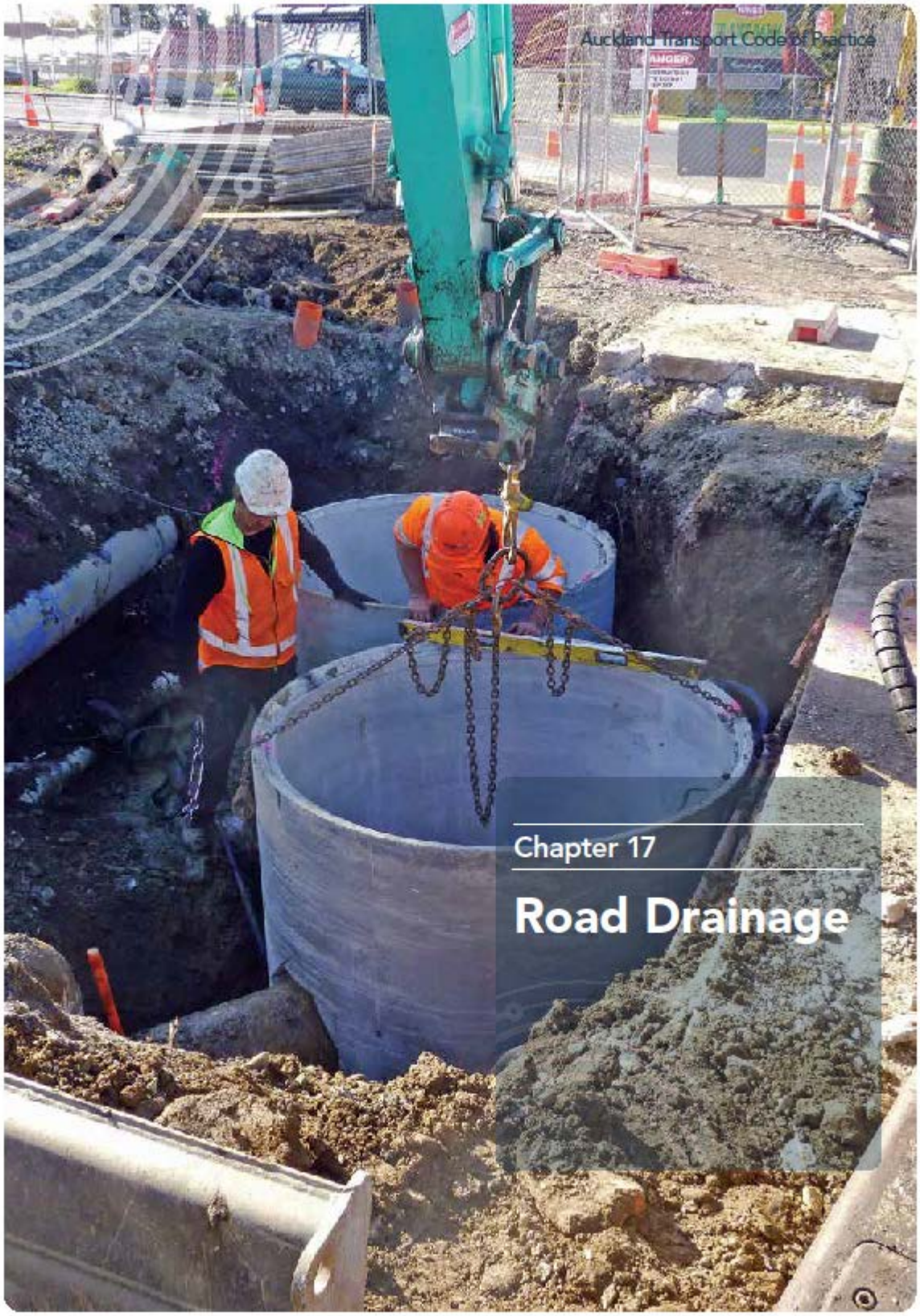

Auckland Transport
An Auckland Council Organisation

17 Road Drainage

17.1 Stormwater Guidelines

It is essential that AT's Stormwater Guidelines (PDF 101KB) are read before reading the rest of this chapter.

17.2 Scope of Road Drainage Design

This Road Drainage Chapter covers:

- Drainage of surface water within road reserves
- Collection, conveyance and treatment of run-off from roads
- Management of stormwater discharging from land onto road reserves
- Discharge of stormwater from road reserves
- Subsurface drainage of roads
- Diversion and culverting of watercourses within road reserves

It deals with the design considerations required for these aspects of drainage, in design principles and detailed guidance.

It specifies limitations on design choice that are made to achieve regional consistency for reasons of local conditions, efficiency, effectiveness and economy of capital and operational management.

Reference documents specific to Road Drainage are listed at Appendix 17A. These are to be used in planning and designing road drainage, subject to the requirements of this Code of Practice. In particular, Stormwater design must comply with Auckland Council Stormwater Code of Practice (AC SW COP)and, where connection is to Combined sewer, with Watercare Services Wastewater Code of Practice (WSL WW COP).

Design storm characteristics are generally set in Unitary Plan, Regional or District Plans expressed as % AEP (Annual Exceedence Probability or years ARI (Annual Return Interval). % AEP is used here, to underline the risk management basis of design.

17.3 Design Principles

17.3.1 Integration of Drainage

Stormwater management of roads should be integrated with management of surrounding land and development. Where it is economical and effective to treat road run-off in conjunction with stormwater from a developed area, shared public SW treatment devices may be used. If the requirements for treatment of road run-off differ significantly from those for developed land, or where existing land uses will continue with treatment to a standard not appropriate for the road run-off, then separate treatment trains will need to be provided.

Treatment requirements should be determined with reference to Catchment Management Plans or Network Discharge Consents where these are in place, or by requirements of a resource consent for stormwater discharge. This will determine the extent of opportunity for integrated management.

In any case, the catchment of run-off from land adjoining roads needs to be investigated and provided for, and flood hazard management needs integration of road with land upstream and downstream, as required by AC SW COP 4.2.8. The capacity of primary drainage of developed

land may be exceeded in events less than 10% AEP due to blockage or provision to lower standard. Probable catchment run-off needs to be calculated for road drainage design.

The effects of road stormwater discharge into public reticulation need to be investigated. Integration of peak flow discharges and time of concentration may be able to provide capacity management of the network.

In certain areas within the region, special ground conditions require stormwater drainage to meet specific policies or code conditions. The principal defined areas are:

- Combined sewer reticulation
- Soakage discharge
- Groundwater recharge

Road drainage in these areas must comply with the relevant policy or code requirements. Design for road run-off should be integrated with land use run-off design as far as possible. Where land use drainage is not being changed in a way that can be integrated with road run-off, then road run-off design may be more difficult. Early discussion with AT and AC consenting organisations is likely to be beneficial.

17.3.2 Water Sensitive Design

Water Sensitive Design is an inter-disciplinary design approach to stormwater management that operates at complementary scales of the region, the catchment, and the site for planning and land development.

Water Sensitive Design seeks to protect, enhance, and ultimately utilise natural systems and processes for enhanced stormwater management, ecosystem services, and community outcome. Its principles are:

- Promote Inter-Disciplinary Planning and Design
- Protect the values and functions of natural ecosystems.
- Avoid adverse effects of stormwater or manage them as close to source as possible.
- Utilise natural systems and processes for stormwater management.

All road construction and improvement should be designed in accordance with Water Sensitive Design principles, even where conventional stormwater management systems may be appropriate.

Road layouts should be designed to retain existing landforms and drainage patterns wherever possible. This can often be done without significant reduction of development yield or level of service to road users, and frequently results in improved quality of built and natural environment.

Impervious surface percentage should be kept as low as possible, within road reserve and on adjoining land, consistent with the road use required.

Stormwater management systems and treatment trains should reflect natural water management systems as far as possible. Methods such as groundwater recharge, tree canopy and vegetated strips should be used in conjunction with designed treatment trains.

Earthworks should be minimised and design choices in accord with Water Sensitive Design principles should align with sustainability and economic objectives.

17.3.3 Tiered Objectives for Stormwater Management Design in Road Reserves

Drainage design requires attention to be given to a range of different objectives. The range of rainfall intensities and the appropriate design solutions differ for these objectives. Each needs to be approached differently and the solutions integrated into a final comprehensive design. The design should demonstrate how each is dealt with.

Quality management design. Designed typically for rainfall up to Water Quality Volume (run-off WQV) given in AC Stormwater Design Guidelines. Rainfall from most of any year should be managed through Water Sensitive Design to reflect natural processes for quality treatment, volume reduction, groundwater recharge, attenuation and dispersed discharge. Quality objectives should be determined from Unitary or Regional/District Plan or Network Discharge Consent requirements and Stormwater Governing Principle. Focus is environmental design for everyday conditions.

Serviceability management design. Designed typically for rainfall up to 10% AEP design storm. Rainfall run-off should be managed within the road reserve to maintain acceptable levels of service for road users, limiting hazards and nuisance. This is to include Surface Water Management (see 15.5) and serviceability for walking and cycling at appropriate lower rainfall intensity. Serviceability objectives should be determined from safety and service requirements set out in Austroads Guide to Road Design Part 5A and in particular design must comply with Guide to Road Design Part 5A Table 5.1. Focus is safe operation for all design road users for occasional events.

Major event management design. Designed typically for storms up to 1% AEP, to ensure survivability or recovery of infrastructure, accessibility for emergency services and protection of personal safety and habitable or commercial property. Also consider any significant consequences of run-off exceeding the design peak flow; greater protection for identified critical infrastructure (0.5% AEP); and effects of coastal inundation from tides, sea-level rise or tsunami. Major event objectives should include flow limitations set out on Austroads Guide to Road Design Part 5A Table 5.2. Focus is personal safety, protection of property and survival and recovery of infrastructure for extreme events.

17.3.4 Major/Minor Drainage Concept

The minor system, or Primary Drainage is intended to capture and convey run-off from frequent rainfall events so as to maintain road safety and avoid nuisance to road users and to adjoining land. The frequency of event for Primary Drainage design is generally defined by Unitary or District Plan to be the 10% AEP design storm.

Minor or Primary Drainage is divided into Water Quality Objectives and Serviceability Objectives, set as shown in Section 17.3.3. These may require separate systems, or one system designed for both objectives.

The major system, or Secondary Drainage, is designed for severe storm events, generally the 1% AEP design storm. This system is to be designed to protect infrastructure from significant damage, to protect habitable property from damage, to maintain safety for people, and to provide sufficient accessibility for movement of emergency services.

In urban areas, the design objective will be to retain major event run-off within road reserve and convey it to defined overland flow path discharge points. Roads should be laid out as far as

possible to facilitate control of major event run-off to this end. Excessive flow and velocity should be avoided, and consideration given to momentum where a change of direction is required.

The 1% AEP storm run-off should generally be contained within the road reserve with sufficient freeboard at the boundary to limit risk of discharge towards vulnerable property. Care should be taken to avoid ponding or spread flow that is deep enough to obscure hazards to road users, especially at intersections and at drop-offs from the roadway such as raingardens, culvert headwalls or roadside drains.

Flood flow should be directed to discharge from the road reserve at natural low points. Where the road layout is designed with regard to the natural drainage pattern, difficulties can generally be avoided.

In some locations, particularly in the central isthmus of Auckland, topography does not provide a natural flow path that can be used to convey major run-off in surface channels. This may also occur where existing vulnerable property obstructs the flow path. In such cases it may be necessary to provide sufficient ponding capacity to detain the design storm volume for discharge by the capacity of the minor or primary system. Where necessary to protect property, the primary system should be designed to carry the 2% AEP storm peak discharge. This is not required where discharge from a trapped catchment is to soakage. In order to alleviate such issues at the bottom of the catchment, consideration should be given to the extent to which road design can contain and attenuate concentration of overland flow.

The discharge flow, velocity and depth of overland flow should be checked on the basis of the primary system being fully blocked to determine the consequences of such an event. However, design may allow for discharge of 50% of the nominal inlet capacity through the primary system which is deemed satisfactory unless particular risk due to blockage is identified by the check calculation.

In rural areas, the design objectives will be to protect infrastructure from significant damage during major events, to limit interruption of service in accord with traffic or lifeline significance of the road, and to allow major event stream flow to cross the line of a road without significant diversion, flooding of land or scour.

17.4 Road surface Run-off Calculations

Road surface run-off calculations are required for:

- All arterial and collector roads
- Roads with channel gradients outside the range 1.5% - 10%
- Roads drained to stormwater treatment systems
- Roadways with more than 8.0m width falling to a channel

17.5 Surface Water Management

Geometric design of roads must include consideration of surface drainage.

The prime consideration for surface drainage is road safety. High speed roads must be designed with regard to the potential for aquaplaning, and also for the effects of spray. Intersections must also be designed for these effects. For lower speed roads, special attention should be given to changes of direction and steep or shallow gradients.

The second consideration is for serviceability. Long drainage paths across paved areas may result in excessive depth of water film, or puddling in uneven surfaces. This can be unsatisfactory for pedestrians and cyclists.

Surface material must be selected with regard to surface gradients and road user needs to ensure surface water film is not allowed to become excessive in depth. Open Graded Porous Asphalt may be suitable in wide or flat areas of roadway, but may not be suitable for significant turning movements at intersections. Large flat concrete paved areas may benefit from spaced grooves to collect and deflect surface film.

Longitudinal gradients of kerbed channels must not be less than 0.5%. Any length of road with a gradient less than this must have provision to avoid ponding. This may be sag curve catchpit inlet, crossfall away from channel, sheet flow discharge over road edge or grated drain channel.

Crossfall and longitudinal gradient must be considered together, to limit the length of any drainage path before water is concentrated into a channel or discharged from the paved surface.

- Steep roads should have maximum crossfall to shorten drainage path to roadside collection.
- Roads with flat grade should have sufficient crossfall to clear surface water
- Transitions from camber to superelevation should be developed at or away from sag and summit curves, in such a way as to avoid flat areas.

Road design for aquaplaning should be carried out in accordance with Guide to Road Design Part 5A Section 4. Where concentrated flow crosses a carriageway, it must be less than the maximum flow in Guide to Road Design Part 5A Table 5.1.

17.6 Stormwater Treatment Devices – Preferred Systems

For Water Sensitive Design see Section 17.3.2. Drainage design for roads should also meet the following requirements.

A treatment train should be identified, taking road run-off through from collection to discharge, with appropriate treatment practices that may include bioretention, wetlands or other suitable practices. Treatment should generally be as close to source as possible, and reproducing the effects of natural drainage as far as possible.

Treatment should be designed with regard to the site context and catchment management priorities. For example, discharge from a low-traffic road to a stream may benefit from volume reduction and temperature mitigation that can be provided by bioretention more than from contaminant reduction through a proprietary filter without flow control, volume reduction or temperature mitigation. Combination in a treatment train can provide all elements that the context requires.

Any devices that store water on or below the ground surface close to roads must be designed with regard to structural support for traffic loads, protection from infiltration into pavement formation, and geotechnical stability hazards. Infiltration to ground may be appropriate in some locations; tanking to avoid infiltration will be necessary in others. Whether the device might interact with subsoil drains should be considered.

Devices should be designed in accordance with Auckland Council Stormwater Guidelines.

17.6.1 Bioretention Swales, Rain Gardens and Tree Pits.

Design and sizing of treatment devices must be in accordance with Auckland Council Stormwater Guidelines.

For use in roads vested in council, bioretention practices must be designed to ensure traffic loads to pavements are transferred to subgrade clear of uncompacted filter materials. Concrete structures should be avoided where possible, but may be required in some cases.

Vegetation plans are to be designed in accordance with *ATCOP Chapter 14 Landscaping* and Auckland Council Stormwater Guidelines.

Where the design requires a drop-off from roadway or footpath into a device, kerbing may be required for safety. See section 17.7.

17.6.2 Paving

Pervious paving can combine elements of capture, movement and management of surface water. It is most suitable for paths and parking areas. It may be used for lightly trafficked roads but only in special circumstances with permission of AT.

Surface materials may be:

- insitu pervious concrete;
- permeable block paving systems;
- reinforced grass or gravel systems.

Design and detailing of surfacing, drainage capture, conveyance, and pavement structure must be carried out in accordance with any suppliers' system requirements and Auckland Council Stormwater Guidelines.

Roadbase material for conveyance and storage is required to meet pavement strength design criteria, in accordance with published specifications. For this reason, the use of pervious paving is limited by the strength of available materials, or the use of structural cells capable of transmitting traffic loads to sub-base.

Pervious paving design must include an operational maintenance plan. This is to include requirements for cyclic cleaning. Layout of the boundaries of pervious paved areas must consider accessibility for specified maintenance equipment such as a vacuum sweeper.

Reinforced grassed systems must only be used where traffic loading and sediment deposition are limited to ensure grass is likely to thrive.

17.6.3 Vegetated Filter Strips

Vegetated filter strips may be used as a treatment for sheet flow from roadway or path before discharge to a side drain or watercourse, or may be used as an element in a treatment train to reduce volume (this benefit is limited), extend time of concentration and filter sediments. For either of these applications, design should be based upon Auckland Council Stormwater Guidelines. Any landscaped area within a road layout may be suitable for inclusion in a treatment train.

17.6.4 Swales

Swales may be effective for Quality design, including reducing discharge volume, and for Serviceability design. Check dams may be required to limit gradient of the base of the swale to 5% or less. Swales will not normally be suitable where road gradient exceeds 8%.

Swale design must comply with Auckland Council Stormwater Guidelines and *ATCOP Section 17.10 Side Drains / Water Tables*.

Swales combine the functions of table drains with treatment. The treatment requirement may lead to choice of either a standard swale or a bioretention swale (see Section 17.6.1).

Grassed swales can be damaged by parking of vehicles, and may be compromised by inappropriate and unauthorised care by frontage occupants. They should not be used in residential local roads, or other roads where berm parking is likely to occur, without permission of AT. Swales with approved vegetation other than grass may be acceptable in such roads. Street trees may be planted in conjunction with swales, subject to requirements of *ATCOP Chapter 14 Landscaping*.

Where services are to be laid under swales, they must be clear of any subsoil collector drain, and access pits and covers must not obstruct the designed waterway.

17.6.5 Proprietary Devices

In some cases, it will not be feasible to provide for stormwater consent treatment requirements using the preferred systems listed above.

Where proprietary devices are appropriate, they must be selected from devices evaluated under Auckland Council Stormwater Guidelines.

Proprietary devices must be selected with regard to whole-life cost, treatment benefit and to operational requirements.

17.7 Kerbs and channels

Provision of kerbs and selection of kerb profile for traffic purposes should be in accordance with *ATCOP Section 7.7 Kerbs and Channels*.

Kerbing may be also be required for surface water control in these circumstances:

- As part of a surface water channel for collection and conveyance to an offlet, a catchpit or a treatment device (such as a rain garden, or filter)
- On all roads where the channel gradient exceeds 8%, or 5% unless a side drain system is provided that collects surface water effectively along its length
- To contain overland flow and ponding within the roadway for the protection of property or the safety of footpath users
- Roads with side drains/ water tables where the road passes through a cutting and the side drain is interrupted to limit the width of cutting or for scour protection of steep grades.

The surface water kerb and channel profile should be selected from one of the details in Plan Set GD000. Selection is to suit both the streetscape design and the drainage design. It must be

capable of collection and conveyance of the minor design storm run-off to the point of discharge and meet the criteria in Section 17.3.3 for major event drainage.

For drainage systems using catchpits selected and located in accordance with Section 17.15, Kerb Types 1 or 3 shown in Plan No's. GD008 and GD009 in *ATCOP Chapter 7* will normally be suitable. This should be used in conjunction with the standard concrete round dish channel profile shown in Plan No.GD012 between the roadway and parking bays or other paved areas falling towards the roadway. Other kerb types may require transition specified over at least 0.9 m between kerb and catchpit lintel.

Where kerbing is required for vehicle containment or path user safety, and drainage is to an extended device such as vegetated strip, swale or raingarden, the kerbing may be interrupted at intervals to allow drainage. For vehicle kerbing, interruptions must normally not exceed 300 mm in length and be at least 600 mm apart, with inlet capacity designed as weir. Operating speed environment should be 60 km/h or less. An acceptable solution is shown in Plan No.RD012. For footpaths, upstand must not be less than 75 mm with short interruptions for inlet, or edge rail 150 mm to top and not more than 75 mm

Where an upstand kerb is not provided in paved areas, a concrete drainage channel must be provided. A drain channel should be at the left or right side of all traffic lanes. One may be located between parking or loading bays and traffic lanes, or between roadway and path where kerb containment is not required in special circumstances.

In low speed traffic and shared use areas, a channel may cross or be between expected vehicle movement tracks, subject to other design objectives.

Where a channel is within a large paved area subject to crossing by path users, a shallow v-shaped or trapezoidal channel may suitable.

If acceptable width of channel flow is likely to exceed the capacity of the channel, then capture by catchpits or grated channel should be considered.

Where adjoining land falls towards a road, and the road surface falls away from the road edge (superelevation or single crossfall), a channel profile is required to intercept run-off that is either:

- significant sheet flow from a wide paved area or
- prolonged surface flow from a landscaped area.

In this case, length of channel flow to a catchpit must be limited by the capacity of the channel profile.

17.8 Catchpits

Public catchpits are provided to drain the carriageway and for sediment or silt retention. Catchpits used in all public roads must comply with this Code of Practice.

Road drainage is managed jointly by AT and Auckland Council Stormwater Unit (SW) and approval is required from AT and SW for any work affecting this system *and from Watercare in the Combined Sewer Areas*.

All catchpits draining to combined networks must have a water-trap discharge, to prevent odours from the combined sewer system escaping from the catchpit. This should generally be in the form of a half-siphon as shown in Plan Nos.RD032, RD035 or RD039.

All catchpits must include a silt trap sump at least 450 mm deep.

Catchpits in town centres, or draining to streams, public beaches or amenity water as described in catchment Management Plans must be fitted with approved gross pollutant traps.

Catchpits discharging to soakage should include inserts in accordance with Plan Nos.RD042, RD043 or RD044.

Grated channel drains or slot drains may be appropriate to drain some areas, especially flat areas with wide sheet flow or to intercept surface flow to protect vulnerable property below the paved area. Channel or slot drains should only be used where areas cannot be laid to fall to surface channels or spread-entry treatment devices without significant problems such as trip hazards, excessive gradients or surface water inconvenience in areas of heavy pedestrian activity. Every channel or slot drain must discharge to a catchpit designed to suit that channel system.

17.8.1 Catchpit location

Catchpits should be located to meet the following requirements:

- At spacing determined by road surface drainage calculation, particularly for very flat or very steep gradients.
- Without specific design, in channels draining one lane, in such a position that the run of water in any channel is a maximum of 90 m, for channels draining two lanes, a maximum of 60 m.

- Where falling towards intersections, at the kerbline tangent points.
- At changes of gradient or direction in the channel where there may be a tendency for water to leave the channel or pond significantly.
- At changes of crossfall where significant flow will leave the channel and cross the roadway
- A catchpit located:
  a) At the lowest point in a sag vertical curve;
  b) At the end of a cul-de-sac where water falls to the end;

  must be designed with inlet capacity sufficient for bypass flow concentrating to that point including allowance for blockage.

17.8.2 Catchpit design

Catchpit inlets should be designed to intercept and convey all stormwater run-off flow from the minor drainage design storm, while limiting risk and degree of interference with traffic, safety risk and risk of flooding due to blockage.

The following general guidelines should be used in the design of catchpits:

- Provide for the safety of the public from being swept into the stormwater system: openings must not pass an object greater than 100 mm least dimension. Openings must be sufficiently small to prevent entry of debris that would clog the stormwater system, or must include a screening element to protect the discharge pipe from debris entry

- Inlet capacity
  a) Inlet capacity should be taken from manufacturers' or suppliers' data for approved types, or from verified testing of data for new types, or from approved design charts. Standard Catchpit 460 by 675 should be taken to have nominal inlet capacity of 28 l/s installed on gradient.
  b) Corrections must be made for crossfall less than 3%.
  c) Calculated catchpit inlet capacity must be reduced to allow for partial blockage of the inlet as follows:

Combined grate and back entry: on gradient	10% reduction
at sag point:	100% capacity of back entry alone
Grate only:	50% reduction
Back entry only:	20% reduction

Catchpits located on gradients must be designed for their inlet capture capacity, and bypass flow must be added to the flow in the next sub-catchment

Catchpits at sag points must be designed for sump condition inlet capacity, and must be Double Standard Catchpits or Splay Catchpit, Street Catchpit 500 by 800, Megapit or other with sump inlet capacity allowing for blockage sufficient for design flow. Where ponding would lead to road safety or property flood risk, consideration should be given to a second catchpit and lead near the sag point.

17.8.3 Catchpit Approved Types

Public catchpits for all new development must be selected from the following approved catchpit designs :

- Standard field Catchpit 440 by 440 Refer to Standard Plan Nos. RD031 and RD032 (not for use in the carriageway) in conjunction with flat or dished channels in paved areas
- Street catchpit 500 by 800 Refer to Plan Nos. RD038 and RD039. This detail may be used with either 1200 mm or 2400 mm inlet block, according to design inlet capacity.
- Splay Catchpit - Refer to Standard Plan Nos. RD036 and RD037
- Standard Catchpit 460 by 675 Combined back and grate entry - Refer to RD 034 and RD035. Where standard catchpits are in good condition, and could be retained during rehabilitation or upgrade works, grate and entry may be replaced with RD041 lintel units. Drainage design must be checked for inlet capacity and location in all works where existing standard catchpits might be retained.
- Standard Catchpit 460 by 675 Grate entry only - Refer to RD033. Use is restricted to channels without kerb upstand where an inlet is necessary for run-off that cannot be captured otherwise, or paved areas.
- Megapit - Refer to RD045. Note the minimum allowable sump depth is 450 mm.
- Other types included in AT Approved Products list

Catchpits of other types must be submitted to AT for type approval before they may be used.

Where site conditions prevent one of the approved types being used without modification, the modified design must be approved by AT before use.

17.8.4 Catchpit selection criteria

Catchpits must be selected with regard to the context for use. See Section 17.8.5 for inlet requirements for pedestrians and cyclists.

Selection may be affected by site constraints on location and design inlet flow, including spacing related to acceptable width of channel flow. Limitations on possible locations for connections to network or discharge from road reserve may influence location and thus selection of type.

Consideration should be given to factors such as run-off from adjoining land, litter in public areas or debris from trees that may affect type or location of catchpits for effective operation.

Megapit or similar can be used if large entry volumes are required for flood hazard reduction where a suitable overland flow path is not available. Note the minimum allowable sump depth is 450 mm. Careful consideration is required when sizing the outlet and designing the number of devices of the downstream network capacity of the stormwater pipe system, watercourse culverts or stormwater soakage system.

17.8.5 Catchpit inlets

Inlet weirs and grates should be selected from the types shown in RD drawings or the list of approved types kept by AT. This section also covers grates and slots for channel drains.

Any catchpits located on a road where cyclists may travel close to the drainage channel line must be provided with inlets that are cycle-friendly. Those shown in Plan Nos.RD036, RD037, RD038 and RD039 are deemed to be cycle-friendly. Where other catchpit types are used, the grate must be replaced by one that is approved by AT, and the apron must be reshaped to the same profile as the road and the frame must be not more than 5 mm below the level of the road. Inlet capacity must be checked.

Any catchpits in locations subject to foot traffic must be provided with inlets that are pedestrian friendly. This includes paths, plazas, shared use areas and pedestrian crossing areas.

17.8.6 Catchpit leads

All leads must be at least 225 mm diameter, except as shown below.

Leads from certain devices specify minimum sizes larger than 225mm. Such specified size will determine the minimum size of pipes downstream from that lead. Any proposed connection to a pipeline of smaller diameter requires approval from AC SW Operations.

Leads from some channel drains may be less than 225 mm diameter, where supplier's design charts show. Approval to use smaller diameter leads is required and will consider capacity, security against blockage, effects of blockage and ease of maintenance.

Catchpit leads discharging to land, to a watercourse or to an open channel drain must be provided with a suitable outlet structure.

Catchpit leads connecting to a piped stormwater network should normally be connected at a manhole.

Catchpit leads should not exceed 30 m in length. Where connection to a manhole would require a lead of excessive length, insufficient gradient, or connection is difficult by reason of manhole

integrity or obstruction of direct line, a saddle or branch connection to pipeline may be considered, subject to ACSWCOP requirements.

If a catchpit lead cannot be laid straight due to obstructions, its length should not exceed 15 m and large radius bends should be used to allow maintenance.

A catchpit lead should not connect to another catchpit. It is permitted to connect to another catchpit lead, subject to pipe capacity, using a fabricated 90° or 135° junction and where pipe maintenance access for jetting is available from the inlet.

17.9 Side Drains / Water Tables

Rural roads must be designed with regard to topography and existing land drainage. An existing or diverted watercourse may lie within or abutting the road reserve. If this is the case, a drainage concept must be agreed with the Stormwater Unit to determine how the road is to drain, what discharge points or sheet flow may be considered, and what treatment may be required.

Adequate drainage channels must be formed such that the design water level is below subgrade level.

The shape and location of the roadside drain must have regard to road safety. Preferred side slopes should be 1:6, with 1.2 m wide level base. Where this cannot be achieved, design must be in accordance with Austroads Guide to Road Design – Part 6.

Steep sided ditches, or deep channels will not be accepted within the clear zone of the road unless safety fence is provided.

AT may require the formation of drainage channels along the top of fill batters to control erosion.

The road drainage channel must be designed to consider the whole of the contributory catchment. Capacity must meet requirements for Serviceability design for the road. Where appropriate AT may require that the road drainage channel be enlarged to deal with the run-off from the 10 % AEP event. The consequent sizing of vehicle crossing culverts will be required to reflect this run-off and particular provision may need to be made to reduce velocities and thereby minimise erosion within the channel and at cut-off inlets.

Adequate cut-off must be provided such that the maximum length of flow path in the road drainage channel does not exceed 200m. Table drain blocks within the channel downstream of a cut-off drain should be provided to ensure flow is captured by the cut-off drain.

The cut-off must discharge to a natural watercourse, by way of an open drain along a lot boundary. Open drains through the body of the lot will generally not be acceptable. All such cut-off drains through private property must be protected by way of a drainage easement registered on the title of the property or properties affected. Where the easement is a specific one, i.e. not an easement in gross, it must be a minimum width of 3 metres to allow for easy maintenance access. Where discharge is through a residential lot, all or part of its length may need to be piped.

Relevant consent conditions from the Auckland Council may require demonstration of erosion and silt control management.

All road discharges should be fitted with erosion protection structures/measures. In steep terrain the construction of stormwater fluming may be necessary.

The minimum longitudinal grades of water tables on completion must be 1 in 100 (1%). Where this may lead to unacceptably deep water tables alternative options must be investigated and agreed with the Auckland Transport representative.

17.8 Subsoil drains

Design is to be in accordance with NZTA spec F/2:2000 (Specification and Notes).

Piped subsoil drains must be provided at all locations where ponding of water is likely, and at any location where groundwater may rise to the subgrade (e.g. natural springs or concentrated flow under steep roads). This includes at under-verticals or other areas where the footpath will otherwise be exposed to wet sheetflow for long periods from groundwater in the berm.

Where subsoil drains pass within the planned root growth zone of trees, unperforated pipe with sealed joints must be used for the length of the zone, unless otherwise protected by their design.

The principles of subsoil drainage design are detailed in Austroads Guide to Road Design Part 5.

CCTV inspection of completed underchannel drains is to be arranged for after kerbs have been poured and the inspection log and disc/tape must be provided with completion documentation for the work. If any underchannel drains cross a carriageway, an as-built drawing to 1 in 200 or 1 in 500 scale must be provided with completion documentation for a record of their location.

17.9 Minor Culverts

Minor culverts are those conveying watercourses or waterways (roadside drains) under roads, with a cross sectional area less than 3.4 m^2. Major culverts are dealt with in *Chapter 18 Structures*.

Culverts should generally comply with AC SW COP 4.3.8.

17.9.1 Fauna passage

The designer must obtain confirmation from Auckland Council whether any waterway to be culverted, or with a culvert that is to be modified, is required to incorporate fauna passage.

Such culverts must incorporate provision for passage of fish in accordance with Auckland Council Guidelines.

17.9.2 Culvert length

A culvert conveying a watercourse under a roadway should generally extend such that inlet and outlet are outside the prolongation of adjoining road boundaries. Where road embankment side slopes are within the road reserve, inlet and outlet should be at least outside the width of level berm on approaches.

17.9.3 Inlets and Outlets

Inlets and outlets are to be provided in accordance with AC SW COP 4.3.8.7.

Safety of all road users should be considered in designing inlets and outlets.

Inlet or outlet structures must be provided with vehicle restraint protection where criteria in ATCOP require. Inlet or outlet structures for pipes crossing roads should be sloped to match drain or

embankment slope if within the clear zone. Pipes under side road intersections or driveways should have traversable ends if within the clear zone.

Fencing for pedestrian safety should be provided where inlet or outlet structures are accessible from footpaths and vertical drop, size of culvert or velocity of flow are hazardous.

17.9.4 Cut-off drains

Culverts conveying run-off from roadside drains under roadway or away from roadway to discharge points as minor drainage must be designed to provide capacity for at least 10% AEP flow. Inlets must be designed to capture this design flow without significant by-pass.

Culverts designed as part of major drainage system must have capacity for 1% AEP flow.

17.9.5 Vehicle crossing culverts

Where a vehicle crossing is to be constructed or redeveloped to cross a roadside drain or swale, and there is not more than 200 m of roadside drain upstream from the crossing without a cut-off drain, then a crossing must be installed in accordance with Plan No.RD026.

For any other roadside drain or watercourse, a crossing culvert pipe should be designed with a capacity of 5% AEP flow without exceeding the capacity of the upstream drain, and such that 10% AEP flow does not exceed the allowable channel flow width or spill from the road boundary.

The minimum internal diameter of a vehicle crossing culvert is 300 mm.

Appendix 17A - Reference Documents

Road drainage design must be in accordance with Auckland Council Stormwater Code of Practice (AC SW COP). For convenience, ATCOP specific requirements in addition to AC SW COP requirements are referenced below. [These Items will be checked for consistency with current SW COP before publication]

4.2.6 Catchment Planning

a) Where existing road run-off is managed under a Network Discharge Consent, proposed road drainage alteration should be discussed with AC SW Unit at an early stage.
b) Any new road design, or improvement to an existing road, that is not covered by an existing current discharge consent or ICMP should be discussed with the AC SW Unit catchment planning to determine design objectives and any opportunities for collaborative work.

4.3.6.1 Stormwater Treatment Device Ownership

a) Choice between suitable permitted designs for drainage assets that are to be provided for roads to vest to Auckland Transport are subject to published guidance on option selection. In general, regard should be given to achievement of design objectives and environmental outcomes compared with whole of life asset cost. Operational maintenance costs will be significant in this regard. Where no published guidelines are available, early discussion with AT Asset Management is recommended.
b) Where approval is sought to connect private drainage discharge to an existing AT road drainage asset (pipeline, manhole or treatment device), the AT asset will need to be vested as an AC public drain asset. This may require an investigation of the condition of the asset, and the cost of the investigation and any reasonable cost of bringing the asset to an acceptable condition may be at the applicant's expense.

4.3.8.1 Alignment of pipelines

Where a pipeline to be vested as public drain is located in private land in a front or side yard, provision should be made for future connection for road drainage from road reserve boundary and an easement in favour of AC must be provided.

4.3.8.3 Minimum Pipe sizes

Leads from certain devices specify minimum sizes larger than 225mm. Such specified size will determine the minimum size of pipes downstream from that lead. Any proposed connection to a pipeline of smaller diameter must be discussed with AC SW Operations.

4.3.8.6 Culverts

A culvert carrying a roadside drain under a driveway may have a minimum internal diameter of 300 mm where 1% AEP flow is contained between the edge of road seal and the road boundary.

4.3.8.9 Subsoil drains for roads to vest as public road are covered in Section 17.9.

4.3.9.8 Manhole covers

Manhole covers within road reserve must be located to be accessible to maintenance vehicles. Regard should be given to Temporary Traffic Management that will be necessary for maintenance access. Where possible, manholes will be located in berm or footpath. Where it is unavoidable, manholes in roadway should be located within parking lanes, or between wheel tracks in traffic lanes. Manholes at intersections must be located in the safest position available, and to require least loss of traffic capacity.

In roadway, hinged lids are to be provided and installed to close in the direction of traffic movement.

Road drainage design must comply with Auckland Council Stormwater Guidelines where these are appropriate.

Road drainage design must comply with Watercare Services Wastewater Code of Practice (WSL WW COP) where required in Combined Sewer catchments.

Road drainage design must comply with Austroads Guide to Road Design – Part 5, Part 5A and Part 5B:2013, except where otherwise required by this Code or by the documents listed above.