 2015 places obligations and responsibilities on everyone in a workplace in New Zealand to take care of their own health and safety, and the health and safety of others.

These duties apply to:

- people conducting a business or undertaking, which includes a self-employed individual, a partnership, and company, and an association (this person is referred to in the HSW Act as a PCBU)
- officers of a PCBU (such as the director or CEO of a company)
- workers (including contractors)
- other people at a workplace, including visitors.

WorkSafe New Zealand is responsible for its administration and works with other agencies to develop safe work instruments and guidance information. They also develop approved codes of practices such as Good Practice Guidelines – Excavation Safety and the Guide for Safety with Underground Services.

Plumbers, Gasfitters, and Drainlayers Act 2006

The purpose of the Act is to protect the health and safety of members of the public by ensuring the competency of the people who work in plumbing, gasfitting and drainlaying services, and by creating controls and regulating the work in these areas.

The Plumbers, Gasfitters and Drainlayers Board is established under the Act and is responsible for the registration and licensing of plumbers, gasfitters and drainlayers, and ensures that those people carrying out such work are competent to do so.

Only persons authorised by the Board under the Plumbers, Gasfitters and Drainlayers Act can undertake drainlaying work.

Plumbers, Gasfitters, and Drainlayers Regulations 2010

A ‘Regulation’ is a rule made under an Act so that the Act is more effective. The Plumbers, Gasfitters and Drainlayers Regulations are made under the Plumbers, Gasfitters and Drainlayers Act 2006.

They describe legal requirements and pathways to gaining registration as a drainlayer, and set down the fees and necessary examination details.

Resource Management Act 1991

The Resource Management Act covers sustainable management of natural and physical resources.

> ***Sustainable*** *means capable of being managed at a steady level without exhausting natural resources or causing severe damage to the air, water, soil, plants or animals.*

The Act covers:

- protection of the environment
- sustaining resources for future generations.

Regional Councils are responsible for the management of air, water, soil and other natural resources, and the control of pollution. Local authorities may be delegated the responsibility to control discharges of sewage and stormwater to the land.

Drainlayers are responsible for ensuring the design and construction of sewage and stormwater systems prevents pollution of the environment.

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Each Regional Council has a Regional Plan which sets the rules for discharges of effluent sewerage and stormwater.

The Plan has:

- Permitted Activities, where a Resource Consent is not required and
- Restricted Activities, where the proposed work will be considered and may or may not be approved.

AS/NZS 3500.3:2015 Plumbing and drainage – stormwater

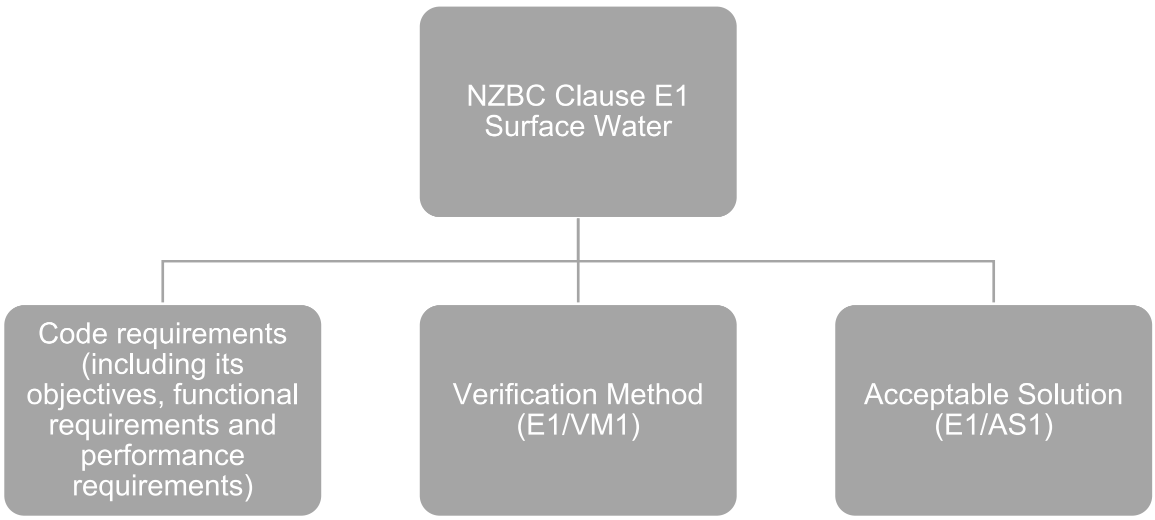
This Standard has been developed to comply with the New Zealand Building Code as an alternative solution. It outlines the requirements for the materials, design, installation and testing of roof, surface and subsoil drainage systems to a point of connection.

When using this standard, care should be taken to ensure that the design meets New Zealand conditions and specifically the building site to be drained. It would be up to the Building Consent applicant to justify its use, and for the Building Consent authority to check as part of the normal Building Consent process.

New Zealand Building Code Clause E1 Surface Water

The primary document used when installing stormwater drainage is the New Zealand Building Code Clause E1 Surface Water.

NZBC Clause E1 Surface Water is made up of three main parts:



Verification Method E1/VM1

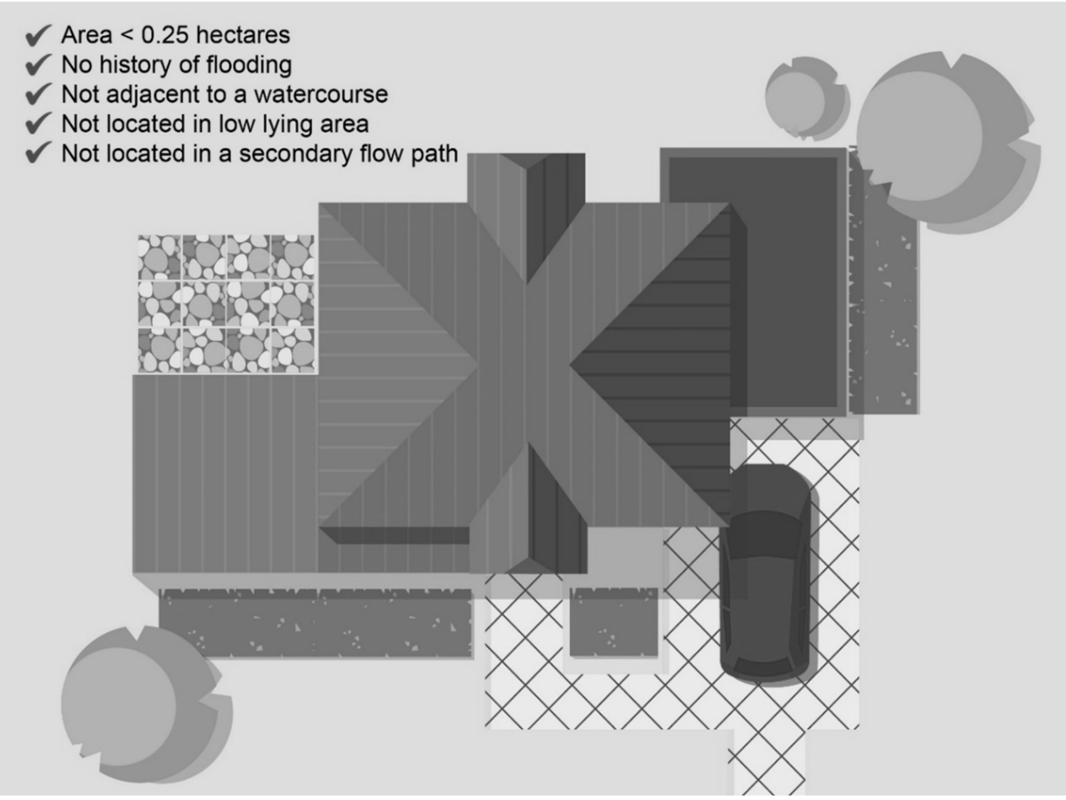
The second part of NZBC E1 Surface Water is the Verification Method E1/VM1 that describes how to determine the volume of water arriving on a building site from an upstream area. This method includes allowance for a secondary flow path and for surface water disposal to a soak pit.

Because E1/VM1 Surface Water is a verification method (a calculation procedure that requires some special knowledge and training to use), it needs to be carried out only by suitably qualified people (see paragraph 1.0.7 of E1/VM1 Surface Water for details of this). E1/VM1 Surface Water is for anyone undertaking building work as well as the territorial authority when processing a Building Consent application (to check that the designer had followed its provisions correctly).

Acceptable Solution E1/AS1

The second part of NZBC E1 Surface Water is the Acceptable Solution E1/AS1, which includes requirements for drainage materials, construction requirements, and sizing of drains, downpipes and roof gutters. E1/AS1 Surface Water is limited to buildings and site work with a catchment area of no more than 0.25 hectares, and those that meet the conditions shown on the following diagram.

*A **catchment area** is a defined area which drains to one outfall, and drains will increase in size if the drain has additional catchment areas added.*



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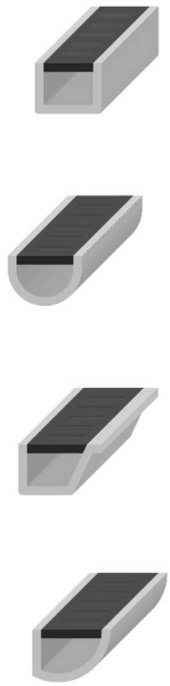
Complying with the relevant legislation is crucial for drainlayers to ensure their work is legal and that public health and safety is protected. Licenced or Certifying Drainlayers need to have a thorough knowledge of the ones which apply.

Surface water collection systems

Surface water

Surface water is all naturally occurring water other than subsoil water including rainwater and water that flows onto the site. It does not usually include rainwater from the roof as this is normally piped directly into the drainage system.

Overland surface water flow can be collected and directed by pre-made channels and grates, kerb and channels, or half-round tiles. These are typically known as surface drains.



An example of pre-formed plastic channel

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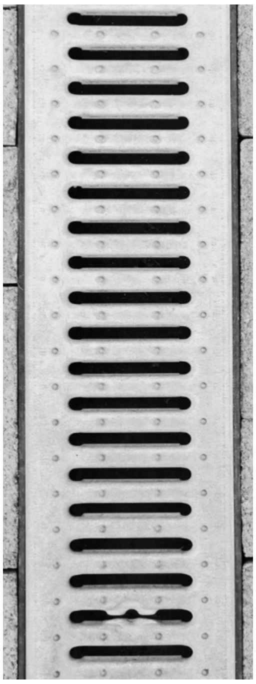
A larger channel with a metal grate



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A typical curb and channel draining to sumps - Learnops

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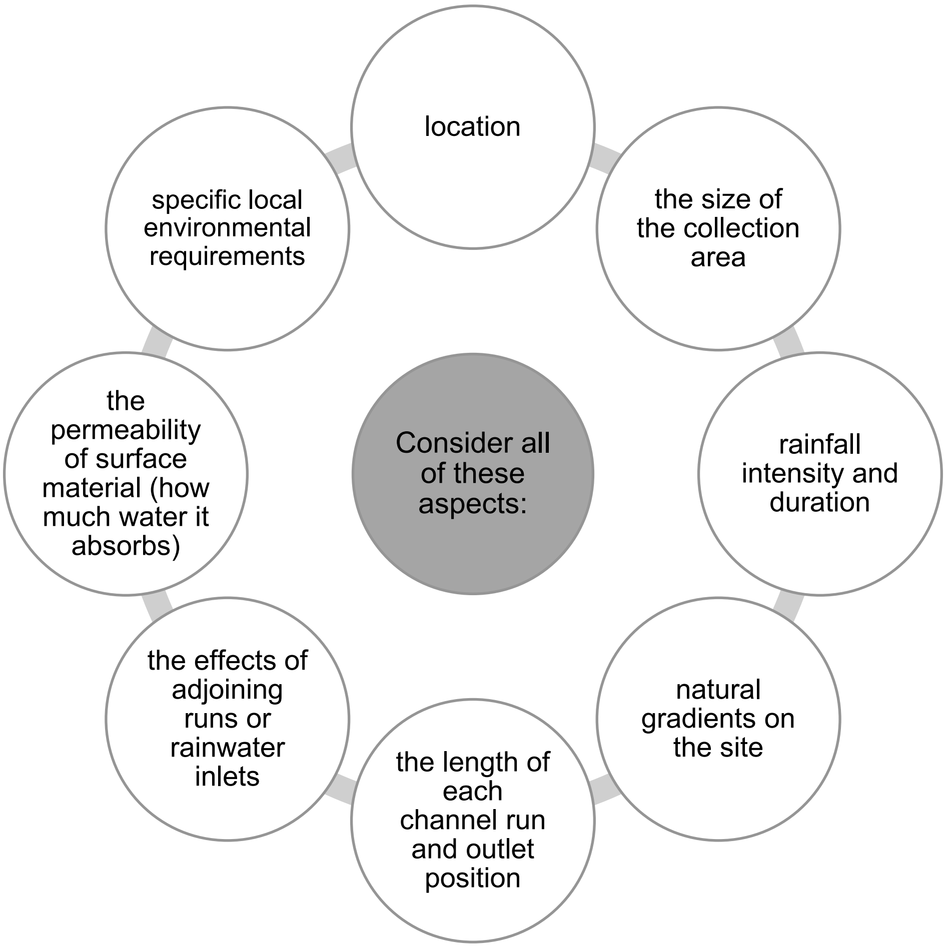
Surface water drainage

Surface water drains are intended to carry surface water to an outfall, and are normally laid below ground level.

The surface water outfall is the part of the disposal system receiving surface water from the drainage system.

A stormwater outfall may include a natural watercourse, territorial authority sewer system, kerb and channel, or soakage system.

The design of a surface water control system will incorporate the following considerations:



Sizing stormwater drains

Stormwater drains are subject to variable flow rates and should be sized appropriately.

Sizing factors

The size of a stormwater drainage pipe will take into account the minimum drain size (85 mm), the catchment area and rainfall intensity. Sometimes stormwater drains will be dry and at other times only partly-filled.

During high rainfall, drains may become pressurised, which is when water flows back out of sump gratings, causing downpipes and spouting to overflow.

Drainlayers need to be able to design basic stormwater drainage systems that meet the requirements of the New Zealand Building Code.

Any stormwater system design should consider the territorial requirements. These will determine requirements such as the pipe diameter, permitted flow rate to the outfall, as well as any detention requirements.

If it is extremely important that an asset such as a road or a specialised building be protected, so a suitable system will need to be designed by an engineer. The E1/AS1 Surface Water requires drains to be of sufficient size and gradient to transport surface water from the site. To avoid blockages, surface water drains must have an internal diameter of no less than 85 mm.

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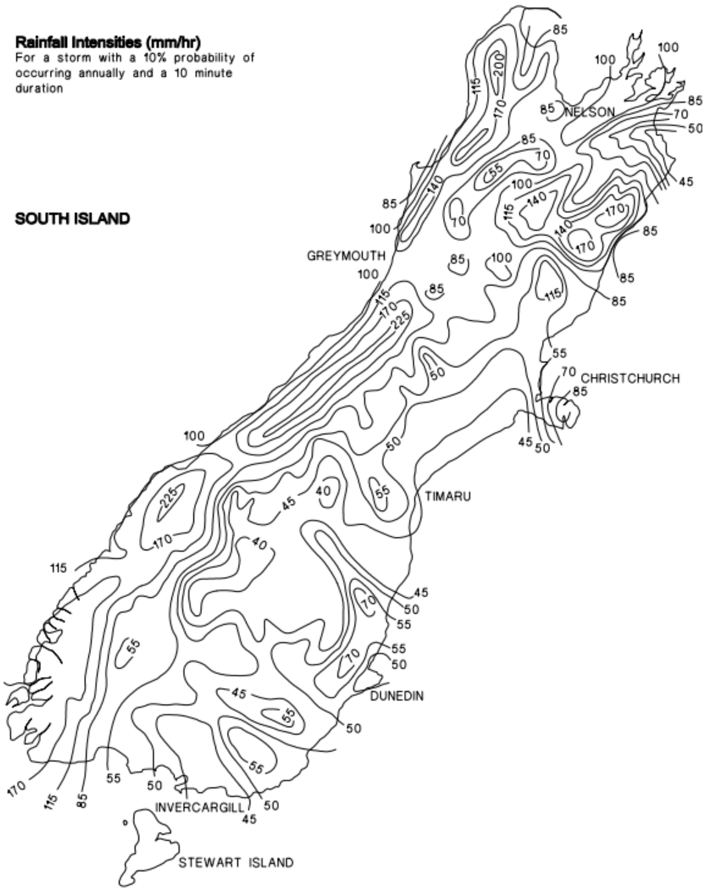
Storms and drains

E1/AS1 Surface Water also requires drains to be capable of handling the rainfall from storms. Because storms vary in size and duration the amount of stormwater collected will also vary in relation to what falls on the roofing and paved areas of a site.

Drains must be of sufficient size and gradient to handle the rainfall from a storm with a 10% probability of occurring annually. This means storms so big that they are predicted to occur only once every ten years. Therefore a '1 in 100 year event' only has a 1% probability of occurring annually.



E1/AS1 Surface Water includes maps of New Zealand showing rainfall intensities from storms that can be expected once in ten years and that last for ten minutes.

E1/AS1 Surface Water states that surface water resulting from an event such as a flood, having a 2% probability of occurring annually (that is, once every 50 years), shall not enter buildings. In response to this, stormwater drainage may need to be designed to avoid a potential building flood happening more than once in every 50 years.

This might be achieved by oversizing pipes and making provision for overflow.

Such a design would also provide for intermittent flooding and secondary flow paths.

> ***Note:*** *NZBC E1 Surface Water makes a distinction between housing and commercial building owners. Clause E1 does not apply to non-residential buildings.*

Commercial building owners who want to protect their interests may take less risk than a residential building owner. Commercial building owners may also have buildings which require specific drainage design, such as for multi-level buildings with car parking areas at different levels.

E1/AS1 Surface Water only deals with surface water that results from rainfall in the catchment area and does not include water from other sources, such as flooding from rivers, lakes or the sea.

Rainfall intensity

A listing of rainfall intensities in different areas can be obtained from the NZBC E1 Surface Water. The average rainfall in New Zealand is 50 mm per hour, as occurs in Dunedin.

Calculating rainfall volume

The volume of water that would be carried to the outfall under a certain level of rainfall can be calculated by multiplying the catchment area by the rainfall intensity.

*To **convert mm/hr to m/hr** divide by 1000 (as there are 1000mm in 1m).*

Below are two examples of how to calculate volumes of rainfall that a drainage system may need to be designed to handle.

Example one

To calculate how much rain would fall in one hour in Dunedin if the rainfall is 50 mm/hr and the catchment area is 400 m^2

Rainfall volume = rainfall in one hour (in m/hr) x area (in m^2)

Rainfall volume = 0.050 m/hr x 400 m^2

<u>Rainfall volume = 20 m^3/hr</u>

Example two

Calculate rainfall volume in an hour for Auckland with a catchment area of 400 m^2 and rainfall intensity of 85 mm/hr:

Rainfall volume = rainfall in one hour (in m/hr) x area (in m^2)

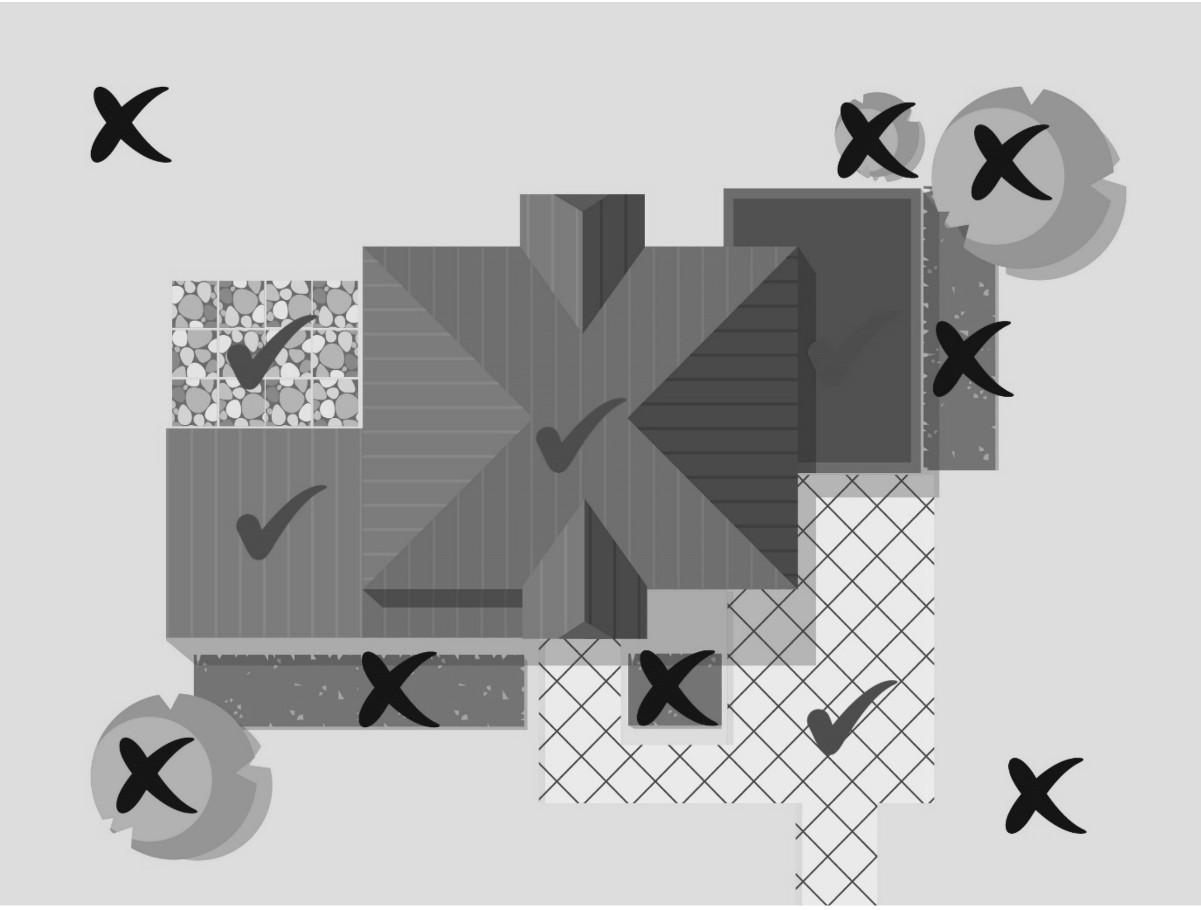
Rainfall volume = 0.085 m/hr x 400 m^2

<u>Rainfall volume = 34.0 m^3/hr</u>

The Auckland drain would therefore need to be able to carry more water.

Modified catchment areas

The measurement of a catchment area relates to the true catchment area in cubic metres (m^3) and includes plan roof area (m^2) plus paved area (m^2). The paved area includes paving blocks, concrete, asphalt and metalled surfaces.



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A modified catchment area is a number which relates to the true catchment area and the rainfall intensity.

A ***modified catchment area*** *can be calculated by multiplying the true catchment area by rainfall intensity, and then multiplying this by 0.01 to allow for combination of the units mm/hr with* m^2 *in the calculation.* *Modified catchment area = catchment area (in* m^2*) x rainfall intensity (in mm/hr) x 0.01*

On the next page are two examples of how to calculate a modified catchment area.

Example one

For a true catchment area of 400 m^2 in Dunedin (with rain intensity of 50 mm/hr), the modified catchment area can be determined with the following calculation:

Modified catchment area in Dunedin = *catchment area x rainfall intensity x 0.01*

Modified catchment area in Dunedin = 400 x 50 x 0.01

Modified catchment area in Dunedin == 200 m^2

Example two

For a true catchment area of 400 m^2 in Auckland (rain intensity of 85 mm/hr):

Modified catchment area in Auckland = *catchment area x rainfall intensity x 0.01*

Modified catchment area in Auckland = (400 x 85) x 0.01

Modified catchment area in Auckland = 340 m^2

Drain size, ground contours, and gradient

When designing a surface water or stormwater system the minimum gradients allowed should be identified. This will help determine the minimum size of drain. Installing a smaller diameter drain at its minimum gradient will cost less in materials and require less excavation.

Ground contours effect the rate of run-off of a particular collection area. Slope corrections for run-off coefficients are used in calculations for sizing of stormwater handling systems.

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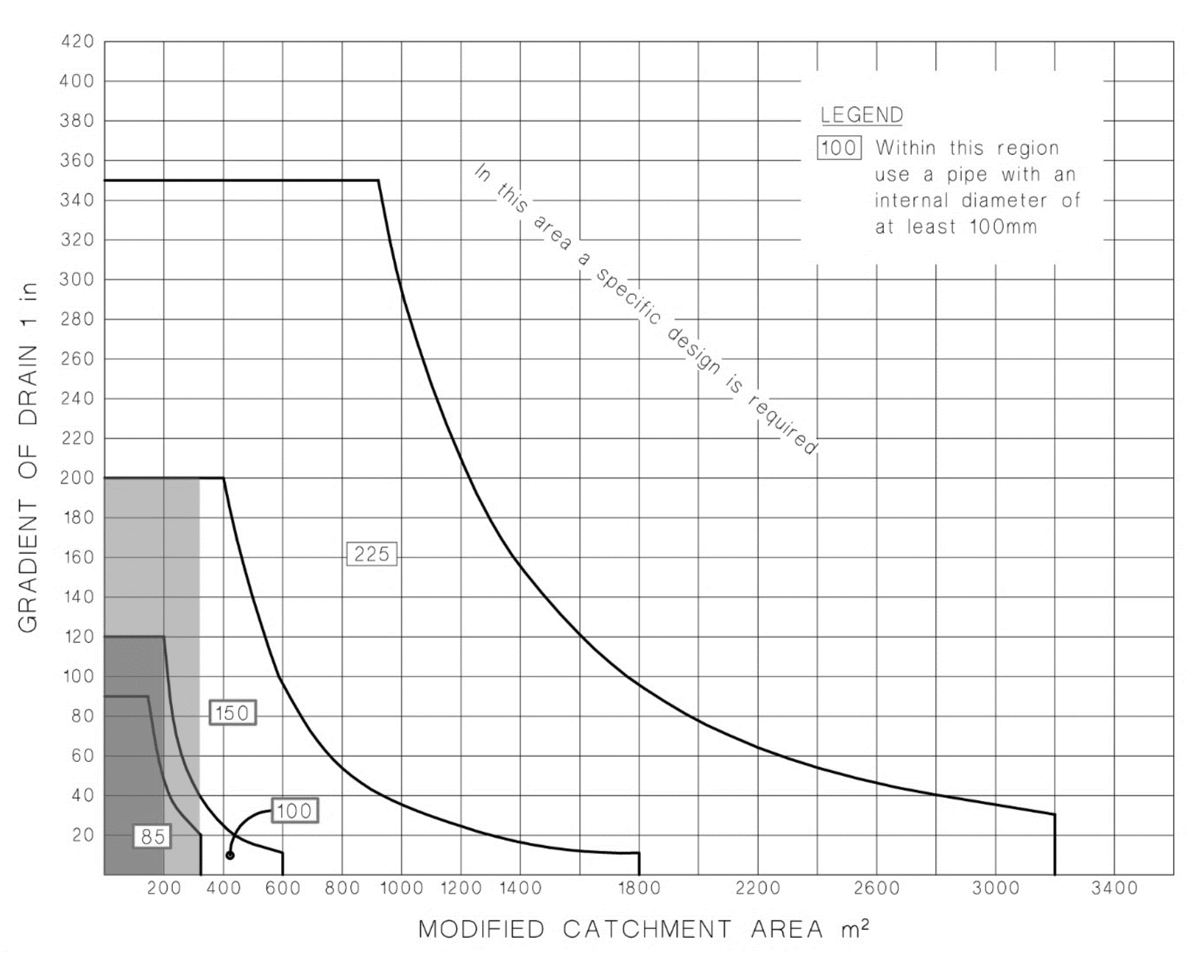
The graph on the following page can be used to determine the appropriate surface water or stormwater drain size for a given modified catchment area. Minimum gradients are indicated by the curved lines in the graph.

Figure 3: Sizing of Surface Water Drains
Relating to Paragraphs 3.2.2 and 3.2.3



From Acceptable Solution E1/AS1

Sizing of surface water drains. Dark grey = Dunedin (100 mm diameter), Light grey = Auckland (150 mm diameter)

Using the graph

Using the results from the two modified catchment area examples above, the graph can be used to find the pipe sizes for those catchment areas.

Dunedin

The Dunedin modified catchment area of 200 m^2 (dark grey shading) when installed at the minimum gradient allowed for that area is 1:120, the graph gives a pipe size of 100 mm.

This figure is found at the top right of the blue shaded area. Steeper gradients could be used, but this would not be as cost effective.

Auckland

The Auckland modified catchment area of 340 m^2 (light grey shading) when installed at its minimum gradient allowed for that area is 1:200, the graph gives a pipe size of 150 mm. This figure is found at the top right of the red shaded area. Steeper gradients could be used, but again, this would not be as cost effective.

However, on steep slopes it is possible to economically use a smaller pipe diameter.

As a general rule, the minimum gradient that is permitted should be used. This will result in less excavation depth. The steeper gradient may sometimes be used for slopes. For example, on a steep slope in Auckland with a modified catchment area of 340 m^2, a 100 mm drain may be used at a gradient of 1:40.

When using the minimum gradient, the drain grade must be set using a laser levelling device, as any imperfection in the bedding will cause water to pond and debris to build up. It is traditional trade practice to use a gradient of 1:60.

On large complex sites designers may also allow for the run-off rate or speed of rainfall for different surfaces, for example, the difference of run-off rate between grass and concrete. Surface water run-off can be calculated by taking into account run-off coefficients.

Run-off coefficients

The table below lists run-off coefficients for a variety of land uses and soil types.

Table 1: Run-off Coefficients
Relating to Paragraphs 2.0.1, 2.1.1, 2.1.3

Description of surface	C
Natural surface types	
Bare impermeable clay with no interception channels or run-off control	0.70
Bare uncultivated soil of medium soakage	0.60
Heavy clay soil types:	
– pasture and grass cover	0.40
– bush and scrub cover	0.35
– cultivated	0.30
Medium soakage soil types:	
– pasture and grass cover	0.30
– bush and scrub cover	0.25
– cultivated	0.20
High soakage gravel, sandy and volcanic soil types:	
– pasture and grass cover	0.20
– bush and scrub cover	0.15
– cultivated	0.10
Parks, playgrounds and reserves:	
– mainly grassed	0.30
– predominantly bush	0.25
Gardens, lawns, etc.	0.25
Developed surface types	
Fully roofed and/or sealed developments	0.90
Steel and non-absorbent roof surfaces	0.90
Asphalt and concrete paved surfaces	0.85
Near flat and slightly absorbent roof surfaces	0.80
Stone, brick and precast concrete paving panels	
– with sealed joints	0.80
– with open joints	0.60
Unsealed roads	0.50
Railway and unsealed yards and similar surfaces	0.35
Land use types	
Industrial, commercial, shopping areas and town house developments	0.65
Residential areas in which the impervious area is less than 36% of gross area	0.45
Residential areas in which impervious area is 36% to 50% of gross area	0.55

Note:
Where the impervious area exceeds 50% of gross area, use method of Paragraph 2.1.2.

From Verification Method E1/VM1

Run-off coefficients for different surfaces (E1/VM1)

The coefficients (shown in column C of the table) represent the effects that infiltration, storage, evaporation, natural retention and interception will have on rainwater run-off on different surfaces. They assume saturated ground conditions from previous rain and should be used in the calculation of surface water run-off.

Manufacturers provide installation requirements or guidelines. Such guidelines may include recommended embedment (bedding methods) and minimum cover requirements. For example, recommended minimum cover for areas not subject to heavy load can be as small as 300 mm for some corrugated pipes.

Calculate rate and volume of flow

To determine the rate and volume of flow from a surface water catchment area, you need three key pieces of information:

Catchment area	Run-off coefficient	Rainfall intensity
A_C = area (hectares) of catchment above the point being considered.	C = run-off coefficient (see Table 1)	I = rainfall intensity (mm/hr)

Catchment run-off calculation in m^3/s Qc = C x I x Ac / 360

Positioning and installation of surface water collection systems

Various surface water collection systems are available, so before you install the surface water system, consider the following layout factors:

- the specified system and materials
- the collection area, taking into account rainfall, ground conditions and land contours
- the type of vehicle traffic that may affect the installation
- existing houses and any proposed extensions
- existing stormwater intakes, outfalls, roadways and kerb and channels
- stormwater flowing from adjacent sites
- the materials of the various propriety systems regarding strength, weight, and the length of the channels, and the number of joints and ease of installation.

Engineers design surface water collection systems. As a drainlayer, you must install the system exactly as it was designed.

Under the Building Code (Clause E1), there must be consent from the local Territorial Authority (TA) to install a surface water collection system. This consent is granted after the plan is approved by the Authority. Any departure from the approved plan leaves the drainlayer liable for any problems that occur as a result of the installation. This means the drainlayer could be sued for any resulting damage.

If, during the installation, you find any factors that might affect the system's final performance, you should raise the issue with the owner or designer. An amended design must be approved before you continue with the installation. The consent applies only to the plan as submitted to the TA (that is, without alteration).

When taking measurements for positioning, use the invert at the outfall, boundary markers, building floor level or other site features.

Secondary flow paths

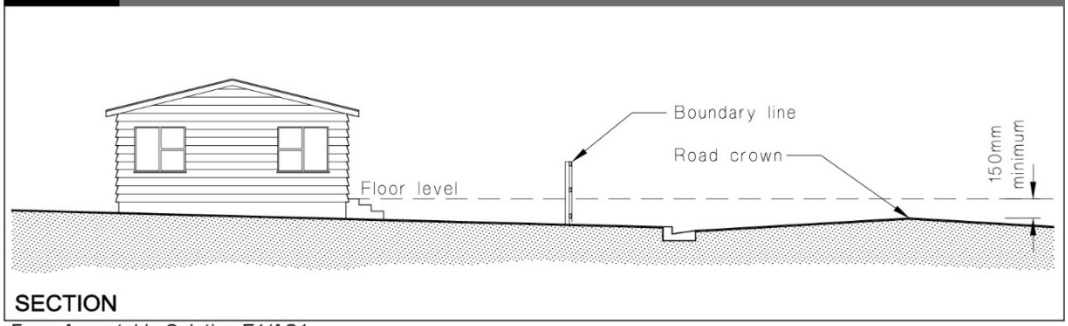
Surface water collection systems should also be positioned with consideration for secondary flow paths.

A secondary flow path is the path over which surface water will follow if the drainage system becomes overloaded or inoperative. Positioning surface water intakes in a location that has not allowed for secondary flow of water could make that part of the collection system inoperable. Care needs to be taken in the design stages to prevent flooding of buildings in this event.

Houses are designed with a minimum floor height to allow any surface water to flow around the dwelling to a neighbouring property or across the street. Boundary fences and other site development must not significantly restrict the flow of surface water from the site.

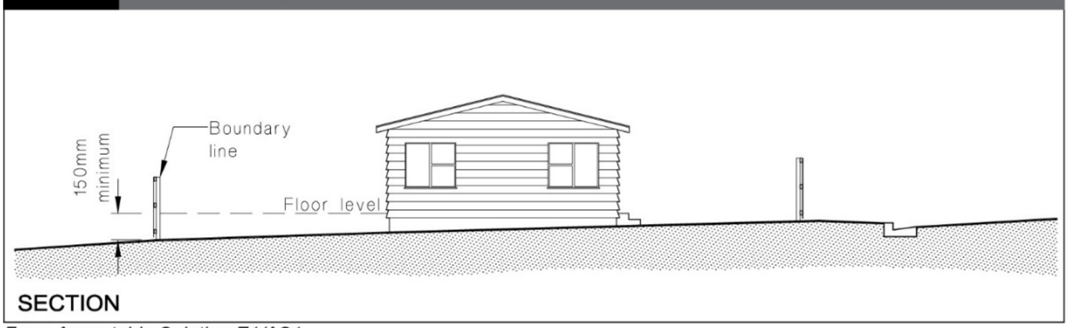
The following diagrams show how the floor level of a house will need to be designed according to the height of surrounding features such as roads.

Figure 1: Minimum Floor Level for Site Above Road
Relating to Paragraph 2.0.1 a)



From Acceptable Solution E1/AS1

Figure 2: Minimum Floor Level for Site Below Road
Relating to Paragraph 2.0.1 b)



From Acceptable Solution E1/AS1

Installation

The installation of surface water collection systems is largely the same for any drainage works. Site inspection, location of other services, establishing correct falls and gradients, and providing a stable base for the system are all considerations for the drainlayer.

Generally, to install a surface water collection system, you will need to:

Excavate the trench

and compact 50 mm of sand for the base

Lay the system

according to the manufacturer’s instructions, with an accurate gradient of approximately 1:70

Discharge the system

to a stormwater sump to collect silt and debris

Surround the system

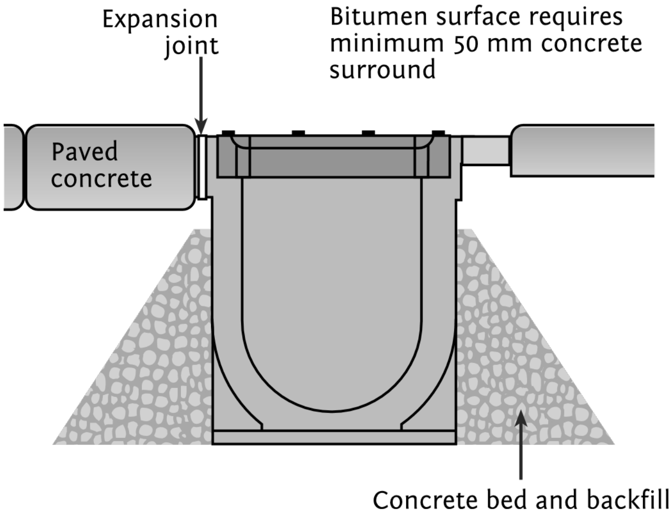
in concrete if it is subject to vehicle traffic.

Channel and grate

Surface water drainage includes the use of channel and grate. The channel and grate components shown below consist of a metallic non-slip grille supported by a polypropylene channel.

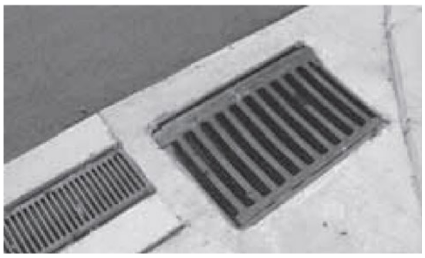
Channel and grate

Channel and grate systems typically require a concrete haunching, or embedment, as shown below.

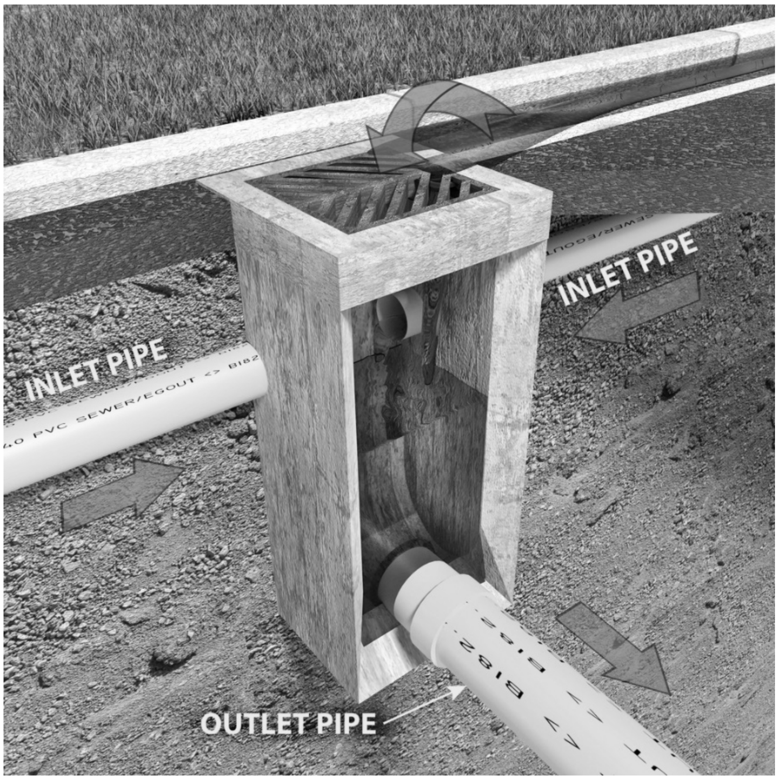


Concrete haunching for channel and grate systems

A channel and grate system then normally discharges to a yard sump. This is the demarcation point of where drainlaying work begins. The installation of the sump and its connection to an outfall is drainlaying work.



A surface drain normally discharges to a yard sump



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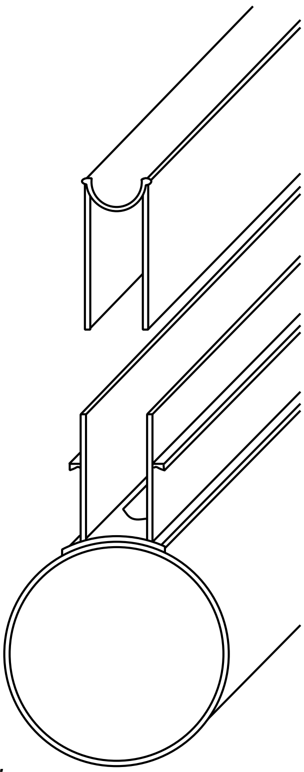
Slot drain

A slot drain normally has a narrow opening at its top with slits to allow water to flow in. It then drains through to a special 90 mm stormwater pipe.



Slot drain

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The slot drain grating may be installed level while the drain itself can be fitted with a fall.

Some slot drains have the ability to provide drainage at a level threshold. This is where external and internal floor heights are at the same level. However, these systems must still be able to keep external moisture out of the building.

Normally the flow is then discharged into a stormwater sump or trap before it enters the stormwater drainage system. This is to collect and prevent any silt and debris from entering the drain.

The size of the sump or trap and stormwater drain is normally stated on the plan or specifications; if it is outside the boundary, the TA will determine the size. This will be covered in a later section.

Remember, every property owner must provide stormwater drains to convey stormwater to an approved outfall.

Drain leakage testing

To perform a drain leakage test on an installed water drain, you can use a water test, low pressure air test or high pressure air test.

If a concrete drain is installed, then it must be soaked for 24 hours prior to testing.

Intake and outfall structures

Intake and outfall structures

NZBC E1 Surface Water requires that drainage systems for the disposal of surface water shall be constructed to:

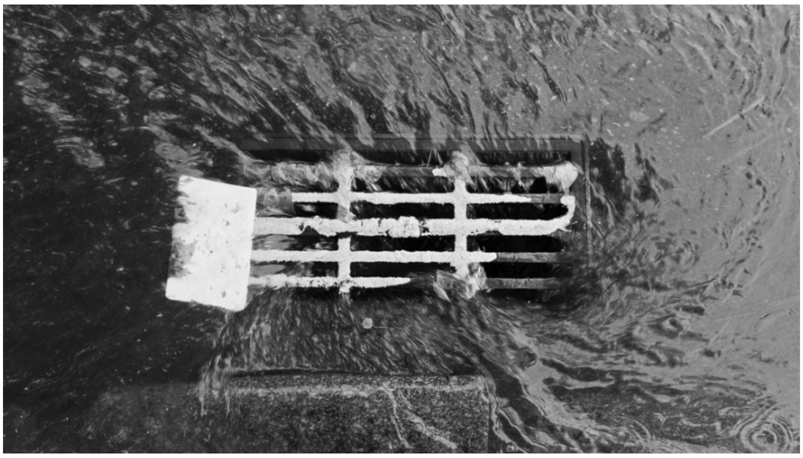
- carry surface water to an appropriate outfall using gravity flow where possible
- avoid the likelihood of blockages
- avoid the likelihood of leakage, penetration by roots, or the entry of ground water where pipes or lined channels are used
- provide reasonable access for maintenance and clearing blockages
- avoid the likelihood of damage to any outfall, in a manner acceptable to the network utility operator
- avoid the likelihood of damage from loads on drains or normal ground movements.

Stormwater intakes

A stormwater intake is generally the point at which stormwater enters a drainage system. Intakes can include such things as:

- kerb and channel sumps
- silt traps
- sumps
- chambers
- watercourse entry wingwalls.

Stormwater entering a drainage system needs to be free from debris and silt. This is to prevent blockages and failure of the system. Provision of grates or grills removes floating and larger suspended solids such as sticks and leaves. Traps in sumps allow for heavier materials such as stones and silt to collect before entering the drainage system.



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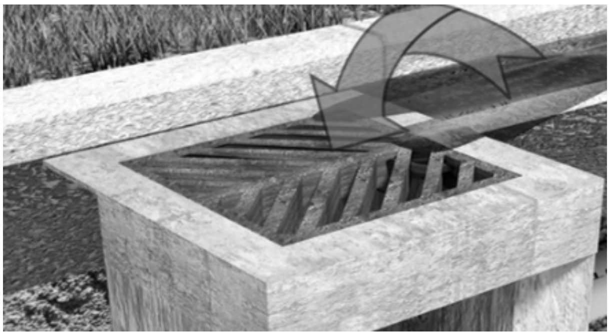
Intake design largely depends on the volume and purpose of the system.

A kerb and channel for example is a concrete or stone structure typically located at the edge of a road. It is designed to act as a barrier to prevent vehicles from leaving the road and to provide road drainage.

Kerb and channel water usually flows into the TA stormwater sewer system via a trapped sump. Because they are subject to vehicular traffic, solid cast iron grills are used and often provision for an overflow can be included. Because they have a trap, sediment can collect as previously mentioned.

Water course intakes, because of their size, don’t need traps, but usually have grills that are set at an angle of 45° and deflect larger floating materials away from the entry, to prevent potential blockage.



Stormwater outfalls

A stormwater outfall is the part of the drainage system that receives the water. For a surface water collection system from a driveway for example, the water may be collected in channel or grate, discharged into a trapped sump, and then piped to the curb. The curb and channel in this case is considered the outfall.

Other outfalls could include;

- natural watercourses
- soak pits
- the Territorial Authority stormwater system
- the downstream side of a watercourse culvert
- retention or detention tanks.

Natural watercourses

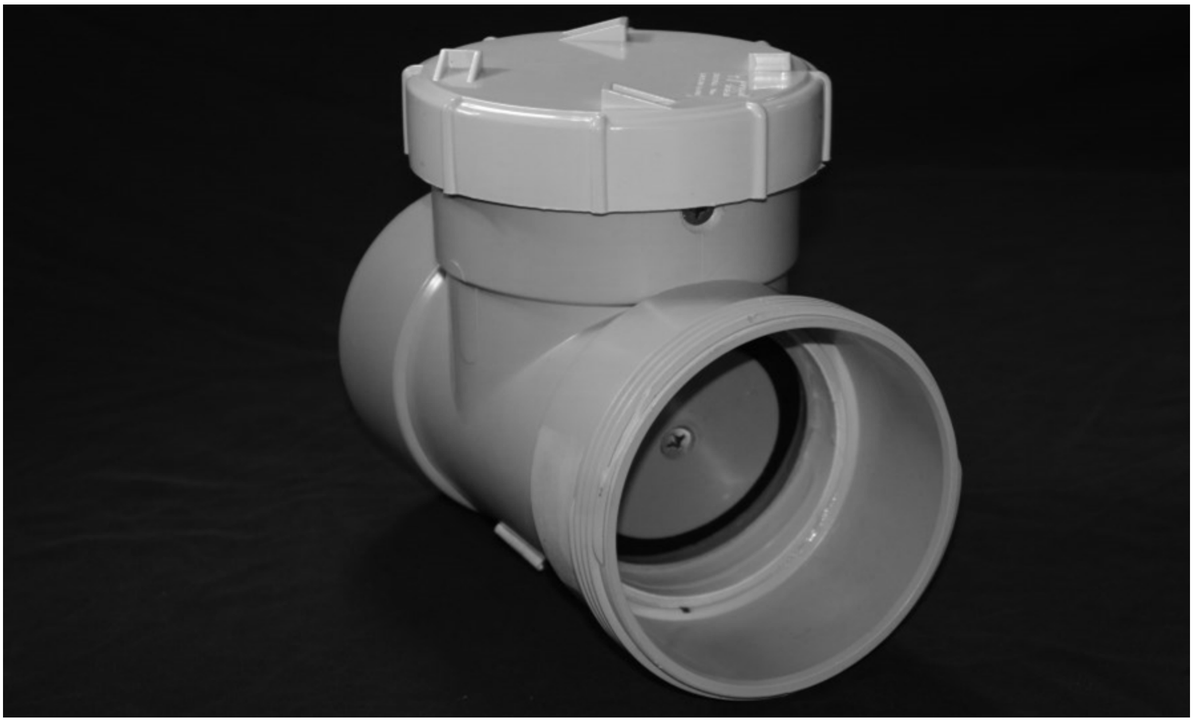
A natural watercourse is a stream of water which flows along a defined channel. It includes a bed and banks. Stormwater drains may discharge directly into a natural watercourse but may require a Resource Consent.

Care needs to be taken when discharging directly to rivers or streams. Pollutants such as cleaners, oils and petrol can be very harmful to aquatic life and the environment.

Where stormwater drains exit to an outlet affected by tide fluctuations, either river or sea, the tidal water should be stopped from flowing back up the drain. This is to prevent build up of silt and debris which can cause blockage, and also surcharge or flooding of the system or property.

Backflow can be prevented by a reflux valve (check valve), culvert sock or flood gate.

A typical culvert sock is manufactured from flexible polypropylene fabric. While the culvert sock is primarily used to transmit water from the discharge end of a culvert and prevent soil erosion at its outlet, it can act to prevent backflow into a stormwater pipe.



A 100mm uPVC reflux valve

Flood gates installed on a stormwater outfall

Soak pits

E1/VM1 Surface Water includes a procedure for determining soak pit requirements for surface water disposal. Surface water can be disposed of by soakage but may require an additional chamber or detention tank that gives additional storage, to avoid overflowing in times of high rainfall.

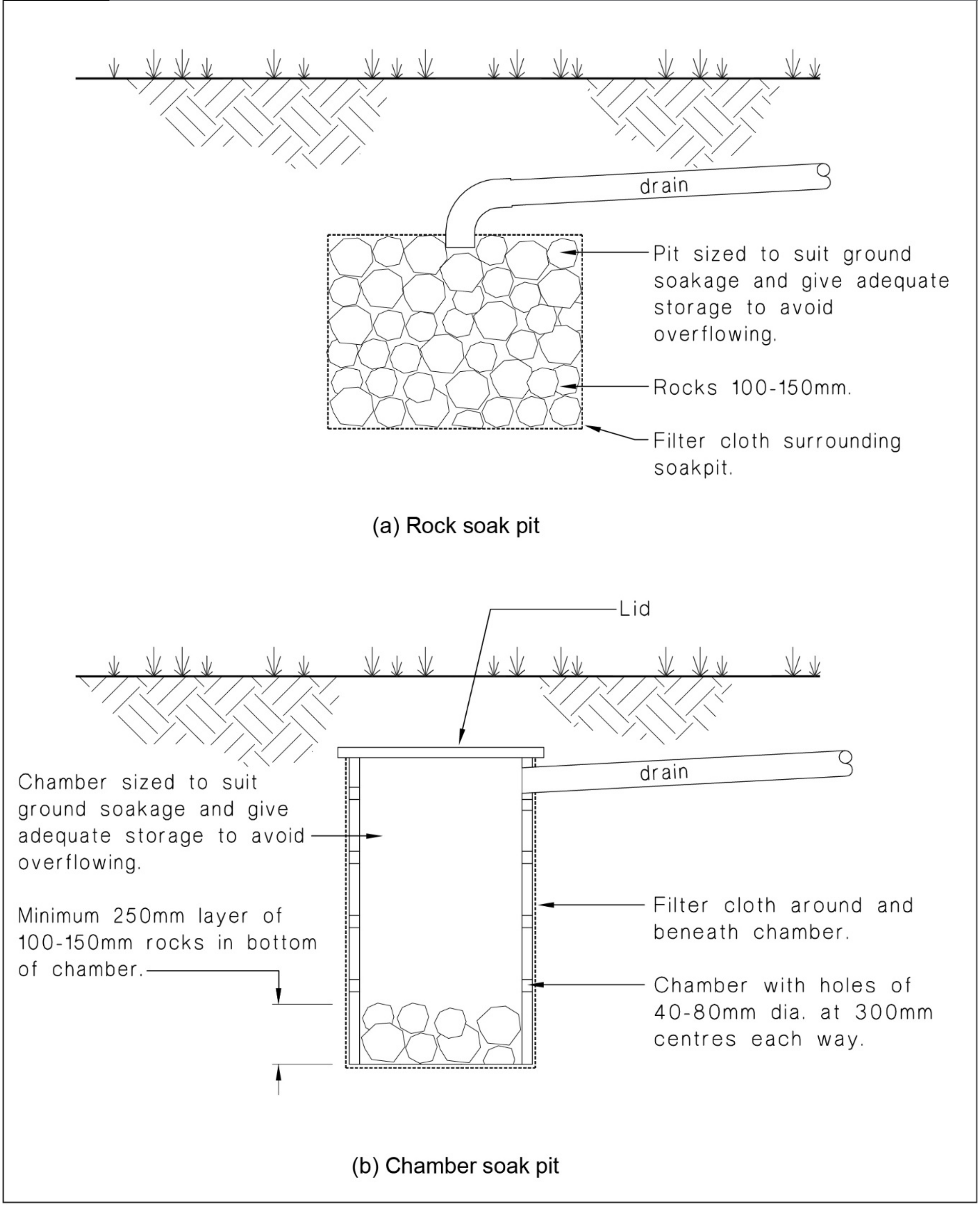
A soakage system and any sub-surface drains need to be higher than the water table in order to dispose of stormwater or sub-surface water. The water table is measured as the level below which the ground is saturated with water. If a hole is dug and stays partially full of water, the water table has been reached.

When installing soak pits the pit or chamber needs to be enclosed in filter cloth or geotextile materials to prevent soil infiltration as shown in the picture below.

Rocks being delivered to a soak pit

The diagrams below from E1AS1 show a rock-filled soak pit and a chamber soak pit.

Figure 13: Soak Pit for Surface Water Disposal
Relating to Paragraph 9.0.4



From Verification Method E1/VM1

Tests to prove the absorption rate of soil are referred to in E1/VM1 Surface Water as field tests. Field testing of soakage includes, for example, the plotting of water level drop against time on a graph.

Usually where the test results show a soakage rate of greater than 500 mm/hr, soakage rather than storage will need to be the main means for removing water. Soakage rates significantly less than 500 mm/hour will usually use storage. Intermediate soakage rates will require a design using both soakage and storage in a way that ensures the water will go away before it overflows from the pit. Such disposal is subject to suitable ground conditions, and as confirmed by site tests.

Points to note:

- where soak pits are used the overall ground stability may need to be verified
- soak pit surface water disposal may require a Resource Management consent
- soak pits should preferably be at least 3m from a building.

Territorial authority stormwater system

A territorial authority stormwater system is operated and maintained by that territorial authority. Direct connection to this system is similar to foul water drain connections to sewers.

Where a stormwater system is near a property, the territorial authority will usually require connection to that system rather than to a kerb and channel. Direct connection to the sewer is preferable to a kerb and channel discharge as it usually provides better fall to the invert of the outfall.

Retention and detention tanks

Retention and detention tanks are large-capacity underground tanks. They control the flow of stormwater run-off from a roof or site for when the stormwater catchment capacity exceeds the stormwater disposal system. The function of a retention tank is different from a detention tank.

A detention tank	A retention tank
• Slows the flow of stormwater. Stormwater enters the tank through a 100 ml inlet and can only exit slowly through a small aperture in the bottom of the tank.	• Keeps or retains the stormwater to be used for household purposes. The overflow is then run off to the council stormwater system.

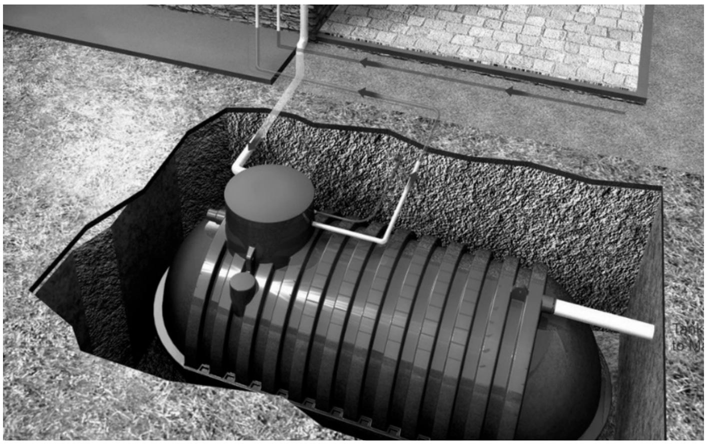
Retention or detention tanks are commonly used in the construction of infill housing in an existing development. The territorial authority may insist that a retention or detention tank be installed to prevent overloading of the existing stormwater disposal system or the homeowner may choose to install a retention tank to collect stormwater for the household. The installations of these tanks are an 'Alternative Solution' under the Building Act.

Retention tanks

A retention tank is a large-capacity tank (or group of tanks) where stormwater is collected from the roof and 'stored' for household use or the garden during periods of water restrictions. A retention tank is commonly known as a rainwater tank.

Many territorial authorities with continuing water supply shortages insist all new houses have a suitable minimum-capacity retention tank installed.

Note in this picture the outlet at the top of the tank, and the pump line back to the dwelling.



Retention tank

Detention tanks

A detention tank collects run-off from the roof or surface water from the site and stores it temporarily for slower release to the stormwater disposal system.

A large capacity tank (or group of tanks), is installed as part of the stormwater disposal drain. The tank collects peak stormwater run-off from the roof or site. The water then trickles through a small-diameter outlet into the existing stormwater disposal system. This slow release of the water from the detention tank reduces overloading of the disposal system.

A large scale detention tank system being installed

Debris and coarse sediment is captured by a sump with a silt trap to prevent blockages to the small outlet and to reduce the frequency of the need to clean the tank. The outlet is normally controlled by an adjustable valve.

Materials

Both types of tank may be made of pre-cast reinforced concrete, corrosion resistant metals or high-density polyethylene. A tank must be strong enough to withstand traffic and other imposed loads.

The material used should also take into account environmental conditions such as acidic soil, saturated soil, and tides.

A tank's capacity is usually between 450 litres and 30,000 litres, although custom-made tanks may exceed this.

Base

A retention or detention tank must be installed on a stable base.

> *If there are doubts about the base's stability, you might need details of how the base is to be strengthened or have a base designed by an engineer.*

> *Before starting work on a base, make sure there are no underground services in the excavation area.*

When installing a retention or detention tank you must take into account two critical factors with regards to the base.

1. The base must be able to support a fully loaded tank without sinking. Generally, the engineer's design for overcoming an unstable sub-base will have been laid out in the consent documents. If you fail to follow this design, you void the consent and may be liable for any resulting damages.
2. The base must be installed level. This will help ensure that the load is evenly spread and that no part of the tank is under more stress than any other (uneven stress may cause the tank to fail).
3. Above all, the manufacturer's installation instructions must be carried out and the conditions of the consent complied with.

Installation

In most cases, the job specifications will dictate where the tank is to be located. However, you must position tanks where the excavation will not damage existing building foundations.

The finished position will be marked on plans or on the building consent documents.

The tank may be located below or above ground. Underground tanks should not be located in any area that will be used for the passage of vehicles unless they are specifically designed for that purpose.

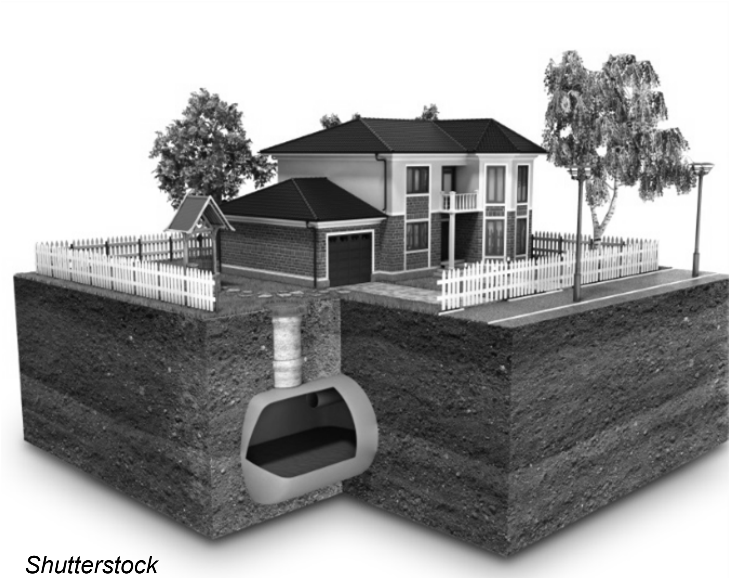
Install the tanks according to the manufacturer's instructions. Make sure you follow these directions closely. You will need to prepare and compact a solid base to hold the weight of the tanks and prevent them from tilting or sinking.

You may need a method to prevent uplift. In such a case, a concrete slab over the top or holding-down straps should have been specified in the consent documents.

Backfill the hole with graded material in 150 mm to 200 mm layers, then compact them.

A tank should have a removable lid located close to the surface. This is for inspection and cleaning. The lid must be sealed properly to stop contaminated water getting in (direct surface water away from all entry points). Overflow pipes run directly to the outlet drain.

Backfilling a tank must be done to the manufacturer's specifications (or the consent specifications, if there are special conditions). Each authority will have its own guidelines; it is your responsibility to know and follow these guidelines. When a tank is filled to capacity, incorrect backfilling might not support the walls sufficiently and could lead to the tank's premature failure.



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Commissioning

The consent or job requirement documentation will state the commissioning procedure. This may consist of filling the tank with water to check it is watertight, and making sure the discharge valves on sewage detention tanks are working properly.

Ensure that the lid is sealed to prevent water getting out.

Watercourse drainage

Watercourses are open drains that occur naturally as depressions in the ground. They might have a continuous flow of water or they may only flow when it is raining.

Watercourses are often piped in order to improve the surrounding land, or through culverts where they need to pass under roads.

Subdivision drainage may also require culverts under new driveways. Drains may be laid from one property boundary to another so that the property owner is able to use all of the land.

Watercourse drain being installed

When a watercourse has been piped, new buildings will be able to be located a lot closer to it. A secondary flow path must be allowed for when designing a building. The secondary flow path is the path surface water will follow if the drainage system becomes overloaded or inoperative.

When piping natural watercourses, outflows such as the example shown should be avoided. The cascade or waterfall that has been created will prevent aquatic and marine life moving upstream to spawn.

A poorly designed outfall inlet

Piped watercourses are the responsibility of the landowner. The piping of a watercourse will require a Building Consent in built-up areas and will usually require a Resource Consent.

Design

A piped watercourse has seven parts:

1. bedding
2. pipe installation
3. intake structure
4. outfall structure
5. haunching
6. sub-soil drainage
7. backfill and finished surface

The design of a piped watercourse is usually done by an engineer. The design will calculate any loss of flow due to the design of the wing walls and any gratings to catch debris.

Materials

The type of pipe used for a watercourse depends on:

- the diameter needed,
- its location, and
- the gradient it will be laid to,

All of these factors will need to be approved by a territorial authority engineer.

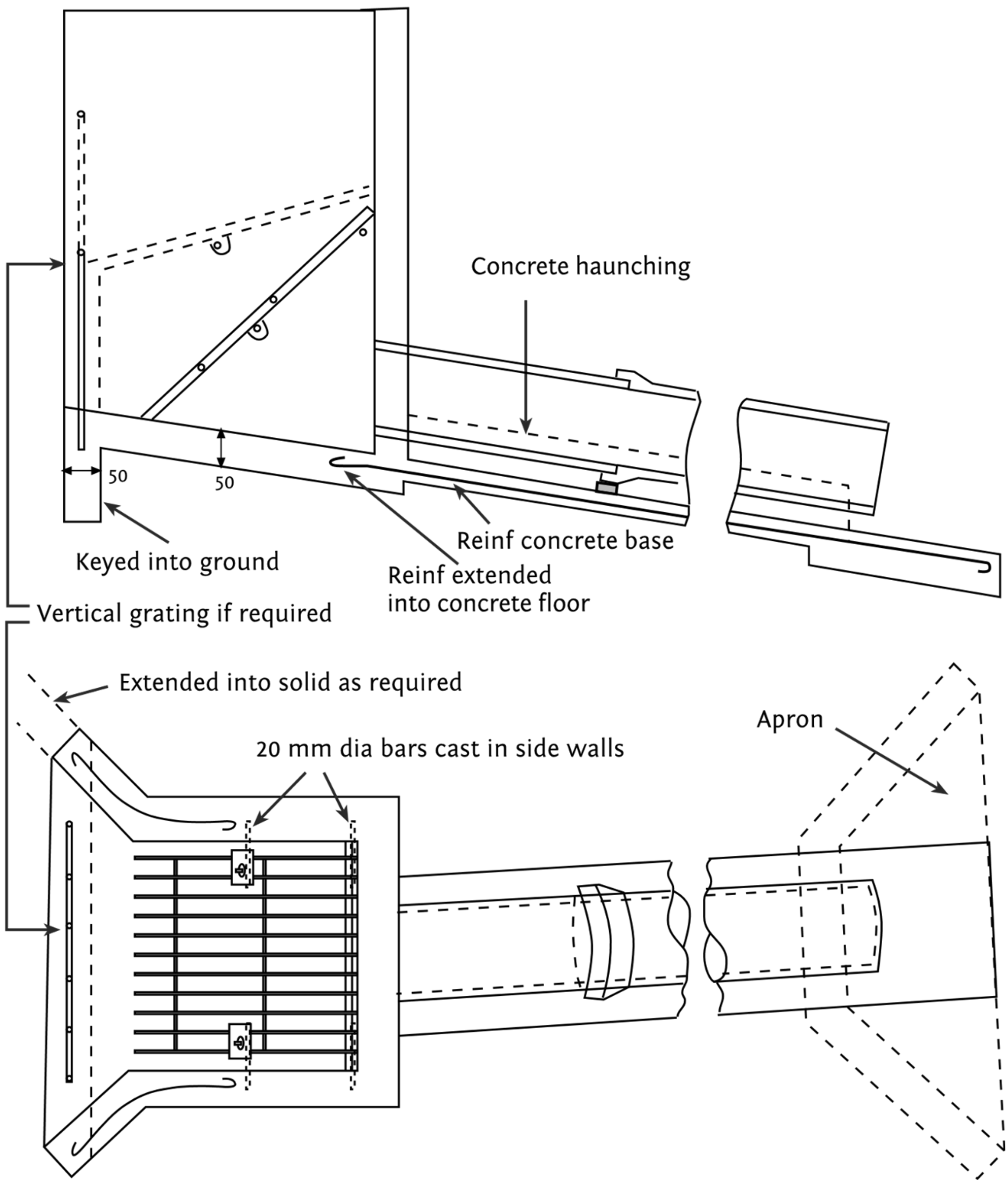
The diameter of the pipe is calculated by mapping the catchment area above the drain and adding any other flows, such as drains from road sumps and any other contributing catchment areas (plus consideration of other factors such as the rate of run-off and expected rainfall intensity).

Intake structures

The following diagram shows a combined precast/in-situ intake installation. The intake structure funnels water into the pipe and allows it to operate at full capacity. It is useful to install the intake and outfall structures as part of the bedding process. The structure needs a sill which should be keyed (locked) into the trench base. This anchors the structure and prevents any leakage from undermining and scouring the drain.

If a concrete base is used, the intake structure needs to be connected to the bedding. Wing walls should be keyed into virgin ground.

A screen or grate should be installed to act as a filter and prevent debris from blocking the pipe.



Combined precast/in-situ intake installation (from James Freuan)

The outfall structure is designed to spread out the flow of water before it re-enters a watercourse, creek, stream or estuary. The installation procedure is the same as that needed for intake structures.

Reducing the velocity (speed) of the water

Energy dissipaters, or energy reducers, are often incorporated into the design to slow down the flow of water and limit scouring of the watercourse downstream from the structure. These could simply be rocks or concrete blocks cast into the base.

Preventing erosion

A stormwater outfall can use rock filled gabion baskets being used to stabilise the watercourse banks and prevent erosion. The rocks are laid to dissipate the water force as well as to aerate the water as it flows over them, thus adding oxygen and assisting in the natural purification process.

Installation

When installing concrete-bedded drains or culverts, drainlayers need to establish a stable base and divert any water flow from the construction site. If the drain will run adjacent to the natural flow of the water, or in ground that has not been subjected to water flow, the ground base will be harder and more stable.

Small water flows can be controlled by installing one or two 150 mm unperforated drain coils from an upstream dam (temporary enclosure to capture upstream water), known as a *coffer dam*.

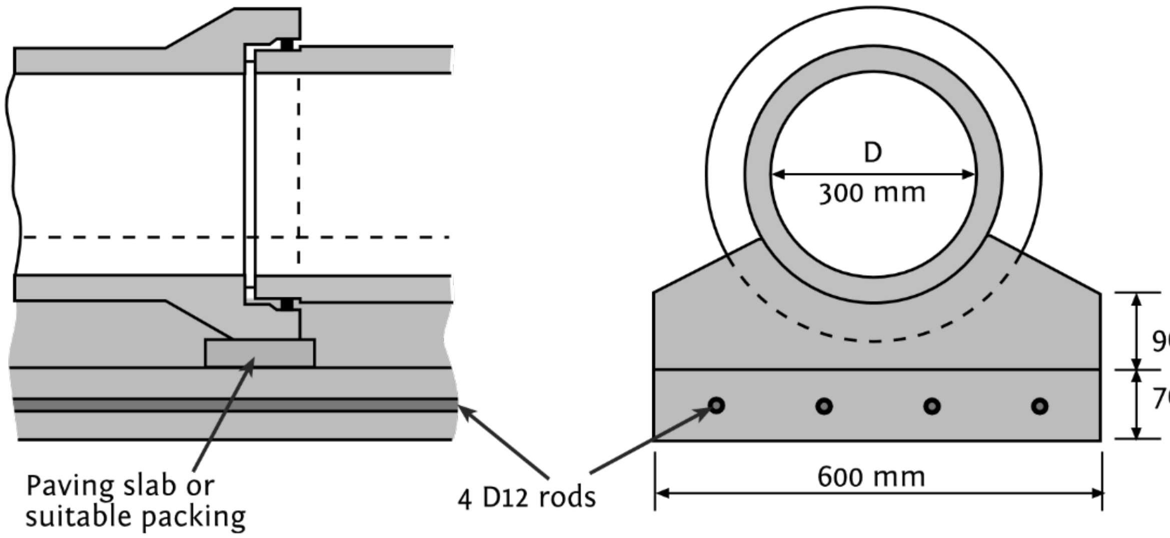
A coffer dam can be built using sacks filled with sand and clay to seal around the pipes. The coffer dam should be funnel shaped and 200 mm higher than the soffit of the pipe to ensure the pipe can run full if required.

Once the base has been prepared and the boxing and reinforcing has been installed, the concrete can be poured. It is first important to check that the surface of the concrete is the correct grade.

If plastic pipe has been specified, it may be placed directly into the wet concrete and secured in place.

A bond breaker such as a plastic sleeve or polyethylene sheet may also have been specified. If concrete pipe is specified, pieces of concrete such as the knockouts from concrete blocks or pieces of paving slab can be set in the concrete.

Remember though that these need to align to the gradient of the concrete trench base. There should also be enough distance between the pipe collars and above the concrete base for haunching under the pipe.



Typical concrete bedding and haunching

Installing the watercourse intake and outfall structures

Intake and outfall structures may either be precast (purchased as a stock item) or cast in-situ (made on site).

Precast intake and outfall structures may be installed as part of the setting out and bedding process. If they are installed at a later stage, reinforcing rods should be left protruding from the bedding so that they can be joined to the bedding with concrete.

In-situ intake and outfall structures have a concrete base that is connected to the concrete bedding. Walls may be formed using boxing and concrete, or by mortar-jointed concrete blocks which are filled with concrete and secured to the base with reinforcing rod starters.

The steps to install intake and outfall structures are:

- install the haunching
- install the sub-soil drains if required
- redirect the diverted water
- redirect the diversion drains via temporary pipes inserted through the finished drain to allow the backfilling of the drain and allow any cast in-situ intakes and wing walls to harden and cure. Seal the drainpipe/headwall gap with mortar or epoxy resin compound
- when the concrete has hardened, remove the diversion drains, install the gratings and clean up the site.

Sub-soil drainage

Sub-soil drainage may also be incorporated where groundwater might affect the bedding and integrity of the drainage structure. This will be specified as part of the engineer's design. Drain coil is laid alongside the bedding material. It is installed from behind the intake wing wall and discharges through a hole in the outfall wing wall onto the apron. The installation of subsoil drainage will also affect the design of the backfill.

Backfill and finished surface

Unless specified by the designer, backfill needs to comply with E1/AS1 Surface Water.

Where sub-soil drainage has been installed, a column of compacted free draining material should extend from the invert of the drain coil to the level of the top of the compacted granular drain backfill. The finished surface should be 150 mm below the top of the intake and outfall wing walls.

Installing intake and outfall structures for drainage systems whether they are small domestic, such as a curb and channel, or civil works wingwalls and culverts are an important part of the drainlaying trade.

Installing wingwall structures

A wingwall structure is installed at either inlets or outlets to direct the flow of water and minimise erosion. A wingwall structure funnels surface water to a pipe, which allow the pipe to run at its maximum flow and capacity.

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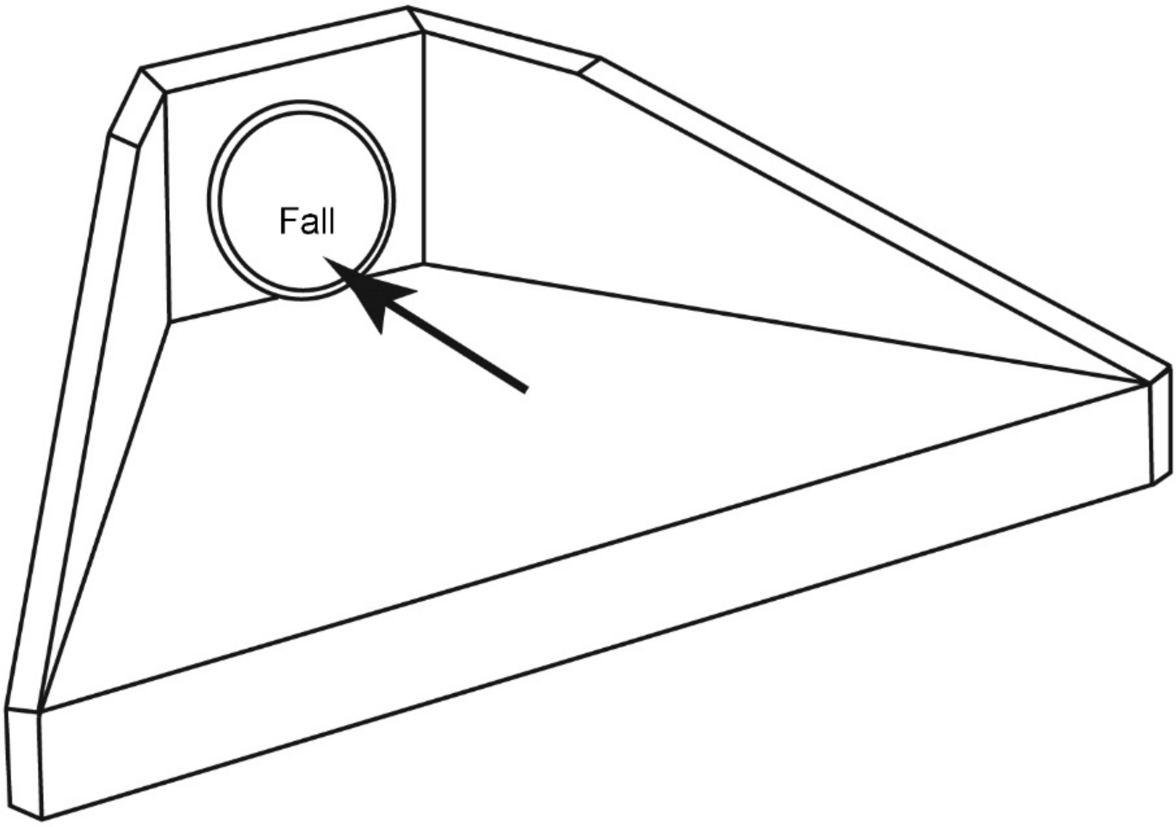
Wingwalls in New Zealand are generally precast concrete that are lifted into place. Before placing wingwalls, work needs to be completed to correctly prepare the base so that it is level and will not sink over time.

The sill (also called the toe, heal, or apron) of the wingwall intake or outfall structure is keyed to anchor the structure and prevent any leakage from undermining and scouring the drain. This will need to be considered when the basecourse materials are prepared.

Wingwalls with more than one barrel usually come in two sides, and may require a section of concrete to be poured in situ after the sides of the wingwall are installed. The concrete will need to be reinforced with steel mesh following the specifications. Make sure the stormwater intake pipe is not protruding.

After the wingwall is installed, the pipes (usually concrete or PVC depending on the size and specifications) are installed and sealed with an epoxy mortar.

Make sure you read the plan and specifications detailing the stormwater intake wingwall installation.

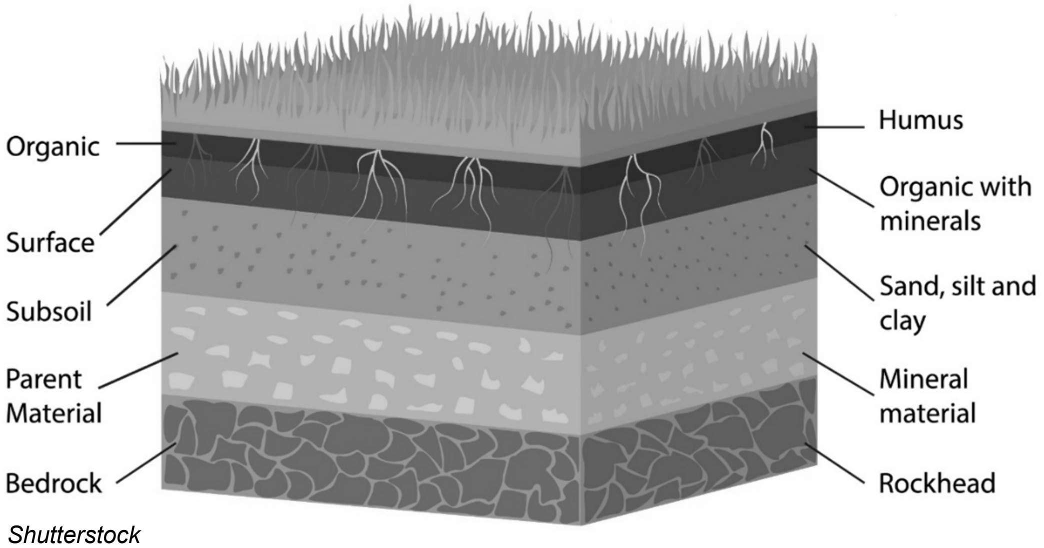


Stormwater intake wingwall

Subsoil drainage

Types of soil

Soil is made up of many different layers. The subsoil layer is shown in the diagram below.



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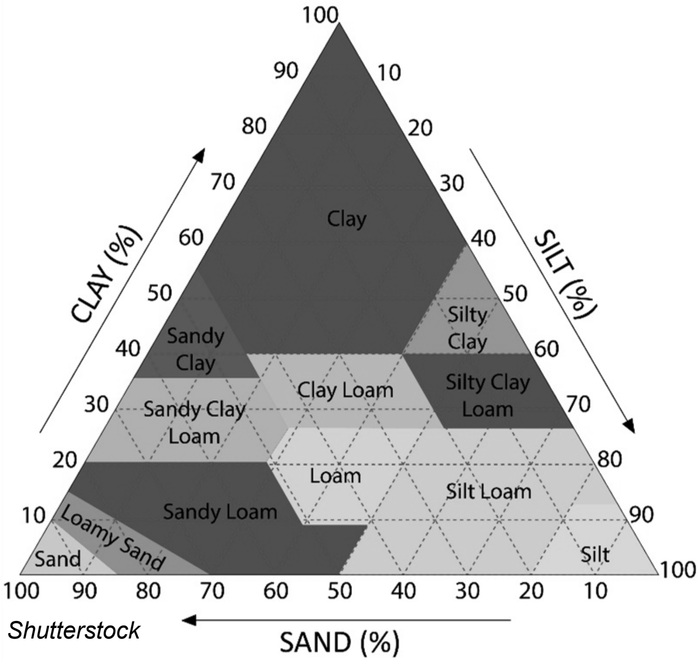
There are three basic types of soils;

Sandy is a naturally occurring granular material composed of ground rock and mineral particles. It is very porous and therefore drains very easily.

Loamy is composed of sand, silt, and clay. It is ideal for gardening and agricultural uses. Loam soils generally contain more nutrients and humus than sandy soils and have a medium drainage rate.

Clayey is made up of very fine particles of soil. It has good moisture and nutrition retention, but drains slowly.



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While sandy soils will drain very quickly, loamy and clayey mixtures will require more drainage to control the ground water.

For the control of subsoil water from a specific area, such as around a basement or retaining wall, a single subsoil drain may be adequate. However, when effectively draining larger or wetter areas, multiple drains may need to be installed.

Subsoil drainage

Subsoil drainage is used to capture, control or redirect subsoil water (also referred to as groundwater).

There are three main reasons for installing subsoil drains;

- to lower the water table, that is the level of water under the ground. These drains will normally be at a depth greater than a metre. Deep drains are more effective in doing this, but therefore need special consideration with regards to their outfall
- to intercept groundwater – interceptor drains, which is where water is seeping underground and needs to be redirected away
- to drain water from the base course or sub-base of a structure, or road using base course drains.

Subsoil drains are also be known as French drains.

A basic French drain with perforated pipe and crushed rock fill

Properly installed subsoil drainage lowers the ground water level but still allows moisture to be retained in the soil. Removal of enough water from the soil improves soil aeration and prevents ponding. Sub-surface water can also be controlled to improve or maintain ground conditions.

Land may also be drained to make it suitable for structural building work. Removing ground water increases the soil strength and stability of the ground and therefore the strength of building foundations, expressly for the purposes of NZBC compliance (B1 Structure).

Subsoil drainage typically connects to a yard sump, but can also connect directly to a stormwater drain. If it does connect directly to the drainage system, care must be taken to ensure silt or soil does not enter.

The design and extent of a subsoil drainage system largely depends on the type of soil.

The amount of water that a particular type of soil usually contains is called the soil moisture regime.

This water and soil mix holds or bonds the soil together. Removing too much of the water especially in clayey soils can dry it out, causing it to shrink and loose its bonding ability. If the drain is too close to a structure (in certain conditions) it can weaken the loading of building foundations by too much drying out.

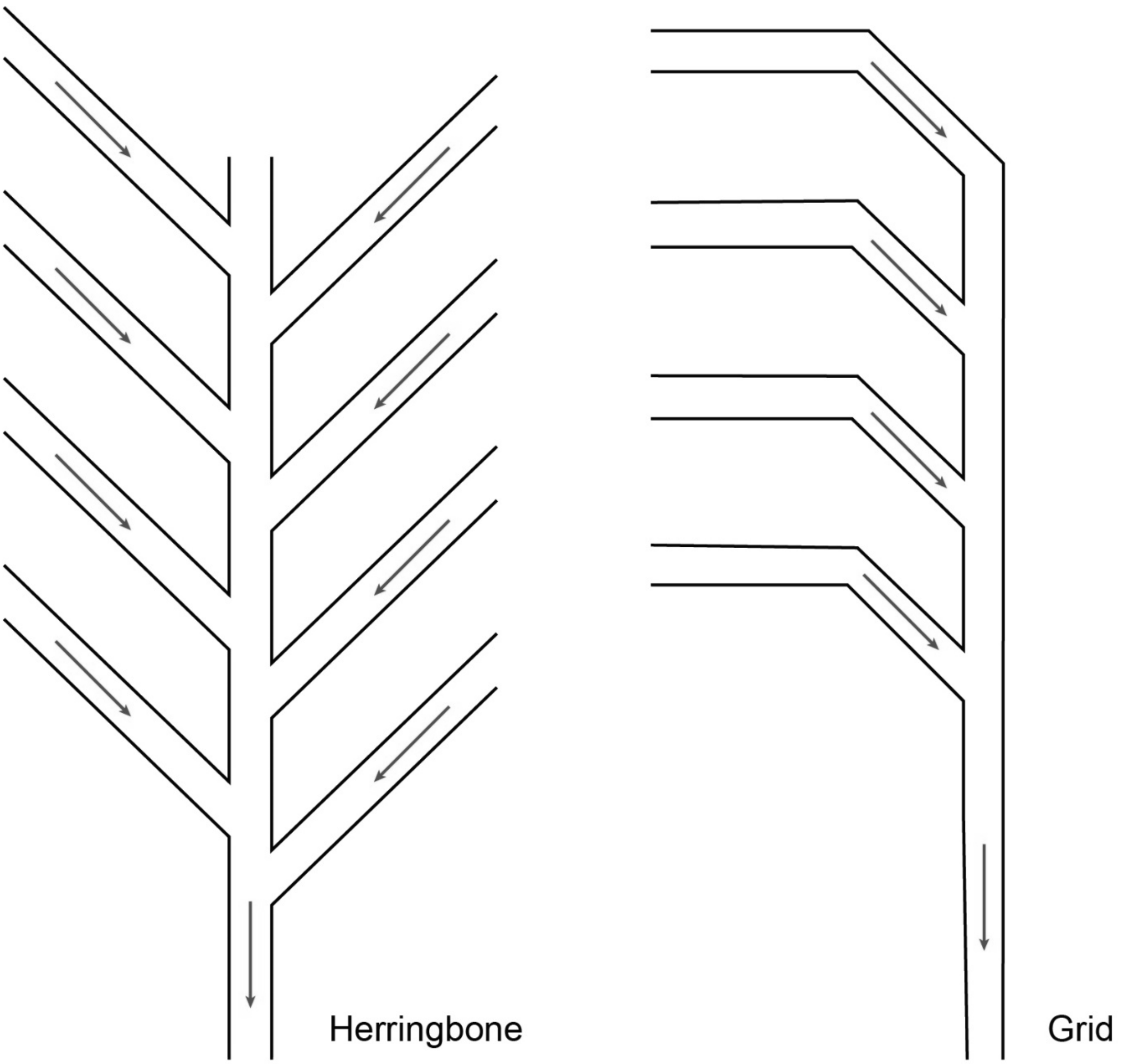
When installing sub-soil drainage, you should do a visual inspection to make sure that the sub-base is stable. An unstable sub-base could be any soil type which looks like it might collapse or compress when backfilled. This includes un-compacted or water-logged soft clay, sand or loam.

If you are unsure of the stability of the base material, a penetrometer could be used, or an engineer's report may be required.

Soil and soakage rates

The soakage rate of different soils relates to the amount of water the soil will contain. Soils with a high soakage rate (such as peat) will hold more water and therefore require more drainage. See the section "Surface water collection systems" for how to calculate run-off coefficients.

Shown below are two common layout patterns with branches into a main drain for draining a larger or wetter area.



Spacing for branch subsoil drains

The layout and spacings of the drains or branch drains will depend on the type of soil and the water it is holding (soil moisture regime).

A/S3500: 3 gives recommended spacings of subsoil drains for effectively draining each type of soil.

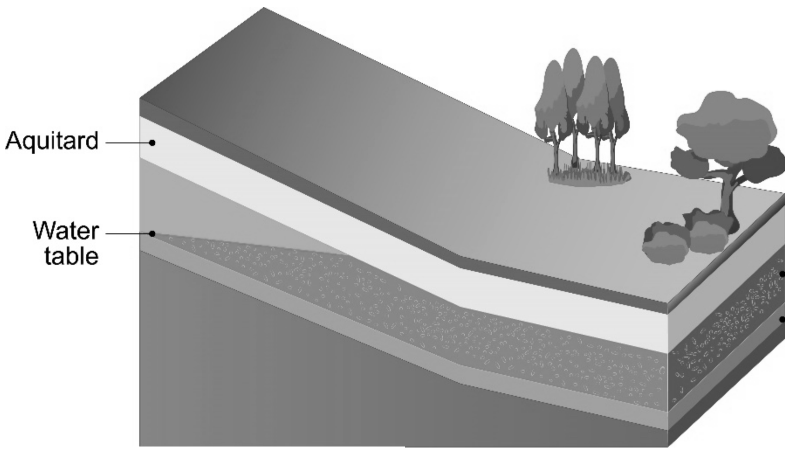
Soil type	Maximum spacing (in metres)
Soil/loam	16 to 20
Soil/clay	12 to 16
Clay	2 to 6

Recommended spacing for branch subsoil drains

A typical subsoil drainage system

Water tables

The water table is the level at which water sits underground. It can fluctuate due to seasonal conditions and rainfall, and may be affected by underground aquifers and streams. High water tables can cause problems for building structures, such as basements, and effect agricultural processes. Farmers often create ditches and install subsoil drainage systems to lower the water table and improve crop production.



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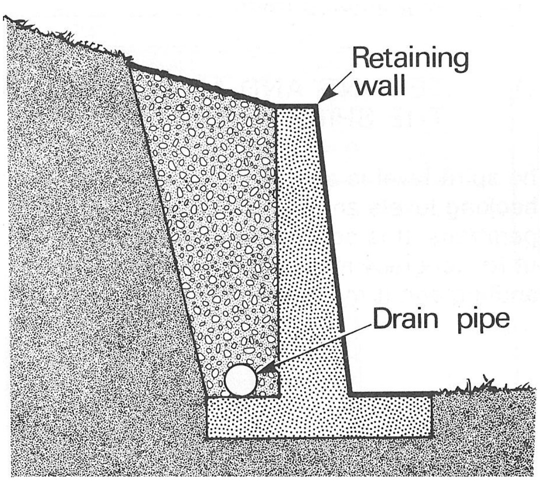
Diverting groundwater from behind basement/retaining walls

Basement and retaining walls need to be provided with drainage, otherwise water will build up behind them and pond. In the case of basement walls, water may then leak into the building, causing a nuisance and effecting its structure.

Ponding water behind a retaining wall can cause it to collapse due to the pressure of the volume and weight of the water. Waterlogged soil will also lose its strength, affecting the stability of the wall foundation and its sub-base.

The diagram to the right shows drainage behind a retaining wall to divert groundwater.

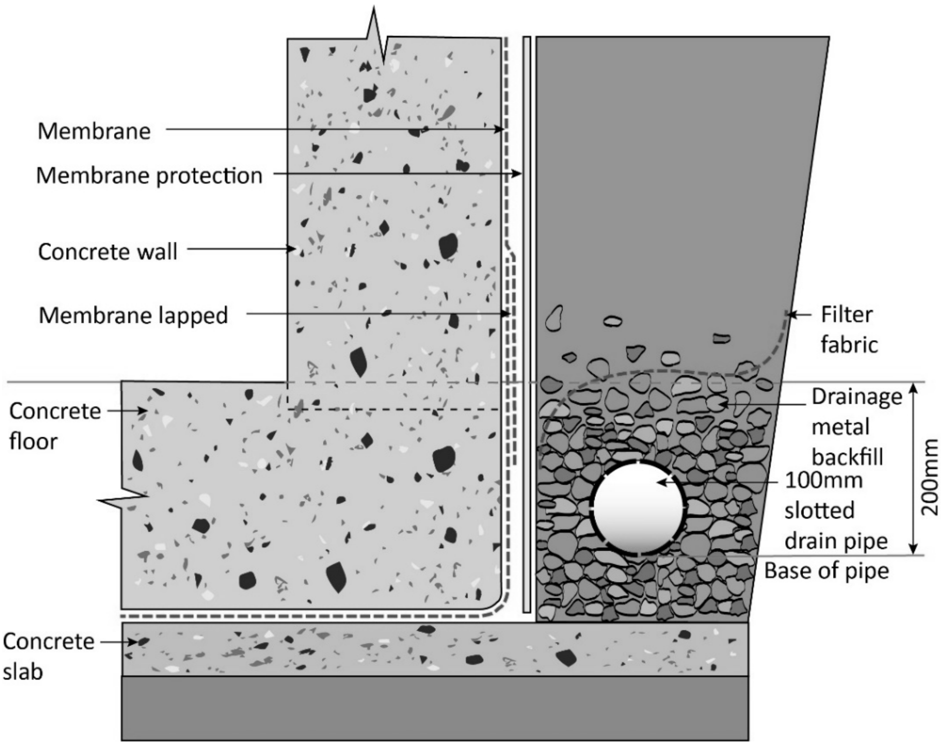


Drainage behind a retaining wall

Groundwater can accumulate against in-ground walls. Subsoil drainage must be incorporated to ensure that water does not accumulate (where the increase in hydrostatic pressure may overload the membrane and cause it to leak) and that the water is drained effectively. To do this, ensure that the building consent documentation is followed.

Drainage systems should incorporate:

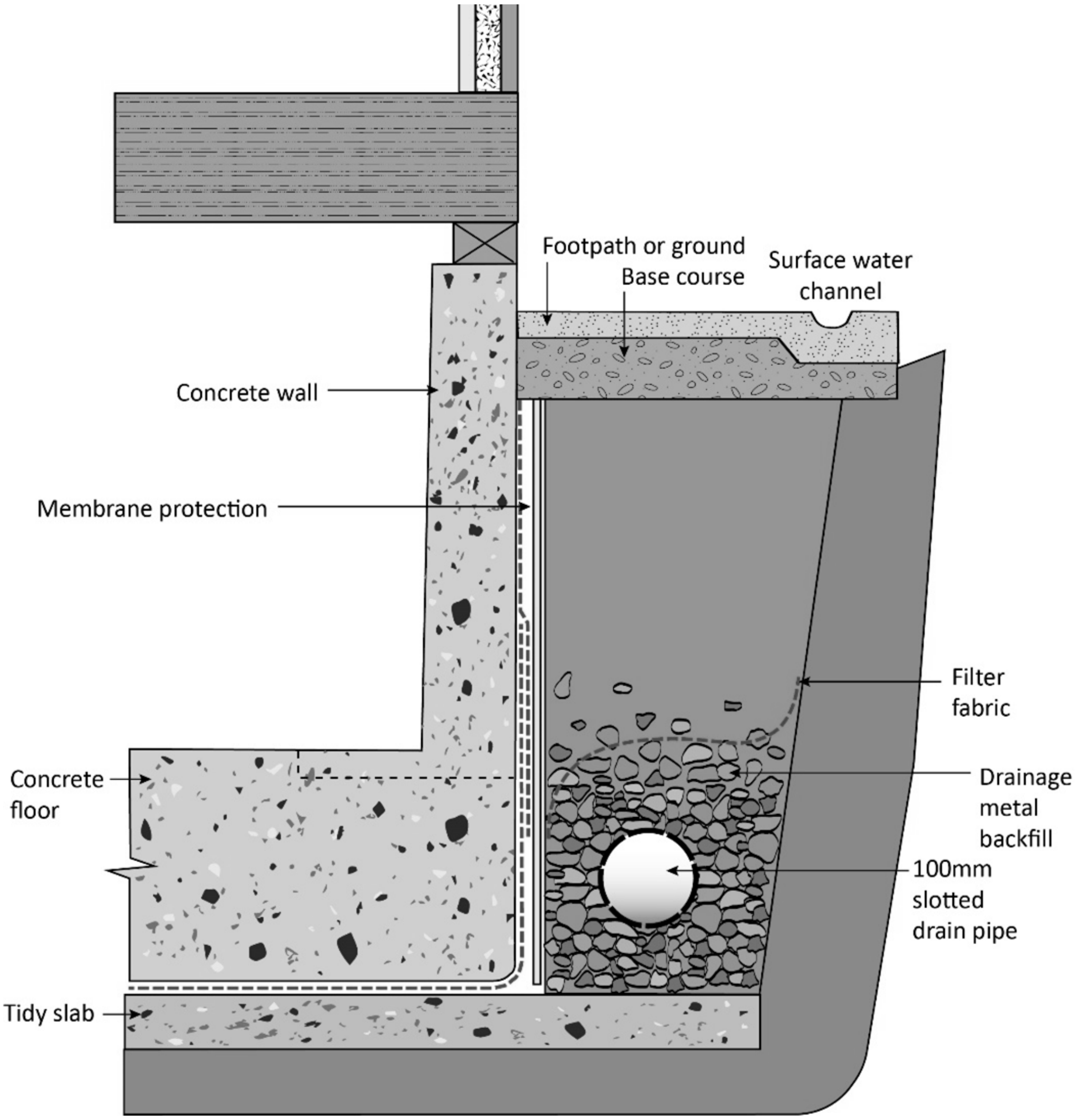
- a minimum 100 mm diameter perforated subsoil drainage pipe installed at the base of the wall on free-draining metal at a level above the bottom of the footing. Ensure the invert level of the drain is a minimum of 200 mm below the finished floor level
- the pipe protected from clogging by a water-permeable fabric
- the full extent of the wall backfilled with free draining metal.



Drainage behind a basement wall - Learnops

All subsoil drainage pipes at the base of in-ground walls need to have sufficient fall to ensure that effective disposal occurs and must be connected to a stormwater system. Pipe outlets need to be accessible so they can be cleaned.

Most below-ground damp proofed basement walls fail because the damp proof system has been put under too great a load as the result of groundwater accumulation from poor subsoil drainage.



Elements of basement drainage - Learnops

Designers, builders and drainlayers need to be aware of all requirements for weathertight basement construction.

They should ensure that:

- a suitable damp-proofing membrane is accurately installed by a specialist installer
- this is protected on all below-ground walls
- adequate drainage ensures that subsoil water is effectively drained.

Access for cleaning the sub-soil pipe behind basement and retaining walls needs to be provided. This can easily be achieved by extending the sub-soil drainage to ground level and fitting an access cap. This allows for periodic flushing of the drain to remove any build-up of silt.

Sub-soil pipe access fitting

Drains under buildings

Under E1/AS1, if a drain has to be laid under a building, it must be laid in a straight line from one side of the building to the other.

There needs to be access to the drain within 2 metres outside the building's exterior wall.

The inlets to the drain can only be from sealed roof-water downpipes, and access must be provided to the drain via a sealed access point in the downpipe. This downpipe must be immediately above the ground floor level.

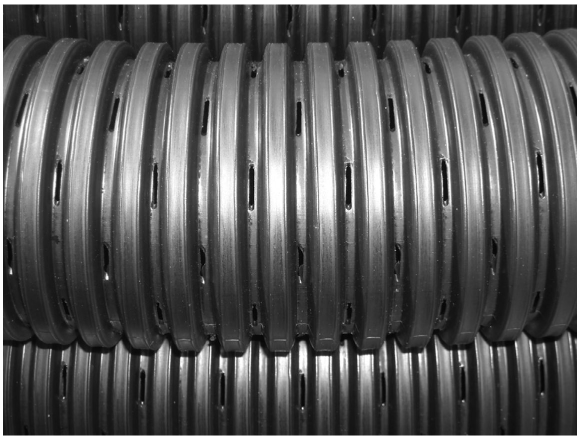
Materials

There are many materials used to control sub-surface drainage, and special consideration needs to be given to their selection and use. Often engineers will specify the requirements for the installation. Always make sure to follow the manufacturer's instructions.

The basics of subsoil drainage systems are to collect water and drain it to an appropriate outfall. All subsoil drainage pipes have gaps, slots or perforations to allow ground water to enter the system, and then be conveyed to the drain.

Typical piping systems used for the collection can be

- 300 mm-long unglazed ceramic field tiles, which are butted together
- slotted or perforated uPVC pipe, which is made are straight lengths or continuous coils.



Perforated drainage coil

Other considerations are the trench size and fill material. The excavated area should be large enough for the specific ground conditions, and be filled with course gravel or rock (compacted granular material) to allow the water to pass easily into the piping system.

The engineer will usually specify the grade and type of fill material.

The drainage system's efficiency and longevity relies on the prevention of silt and soil particles entering the fill material and then the drain. Filter cloth or geotextile materials help prevent this, but remember, you should always provide access for cleaning.

Geotextile or filter cloth is a permeable fabric material. It allows water to filter through it while preventing the entry of soil or silt. It helps to promote "wetting of the area" and prevents trench erosion. It comes in varying width rolls for lining and covering trenches, and also as a sock which can be slid over the pipe.

Drainage pipe encased in geotextile filter

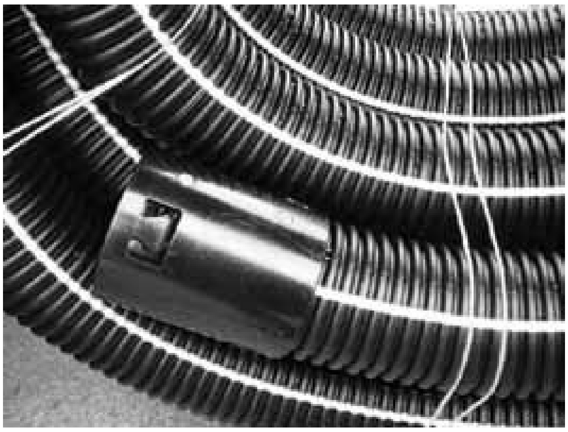
Some manufacturers make drainage pipes encased in geotextile as shown above.

Dependent upon the soil conditions, and in the case of very clayey, fine silt or sand, it is good practice to encase both the trench walls and the pipe with filter cloth. Remember also to cover the top of the trench to prevent ingress of soil particles into the drainage system from above.

It is important to use the appropriate materials and design to control sub-surface drainage, to comply the New Zealand Building Code and manufacturer's instructions.

A basic installation will be installed pipe and fill that is geotextile wrapped. The depth of the trench could be around 300 mm to 400 mm deep and ranges from the width of a spade to the pipe's diameter plus 200 mm. A suitable grade to lay drain is about 1 in 50 (20mm drop per metre of drain).

Non-perforated polyethylene pipe is also available. This pipe is typically used for temporary stormwater diversion from and around building sites. It is marked with a white stripe.



Non-perforated polyethylene pipe

Sumps

A sump is installed to intercept sediment and debris to prevent blockage of the stormwater's drainage system.

Sumps provide access to the stormwater drain for maintenance purposes. When a sump is used as an access point for a drainage installation, the maximum distance that the sump should be positioned from another access chamber is 100m.

Sumps can also be used as intakes for the collection of surface water from driveways and roads, as a point of connection for joining branch or subsurface drains, and to provide overflow relief.

All surface water, except rainwater from roofs, must enter the drainage system via a sump. This is to prevent silt, sand or debris such as paper or leaves entering the stormwater disposal system. There is a minimum measurement from the base of a sump to the invert level of the outlet to provide space for the collection of silt and debris.

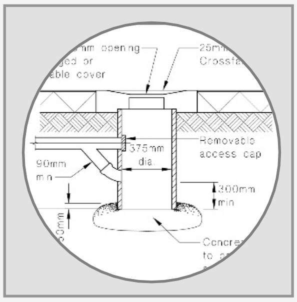
Interceptor traps, such as a petrol or oil trap in a service station forecourt, can also be incorporated into a stormwater drainage system. These will be covered in another unit.

Generally surface water traps or sumps that are inlets to drains must have a:

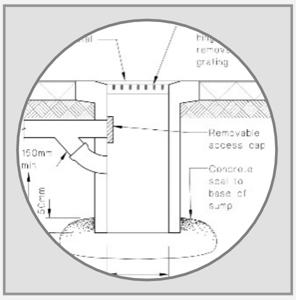
- grating with at least 35% open area that is hinged or removable to provide access for maintenance (this is the minimum required opening space)
- capacity at the base of the for the settlement of silt
- submerged or trapped outlet to prevent floatable solids entering the drain.

Types of sumps

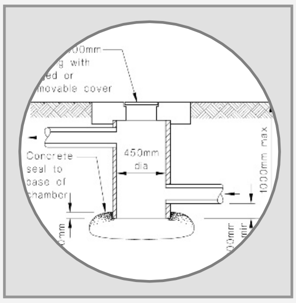
There are three main types of sumps used for stormwater drainage



Type-one surface water sump



Type-two surface water sump



Bubble-up chamber (or sump)

The type-one surface water sump

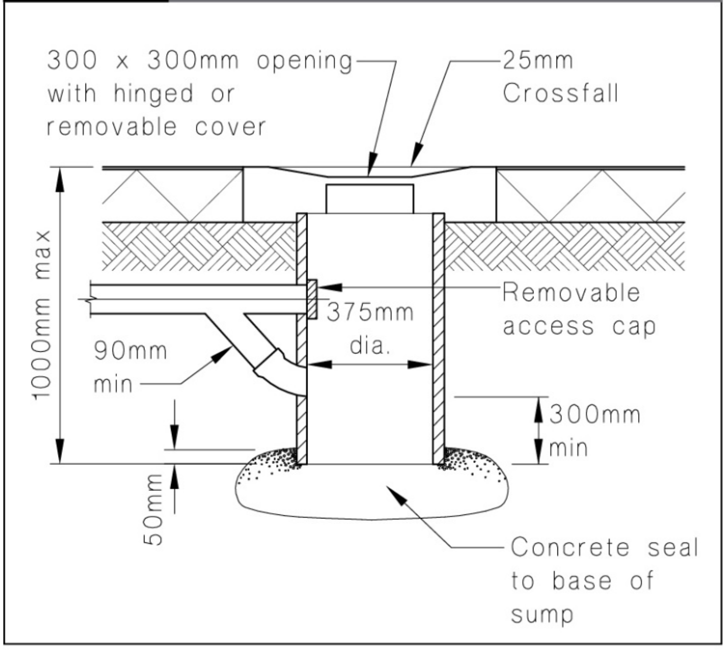
This type of sump is designed to accept stormwater from catchment areas that have a flow no greater than 4500/I m^2. This is based on the calculation given in E1/AS1, previously covered in the Section "Surface water collection systems".

They should be no deeper than 1m to allow access and for cleaning by hand.

The arrangement of the pipework incorporates a water seal to prevent floating debris entering the drain, and space for the allowance of sediment to collect. They also provide an access point to the drain for maintenance.

There must be a concrete seal at the base structure of the sump. This seal must extend 50mm up the sides.

Figure 8:	Type-one Surface Water Sump Relating to Paragraph 3.6.2



From Acceptable Solution E1/AS1

> *An important point to remember is that type-one sumps have a minimum outlet diameter of 90mm, where a stormwater drain can have a minimum of 85mm. Drains cannot be reduced in size, therefore the drain serving the outlet of this type of sump would have to be greater than 90mm.*

Often, with the type of installation as shown above, when the sump becomes fill of silt and blocks, the access cap in the sump is removed rather than it being cleaning. This allows water and floating materials to enter the drain directly, rather than through the trap as intended.

One preferred method by some Territorial Authorities (TAs) is to arrange the outlet fittings on the exterior, using an inverted "Y" to create the trap and to bring the access cap to ground level. This method not only ensures that a trap is maintained, but also means that there is only one hole through the sump wall.

As with any other drainage structures, a stable base and corbel for support are required with the installation.

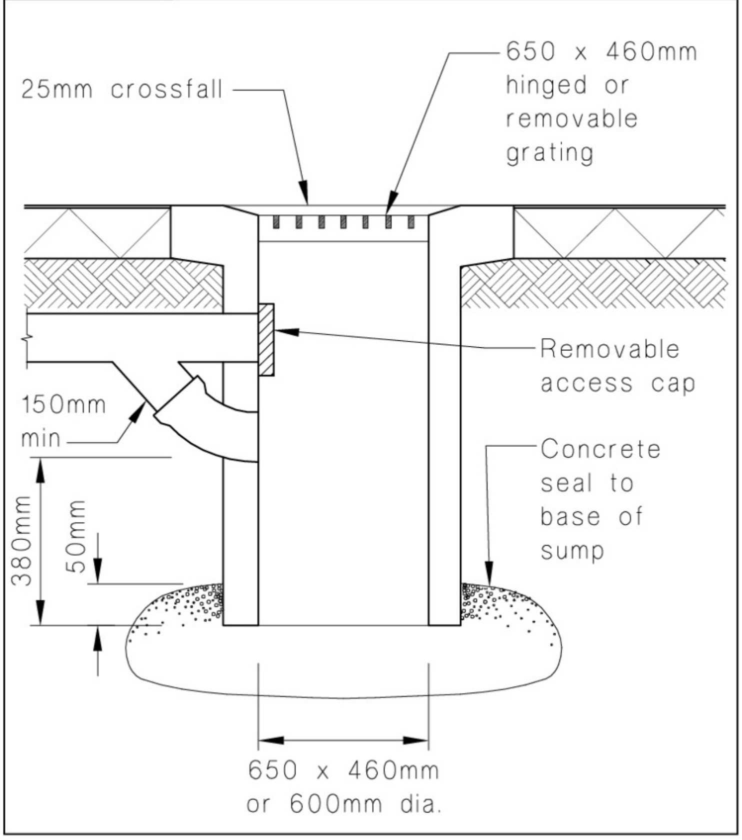
Type-two sumps

Type-two sumps are intended for catchment areas receiving rainfall greater than 4500/I m² and up to 40,000/I m².

To do this the design is larger, with an access that will allow entry for maintenance, and a minimum outlet size of 150mm.

Provision for collection of both sediment and floating debris, as well as maintenance are the same as the type-one.

Figure 9:	Type-two Surface Water Sump Relating to Paragraph 3.6.2



From Acceptable Solution E1/AS1

Bubble up chambers and charged systems

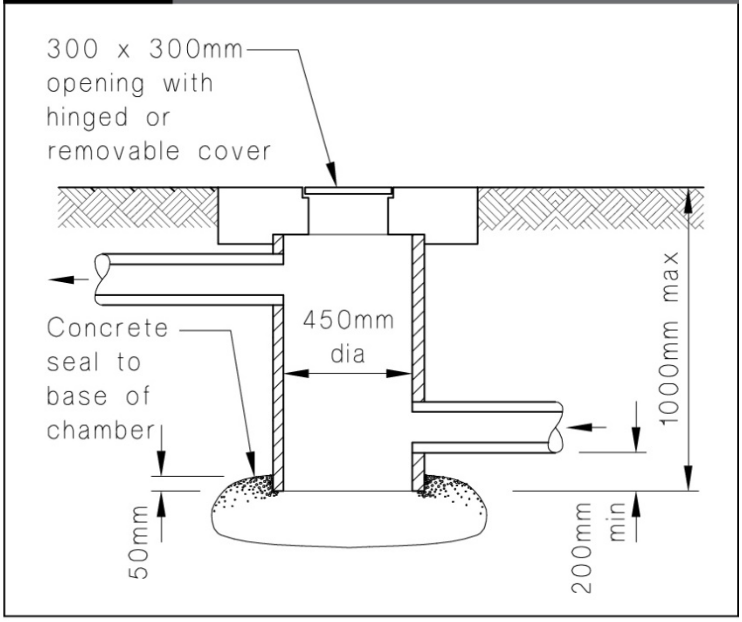
A bubble-up chamber allows water to enter at a low level and discharge (or bubble up) at a higher level.

The pipework entering the bubble-up chamber will be full of water up to the level of water in the bubble-up chamber. This section of pipework is said to be charged, or under pressure.

Similarly, bubble-up chambers allow for the convenient collection of silt or debris, **however they do not feature a trap or water seal.**

The diagram shows the features of a bubble-up chamber.

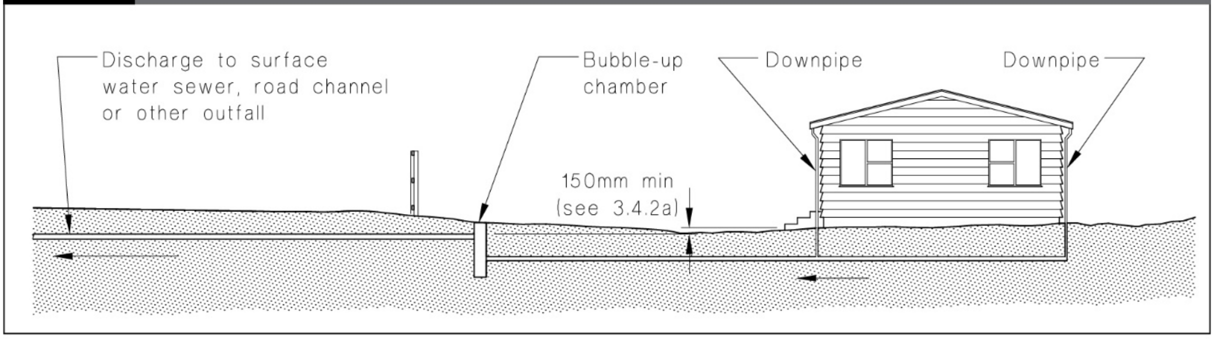
Figure 6:	Bubble-up Chamber Relating to Paragraph 3.4.2



From Acceptable Solution E1/AS1

E1/AS1 Surface Water requires that a bubble-up chamber is to be used in situations where the level of the surface water sewer, road channel or other outfall is too high to allow the gradient required. The diagram below shows such a situation.

Figure 7: Longitudinal Section of Bubble-up Chamber System
Relating to Paragraph 3.4.2



From Acceptable Solution E1/AS1

Longitudinal section of a bubble-up chamber system

The bubble-up chamber allows the water to be discharged through pipes laid at the allowable minimum gradients. Charge systems (bubble-up) should be at 1:60 so that light debris will be flushed clear.

Further requirements are that:

- the ground level adjacent to any downpipe discharging to the bubble-up chamber is at least 150 mm higher than the level of the top of the chamber outlet
- the connections between the drain and downpipes are sealed
- the total chamber depth does not exceed 1.0 m.

Sizing of sumps

There are many off the shelf and precast sump options available. It is important to size and select the appropriate one for the installation.

The type-one sump shown in E1/AS1 above has an internal diameter of 375mm and a minimum depth of 300mm for the collection of silt.

Calculating the volume ($\pi r^2 \times$ depth) gives us a minimum volume of 33.1 litres for the collection of silt in this type of sump.

Type-two sumps calculate out to be 107 litres.

Remember, this is the volume required for the collection of silt below the level of the trap outlet, not the total volume of the sump.

Plastic sumps

Silt traps

Silt traps or arrestors differ to sumps in that they do not have provision for the collection of floating material, only silt. That is, they don't have a water seal.

Silt traps are used solely for the collection of silt and where other materials can't enter, such as from outfalls of subsoil drainage systems.

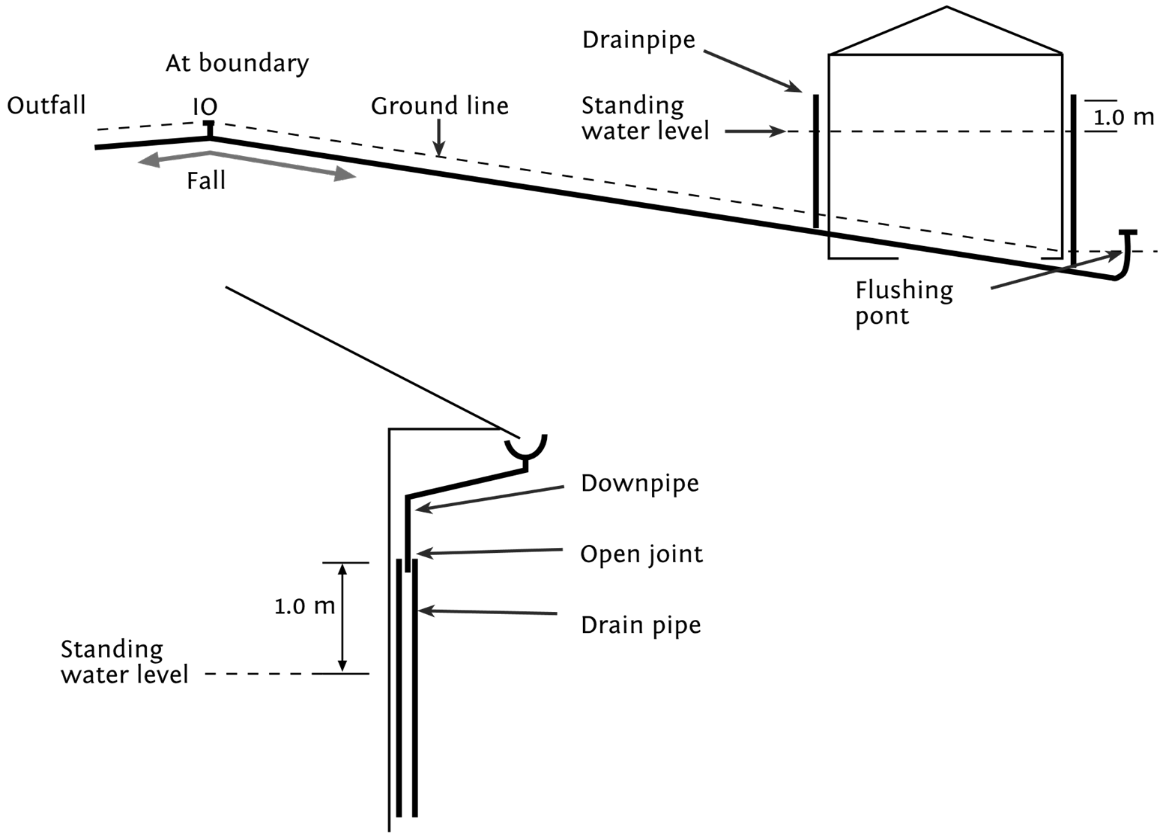
AS/3500:3 gives the dimensions and specifications for the sizing of silt arrestors.

Displacement system (charge system)

A displacement or charge drainage system may be used to drain stormwater. The drain is always full of water and when additional water is added it pushes (displaces) the water that was in the pipe.

The displacement system shown on the following diagram shows a downpipe filling the drain and the displaced water flowing to the kerb and channel. Often buildings will be below the street with their spouting above the kerb and channel. In these cases, surface water drains may still work successfully by extending the drain vertically as a sealed downpipe to a minimum of 1 m above the outfall.

The connection between any downpipe and the vertical drain should not be sealed. This will act as a relief point in the event of the drain becoming blocked or surcharged. It is important that this system has a section of gravity drain discharging to the kerb and channel to ensure there is no flow back into the system.



Displacement (charge) system

Reverse fall (displacement system)

Many bubble-up systems do not work because they are installed falling backwards or are level. Drains should never be laid level. A reverse falling displacement system can function well for many years if they have good fall. Maintenance is easily carried out.

An inspection point should be installed at the lowest point in the drain to allow flushing of the system. A good grade will ensure scouring of the drain. The downpipe is not sealed into the drainpipe to allow a relief point indicating the drain requires maintenance (flushing).

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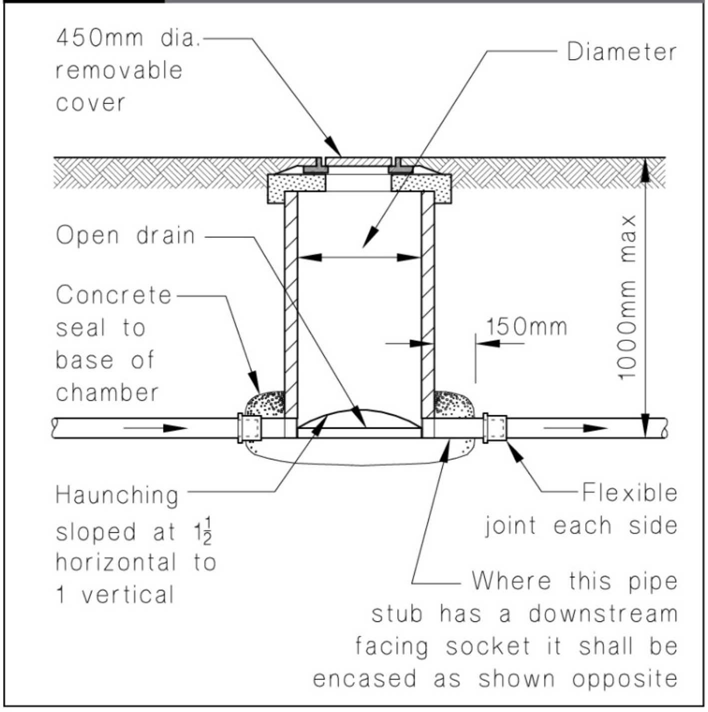
Figure 11: Typical Inspection Chamber
Relating to Paragraphs 3.5.3, 3.7.1 and 3.7.4



From Acceptable Solution E1/AS1

Flooded systems

Another charged system which includes stormwater drains connected to downpipes and retention tanks is a flooded system. In this situation, the water level in the downpipes will be at the same level as the water level in the tank or tanks. It is important that these drains fall to a point that has an access point for clearing blockages.

AS/NZS 3500:2 Storm Water Drainage includes specifications for stormwater pits, inlet pits and arrestors. Although essentially performing the same functions as the sumps already mentioned, some of the installation requirements differ. It is important to follow the installation requirements mentioned for each Code or Standard.

Any installation procedures will be governed by the consent specifications. Any deviation from the specified materials, size, or installation procedures may result in non-compliance. This can lead to the drainlayer being liable for the performance of the installation or bearing the cost of rectifying any problems.

All territorial authorities have their own descriptions and plans regarding the type of traps or sumps that are approved for use in their area outside the boundary. Any job specifications will provide specific details on the size, material and installation procedures for that job.

Maintenance of stormwater handling systems

As with all drainage installations, stormwater handling systems need to have provision for maintenance. Stormwater systems remain largely forgotten, until a period of high rainfall occurs and identifies a fault or failure of the system.

The faults or failures of a stormwater handling systems can be identified by:

- flooding and ponding of water
- surcharge from intakes
- poor or slow draining of sumps
- water entering buildings
- unusual overland flow of water
- changes in vegetation growth.

An entry to a stormwater sump blocked with debris

Surface water collection systems

Maintenance of surface water systems involves regularly removing weeds, silt, and debris from all channels and sumps. Removable grates allow for easy cleaning.

Avoid potential problems by regularly inspecting the grate's channels and joints for signs of damage, particularly if they are installed in trafficable areas.

Vehicles can damage the channel system, especially if it has been poorly installed in inadequate bedding. Slumping of the ground can also cause depressions, resulting in surface water to pond. To reinstate the channel, remove any sections of damaged channel, select heavier duty channel if required, and provide adequate support and backfill when installing the replacement.

The most common signs of a fault with the collection system is the ponding of surface water, although this may also indicate a problem further down the system. Water ponds in low lying areas, and usually by design, this is where the intake is located.



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Often the remedy can be as easy as locating and cleaning the grate, but you need to be careful that large amounts of debris don't enter the drainage system itself. It's a good idea to have a bucket ready.

Normally the intake to a surface water collection will include a sump for the collection of silt and debris and because silt traps and the smaller, type-one sumps are designed to be cleaned by hand, the job should be easy enough to do with a shovel.

In times of heavy rainfall, the system may have just become overloaded. If the grate and sump are clear, check to see the flow rate of water that's draining away. If it's slow, the problem is likely to be further down-stream.

If the flow out of the sump is good, check to see other drainage structures in the vicinity. There may be another blocked sump, or it may be in the path of a secondary flow.

Buildings are designed so that water will naturally drain away from around them. This 'secondary flow path' is provided as the path over which water will flow if the drainage system becomes overloaded or inoperable.

Changes to the property itself, like recently built gardens, or fences, may alter the secondary flow path. It also pays to consider runoff from adjacent properties. There may be water coming from a blocked drainage system on a neighbouring property, or it may be coming from a road.

Sumps

Sumps need regular maintenance. A hinged or removable grating provides access for silt to be cleaned out, with any sticks, leaves, or other debris removed.

Pipe penetrations should be checked for soundness, and if the sump is installed with a trap, it should be checked for its operation.

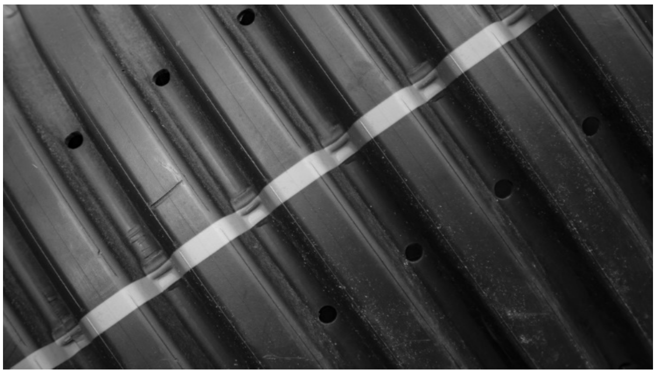
Older type sumps are often fitted with a 90° bend on the inside of the chamber, to create the water seal. Make sure these are re-instated if removed, otherwise floating materials will enter the drain and block it.

A sign of a problem can be surcharge from other drains entering the blocked sump itself, or perhaps water is flowing back up the drain from another downstream fault. If the drains are laid in low lying areas such as near a tidal zone, or where the Territorial System is prone to becoming overloaded, reflux valves or flood gates may have been installed and are faulty.

Sub-soil drainage systems

Sub-soil drainage systems are installed to drain the ground itself and signs of a problem are not always so obvious. Water ponding, saturated and soggy ground conditions, and changes to vegetation growth are typical indicators of problems. Again, the first place to check is the system out-fall.

Perforated plastic subsoil drainage pipes often have corrugated interior walls. This means that the pipes collect and retain silt easily if they are not protected by a geotextile cover.



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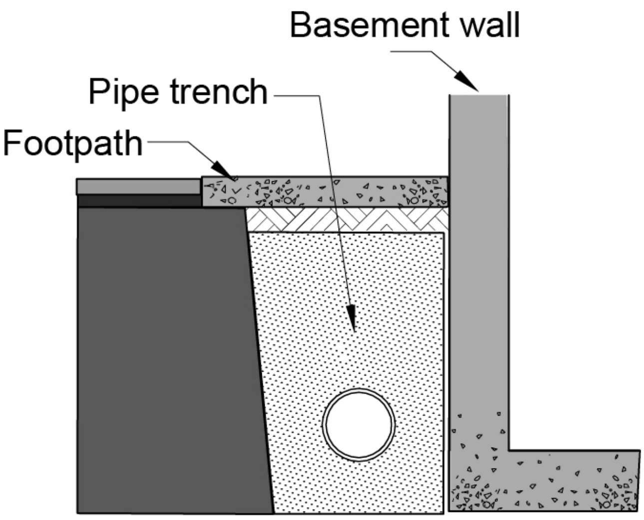
The system should be installed with an access point raised to ground level at the head of the drain. They should be cleaned by hose or water-jet regularly to prevent build up. Often the access points are difficult to find, and it might pay to check with the owner of the property or check any drainage plans for their location.

As with any drainage system, tree roots are a particular problem to subsoil drainage. If any part of a drain is damaged or blocked by roots, excavate the drain, remove the roots and reinstate.

Basement and retaining walls

Sometimes there are faults to drainage systems which are laid to control ground water from behind basement and retaining walls. These can be particularly difficult to rectify, because they are normally laid at the walls base and can often be quite deep.

Signs of failures of these systems can be dampness, water entering a basement, and the ponding of water behind a building. In the case of retaining walls there can be tilting of the wall, from the pressure of the water and sodden soil behind it. In most cases retaining walls, as well as having a drainage system behind them, will have holes along the front to let any extra water out.
Check to see if these holes are clear.



Learnops

It is important to ensure drainage systems for both basement and retaining walls work properly, as substantial defects to their structure and foundations can arise if the systems are not maintained.

Some of the causes of a leaking basement wall are;

- no perforated drainage pipe at the base of the wall for ground water removal
- no drainage gravel above the drain, resulting in the drainage pipe becoming blocked with silt
- no filter fabric between drainage gravel and the drain, resulting in the drainage pipe becoming blocked with silt
- the drainage behind the wall has stopped working due to the pipe being blocked
- the drainage gravel becoming filled with fine soil material.

To repair these firstly, locate and flush the drain from the head of the system, checking the flow at the outfall. You may need to dig out and expose the pipe if it is blocked, but this can be difficult where the drain is deep.

If you do choose to excavate it, remember when re-installing to:

- check the complete drainage system for blockages; clear by flushing out with high pressure water
- install a perforated drainage pipe at the base of the wall placing pea gravel around the pipe, and lay a geotextile filter fabric over the gravel
- seal the exposed wall with a waterproof coating or membrane
- protect the waterproof membrane with sheet material such as polystyrene
- line both excavated face and the face of basement wall with geotextile fabric
- backfill to ground level using a free-draining granular fill.

It can also be a good idea to consider installing more sub-soil drainage, re-shaping or sloping the land away from the wall, or installing channel drainage at the surface to intercept the water.

Intake and outfall structures

These structures are more prone to erosion than anything else. Potential faults can be undermining of the inlet and outlet structures, or the collapse and scouring of the banks downstream.

Grills and baffles can become blocked or clogged with debris; these should be regularly cleaned. Stone and gravel can also build up throughout the structure. Periodic inspection and maintenance are required.

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Got questions?

If you have any questions, please contact your assessor directly.

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