# PART D. SANITARY SEWER AND STORMWATER DESIGN AND CONSTRUCTION

## CONTENTS

Note:
Full requirements for construction are set out in the “Drainage General Conditions of Specification”.
This Code of Practice covers the design of all new sewers and stormwater systems

# D.1 DEFINITIONS

| | |
|---|---|
| Culvert | Means any stormwater drain whose length is less than 20 diameters. It does not mean a large drain or a drain made from brick. |
| Infiltration | Is extraneous flow that enters the sewer system through faults in the integrity of the pipes. It is typically a constant flow over a day, and is normally present in all sewers. Such faults include: leaking joints, cracked or corroded pipes, porous pipes and broken pipes. |
| Inflow | Is extraneous water which enters the sewer system directly from sources other than those causing infiltration. It typically varies greatly over a day and is usually associated with rainfall or very high tides. It normally comes from faults in the layout of the drainage system or from overflows from the stormwater system. Examples of faults which cause inflow are: the connection of rainwater downpipes to sewer gully traps, cross connections of private stormwater leads to sewer mains and connections of sumps to sewer mains. |
| NCD (New City Datum) | The datum reference used by WCC.<br>Mean sea level (WHB standard) = RL 0.012m NCD.<br>To convert readings from the New Zealand tide tables to NCD subtract 0.912m from the tide table figures.<br>To convert Old City Datum to NCD, convert from feet to metres, then subtract 11.57m |
| Drainage Engineer | The drainage engineer is as designated by the WCC Infrastructure Director. |
| Drain | A generic term for open streams, watercourses or enclosed pipes. Can be either sanitary sewer or stormwater. |
| Stream | Includes watercourses |
| Specification | Reference to specification, or to drainage specification, shall mean the Wellington City Council 'Drainage General Conditions of Specification' current at the time. |
| Stormwater network | Includes kerbs and channel, pipes, drains, watercourses and streams. |

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## D.2 Approval

Prior to works starting, a plan, calculations and producer statement for the design of the proposed drainage work shall be prepared by a chartered professional engineer, or if acceptable to the public drainage engineer prepared by another approved competent person, and submitted for approval. The calculations shall include all design assumptions and any specific structural design as appropriate.

The drain will only be taken over as a Public Drain if:

- A public Drainage Permit has been uplifted,

- The work passes the Final Inspection which shall routinely include CCTV,
- Satisfactory “As Built” plans have been provided,
- A Construction Producer Statement has been provided.

A Producer Statement will be required from a chartered professional engineer, and shall make specific mention if any of the following apply:

- The design falls outside the guidelines of this Code.
- It is proposed to use a concrete pipe with a different class than that set out in the appendix (see also clause H.5.1, page 28 & 17).
- The drain is a concrete pipe or earthenware pipe and falls into the area marked “special design” on the graph in the appendix[1].
- The drain is not a concrete pipe or earthenware pipe and will have a cover greater than 3m or less than 600mm.
- For all drains listed as “S” in clause J.1.1, page 30 & 19.

The Statement shall cover the hydraulic design (if applicable), the structural design and the construction of the works. It shall normally include the statement: “The drains have been laid as per the Drainage General Conditions of Specification (date) and the assumptions made in the design[2] have been fulfilled in construction.” This statement shall not be qualified.

***The designer should note that where a Statement is required, Council will hold the provider of the Statement responsible for the satisfactory design and construction of the works.*** Any inspection of the works by Council may be limited to an audit function only *but this will not reduce the provider’s responsibility.*

Alternative stormwater solution proposals must meet the performance objectives of the this code and the Building Code (Clause E1 Surface Water) and the detail of proposals will be subject to building consent approval.

Wastewater disposal is not open to alternative solutions. The provision of adequate disposal and treatment of wastewater must be compliant with minimum engineering standards as outlined in this document.

Council protects public health by ensuring wastewater is safely and efficiently collected, transported and disposed of.

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[1] This includes all drains subject to traffic with cover less than 600mm.

[2] For example, if it has been assumed that the pipe will be laid in a trench of no more than 900mm wide, then this is met in construction.

Council provisions for wastewater and stormwater disposal and treatment are based on the following statutory documents;

- Resource Management Act 1991
- Local Government Act 2002
- Building Act 1991
- Health Act 1956
- Health and Safety in Employment Act 1992
- Civil Defence Emergency Management Act 2002
- Soil Conservation and Rivers Control Act 1941

**D2.1.1 Connection to existing services**

Connections to existing public drainage services will be arranged by the Council Drainage Representative upon payment of the appropriate fee. Alternatively the connection may be carried out by the Subdivider with a permit. Where this drainage connection has to be carried out on private property not owned by the Subdivider, the Subdivider shall provide written evidence of the owner's approval for entry onto the property.

**D2.1 .2 Provision of drains**

Public drains shall be provided to within 10m of proposed lots and building platforms within intensive developments.  The Drainage Engineer may allow a lateral to run across one property to serve another under easement.

## D.3 SANITARY SEWER DESIGN FLOWS

OBEJECTIVE

The objective of the sanitary sewer chapter of this Code is to have a safe, affordable, reliable, environmentally friendly wastewater system

**D3.1 General Design Criteria**

All sewers shall be designed so that they meet two performance criteria:

- They are self cleansing
- They flow un-surcharged under the maximum expected flow

C.1.1 SELF CLEANSING FLOW

The self cleansing flow is the greatest flow that will occur on each day at any stage in the development of the catchment.

Where no factor indicates otherwise the flow used to calculate the self cleansing velocity shall be the minimum expected peak dry weather flow.

Unusual factors, such as an entire industrial catchment with little flow in the weekends, will require special consideration.  In this case the Drainage Engineer should be consulted.

A drain will be considered to be self cleansing if the velocity of the self cleansing flow exceeds 0.75m/sec at least once per day.

Alternative approaches, e.g. tractive stress analysis, are permissible.

Where it is not possible to provide a drain with suitable self cleansing velocity in the first five years of an entirely new catchment, the Drainage Engineer may waive the self cleansing requirement if alternate arrangements are made (e.g. provision of flushing tanks).

### C.1.2 MAXIMUM EXPECTED FLOW

Where no factor indicates otherwise the maximum expected flow shall be the peak wet weather flow (PWWF) that may occur at any stage during the development of the catchment.

Unusual factors, such as the presence of a high water use industry will require special treatment. In this case the Drainage Engineer should be consulted.

The catchment used for calculations shall be all that area that drains or could physically and legally drain to the point under consideration.

When determining the maximum expected flow, the catchment shall be, as a minimum, considered to be developed to the full extent allowed by the district plan. All permissible bonuses etc. which increase building floor area or coverage, or otherwise increase the likely occupant population shall be considered to the maximum extent normally permissible without a special hearing.

Where further development is possible in the future (i.e. if a District Plan change is likely or possible) the possibility of extra future flows and Council cost contributions is to be discussed with the Drainage Engineer.

Except in unusual circumstances, peak wet weather flow is defined as being:

$$PWWF = PSWF + PGWF + PRWF$$

where:

| | |
|---|---|
| PSWF | is the peak sewage wastewater flow |
| PGWF | is the peak groundwater flow; or infiltration |
| PRWF | is the peak rain water flow; or inflow |

The components of sanitary sewer flows are: sewage wastewater flow (SWF), infiltration or ground water flow (GWF) and illegal inflow or rainwater flow (RWF). The prefix “P” before the abbreviation indicates the peak value of the component whereas the prefix “A” indicates the average value of this component.

The peak wet weather flow (PWWF) for a catchment is the sum of: peak waste water flow, peak infiltration, and peak inflow for that catchment, i.e.:a catchment may be split into a number of zones where each zone has uniform rules governing development and a uniform style of development and thus uniform sewage wastewater generation with the total flow for the catchment being the sum of the flows of each of the zones.

Sewage flows from the areas listed below require special treatment. These shall be determined in consultation with the Drainage Engineer:

- Wellington Hospital
- Massey University ,Wellington
- The National Art Gallery and Museum
- Te Papa
- Oriental Parade high rise residential
- Taylor Preston Ltd Abattoir
- The Lambton Harbour foreshore facilities
- The commercial port area
- The foreshore area seaward of Evans Bay Parade
- Flows from residential buildings in excess of 3 storeys

## C.2 Calculating PWWF

### C.2.1 INFILTRATION (PGWF)

Peak infiltration, i.e. peak ground-water flow, (PGWF) shall be calculated as follows:

$$PGWF = A_{wet} * 0.347 + A_{dry} * 0.044$$

where: $A_{wet}$ is the area with a high water table including (but not limited to) those areas with a surface level below 3.0m NCD.

$A_{dry}$ is all other areas.

(A is in hectares and PGWF is litres/second).

Inflow (PRWF)

Peak inflow; i.e. peak rain-water flow (PRWF) shall be calculated as follows:

$$PRWF = A_{res} * 0.440 + A_{other} * 0.232$$

where: $A_{res}$ is the area of residential area.

$A_{other}$ is all other areas.

(A is in hectares and PRWF is litres/second).

### C.2.2 AVERAGE WASTEWATER FLOW

The average sewage wastewater flow (ASWF) is the product of the population of the area (EPz) and the average flow rate per person, i.e.:

$$ASWF = EPz * pz$$

Measured wastewater flows shall be used in preference to calculated flows where accurate current flows are required. Sites suspected of discharging significantly atypical wastewater flows shall be investigated individually to determine what the correct current flow is.

Ultimate average wastewater flows shall be calculated using data in Table B.

In calculating ultimate flows from a zone, the average waste water flow rate shall be the greater of:

- The flow which would result from current use
- The flow which would result if the zone was redeveloped as per the majority use of the catchment.

For example, if a school was in a residential area, then the ultimate average wastewater flow rate would be based on the greater of:

- The existing school
- The school being replaced with residences.

**Table B. Ultimate Sewage Flow Data**

| Area Type | Population Density (pz) | | Average Wastewater Flow |
|---|---|---|---|
| | per ha of site | per ha of floor | 1/s/person |
| Inner Residential | 400 | | 0.002 30 |
| Outer Residential | 140 | | 0.002 30 |
| Suburban Centres | 1,200 | | 0.002 30 |

| | | | |
|---|---|---|---|
| Central Area | | 400 | 0.002 30 |

The current population in residential areas may be estimated by counting the number of dwelling units and assuming an occupancy rate of 3.1 people per unit.

The current population in non-residential areas may be estimated by estimating the floor area of other buildings and presuming an occupancy rate of 1 person per 25 $m^2$.

The ultimate population for the Central Area shall be determined by the equation:

EPz = pz * Af

where Af = the maximum likely floor area

pz = the population density as shown in Table B

The maximum likely floor area (Af) shall be determined as follows:

1. Determine the number of permissible floors (Nf). This may be either taken from the District Plan or calculated by dividing the District Plan's height limit by 3.0m.
2. Determine the maximum permitted coverage area (C) as specified in the District Plan (use 100% where none is specified).
3. Af is the product of site area (As), number of floors (Nf) and coverage area (C).

The maximum likely floor area shall be determined by calculating the floor area that may be present in a catchment.

The number of permissible floors **(Nf)** shall be taken directly from the District Plan, or determined by dividing the District Plan's height limit by 3.0m, and the area of each floor is the product of the area site area and the area's maximum coverage **(C)** as specified in the District Plan for that area (or 100% where none is given), except that for the ninth and higher floors the maximum coverage need not to be considered to be more than 50% for the purposes of this calculation.

Af = As * (C * min(Nf,8) + min(C,0.5) * max(0,Nf-8))

PEAK SEWAGE WASTEWATER FLOW (PSWF)

The peak sewage wastewater flow in a catchment is the product of the average sewage wastewater flow and the peak factor (PF) for that catchment; i.e.:

PSWF = ASWF * PF

The peak factor depends on the population and the maximum possible reticulated area of the catchment and is set out in the appendix. The maximum possible reticulated area is measured as land area only, and is not increased by multiple floors.

Consideration shall be given to industries producing more wastewater or a greater peak wastewater flow than allowed by the general rules.

# D. STORMWATER SYSTEMS

**OBJECTIVE**

The objective of this section of the code is ensure the stormwater system protects property, public health and the environment by the safe disposal of rainwater and associated runoff.

## D.1 GENERAL

All stormwater systems shall be designed with regard to the following criteria:

- Flooding minimised
- Water quality to be maintained or enhanced.
- Land stability and erosion control maximised
- Soil moisture content optimised
- On going maintenance costs of assets miniimised

Urban areas need to be drained to remove surface water that could cause flooding. Conventionally, this was done using pipes to convey water away as quickly as possible. This concentrates flow and can lead to problems such as erosion and flooding elsewhere in the catchment. Intensive urban development is generating runoff that exceeds the networks design capacity.

Emphasis has turned to reducing the flow volume and the contaminants in the stormwater discharged into receiving environments. These objectives can be partly met through on-site stormwater management, which involves retaining the runoff to reduce peak flows and/or to filter out contaminants at source.

Where practical alternative approaches to stormwater management including attenuation and/or some disposal on site will be encouraged. This is for the primary purpose of controlling the peak stormwater flow and preventing the further degradation of the water quality and ecology in receiving waters. There is also the prospect of these options being a more cost effective solution than simply using pipes.

Alternative solutions sometimes rely on open or secondary flow paths to a much greater extent than conventional piped systems, particularly for large long storms in saturated conditions producing excessive runoff. These flow paths require careful conservative design, and protection into the future.

## D.2 WATER QUALITY

Stormwater quality consideration is a RMA requirement. There is a growing importance being placed on the quality of stormwater. Strategies to treat the water at source or near the top of the catchment are to be encouraged. The practicalities of this are fully recognised as suitability of land and maintenance costs are influencing factors. Where the possibility of treatment by means of wetlands or retention exists though, the opportunity is to be considered and may be required.

Water can be treated and quality enhanced through a range of best management practice alternative solutions, forming a treatment train. Water quality work is best implemented through integrated catchment management plans or other planning mechanisms that incorporate the principles of low impact urban design and development. This helps to meet the Council's outcomes of a healthier environment and a more sustainable city.

## D.3 Alternative Solutions

Alternative stormwater solutions with the aim of allowing infiltration and filtering to occur will be considered on a case by case basis subject to appropriate site investigations, geotechnical survey; and specific engineering design.

The topography, slope, neighbouring properties, etc of the development will be considered in approving the design. The successful implementation of alternative solutions depends on individual circumstances. Each application will be assessed against criteria which include topography and soakage.

Soakage will only be considered when there is sufficient proven soakage capability available on the section and subject to satisfactory test by an engineer. Available soakage can be established from the Department of Building and Housing's Verification Method E1/VM1 December 2000.

Where topography, soils and slope permit vegetated open channels should be used to convey and treat stormwater. Where soils and slope are not suitable for open vegetated channels, rock lined channels or other filtration practices will be considered.

New Zealand Water and Environmental Research Foundation's (NZWERF) On-Site Stormwater Management Guideline provides the information needed to select and design appropriate on-site stormwater management devices for the majority of applications in New Zealand. A combination of devices will be favoured.

The design guide SNZHB44:2001, Subdivision for People and the Environment promotes innovation in developments and provides alternative methods of compliance.

There will be development situations unable to use alternative solutions; the decision rests with Council.

### D.3.1 ONGOING COUNCIL MAINTENANCE

On public land, where Council is to have the asset vested, alternative solutions are to be designed such that Council is willing to maintain the device.

Council require that sufficient information is provided by the applicants to address ongoing management and maintenance considerations i.e. private versus public ownership of infrastructure, and future maintenance of components of alternative solutions.

Alternative solutions should have the same or better whole life costs than gravity piped systems.

Council will not maintain alternative solutions constructed on private land. Any devices on private land will be contained within the property and are to have an overflow to the reticulated system. This is to ensure if the alternative system fails, there is no adverse effect.

## D.4 Streams

Council's draft Biodiversity Action Plan (2007) states that the natural character of streams is to be retained wherever possible.

There should be no modification of stream systems unless it is for flood mitigation purposes and there are no viable alternative flood management methods available.

All development work should be located away from the riparian buffer where possible and impediments to the natural flow with barriers to fauna should be avoided.

A resource consent from Greater Wellington Regional Council is required in each case. Also a Wellington City Council land use resource consent is required for work within 5m of a watercourse.

## D.5 OVERLAND FLOW PATHS

There will be an appreciable risk associated with situations when the design flow will be exceeded. The overland flow path is to be identified on a plan with appropriate cross sections and catered for. An easement in favour of the Council may be required.

Any building platform is to be located well clear of the flow path.

Subsection 4.3.1 of Section E1 of the Building Code, Section E1.3.2 of the Building Regulations and also the Council flood hazard maps shall be considered in respect of minimum freeboard provision to buildings, in the design of drains.

## D.6 PRIVATE LEADS

In residential areas a stormwater disposal system which may include street side channel, pipe watercourse or alternative solutions, is to be provided to serve all sections.

Alternative solutions with provisions for infiltration or detention can either:

- Percolate through the ground where long term capability is available and is satisfactory to the Drainage Engineer.
- Temporarily store run off and release at a slower rate to the public stormwater system

However overflows from a section where alternative solutions are incorporated must drain to an approved outfall.

100mm private stormwater leads from buildings must flow to a watercourse or swale, where this is not appropriate they may drain to the public stormwater system where one is available.

Council would rather no private 100mm leads go to the kerb but understands there are circumstances where this may be necessary. In such circumstance Council's Drainage and Roading Engineer shall be consulted.

All stormwater disposal systems are to be designed to carry by gravity the full flow from their catchment and not just water from part of the catchment (e.g. not from a site, from rooves or streets only).

## D.7 DIVERTED CATCHMENTS

No development, subdivision, new drains or construction works may cause water to be diverted from one catchment to another either directly or indirectly.

# E. CULVERTS, ENTRIES TO and Exits From STORMWATER SYSTEMS

## E.1 GENERAL

All culverts are to be provided with adequate wing walls, aprons and detritus traps and/or pits to prevent scouring or blocking.

In general, the minimum height of headwall above the design stream flow should be 300mm and the headwalls should extend 300mm above finished ground level. Barriers complying with Building Act may be required if the drop is greater than 1m.

An access way must be provided to the entrance of all intakes. Access-ways to intakes larger that 375mm shall be appropriately designated to ensure that access will always be available. In general, either an easement or a right of way would be suitable. The access should be at least 3m wide and no steeper than 1 in 5 and suitable for use by trucks. In exceptional circumstances, the Drainage Engineer may approve an access suitable for plant only. Under no circumstances though, will approval be given for an access steeper than 1 in 2. There must be room for plant to work at the intake.

Access-ways to intakes on drains 375mm or smaller shall be suitable for pedestrian access and should be suitable for wheel barrow use. An easement may be required to protect the access-way.

All structures are to be constructed in reinforced concrete and be aesthetically pleasing.

Adequate provision is to be made to prevent scour when returning the water from the drain outlet to the watercourse.

Culverts are to be constructed to allow fish passage to enable the fish to migrate further upstream. Further information can be found in Chapter F Open Spaces.

### E.1.1 INTAKES AND GRIDS

In general, the intake shall be a RRJ concrete pipe flush with the headwall. Such an intake has an entrance loss of 0.2. Details of the entrance shall be detailed on the drawings.

The intake shall be constructed in accordance with the entrance loss assumed in the design.

Grids are required to protect the pipe from blockage, to collect the debris and for safety reasons.

Grids must be placed on all pipe entries, drawing A526/1316 (see appendix 10). Log stops of vertical rails or universal beams may be required upstream of larger diameter pipe or tunnel entrances.

There shall be no grid on an outlet.

Grids shall meet the conditions set out below:

- The grid shall be bolted to the headwall using hot dipped galvanised or stainless steel bolts.
- The grid shall be bolted to the headwall in such a fashion that it can be readily replaced.
- The grid shall consist of a vertical front face of a height at least equal to the pipe diameter and a sloping “top”. The angle of the top shall be steeper than 1 in 4.
- The vertical portion of the grid shall be at the greater of 500mm or one pipe diameter from the headwall.
- The maximum gap in the grid or any point between the grid and the headwall on a pipe less than 675mm$\phi$ shall be 115mm[3].
- For pipes equal to or greater than 675mm$\phi$, the maximum gap in the grid shall either be less than 115mm or greater than 450mm[4].
- Grids shall be sufficiently strong to resist the impact of any debris which may come down the water-course.
- Grids which can physically be cleaned by a digger should be constructed from a material sufficiently strong to resist the impact of a digger bucket. As a guide, grid members with a Section Modulus (Z) of 1.2 $cm^3$ have proven to be suitable for grids on drains of about 450mm - 600mm diameter.
- The top grill of the grid shall not protrude out in front of the vertical grill (to reduce the risk of a digger ripping the top grill off).

Drawing A526/1316 in Appendix 10 is an acceptable solution.

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[3] This is to prevent a child entering the drain.

[4] This is to allow an adult to squeeze through to rescue a child.

#### E.1.2 SECONDARY INTAKES

Secondary intakes are to be considered in all circumstances. When there is serious risk of damage from heading-up or overtopping a secondary intake must be provided. The preferred form of secondary intake in a confined ponding area is a mushroom intake as per the drawing in Appendix 11.

Protection may be necessary where the water returns to the stream and in other places where a secondary flow path is used.

The design of any secondary intake shall be based on the assumption that the main intake is completely blocked. See clause G.6 for requirements for second intakes.

#### E.1.3 OUTFALLS AND ENERGY DISSIPATERS

New stormwater outfalls should avoid the discharge of contaminated stormwater to streams, the harbour and coastal areas or other water bodies.

An energy dissipater may be required at the outlet of a drain. Refer section 8.1.8

## F. SUBSOIL DRAINS IN EARTH FILLS

Refer to Earthworks (Part B).

### F.1 General

The recommendations of NZS 4431:1989, Code of Practice for Earthfill for Residential Development shall be followed except where otherwise specified in this code:

Permanent subsoil drains shall be installed except where all of the following criteria can be demonstrated:

- There are no natural springs which will discharge at the base of the fill
- Positive provision (e.g. cut-off subsoil drain) are made to prevent surface runoff entering the fill at the exposed fill/natural ground contact.
- The natural ground on which the fill is to be placed is contoured and scarified prior to the placement of fill to ensure that, over the whole base of the fill, the fill can be fully compacted to specification and continuity achieved between the fill and natural ground.
- The fill material is uniform, of relatively low permeability and is not erodible.

## F.2 Surface Infiltration Cut-off Drains

Subsoil drains to prevent water entry at exposed fill/natural ground contacts shall skirt the fill area at approximately 1 m below finished level. The drains shall be permanent drains detailed as set out below, but with the upper 200 mm of the trench backfilled with a low permeability capping material. The exit point location and the disposal of flows shall be as for permanent subsoil drains.

## F.3 Sub-soil Drains

Sub-soil drains shall be laid as public drains and a permit for them shall be obtained. The requirements for a public drain will in general apply though the access requirements may be eased. Subsoil drains shall be constructed as follows:

- They should be laid in a narrow trench, though if the loading permits, they may be laid in the cleaned out bed of the old water course with gentle horizontal and vertical curves. There shall be no abrupt changes in grade.
- The drains in the main gullies shall be a minimum diameter of 225mm and shall be at least one pipe size larger than any connecting branch drain.
- Branch drains shall be laid in all adjacent gullies and to any wet areas such as a spring.
- Branch drains shall be a minimum of 100mm diameter and shall be connected to the main by means of Y junctions only. Open butt joints will not be permitted.
- Where the design load allows, perforated concrete, HDPE or ceramic pipes may be used:
- These pipes must all be bedded and surrounded with a minimum of 150mm of suitable graded filter material. Alternatively a suitable permanent filter fabric may be placed around granular pipe bedding in lieu of the graded filter.
- Where the design load precludes the use of these pipes or where significant localised inflows or ground water are to be intercepted then drain shall be laid as a sealed drain of adequate strength and may have multiple branches with multiple inlets to collect ground water.
- Where perforated pipes can not be used stones larger than the pipe diameter shall be hand placed over the inlets. The larger stones are to be covered with 50mm of ballast. A suitable graded filter material shall be placed over this ballast.

- Where perforated pipes are used, the ends of the branch drains shall be sealed off and the drain backfilled as normal.
- They shall have a surface opening at the top and bottom ends to facilitate flushing of the line.

# G. STORMWATER DESIGN

## G.1 DESIGN METHODS

All drains are to be sized to current requirements regardless of the downstream pipe size. Where existing downstream drains are under-capacity, the Drainage Engineer shall be notified. The capacity of a drain shall not be less than that of the drain upstream.

All catchments are to be analysed using the rational method except for catchments greater than 500 ha which may be analysed using the modified rational method.

Other methods may be more suited to some complex catchments, but in those cases it must be demonstrated explicitly that the design and results are at least as conservative as if the rational method was used throughout, as described in the Sections below and approved by the Drainage Engineer. This provides a consistent approach to built works within the city.

Current mean high water springs[5] in Wellington Harbour is 0.835m.

In July 2008 the Ministry for the Environment issued updated guidance to local government on the impacts of climate change. The advice included updated information on sea level rise and advice on what assumptions Council should make when planning for activity in coastal zones or building/maintaining infrastructure/buildings in coastal zones with timeframes out to the 2090s.

Council is planning for a sea-level rise of 0.8m by 2090. Beyond 2100, Council are currently planning for sea-level rise of 10cm per decade. These values may be adapted in future as more information is made available.

Where a drains capacity is affected by the sea level it shall be designed assuming the sea-level is at 1.35m NCD.

[5] The dividing line between land and sea under both the Resource Management Act and Foreshore & Seabed Act.

## G.2 Calculation of flow

### G.2.1 RATIONAL METHOD

The formula to be used is:

$$Q = CIA/360$$

Where Q = runoff in cubic metres per second

C = runoff coefficient

I = rainfall intensity in mm/hr

A = area of watershed in hectares.

### G.2.2 MODIFIED RATIONAL METHOD

The formula to be used is:

$$Q = CIASF/360$$

Where Q, C, I and A are as defined above

S = shape factor (dimensionless)

F = Area factor (dimensionless)

$S = 0.4253 + 1.266\ k - 0.3952k^2$ (but not less than 0.8)

$k = A/100L^2$ Where L (km) is the straight line length to catchment head

$F = 0.6 + 0.4e^{(-A/7700)}$

S and F can be determined from the following tables:

| k: | 0.33 | 0.35 | 0.40 | 0.45 | 0.50 | 0.60 | 0.80 | 1.00 | 1.20 | 1.40 | 1.60 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S: | 0.80 | 0.82 | 0.87 | 0.91 | 0.96 | 1.04 | 1.19 | 1.30 | 1.38 | 1.42 | 1.44 |

| A (ha): | | 500 | 800 | 1,000 | 1,500 | 2,000 | 3,000 | 5,000 | 7,000 |
|---|---|---|---|---|---|---|---|---|---|
| F: | 0.975 | 0.96 | 0.95 | 0.93 | 0.91 | 0.87 | 0.81 | 0.76 | 0.71 |

### G.2.3 RUN OFF COEFFICIENT

The runoff coefficient is the fraction of the rainfall which reaches the stream by flowing off the surface. The ground is considered to be saturated from previous rain.

The following minimum runoff coefficients are to be used[6]:

- Central area, Suburban Centres, industrial and institutional areas, Oriental Bay Height area (i.e. Oriental Pde frontage), (100% coverage permitted): C = 0.95
- Inner residential areas (50% coverage permitted): C = 0.70
- Roseneath (45% coverage permitted): C = 0.70
- Aro Valley including Holloway Road (up to 40% coverage permitted): C = 0.60
- Outer Residential areas (35% coverage permitted): C = 0.50
- Rural areas and reserves: C = 0.35

The runoff coefficient should be based on the catchment that can be expected to ultimately exist when the catchment is fully developed as allowed under the District Plan.

### G.2.4 RAINFALL INTENSITY

This is to be determined from the graph in Appendix D after having established the values of the following parameters:

- Duration of critical storm (which equals the time of concentration. See clause G.3)
- Return period of the design storm. (See clause G.4)

## G.3 TIME OF CONCENTRATION

### G.3.1 GENERAL

The time to be used in selecting a rainfall intensity is the "time of concentration" for the watershed, or time taken for water to travel from the remotest part of the watershed to the head of the section of the drain or culvert in question.

Note that the ground is to be considered to be already saturated from previous rain.

The time of concentration shall be calculated as follows:

$$T_c = T_e + T_f$$

Where $T_c$ = time of concentration (minutes)

[6] Cf District Scheme, clause 5.1.3.3, page 5/8.

$T_f$ = time of flow in pipes and or channels to design point

$T_e$ = time of entry. This is calculated from:

$$T_e = T_o + T_g$$

where $T_o$ = time of overland flow

$T_g$ = time of gutter flow and entry to SW pipes, culverts or channels.

$T_e$ shall not be less than 5 minutes.

The time of concentration shall be the lesser of the two values calculated using the following flow paths:

- Those flow paths that can be reasonably expected to exist when the catchment is fully developed to the full extent permitted in the District Plan.
- The existing flow paths

### G.3.2 TIME OF PIPE FLOW

The flow time is best calculated from table or charts based on Manning's equation. To follow this procedure, longitudinal sections of the piped systems giving approximate pipe diameters, lengths and gradients are normally necessary.

For preliminary calculations when there is little detail of the final pipe systems it is suggested the following average pipe flow velocities be used.

- Moderate to steep gradients - 5 m/s
- Low gradients (less than 1-20) - 3 m/s

### G.3.3 TIME OF CHANNEL FLOW

The time of flow in open channels (either water courses or lined channels) may be calculated by means of the Manning's Formula. The photographs in Ven Te Chow "Open-channel Hydraulics" (McGraw-Hill, 1959) may be of assistance for determining Manning "n" values.

The length of channel used in the calculation should be measured along the deepest part of the stream channel. Flood storage and flood routing may be considered when calculating the time of concentration and the peak flow.

## G.4 RETURN PERIOD

Stormwater pipe and channel systems shall be designed for the minimum return period as set out below for the catchment environment that can reasonably be expected to exist once the catchment is fully developed as allowed under the district plan.

| | Standard for New Design |
|---|---|
| Arterial roads, major community facilities related to essential services | 100 year flow |
| Internal flooding of houses, commercial and industrial buildings, | 50 year flow |
| Primary roads, detention structures designed to withstand damage and failure from being over-topped. | 20 year flow |
| Garages, sheds and unoccupied basements, internal flooding | 10 year flow |
| Safe use denied or damage to active recreational areas, urban roads, property access and backyards of property. Secondary overland flow paths through private property where nuisance and damage will be minimal. | 5 year flow |
| Gardens, yards, passive recreation areas, flooding >150mm deep over more than 20 square meters<br>Parks and reserves, secondary overland flow paths through publicly controlled land or drainage easements. | 2 year flow |

Where the consequences of the design flow being exceeded is severe (e.g. total inundation of buildings) then the Drainage Engineer can require a higher Return Period than specified above.

## G.5 FLOOD LEVELS IN OPEN CHANNELS

When setting flood levels for open channels and streams a nominal freeboard allowance of 0.3m is to be included. Consideration is also to be made for wave action, possible constrictions and possible deficiencies in assumptions made such as roughness coefficients.

A Resource Consent may be required from Greater Wellington Regional Council for works associated with natural waterways or new discharges of stormwater to natural waters.

## G.6 SECONDARY FLOW PATH

A secondary flow path[7] is the path the stormwater (or sewage) would take if the drain was in-operable; either due to blockage or excess flow. These paths shall be identified and shown on construction and as-built plans. Designers shall endeavour to ensure that current and future property will not be damaged during operation of the secondary flow path.

A formed secondary flow path is required when there is only one intake on a stormwater drain. They shall be sited to ensure that they remain unobstructed. It is preferred that the road be used for this purpose. This formed flow path shall be sized as follows:

- When there is only one intake; all of the stormwater flow.
- When there is a secondary intake in addition to the primary intake, the difference between a 50 year flow and the capacity of the stormwater system assuming the primary intake is blocked.

Secondary flow paths on private property shall be protected with an easement in favour of the Council.

## G.7 DETENTION and attenuation STRUCTURES

Detention areas must have formed access for maintenance to at least the standard required for intakes, and are subject to specific design.

Moderate lengths of oversized pipes may also be used for detention purposes with provision for overflow to the downstream pipeline. Manholes are to be provided at each end. Provision for other utility services is to be considered during design including passage across or through the detention pipe.

Alternative "on site" detention solutions typically receive stormwater from small scale impervious areas such as individual sections and temporarily detain run off to meet one or more of the following

- Flow and volume control
- Water quality control, i.e. to filter out contaminants associated with sediments
- Provide dispersal, i.e. through an infiltration trench

Sufficient soakage capability available on the section should be proven and is subject to satisfactory test by an engineer.

7 It could be argued that these should actually be considered to be the Primary Flow Path.

Overflows from such a device must drain to an approved outfall and the downstream system have sufficient capacity to carry the full flow.

# H. DESIGN OF DRAINS

## H.1 HYDRAULIC DESIGN

### H.1.1 GENERAL

Manning’s formula or Colebrook-White’s formula shall be used. However where the Colebrook-White’s formula is used the roughness chosen shall be demonstrated to be equivalent to relevant Mannings ‘n’ for the typical pipeline sections concerned.

### H.1.2 AIR ENTRAINMENT

Where the pipe grade exceeds 1 in 10, allowances shall be made for bulking of the flow due to air entrainment and special precautions taken to release the air and surplus energy. The air to water ratio may be calculated from the formula:

$$\text{air/water} = Kv^2/gR$$

where K = coefficient of entrainment (dimensionless) (= 0.004 for smooth concrete pipes)

v = velocity

R = hydraulic radius

(Reference “Hydro-Electric Handbook” Creager &Justin. John Wiley and Sons, second edition 1950)

Alternatively, the nomograph in the appendix may be used.

### H.1.3 MANNING’S FORMULA

$$Q = A \times R^{O.667} \times S^{O.5}/n$$

where: Q = flow in cubic meters per second

A = cross sectional area of the water-way in square metres

R = hydraulic radius in metres

S = slope

n = roughness coefficient

For circular pipes flowing full, ‘n’ shall be taken as:

- 0.011 for PE & PVC stormwater drains with velocity greater than 1 m/sec.
- 0.013 for ceramic and concrete stormwater drains with velocity greater than 1 m/sec.
- 0.013 for all sewers.
- 0.015 for cast-in-situ concrete stormwater drains; and all stormwater drains with velocities less than 1 m/sec.
- 0.030 to 0.035 for open ditches (or see photos in Ven Te Chow, 1959, Open-Channel Hydraulics).

### H.1.4 GENERAL

The hydraulic design of drains shall make allowance for energy losses at structures. These losses include losses due to changes in direction, entry/ exit losses in the structure and losses as a consequence of connections.

Large drops in invert level must be taken out through special structures.

The fall through a manhole consists of the sum of:

- That provided as a consequence of the grade of the drain.
- That provided to compensate for energy losses at manholes caused by a change in direction and an increase or decrease in pipe size.

### H.1.5 INCREASE IN PIPE SIZE

The hydraulic grade line should be designed to continue through the manhole with no heading up. Generally the soffits of the drains at the manhole shall be on grade.

### H.1.6 CHANGE IN DIRECTION

The head loss across a 1050mm manhole with a smooth bend shall be calculated from $kv^2/2g$ where k is from the graph in the appendix.

### H.1.7 REDUCTION IN DIAMETER

In cases where a reduction in drain size is justified by a large increase in gradient, the pipe size reduction is to be at a manhole and to the approval of the Drainage Engineer. In designing the transition structure, it shall be assumed in general, that the velocity exiting a manhole is the same as the velocity entering the manhole. An additional head loss of $0.25v^2/2g$ shall also be allowed for.

Reductions in size are only considered where the exit pipe is 300mm or greater.

Where it is agreed to reduce the size of the pipe, calculations of the hydraulics will be required. These calculations shall include a sketch of the drain and show the hydraulic grade line and the total energy line.

### H.1.8 ENERGY DISSIPATION STRUCTURES

Where analysis of the hydraulics of the proposed flow demonstrates that significant turbulence or a velocity high enough to scour the channel will occur, (e.g. greater than 1.8m/s for grass) due account is to be taken of this and structures designed to eliminate damage to either the drainage structures or any existing natural formations. Backwater or similar calculations may be necessary to analyse flows and determine stream velocites. Short duration local velocities up to 3m/s max may be acceptable in some cases without a dissipater where it can be shown that the channel is in stable strong ground, the consequences of erosion are small, and maintenance is easy.

Energy dissipation structures are to be designed to minimise the collection of debris. Where debris will collect, provision and access must be made for easy removal.

## H.2 Location

Wherever possible, public drains are to be located in public land.

Where practical, drains should be laid with a cover between 1m and 2m and in road carriageway.

Where two pipes are located in one trench the minimum distance between the two pipes will be 150mm, unless specifically approved by the Drainage Engineer.

Where drains are to be located in private property, they shall be located clear of existing and future building sites.

Surface openings shall be situated clear of existing or possible future boundary fences.

## H.3 MINIMUM DRAIN SIZE, GRADES AND VELOCITIES

The minimum diameter for a new sanitary sewer pipeline is 150mm.

All sewers must be laid to achieve a self cleansing velocity during the minimum expected peak dry weather flow. The normal minimum gradient for a 150mm diameter drain is 1 in 100 though gradients down to 1 in 150 are acceptable. Gradients flatter than 1 in 150 will require the permission of the Drainage Engineer. However for HDPE sewers laid with manhole spacing greater than that normally permitted, the minimum grade is 1 in 50. Under no circumstances will approval be given for gradients flatter than 1 in 200 for a new small sewer.

Grit traps will be required on all tributary sewers to the main intercepting sewer.

For a trapped drain (i.e. where all tributary drains come from sumps, house downpipes, or pass through grit traps so there is no entry of grit into the drain), the minimum size is 150mm diameter and minimum velocity 0.75m/sec.

For an untrapped drain, (e.g. open intakes connected to the drain), the minimum size is 225mm and the minimum velocity is 0.9 m/sec.

## H.4 Water stops AND Trench GROUND WATER

Water stops shall be provided at intervals as specified below.

Water stops also help control unwanted movement of groundwater along the trench and pipe bedding. Where necessary and practicable additional small subsoil drains should be provided within an enlarged trench and bedding. The outlets of small subsoil drains are then connected into an adjacent stormwater system at manholes, to discharge above the nominal design flow levels. Where these small subsoil drains pass a water stop, or leave the trench, they should be 'sealed'. This can lead to multiple pipes being needed.

Manholes can be considered to be water-stops provided they are constructed appropriately.

These water-stops or anti-scour blocks shall be constructed from 17 MPa concrete, shall be 150 thick and shall be set a minimum of 150mm into the sides and floor of the trench. They shall extend 300mm above the top of the pipe.

Care shall be taken to ensure that the pipeline is well supported on each side of the barrier.

| Grade | Spacing |
|---|---|
| Steeper than 1 in 5 | 5m |
| 1 in 5 - 1 in 8 | 7.5m |
| 1 in 8 - 1 in 15 | 15m |

| | |
|---|---|
| 1 in 15 – 1 in 100 | 90m |

## H.5 STRUCTURAL DESIGN

### H.5.1 GENERAL

All structural design is to be carried out by a competent person and the plans approved by Council.

The class of earthenware or reinforced pipes shall be as set out on the charts in Appendicies 4-7 unless they are specifically designed.

Where pipes are specifically designed, then the conditions set out below shall apply.

⇒ They shall be designed to either NZ/AS 3725:1989, Loads on Buried Concrete Pipes, ASCE Manual of Engineering Practice No. 37 (WPCF Manual of practice No. 9) Design and Construction of Sanitary Storm Sewers or AS2566:1982 Plastic Pipelaying Design.

⇒ The design assumptions shall be appropriately detailed on the drawings and appropriate supervision of the works shall be carried out by the designer or his/her nominated agent to ensure that the design assumptions are met.

⇒ The design assumptions used shall be as set out below.

### H.5.2 DESIGN ASSUMPTIONS

Pipes shall be assumed to be in embankment conditions as trench conditions requires a very narrow trench width; too narrow for timbering or compaction of backfill material.

The bedding type assumed for pipes in roads with less than 2m cover shall be H1. This is to allow for the pipe to be exposed by other utility operators at some time in its life and inadequately backfilled.

Pipes in private property where it is feasible to be subject to traffic loading shall be designed to carry a truck with a 5t wheel load.

Pipes in minor roads private roads, footpaths and areas where traffic loading is possible, shall be designed to carry a traffic load of two trucks with wheel loads of 10 tonne.

Pipes in main roads, CBD, industrial and commercial areas shall be designed to carry a traffic load of two trucks with wheel loads of 10 tonne or one truck with wheel loads of 15 tonnes.

The maximum Load Factor (LF) (or Bedding Factor (BF)) used in calculations shall be:

| **Description** | **Bedding Type** | **Load Factor** |
|---|---|---|
| Drainage Bedding Material for D/10 with uncompacted side fill: | Class C, H1 | 1.5 |
| Drainage Bedding Material for D/4 depth with selected compacted fill for side support. | Class B, H2 | 2.0 |
| Drainage Bedding Material for bedding and compacted road base for side support. | | 2.25 |
| Drainage Bedding Material for bedding and side support. | HS2 | 2.5 |

**Specifically:**

Pipes shall be at least as strong as a pipe designed to the following assumptions:

| | Location | Design Assumptions |
|---|---|---|
| ⇒ | All pipes during construction: | Embankment conditions unless specifically designed and constructed otherwise. |
| ⇒ | Pipes in private property where it is unlikely that they will be disturbed and there will be no traffic loading. | Embankment conditions with a projection ratio of +1.<br><br>Drains <300mm, HS2 bedding (full surround with Drainage Bedding Material).<br><br>Drains >=300mm, H2 bedding. |
| ⇒ | Pipes in private property subject to domestic traffic loading. | Embankment conditions, p = +1.<br><br>HS2 or H2 bedding as appropriate.<br><br>One truck with 5t wheel load. |
| ⇒ | Pipes in roads other than listed below. Includes private roads. | Embankment conditions, p = +1.<br><br>Minimal bedding for pipes with less than 2m cover (H1 bedding).<br><br>For pipes deeper than 2m cover, either HS2 or H2 bedding as appropriate.<br><br>Two trucks with 10t wheel load. |

| | Location | Design Assumptions |
|---|---|---|
| ⇒ | Pipes in the following areas:<br><br>CBD<br><br>Bus routes<br><br>Main or arterial roads<br><br>Main thorough-fares<br><br>Industrial, commercial and shopping roads and access to these areas. | Embankment conditions, p = +1.<br><br>Minimal bedding for pipes with less than 2m cover (H1 bedding).<br><br>For pipes deeper than 2m cover, either HS2 or H2 bedding as appropriate.<br><br>The worst case of two trucks with 10t wheel loads or one truck with 15t wheel load). |

# I. Joints

All rigid pipes shall have an approved flexible joint (i.e. normally a rubber ring joint).

Details of any special methods of sealing a joint shall be specified on the drawings and relevant technical information shall be included in the document set submitted for approval.

# J. LAYING OF PIPES

## J.1 PIPE MATERIALS

### J.1.1 GENERAL

Due to the earthquake risk in Wellington City, PE pipes shall be used for all public sanitary sewer mains.

Concrete pipes 225mm and greater are generally used for stormwater drains, except for steep sites with difficult access and as approved by the Drainage Engineer.

Information regarding liquefaction hazard areas is available from Greater Wellington Regional Council.

The following table sets out the permitted materials for drains:

| Material | Stormwater | Sanitary Sewer |
|---|---|---|
| Ceramic to NZS 3302 | A | PP* |

| | | |
|---|---|---|
| Cast-in-situ concrete | S | S |
| Titan branded roller compacted pipes NZS 3107:1978<br>225mm-600mm diameter only | A | A |
| Cast iron to BS 437 | U | S |
| HDPE to NZS 7604 | A | A |
| Lined steel | S | S |
| uPVC to AS/NZS 1260 | P | P |
| uPVC, class C equivalent. | PP | PP |
| ABS | S | S |
| GRP | S | S |
| Aluminium, Hi Flow or Aluflo | S | U |
| Corrugated steel | U | U |

* Only for repair not for new pipes

Where

U = Unacceptable

A = Accepted

S = May be approved in special circumstances

P = Acceptable for private drains in private property not subject to heavy traffic. Unacceptable for public drains and private drains laid in road reserve.[8]

PP = Acceptable for private drains laid in road reserve.

All wastewater concrete pipes are to be constructed of a suitable sulphate resisting concrete, or contain a suitable corrosion inhibiter additive to ensure they are not affected by sulphide attack.

Good benching will minimise imperfections, that create sediment traps and slime growth which deplete dissolved oxygen.

## J.1.2 STORMWATER LATERALS TO KERB

Stormwater laterals to the kerb shall be laid in either cast iron or galvanised steel.

[8] uPVC will not perform as well as other pipe materials in the event of an earthquake or in heavy traffic situations.

## J.2 PIPE CLASSES

### J.2.1 PIPE COVER

All pipes in vehicular trafficked areas should have a cover of more than 900mm. Pipes with a cover of less than 900mm require the permission of the Drainage Engineer.

All pipes in private property are to have cover of 600mm or more or be provided with appropriate protection.

Pipes in steep, un-developable land shall have sufficient cover to protect the drain from physical damage, ultraviolet light, extreme temperature changes and be visually acceptable.

### J.2.2 REINFORCED CONCRETE & CERAMIC PIPES

The minimum class for Reinforced Concrete shall be X.

The minimum class for ceramic shall be Y.

### J.2.3 HDPE PIPES

All HDPE pipes and fittings for gravity pipelines shall be to "Hard Metric" sizes (i.e. 160, 250, 315, 400, 500, 560, 630, 710, 800, 900, 1000mm OD). Rising mains shall be to one of the above sizes or 50mm, 63mm, 110mm, 125 and 200. The required minimum SDR[9] for 160-355mm O.D pipes with a cover of 0.9m to 4m shall be SDR 17.6:

## J.3 PRIVATE LEADS and Manholes

The minimum size pipe for private drains is 100mm.

Council lids are not to be used on private drains.

Leads are to be provided as follows:

- Where the public drain is in the roadway, 100mm leads extended to inside the section.
- Where the public drain is more than 2m deep, 100mm leads extended to between 1.0m to 1.5 of the ground surface.
- Where it will be necessary for a lead to cross private property other than the section which it is intended to serve, then that lead is to be provided at the time of subdivision and laid within an easement.

[9] SDR = $\frac{\text{Outside Pipe Diameter}}{\text{Wall Thickness}}$

- Where a public drain terminates just inside a private section.
- All extended leads up to the connection to the public main will remain private and belong to the section which they are intended to serve.
- It is preferable for private leads to be connected to manholes rather than to the pipe.
- Where a private stormwater drain discharges to the kerb, the section of the drain crossing the footpath and though the kerb shall be cast iron or galvanised steel.

# K. MANHOLES

## K.1 General

A manhole is to be constructed on every junction on Public Drains (but excluding inline Y junctions to single 100mm laterals).

Where circumstances dictate the Drainage Engineer may allow a single short 150mm pubic drain to be terminated with a lamphole cleaning eye in lieu of a manhole - detail is shown in the Appendix 12. A lamphole cleaning eye may also be approved at a change of grade at the top of a steep slope.

All bends shall be fully within a manhole except as set out below.

The access holes for manholes shall be in the centre of the top slab for 1050mm diameter manholes, and offset for larger diameter manholes to be positioned over the rungs.

Concrete manholes subjected to high concentrations of hydrogen sulphide are to be constructed of a suitable sulphate resisting concrete, or contain a suitable corrosion inhibiter additive.

## K.2 Manhole Size

Manholes shall have a riser diameter of at least 1050mm. Pipes larger than 750mm require a manhole diameter of 1200 minimum, or when the manhole diameter is smaller than the pipe a pre cast manhole tee may be used. Tee manholes likely to receive traffic loading shall be designed and installed to take full traffic loading.

Manholes in the CBD and other streets which are likely to be become congested with utility services in the future shall have a precast floor 300mm below drain invert.

See section K.8 for size of manholes with internal drops.

Bends must be sufficiently gentle for the flow not to leave the channel and deposit debris on the benching[10].

Manholes shall be designed to allow all drains entering (and leaving) the manhole to be inspected by a CCTV camera. The size of the design camera shall be taken as a body size of 470 x 85 x 85mm (and 130mm wide to outside of the wheels) [11].

Allowance shall be made for adequate benching of existing connections and the installation of likely future connections.

Manholes shall be designed to pass the flow with minimal loss of energy.

Except in exceptional circumstances and with the permission of the Drainage Engineer, manhole riser diameter[12] shall not be smaller than:

| | |
|---|---|
| • Manholes less than 2m deep.[13] | 1050mm. |
| • Manholes 2-4m deep. | 1200mm. |
| • Manholes in the CBD and other streets which are likely to be become congested with utility services in the future. | 1200mm. |
| • Manholes over 4-5m deep. | 1500mm. |

- Manholes over 5m deep usually require special engineering design (see D11.7)

Note:

The following manhole sizes have been found to be suitable to enable the adequate construction of the manhole where there is a change of direction at a manhole and the bend is fully within the manhole:

---

[10] This normally requires channels of 45$^{o}$ or less.

[11] . It is not possible to insert a camera in a 150mm drain if there is 45$^{o}$ channel hard up against the manhole wall and the invert is benched to full pipe height.

[12] These sizes are the minimum necessary to adequately maintain the drain and allow for future rehabilitation.

[13] Minimum size is 1050mm as this has been found by experience to be the minimum practical size for CCTV, trenchless repairs and rehabilitation techniques and health and safety considerations.

| Pipe Diameter (mm) | Change of Direction (Degrees) | Diameter of Manhole Riser (mm) |
|---|---|---|
| 450 | 10-55 | 1050 |
| 450 | 55-65 | 1200 |
| 525 | 10-30 | 1050 |
| 525 | 30-55 | 1200 |
| 600/675 | 10-15 | 1050 |
| 600/675 | 15-35 | 1200 |
| 600/675 | 35-50 | 1350 |
| 750 | 5-25 | 1350 |
| 750 | 25-35 | 1500 |

## K.3 Manhole rungs

Manhole rungs are to be constructed in all manholes. They are to be positioned parallel to the main flow so they are over the benching. They are to be constructed of non corrosive, non slip material as detailed in the Drainage General Conditions of Specification.

## K.4 Manhole materials

Manholes are to be constructed with the minimum possible number of manufactured pre-cast concrete risers to minimise infiltration.

In back properties where access is difficult, PE manholes may be used, however only with the written approval of the Drainage Engineer.

## K.5 Manhole Spacing

In road reserve, the maximum manhole spacing shall be 90m for pipes of up to 1m diameter or 90D for pipes larger than 1m diameter.

In private property, the normal maximum manhole spacing shall be 60m. A greater spacing may be permitted provided that the following conditions are met:

- The pipe is laid in PE.
- There are no connections between manholes.

- For stormwater drains, there are no creek entries or un-trapped sumps upstream of the drain.
- The grade is steeper than 1 in 30 over the entire length of the drain.

## K.6 Change Of Grade & Direction Between Manholes

### K.6.1 CHANGES OF GRADE

There shall be no more than one change of grade between manholes and this shall not exceed 45 degrees.

### K.6.2 DRAINS LAID ON A CURVE

PE drains may be laid on a curve provided that:

- There is good reason for the drain not to be laid in a straight line.
- The bends are made by bending straight lengths of pipe. The minimum radius of curvature for bending shall be 50 x the OD of the pipe.
- The entire length of the pipe is surveyed to +/- 100mm to NZMG.
- If there are creek entries or un-trapped sumps upstream, the pipe size is greater than 300mm.
- Detector tape is placed on top of the pipe.
- A twin 1.0mm TPS electrical locator cable is laid along the top of the pipes. The ends are to be extended into the manholes and up to the lid, as provision for connection of locating instruments. If it is necessary to make joints in the cable, they are to be made with electrical connectors and shall be completely encased in a silicon rubber sealant to seal the joint against corrosion.

### K.6.3 BENDS OUTSIDE OF MANHOLES

Bends will be permitted outside of a manhole provided the following conditions are met:

**Drains 350mm – 750mm**

There is good reason for the bend not to be fully within the manhole.

There is a manhole within 5m of the bend.

There are no connections to the bend and it is most unlikely that a connection will be required to the bend sometime in the future.

The manhole spacing is less than 60m.

The as-built of the drain shows sufficient co-ordinates or references to known marks to enable the position of the entire bend and drain to be defined to $^{+}/-$ 100mm to NZMG.

The manhole should be down-stream rather than up-stream of the bend.

### Drains Greater Than 750mm.

The as-built of the drain shows sufficient co-ordinates or references to known marks to enable the position of the entire bend and drain to be defined to $^{+}/-$ 100mm to NZMG.

## K.7 Deep Manholes

Manholes deeper than 5m shall be at least 1800mm in diameter and must be specially designed for access and strength. Health and safety, maintenance and rehabilitation needs are to be considered.

Landings are to be provided at distances of 5m maximum. The access through the landing is to have a hinged cover opening into the centre of the manhole and be positioned over the rungs. Suitable permanent ladders may be approved in lieu of rungs.

## K.8 Drops at Manholes

Sump leads or normally dry stormwater drains may enter above the benching. The rest of this section does not apply to these drains.

A drop in a manhole shall not exceed 500mm. Drops up to this size are to be benched in the manhole.

Where the drop at the manhole exceeds 500mm and the drain is smaller than 250mm, an internal drop pipe as per Diagram 6 in the specification may be used provided that the manhole diameter is at least as big as the sum of:

The size as set out in section K.2 **plus** the outside diameter of the drop pipe **plus** 150mm.

In all other cases, drops shall either be by way of laying a steep length of pipe with a manhole at the top and bottom or by way of a special structure (with facility for access and cleaning). Large drains laid on a steep slope may require an energy dissipater system.

Where flow in a steep drain can move into a low surcharged state, it may be necessary to provide special outlet capacity from vulnerable manholes . This is to avoid entrance control causing undue heading up and potentially blowing the manhole top.

## L. Pumping Stations

No pumping station is permitted if a gravity connection is possible.

Pumping stations with more than 10 connections may be vested in the Council.

The Pumping Station design and equipment is to be specifically approved by the Council Pump Station Engineer.

For Sanitary Sewer pumping stations, the design is to include:

- 4 hours of storage based on ADWF
- Include one standby pump
- Flyght pumps are preferred
- Pipework is to be epoxy coated cast iron, or ABS
- Approved shut off valves, telemetry, alarms and level sensors are to be provided (float switches will not be approved).

## M. Bridges

Bridges shall have a minimum of 500mm freeboard between the level of the water during peak design flows, and the underside of any part of the bridge.

As far as practical and reasonable the design of the bridge shall minimise potential adverse effects to the floodway or adjacent property, including from overdesign floods or obstruction and accumulation of detritus by the bridge.

## N. Rural situations

### D.4.1 Sanitary Sewer

Detailed design of septic tanks and effluent disposal systems are to be submitted for approval. The design must provide assurance that the system will not be affected by flooding in compliance with section E1 of the Building Code.

### D.4.2 Stormwater

In rural catchments, the time of concentration may be calculated from the following formula:

$$Tc = 0.0195\ (L^3/H)^{0.385}$$

where

L = length of catchment in metres measured along the flow path

H = rise from bottom to top of catchment in metres.

A runoff coefficient of 0.35 would normally apply to rural situations.