DEVELOPMENT CODE

June 2009
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PAPAKURA DISTRICT COUNCIL

DEVELOPMENT CODE

JUNE 2009

PART 4: STORMWATER

4.1 GENERAL POLICY

4.1.1 Overview of Drainage Infrastructure Services in Papakura

The urban area of the Papakura District is serviced by a public stormwater system which contributes greatly to the health and safety of our community, and well-being of our much valued terrestrial and coastal environments.

The public stormwater network is operated and maintained by the Council. The network includes approximately 194km of pipe, 32km of open channels, 448 inlet/outlet structures and 3,202 manholes as at year 2005. There are also stormwater treatment ponds and other devices at various part of the District.

4.1.2 Stormwater Management Objectives

The objectives of stormwater management in Papakura District Council are:

1. To provide an adequate stormwater drainage system including the primary drainage system and the secondary overland flowpaths system to minimise flooding of properties and public roads and frequent drainage nuisances to general public.
2. To protect the stream bank and properties from excessive erosion which could cause instability to land.
3. To maintain and improve the water quality in the fresh and marine water receiving environment. To continually improve the amenity value and habitat in the stream and associated riparian reserve.

The above objectives can be achieved through:

1. Undertaking catchment management study in an integrated systematic approach to assess the effects of future developments in the catchment area and identity a range of remedial options.
2. Incorporating low-impact development measures in new development if practicable.
3. Protection of the stream riparian margin and minimise infilling of 1% AEP flood plain.
4. Implementing remedial works to augment the capacity of the stormwater drainage system by removing bottlenecks.

4.1.3 Stormwater Catchments and Catchment Management Plans and Comprehensive Discharge Permits

All new stormwater assets are to comply with relevant integrated discharge consents and integrated catchment management plans.

There are a total of five integrated stormwater management areas in the district. A map of all catchment boundaries is included as Standard Drawing SW2. Table 4.1 shows a list of Catchment Management Plans currently held at Council. Catchment Management Plans may be viewed by arrangement with the Stormwater Asset Manager.

Table 4.1 List of Stormwater Catchment and CMPs

ICMP Area	ICMP Study Area	Stormwater Catchment	CMPs	NDC Consent/Expiry	Comments
Papakura Stream	Papakura Stream	Alfriston	Papakura Stream Flood Management Study and Plan (ARC, TP29A, 1993)		Rural catchment with potential development beyond year 2050
		Alfriston East			
		Porchester			
	Takanini North	Takanini North	Takanini North Catchment Management Plan (Consented, 2004)	Permit No. 24814 Expiry: 31/Dec/2022	
	Ardmore	Ardmore			Airport has its own discharge consent. The remaining catchment is rural and will stay rural for the foreseeable future.
Pahurehure Inlet	Pahurehure Inlet North	Conifer Grove			Misc discharge consent obtained by various developers. However, most have not been transferred to PDC.
		Longford Park			
		Takanini South	Takanini South Catchment Management Plan	Permit No. 24670 Expiry:31/Dec/2022	
		Youngs			
	Central Papakura	Old Wairoa Road	Old Wairoa Road Catchment Management Plan	Permit No. 27850 Expiry: 31/Dec/2038	
		Elliot			NDC Applied in 2001
		Prince Edward			
		Pahurehure			
	Hingaia North	Hingaia North	Hingaia Stage 1 Catchment Management Plan	Permit No. 27850 Expiry: 31/Dec/2036	
Slippery Creek		Croskery Road Drain	Slippery Creek Catchment Management Plan	Permit No. 928081 Expiry: 31/Dec/2028	
		Bellfield			NDC applied in 2001 (also named Opaheke)
		Slippery Creek			

ICMP Area	ICMP Study Area	Stormwater Catchment	CMPs	NDC Consent/Expiry	Comments
		Rural			
Drury Creek		Hingaia South			
		Hingaia Stream			
		Drury Triangle			NDC application at ARC
		Ngakoroa Stream			Rural Catchment. Upstream catchment in Franklin
		Oira Stream			
		Jesmond			
		Drury Town			NDC applied in 2001
Upper Taitaia		Upper Taitaia			Rural Catchment

4.1.4 Health and Safety Requirements for Working on Public Stormwater Assets

Public stormwater infrastructure can be a hazardous working environment, thus access to public stormwater infrastructure is restricted to protect the health and safety of the workers and general public.

No person may access public stormwater pipes, manholes, chambers and drains without an approved planned work permit obtained from the Stormwater Asset Manager at Papakura District Council.

Any persons or parties granted access to work on public stormwater infrastructure must have a current and specific health and safety management plan in terms of the Health and Safety in Employment Act 1992 (and amendments).

The Health and Safety Plan shall deal with the identified hazards, including the following:

- Hazardous fume and gases accumulated in pipes and manholes.
- Confined space.
- Flash flooding in stormwater system.
- Drowning in water body, including ponds, wetlands and open drains.

4.1.5 Building Over or In Close Proximity of Public Drains

Building over or in close proximity of public stormwater infrastructure is discouraged and the last option, which may be discretionally granted by Council depending on the circumstance. Every endeavour shall be made by the developer and its engineer to avoid this as building over can greatly limit the future maintenance access and renewal options of critical asset. Detailed specific building design is required. An engineering report investigating all available options will be required to accompany any application.

If any proposed development is within 20m of Watercare Services' pipelines, then written approval from Watercare Services Limited will be required.

Building over private drain serving the property it runs through or adjacent properties, is generally not permitted. The option of realigning the private drain outside the proposed building platform is preferred. Modification to the easement and consent from the affected owners will be required.

4.1.6 Modifications to Existing Public Asset (diversion, realignment, relay and decommissioning of public assets)

Modifications to existing public asset shall generally be avoided in any development. Depending on the circumstance, Council Development Engineer may discretionally approve diversion, realignment and decommission of existing public assets.

Any modifications to the public system shall not compromise the level of service of the existing public system in terms of hydraulic capacity, self cleansing velocity and its potential in serving future probable development in the catchment areas.
An engineering report investigating all the options available and hydraulic calculation from a qualified engineer will be required to accompany any development proposal lodged at Council.

An application for any modification to existing public asset shall be submitted to Council for approval.

4.1.7 Extension of Public Drains

Council, at its discretion, may extend or add new infrastructure to the existing public system to improve or enhance the performance of the existing public system.

4.2 STORMWATER DRAINAGE

4.2.1 Definition of Public Stormwater Drain

The definition of what a Public Stormwater System is and when it is not available is as follows:

1. All public stormwater drains are shown on the Papakura District Public Stormwater Drainage Maps (available via the PDC GIS system).

2. The Public Stormwater System in the Urban Zone does not include :
   roadside kerb
   catch-pit in the road reserve
   common private drains

3. The public stormwater system in the Rural Residential Zone is identical to that of the Urban Zone but does not include the following:
   Open drains in the road reserve
   All natural watercourses.

4.3 FLOOD HAZARD AREAS

Council maintains flood hazards maps for the district. The maps are generally based on historic catchment studies and reported flooding problems in the district.

For any new development or alterations to existing development within the proximity of flood hazards area, advice should be sought from a chartered professional engineer experienced in catchment hydrology on the general layout of the development in the flood plain or safe building floor levels.

The Papakura District Plan restricts development in the 1% AEP flood plain especially for those involving filling in the flood plain.

4.3.1 Minimum Floor Levels and Freeboards

The habitable and non-habitable floor levels of buildings shall be determined based on SW24, catchment management plan and other specific studies related with the development site.

In general, the habitable floor levels shall be above the analysed 1% AEP flood level at the upstream side of the building with a minimum freeboard of 300mm. The non-habitable floor levels shall be above the analysed 10% AEP flood level at the upstream side of the building with a minimum freeboard of 200mm. The freeboards may be increased where the stream channel is narrowly confined with potentially significant variations in peak flood levels, or greater uncertainties are associated with the prediction of the peak flood levels.

Residential and commercial building floors to be constructed in area subject to wide spread surface flooding problems shall have a minimum freeboard of 300mm above the maximum depth of surface flood in a 1% AEP extreme storm event.

4.3.2 Encroachment of Flood Plains

In general, no building or infilling earthworks are permitted in the identified 1% AEP flood plain. Dispensation may be granted to minor encroachment into this 1% AEP flood plain where the minor loss of the storage volume in the flood plain due to infilling has less than minor effects in maintaining the delicate hydrologic balance in the overall catchment.

Any proposed work in the flood plain will require a resource consent, application for which must include a report by a suitably qualified engineer.

4.3.3 Tidal Inundation Zone

Development in the low lying coastal area may be subject to tidal inundation. Extreme tide level can combine with other factors such as storm surge, wave run-up, and future sea level rises, may pose a significant hazard to low lying coastal properties, if the building floors have not been elevated adequately.

Typical and extreme sea levels at Onehunga, Manukau Harbour are shown on SW7. For any new buildings in the coastal area fronting Manukau Harbour:

- The minimum habitable building floor levels shall be no less than 4.6m above the Auckland Vertical Datum 1946.
- The minimum non-habitable building floor levels shall be no less than 4.2m above the Auckland Vertical Datum 1946.

Variation to this level may be considered if a specific site assessment by a suitably qualified engineer experienced in coastal engineering has been carried out. Minor alterations to existing buildings which match existing floor levels may be permitted subject to assessment of the risks.

4.4 STREAM MANAGEMENT

4.4.1 Piping of Watercourse

Piping of a permanent stream/ river on residential lot other than for roading access is generally discouraged in the District. Piping of any permanent stream or river will require a resource consent obtained from the Auckland Regional Council and Papakura District Council.

Intermittent streams in the District play critical roles in the surface water drainage system. Works, infilling, piping and any other modifications to the stream channel will potentially modify the natural drainage pattern of land, cause flooding to upstream and downstream properties if they have not been properly managed. These activities will only be approved by the Council under special circumstances when the applicant has produced sufficient evidence to prove that any adverse effects from the activity can be mitigated by the proposal.

4.4.2 Stream Crossings (Culverts and Bridges)

Stream crossings, such as culverts and bridges on any permanent stream should be avoided as far as possible and will require resource consent from the Auckland Regional Council and Papakura District Council.

The Development Engineer will also assess the engineering details of the proposal based on the following criteria:

1. The proposed stream crossing generally complies with the relevant catchment management plan.
2. The proposed stream crossing will not significantly raise the water surface profiles beyond the upstream boundary of the road reserve or the property. Any rise of water surface profiles under extreme rainfall events, if not avoidable:

   shall not endanger the habitable and non habitable floor levels of any existing buildings,
   shall not affect the further development potential of any land upstream,
   the increased flood plain extent shall not extend beyond the riparian margin.
3. The proposed stream crossing will not cause erosion at the inlet and outlet.
4. The exiting flow direction is in line with the original flow direction in the stream.
5. The maximum velocity in the conduit will not exceed 8m/s for RC pipes.
6. Fish passage can be maintained at pre-construction levels.

4.4.3 Stream Riparian Margins

The following riparian margins shall be generally provided in lack of specific requirements from relevant Catchment Management Plans, unless otherwise approved by the Stormwater Asset Manager.

Table 4.2 Minimum Riparian Margins

Natural Stream Management Areas	40m on either side
Permanent Streams in Rural Area	20m on either side
Permanent Streams in Urban or Future Urban Area	20m on either side
Intermittent Streams in Urban or Future Urban Area	5m on either side

Note:

1. The required riparian margin is to be measured from the edge of the extent of mean annual flood at the specific section of the stream.

2. The natural Stream Management Areas are shown on the Auckland Regional Plan Air Land & Water.

3. The widths of riparian margins specified in the relevant ICMP's or CMP's shall take precedence over those in the above table.

The riparian margin shall be kept clear of development. Indigenous planting in the riparian margin shall be protected and possibly enhanced during development.

The riparian margin acts as an aquatic buffer - a natural boundary between local waterways and existing development and helps protect resources by filtering pollutants providing flood control, alleviating stream-bank erosion, mitigating stream warming, and providing room for lateral movement of the stream channel.

Unsuitable plants and weeds shall be cleared from the stream channel and riparian margins, and replanted with suitable species as per the landscape design during the development. Habitat for native fish and birds shall be provided. Works shall also include the protection of the low flow channel against scour and erosion of the streambed where necessary.

4.4.4 Stream Hydraulics

The flow characteristics of all open drains, particularly natural open stream systems, shall be based on the likely long term stream condition in terms of density of vegetation and take due account of potential blockage under peak flood conditions.

4.4.5 Stream Bank Erosion Protection

It is the responsibility of individual owners to maintain the stream channel which runs through their properties. The individual owners shall ensure adequate measures have been put in place to protect the stream bank from erosion, undercutting, slippage and other instability which could undermine the safety on their/ others properties. Excessive sediment generated from stream bank erosion can also be harmful to aquatic health by smothering benthic organisms, reducing light penetration, and losing habitat in stream flows.

4.5 OVERLAND FLOW PATH MANAGEMENT

Overland flow paths form an important part of the urban surface water drainage system. Provisions and protections of overland flow paths in urban development are critical in protecting properties from flooding.

4.5.1 Definition of Significant Overland Flow Paths

A significant overland flow path is defined as:

- An overland flow path which forms the primary drainage system (no stormwater drainage pipes exist in the areas) where the 10% AEP peak discharge exceeds 50 l/s.

- An overland flow path which forms the secondary drainage system (supplementary to the primary stormwater drainage system) where the 10% AEP peak discharge in the primary system exceeds 200 l/s or the 1%AEP peak discharge exceeds 1.0 m^3/s.

4.5.2 Provision and Protection of Overland Flow Paths on Development Sites

For any proposed new development, the applicants and their agents shall identify all significant overland flow paths through the development site and on downstream properties. Significant overland flow paths on downstream properties if they have not been protected, shall be formalized as a part of the proposed development by removing obstructions and even notified on titles as covenants.

In general, overland flow paths conveying a design flow of 1.0 m^3/s or greater shall be located within Council owned land such as roads, pedestrian access ways, dedicated drainage reserves etc.

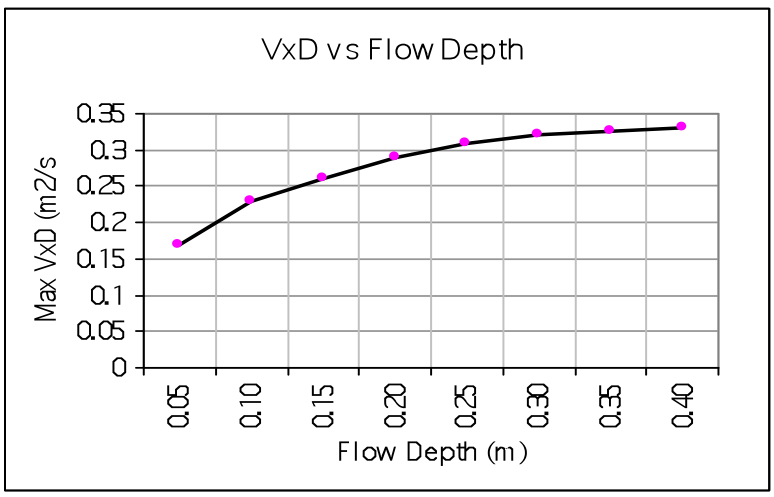
Where significant overland flow paths conveying design flow of less than 1.0 m^3/s and cannot be reasonably located in Council owned land, they may pass through the new lots. In such cases an appropriate easement in gross in favour of the Council shall be provided.

The terms of any such easements shall be worded to prevent the erection of buildings, structures or other obstructions which may impede the flow in the overland flow paths, shall require appropriate maintenance by the landowner(s).

Insignificant overland flow paths passing through new lots will not require an easement. However, a notice will be placed on the property file and Council's GIS system, and any proposed development of the property shall make provision for the safe passage of overland flow through the site.

4.5.3 Design of Overland Flow Paths

Overland flow paths shall be designed in a manner that ensures that the combination of flow velocity and depth do not create a hazard. Generally, the product of the velocity (V) times flow depth (D) under the 1% AEP storm event shall not exceed the values given in the following graph.



The maximum depth of flow in an overland flow path under a 1% AEP extreme storm event shall be less than 0.5m

4.5.4 Maintenance of Overland Flow Paths

All newly identified significant overland flow paths shall be registered on the titles of affected lands with a memorandum listing out the owner/s responsibility.

The overland flow paths shall be made clear of obstructions at all times. No building or other permanent or temporary structures, which could potentially block the overland flow, shall be placed across the overland flow paths.

Any fence lines across the overland flow paths shall be made with pool fence, or alternatively, the lower rail shall be made at least 400mm above the ground surface beneath the fence, and clear openings beneath it be maintained between the posts.

4.6 STORMWATER RECHARGE IN PEAT AREA

4.6.1 General Policy on Stormwater Recharge

There is a significant area of peat and soils with high organic content in the Papakura District, as shown in SW3. The majority of this area is planned for either future urban development, or infill subdivisions. This reduction in pervious area will in turn reduce the amount of rainwater that infiltrate into the soil and recharge the groundwater, which may result in gradual lowering of the groundwater levels. This is a serious issue in peat soil areas because dewatering the peat soils may result in consolidation, which can cause significant damage to roads, building foundations, and underground services.

In order to maintain the groundwater levels as close to their current state as possible, a recharge pit will be required on every new development or subdivision within the peat areas. Site specific investigations should be carried out to check for the presence of peat to determine the need for a recharge pit. This recharge pit will collect a proportion of the stormwater runoff from the roofs of the new development. This water will be left to infiltrate into the soil, and recharge the localised groundwater table.

The recharge pits have been designed to retain the stormwater runoff from all impervious areas from the first 15mm of any rainfall event. However, to prevent sediments from clogging the pit, only water from the roofs of new developments will be diverted to the recharge pit. Runoff from other impervious areas will require treatment to remove coarse sediment and other gross pollutants prior to discharge to the recharge pit.

4.6.2 Engineering Design of Recharge Pit

Specific engineering design is required for stormwater re-charge in peat areas. As a minimum:

1. The recharge pits are required for all new developments with over $50m^2$ impervious area. This includes additions to existing structures, residential infill subdivisions, and large scale Greenfield residential or commercial developments.
2. The total site impervious area threshold for requiring a recharge device is $50m^2$, however all developments between $50m^2$ and $100m^2$ require a device sized for

100m^2. Any development on a site that increases the impervious area by 20m^2 or more will require a recharge pit sized for and connected to the entire impervious area of the site.

3. The largest contributing catchment for one recharge pit is 1000m^2 new impervious area. For developments with over 1000m^2 new impervious area, a number of recharge pits will be required. These shall be spaced equidistantly around the site where possible, with the locations to be confirmed with PDC.
4. For residential infill subdivisions in existing developed areas, only the new development will require a recharge pit.
5. Recharge pits must not be located within three metres of buildings or site boundaries. Where this is not practical, a site geotechnical investigation report, and possibly an alternative recharge pit design, must be undertaken to take into account the effect of the device on building foundations.
6. Runoff from ground level impermeable areas, such as driveways and patios, should be treated prior to entry into the recharge device. The pre-treatment options shall be in accordance with ARC TP10, which details devices such as swales, filter strips and coarse sediment traps. These pre-treatment devices shall be sized for 10% of the Water Quality Volume in accordance with ARC TP10.
7. A minor geotechnical investigation is required to confirm that the soil conditions in the proposed location of the recharge pit are similar to the generic conditions described above and that the recharge pit will connect to the peat layer. The required results from this investigation are as follows:
   - Depth to top of peat layer
   - Depth to groundwater level
8. If the depth to the peat layer or the groundwater level is less than 1m or greater than 2.5m, consultation with the Development Engineer will be required to determine whether an amended version of the standard design or a different site specific groundwater recharge device is required.
9. For large ground level impermeable areas such as carparks, the recharge pits should again be located at the end of a treatment train. Devices such as swales, rain gardens or sand filters are possible, however special care must be taken in the design of the entire treatment train to ensure that the recharge pit can be located at the appropriate depth below ground level.
10. These devices may not be suitable for new roads where there is limited space available in the road reserve. In general, devices such as rain gardens, swales and filter strips should be used where recharge devices are infeasible in order to maintain some form of ground recharge.
11. It is at Papakura District Council's discretion as to whether new roads in these areas will require these recharge devices.

4.7 STORMWATER SOAKAGE

Ground soakage systems may be used as primary or secondary means of stormwater disposal associated with new or existing developments if the general geological condition permits.

1. When the soakage system is used as the primary stormwater disposal system, the soakage system shall be designed with adequate soakage surface areas and live storage volume to cope with run-off from a range of 10% AEP storm events with durations varying from 10 minutes up to 72 hours.
2. When the soakage system is used as the secondary stormwater disposal system supplementary to the primary piped reticulation system, the system may be designed with a capacity to cope with run-off from events less than 10% AEP, and an overflow system should be provided to connect to the primary piped stormwater reticulation system.
3. The recovery periods for all soakage systems shall be no more than 24 hours from the end of the storm event. The recovery period refers to the time taken to drain the maximum live storage until it is empty via ground soakage.

Soakage devices shall be positioned on site where:

4. Adequate access for maintenance can be maintained on a long term basis.
5. It is no closer than 3.0m from the closest point on the outline of a building and no closer than 1.5m from a boundary with another property, unless specific geotechnical advice has been given and the affected parties have given written consents.
6. It is not less than a horizontal distance equal to the height of a retaining wall plus 1.50m from a retaining wall.
7. It is not less than 2.0m from a public drainage system.
8. The failure of the soakage system will not result in flooding of any buildings, or cause instability to this or any adjacent lands.
9. It is not shared between private properties.

The chosen runoff coefficient shall be based on the conditions likely to exist after the full development of the catchment area.

The rainfall intensities shall be based on the Council's Design Storms and relevant Depth-Duration-Frequency chart.

Refer Soakage Pit Design example methodology in Appendix C.

4.7.1 Percolation Test

1. A percolation test is to be carried out on site to assess the rate at which the stormwater will soak into the ground. A minimum one test bore hole shall be drilled at the location of each proposed soakage system.
2. Boreholes shall be a minimum of 100mm diameter and should be bored to at least 1.5m below the topsoil layer or reaching a depth of unable to penetrate. Boreholes are to be geologically logged in terms of the soil layers and types.
3. Prior to commencing the percolation testing the boreholes must be thoroughly pre-soaked to simulate winter conditions during Spring, Summer and Autumn seasons. In September – May holes must be kept full for a minimum of 17 hours prior to testing.

During winter months (June, July and August), holes must be kept full for a minimum of 4 hours. This will normally provide adequate time for the soils surrounding the hole to become saturated, and for any clay soils to swell.

4. Percolation testing can be carried out as a Falling Head or Constant Head test. A falling head test consists of determining the percolation rate of an area by filling the boreholes with water and recording the rate at which it drains away. Constant head test determines the percolation rate of an area by maintaining a constant head of water in the boreholes. Water that drains away is replenished at the same rate and the rate recorded.
5. Percolation tests shall be carried out in soils below the topsoil layer, and not less than 200mm below the existing ground level.

4.7.2 Minimum Percolation Rate

The guideline for the minimum percolation rate is 0.25 litres/m^2/min. Percolation test rates less than 0.25 litres/m^2/min are to be retested by an IANZ (International Accreditation New Zealand) Laboratory qualified to do percolation tests, and the applicant shall demonstrate adequate site area will be available to accommodate a soakage system relying on very low percolation rates.

4.7.3 Approved Soakage Devices

There are six main types of soakage devises that are approved by Council. These being Onehunga soakholes, Filter-strip soakholes, Rain-gardens, Rock-bore soakholes, Porous paving, and Nominal soakholes for catchment areas less than 20.0m^2. Nominal soakholes are typically scoria filled pits.

A coarse sediment trap such as a catch basin in the access chamber shall be used to minimise the cleaning frequency of the soakage system.

The engineer shall recommend an operation and maintenance schedule and inform the future owners their responsibilities in maintaining the proper function of the soakage system.

4.7.4 Falling Head Percolation Test

Falling head percolation tests determine the percolation rate of an area by filling a borehold with water and recording the rate at which it drains away. This test method is most suitable for use in soils with a medium to low permeability.

To carry our a falling head percolation test on a borehole;

1. Note percolation rates are likely to be below 1.0 litres/sqm/min
2. Thoroughly pre-soak the borehole according to the instructions in Section 4.7.1 part 3
3. Fill the hole with water to a level between 200mm and 350mm below the ground level or to a level below the topsoil layer, whichever is the deeper. Record the depth/level of the water and record the drop in water level against time at evenly spaced intervals of no greater than 20 minutes, until the water level is around 0.20m from the base of the hole or 4 hours has passed.

Where the hole drains quickly, the test should be repeated several times (would expect a minimum of four times or repeat tests to the lapse of the 4 hour period).

4. Graph the results and derive the percolation rate in litres / m^2 / minute from the average slope of the curve at the middle to low section (ignore the initial fast draining period).

4.7.5 Constant Head Percolation Test

Constant head percolation tests determine the percolation rate of an area by maintaining a constant head of water in a borehole. The water that drains out of the borehole is replenished with water at the same rate from a water source such as a fire hydrant. The stabilised flow rate of water entering the borehole is measured over time to determine the permeability of the soil.

To carry out a falling head percolation test on a borehole;

1. Fill the borehole using a pipe connection to a flow meter. Observe the water level and adjust the hydrant valve until the bore is maintained close to full. This step must be continued for at least 10 minutes to ensure that the hole is adequately pre-soaked

2. Borehole positioned within 10.0m of each other must be tested simultaneously

3. Continue the test for a further 10 -15 minutes, and ensure a constant water flow rate is achieved

4. Apply a factor of safety of 1.4 to account for the likely reduction in future soakage rate due to clogging

5. Convert the flow rate into a litres/m^2/minute percolation rate.

4.8 STORMWATER QUALITY AND QUANTITY MANAGEMENT DEVICES

4.8.1 Stormwater Quantity Management

Stormwater quantity management measures may be required for a new development by Council under the following circumstances:

1. Where a catchment management plan has identified such a requirement.
2. Where downstream flooding problems have been identified and the most practicable solution is to incorporate stormwater quantity control in the upstream catchment.
3. Where downstream channel erosion has been identified.
4. Where a resource consent condition requires stormwater quantity management.

On many occasions, stormwater quantity management measures can be incorporated into stormwater quality treatment devices.

Approved stormwater quantity management measures include:

- Extended detention
- Low impact design techniques
- The stormwater detention tanks

4.8.2 Stormwater Quality Management

Stormwater treatment will generally be required for discharge from an impervious catchment area of more than 1000m² or from a high environmental risk activity site (as per The Auckland Regional Plan: Air, Land and Water).

All stormwater quality and quantity management devices shall be designed in accordance with ARC TP10 Design Guideline Manual: Stormwater Treatment Devices 2003 and PDC Stormwater Ponds/Wetland Design Guidelines (June 2005).

For all proposed stormwater quality and quantity management devices for vesting to Council as public assets, the applicant shall consult and obtain prior approval of the Development Engineer.

4.8.3 Low Impact Urban Design (LID)

Low impact urban design is a design approach that incorporates engineering features that minimise stormwater runoff and sediments and other contaminants in the stormwater runoff, thus reducing the impact of urban development on the downstream receiving waterways.

Council encourages developments to incorporate LID features in the District.

Typical LID features include:

- Use of low environmental risk roof materials
- Use of permeable pavement systems
- Rain tanks for water re-use
- Rain gardens
- Swales.

The ARC TP124 "Low Impact Design Manual" provides guidance on low impact urban design in the Auckland Region. Well designed LID features may provide an economic alternative to traditional stormwater management measures.

For all LID features, the applicant shall consult the Development Engineer to ensure their compliance with the ICMPs and Asset Management Plan.

4.8.4 Operation and Maintenance Requirements

An operation and maintenance manual including procedures, initial settings and other specific requirements for operation, and a maintenance schedule detailing the tasks and occurrence frequency, shall be prepared for the stormwater quantity and quality management devices.

The operation and maintenance manual shall generally be required for new assets such as stormwater management devices including constructed wetland, pond, sand

filter, rain garden, or detention pond, etc. Council may require an Operation and Maintenance Manual to be prepared for any other unusual and new asset items proposed for a new development, as a condition of the engineering plan approval.

4.9 STORMWATER DISCHARGE

Where stormwater is discharged into existing streams, rivers, ephemeral streams, significant overland flowpaths or the sea, the following conditions shall apply:

- A suitable outfall and energy dissipation structure shall be constructed at the outlet to ensure no erosion occurs. This structure shall be specifically designed in such a way as to blend in with the immediate natural surroundings.
- The direction of the discharging pipeline shall be aligned with the flow direction in the stream or other receiving water to reduce erosion from localized turbulence.
- A resource consent, if required from the Auckland Regional Council, shall be obtained.

4.10 RESOURCE CONSENT FROM REGIONAL COUNCIL

Any resource consent from the Regional Council in respect of the permanent diversion of natural water will be exercised in the name of the District Council once the development has been accepted as complete by the District Council. The developer shall make the initial application in the name of the developer.

Any resource consent covering the discharge of stormwater will be exercised in the name of the Council, when the system has been accepted as completed by Council. The developer shall make the initial application in the name of the developer.

The Council should also be consulted as it may hold a Comprehensive Water Permit for the whole catchment, in which case a separate permit will not be required from the Regional Council.

All elements of new stormwater assets within a development are to be approved by the Council. Obtaining consents from the Regional Council in no way negates this requirement, and application to the Regional Council for consent shall only be made after obtaining approval in principle from the Council Development Engineer.

4.11 PRIMARY DRAINAGE SYSTEM

4.11.1 Catchment and Land Uses

The stormwater drainage system shall be capable of serving the entire contributing catchment upstream of the development, under the maximum probable development scenario likely to prevail during the useful life duration of the system. The design life shall not be less than 80 years, for the main components such as manhole structures and pipelines.

4.11.2 Design Storms

The primary reticulation system shall be designed to have adequate hydraulic capacity to pass the peak flows from the following minimum storm events without surcharges in manholes:

- Residential Areas 10% AEP
- Commercial and Industrial Areas 10% AEP

The reticulation system in commercial and industrial areas where 100% site coverage is permitted by the District Plan, and no overland flow path can be provided, shall be designed for 1% AEP storm events together with engineering measures to prevent blockage of the pipe system and inlets.

4.11.3 Hydrological Analysis

The peak flows and total runoff volumes for the design storms shall be analysed using the methodology in ARC TP108 "Guidelines for Stormwater Runoff Modelling in The Auckland Region" (April 1999), or the Rational Method as described in New Zealand Institution of Engineers Auckland Branch "A Guideline and Procedure for Hydrological Design of Urban Stormwater Systems (Dec 1980)". Any other hydrological analysis method shall only be used with specific approval from the Development Engineer. Council's rainfall Depth-Duration-Frequency data can be used with the Rational Method.

4.11.4 Time of Concentration

Initial time of entry (te) shall be 8 min 30 sec. Network flow time (tf) shall be time of flow in pipes or channel to design point. The Time of Concentration shall be the sum of te and tf. The minimum initial time of concentration for design purposes shall be 10 minutes.

4.11.5 Runoff Coefficient

The following composite runoff coefficient can be used with the Rational Method:

Table 4.3: Runoff Coefficient

Road Reserves	0.85
R.O.W/Access Lots	0.95
Residential Lots	0.75
Industrial/ Commercial Lots	0.95
Pervious Areas	Refer to "Guidelines and Procedure for Hydrological Design" Section 4.3

4.11.6 Hydraulic Design of Pipelines

The hydraulic design of stormwater pipelines shall be based on the Colebrook-White formula or the Manning's Equation. The Colebrook-White roughness co-efficient of Ks = 1.50mm for concrete pipes up to and including 1000mm in Diameter and Ks = 0.6mm for larger concrete pipes shall be used. For stormwater pipes of other materials, roughness factors from manufacturers' publication for aged wall surfaces with sediment debris accumulation at pipe inverts shall be used.

Hydraulic design of culverts shall be in accordance with "Hydraulic Design Manual New Zealand Edition" (Concrete Pipe Association of Australasia, Dec 1997) or alternatively in accordance with "Hydraulic Design Series Number 5 - Hydraulic Design of Highway Culverts" (US Department of Transportation - Federal Highway Administration, revised May 2005)

The design shall provide that:

(a) Road catchpit outlets shall be not less than 225 mm diameter; or exceed 40 m in length.

(b) Catchpit leads shall not be connected to more than one catchpit.

The minimum pipe gradient shall be such that a minimum velocity of 0.7 m/s under a flow equivalent to half of the 50% AEP peak discharge from the catchment shall be achieved.

Evidence of this is to be provided for any pipe designed with a gradient of less than 1% (1 in 100).

4.11.7 Outfall Water Levels

The water level at the stormwater outfalls is critical in determining the water surface profile through the upstream stormwater pipe network. The following general guides shall be followed when deciding the water levels at the outfalls:

1. Using computer modelling package to simulate the true water level in the receiving system.
2. If the stormwater outfall is only draining a small tributary catchment with a short time of concentration, and the receiving drain or stream drain a much larger catchment with longer time of concentration, then the true water level at the receiving drain or stream corresponding to the peak flow at the time of concentration of the small tributary catchment shall be used. A freeboard of at least 0.3m may be applicable to take into account the inaccuracies associated with the flow estimation, channel geometry and channel roughness factors.
3. If the time of concentration of the catchment for the receiving drain or stream is less than 20 minutes, then the peak flood level at the receiving system shall be used.
4. If the stormwater discharges into a tidal influenced area, the water levels shall be determined as the mean high water spring plus 0.5m to allow for storm surges and wave run-ups, etc and/or a 10% AEP extreme high tide level for half peak design flow conditions. A backflow prevention device such as a Tideflex or a flap gate may be used at the outfall to prevent seawater inundation of upstream pipes.

All stormwater systems discharging through submerged outlets must be modelled.

4.12 DESIGN OF STORMWATER DRAINAGE RETICULATION

4.12.1 Service Connections

Each proposed lot shall be served by a stormwater drainage connection located approximately 1.5 m inside the main body of the lot. Each new lot will require a separate connection.

Each stormwater connection shall be capable of serving of the whole of the building area of the lot including the driveway and other paved area on site by gravity from a ground level discharge, except where this requirement seems unreasonable and it can be shown that the proposed connection is adequate for a predetermined building location.

Unless otherwise required by the council, where a connection point is 1.5m or greater below ground level, a ramped riser shall be installed to bring the connection point to within 1.2m of ground level. Refer standard drawing SW18.
A drainage connection to any lot shall originate on a public drainage line which may lie in the immediately adjoining lot. However any such connection will be a private drain, and shall be covered by a drainage easement in favour of the lot being served, where it passes through an adjoining lot. Such private lines shall not cross more than one property boundary (this does not include the road boundary) or be longer than 50 metres.

All connection pipes shall be a minimum of 100mm diameter and shall be sealed by removable sealing caps.

Connections to pipelines shall be factory made Wye junctions. Connection to manholes shall be via drilled holes and all gaps sealed with epoxy mortar.

All connections shall be accurately indicated on As-Built plans with the distances in metres from the downstream manholes.

On developments where less that 4 additional lots are being created, each stormwater connection shall be marked by a minimum of 50mm x 50mm timber stake extending 600mm above ground level and painted blue or otherwise clearly identified as a stormwater connection indicator. This marker shall terminate a minimum of 300mm above the access cap of the service connection.

Where settlement is expected to occur, all service pipes installed within or under earthfilling shall be designed and constructed to ensure adequate capacity, strength and water-tightness to withstand the loads due to settlement and to prevent leakage into the fill.

4.12.2 Stormwater Reticulation Layout

Stormwater drainage pipelines shall generally be sited in front, side and rear yard areas of the lot well clear of future building footprint or in reserve areas. Pipelines adjacent to boundaries shall be a minimum of 1m clear of all boundary lines and at least 1m clear of the edge of foundations.
The outer edge of any manhole structures shall be at least 1m from boundary lines and edge of foundations.

For pipelines and manholes, either directly under or adjacent to, retaining walls, building foundations and any other structures, the engineer shall be convinced himself that future maintenance, repair and renewal of the pipelines and manholes will not adversely affect the overall stability of these structures.

Stormwater reticulation pipelines and manholes in road reserves are permitted provided that they don't interfere with other utility services.

The minimum vertical clearance between any two crossing pipelines shall be 300mm, measured from the outside of pipe collars. Where unavoidable, the Council Development Engineer may approve a clearance of less than 300mm subject to specific design.

A good stormwater reticulation design shall ensure:

- Uninterrupted access to all parts of the reticulation for inspection, maintenance, repair and renewal. Manhole access shall be provided to ensure access to pipelines by equipment for CCTV inspection, water jetting, root cutting and inline replacement.
- Safety of stormwater system operators.

The vertical and horizontal alignment of pipelines between two access points shall be straight. Horizontal and vertical curves within the tolerance specified by the pipe manufacturer may be approved by the Council Development Engineer under special circumstances.

Road crossings are to be at 90^{o} wherever possible.

Stormwater pipelines which collect water from public roads or serve two or more properties may at Council's discretion and on satisfactory completion be taken over by the Council as part of the public system.

Public drains will be required to terminate with a manhole and have a minimum diameter of 225 mm.

All lots in Rural Areas that do not have direct physical access to existing natural watercourses shall provide a drainage system approved by the Development Engineer.

4.12.3 Pipe Joints

Pipes of less than 1000mm in diameter shall be spigot and socket type with flexible sealed joints. Reinforced concrete pipes of 1000mm and greater may be flush jointed. Flush jointed pipes shall normally be sealed with cement mortar. Where joints are left wholly or partly unsealed for subsoil drainage or other reasons, adequate provision against entry of silt into the pipeline will be required.

4.12.4 Pipe Material

Stormwater pipelines may be constructed from the following readily available materials:

- Reinforced concrete pipes to NZS/AS4058.
- PE (Polyethylene) - to AS/NZS 4130 & 4131 - PE 80 SDR21 for thrusting installation or where a fully sealed pipe system will be required.
- PVC (Poly Vinyl Chloride) – to AS/NZS 1524 and AS/NZS 1260 for acidic groundwater or soil conditions.

The use of PE and PVC pipelines will require specific written approval from the Development Engineer.

Pipe material shall be selected based on their durability in the site groundwater and soil environment. Concrete pipes and manholes for use in peat soils shall be manufactured using sulphide resistant cement.

4.12.5 Pipeline Strength and Bedding for Reinforced Concrete Pipes

All stormwater pipelines shall be designed and constructed to withstand all likely loads to which they will be subject, both during construction and in the long term.

The pipe classes and bedding types shall be selected in accordance with NZS/AS 3725, based on the maximum depth of fill, construction load, long term traffic load and other live loads applicable. All RC pipes under public road reserve shall be a minimum of class 3 with a bedding support type of HS1. Pipe structural analysis using CPAA Pipe Class V1.3 will be acceptable.

The structural design of PVC pipes and beddings shall be in accordance with AS/NZS 2566.1:1998 Buried Flexible Pipelines Part 1: Structural Design.

Type 4 supports, as shown on DWG CM 002 NZS 4404:2004, shall be used for flexible pipes installed in open trenches.

4.12.6 Pipeline Cover

All pipelines shall be designed with adequate cover to support the likely loadings both during construction and in the long term. The following minimum cover shall be applicable:

- On private property 600mm
- Under carriageways 1200mm

Where due to topography and other limitations, the minimum cover set out above cannot be satisfied, reinforced or un-reinforced concrete protection shall be provided with specific approval obtained from the Development Engineer.

4.12.7 Anchorage for Pipes with Steep Gradient

For stormwater pipelines at gradient steeper than 10%, the bedding and surrounding shall be low grade (5 MPa) scoria concrete (mixing of 1 part cement and 4 parts scoria). For pipelines at gradients exceeding 20%, concrete anchor blocks shall be provided at every pipe joint as shown on SW20.

Specific design of bedding and anchorage will be required for pipelines with gradient exceeding 35%.

Unless required otherwise by the Engineer, where a connection is deeper than 1.2 m below ground level a ramped riser shall be constructed to bring the connection to within 1.2 m of ground level.

A typical example of a ramped riser is shown on Papakura District Council Drawing SW14.

4.12.8 Connection to Deep Lines

Where an existing or proposed stormwater pipeline is more than 5 m deep to the top of the pipe, connections shall not be made directly to it, but a new, shallower branch pipeline shall be laid from a manhole on the deep stormwater line and connections provided to the lots to be served.

4.12.9 Extended Connection

Where an extended connection is to be taken from a stormwater pipeline to the boundary of another lot a ramped riser need not be used, and the extended connection may be sloped up at a continuous gradient from the sewer, to terminate just inside the lot to be served at sufficient depth to drain the building site.

4.12.10 Pipes in Weak Ground or With High Ground Water Table (other than peat soils)

Where any pipeline is to be constructed through soft ground unsuitable for foundations, such material shall be removed and replaced with suitable fill material or such other method of construction as approved by the Water Resources Manager shall be employed to provide an adequate foundation for the pipeline. For pipelines in refuse or soils with high organic content and ground settlement is likely to occur in the future, the pipeline shall be specifically designed to allow for the adversity while ensuring proper function of the pipelines in the long term.

Where high ground water table exists, the manholes and pipeline shall be checked against floatation. A minimum factor of safety of 1.25 will be required against floatation.

Where the natural transfer of water from the trench into surrounding ground will not provide sufficient drainage, and excessive water accumulated in trench either from upstream land or leakage from the pipeline, could have adverse effects on the stability of the land or building foundations, trench drainage shall be provided to direct the water to approved outlets.

The construction of pipelines shall be carried out in accordance with the requirements of NZS 4452 and NZS 7643.

4.12.11 Pipe Construction in Peat Areas

Maintaining the current groundwater table is critical to minimize the risk of ground settlement in the Takanini Peat Areas. Piped or open drainage systems in accordance with normal engineering practice are likely to lower the groundwater table, through the following means:

1. Infiltration via faulty pipe joints,
2. Longitudinal percolation flow via porous trench fills, and
3. Reduction of flow residence time on ground surface due to effectiveness of the drainage system.

The effects of No.3 above can be mitigated by installing a proper groundwater recharge system as discussed earlier.

To counter the effects of No. 1 and 2 above, it will require specific engineering considerations when designing either an open or piped drainage system in the peat

area. The requirements on design and construction can differ greatly from those for general urban development.

It is recommended that all open and piped drains be kept as shallow as possible following the natural grade of the country. The piped drainage system shall run wherever possible above the current summer water table, i.e. generally less than 1.5m from the existing ground surface. If this is not possible then a fully sealed pipe system with water tight manholes will be preferred. Seepage barrier, such as cast in situ polyurethane collars, at regular intervals to cut off longitudinal percolation flow along the trench may also be required. The engineer shall give specific consideration to risk of floatation of manholes and pipes both during construction and after they have been installed.

4.12.12 Acceptable Standards for Defects with Concrete Pipes

All pipes shall be visually inspected by the supervising engineer before being laid. A maximum of two hair line cracks (<0.25mm) and one small chipping damage (< 2 cm^2) may be allowed on any section of pipe (2.4m section). Pipe with cracks through the wall, exposed reinforcing steel, or damaged bells, spigots or joint grooves shall not be accepted.

For pipes that have been installed and the backfill completed, circumferential cracks less than 0.5mm and longitudinal cracks less than 0.15mm in width may be accepted at the discretion of the Manager Stormwater Assets. Cracks on installed concrete pipes should generally be assessed in accordance with the CPAA Publications Engineering Assessment and Acceptance Guideline for circumferential and longitudinal cracking.

4.13 MANHOLES, CATCHPITS AND OUTLET STRUCTURES

4.13.1 Position of Manhole

Manholes shall normally be provided at each change of direction or gradient and at each branching line and at a spacing of not more than 120 m for pipe lines up to and including 1200mm. For pipe lines larger than 1200mm, manhole spacing may be increased up to 200m. Manholes shall be made of precast concrete, except in special circumstances where the Engineer may approve cast in situ concrete manholes.

For pipes larger than 1200mm, precast saddle on manholes may be permitted subject to approval of the Development Engineer.

Manholes shall generally be placed where easy and safe access is available. Placing manholes directly under carriageways with busy traffic flows is generally discouraged. Manhole lids shall be clear of all boundary lines.

4.13.2 Standard Manholes

These are to be circular manholes with a minimum internal diameter of 1,050 mm (refer Papakura District Council Drawing SW9 and SW10) and are to be used on pipelines up to, and including, 600 mm diameter.

Precast manholes shall consist of centrifugally spun 1050mm, or larger diameter concrete pipes to Class 3 or greater standard. They shall have holes cast in the side for step irons.

All wall joints in manholes and the joint between the wall and concrete lid must be sealed with Bostick Titan Seal or an approved equivalent. The application shall be in conformity with the manufacturer's directions to provide a watertight and rootproof structure to the satisfaction of the Development Engineer.

Cast in situ manholes may not be used, except with the specific approval of the Development Engineer.

4.13.3 Deep Manholes

Where manholes are more than 5 m deep, they shall be specifically designed and shall incorporate intermediate landing platforms or grills in order to prevent a free-fall of more than 5 m. Refer Papakura District Council Drawing SS3 for typical detail.

4.13.4 Shallow Manholes

Where the stormwater line does not exceed 250 mm diameter, the depth to invert does not exceed 750 mm, the upstream grade does not exceed 10% and not more than two lines or connections enter the manhole (i.e. three including the discharge) the Development Engineer may approve of the use of mini-manholes.

Mini-manholes shall consist of a single length of centrifugally spun 675 mm diameter concrete pipe to a minimum of Class 3 standard, fitted with a standard cast iron frame and lid. The invert shall be fully benched as for standard manholes. Refer Standard Drawing SS2.

4.13.5 Stormwater Manholes on Larger Pipelines

Manholes on stormwater pipelines more than 600 mm in diameter and on smaller pipelines where the use of standard manholes is not suitable should be specifically designed.

For deep special manholes, it may be more economical to construct the lower portion to the required larger dimensions with the standard 1,050 mm diameter riser supported on a reinforced concrete slab on the lower large diameter chamber.
The use of fixed steel ladders instead of separate step irons is acceptable. Recessed steps without rungs may be permitted below pipe benching level, provided the lowest rung can be easily reached by a person standing at invert level. Typical details of fixed steel ladder and recessed steps can be found on Standard Drawing SS3.

On stormwater pipelines equal to or greater than 1200mm diameter, the spacing of manholes may be extended to up to 200 m and curvature on the pipeline may be permitted providing that joint deflections are within the limits of the manufacturer's recommendations. Any pipeline curvature is subject to specific approval by the Development Engineer.

Manholes on straight sections of stormwater lines of 1200m diameter and above may be constructed using offset intakes which may also be used in conjunction with bends, formed using epoxy mortar adhesive.

4.13.6 Hydraulic Flow in Manholes

In addition to the normal pipeline gradient, all manholes shall have a minimum drop of 20 mm plus 5 mm per 10º of the angle of change of flow within the manhole. Manholes on pipelines greater than 1 m diameter shall have the drop through the manhole designed to compensate for the energy lost due to the flow through the manhole at the design radius.

Surcharging of manholes is discouraged by Council. However, where unavoidable, surcharging up to a maximum surface level of 1.2m below the manhole lid will be accepted.

Where a change in pipe diameter occurs soffits shall be matched for stormwater drains.

4.13.7 Steps Irons, Steps and Ladders

All manholes other than shallow manholes shall be provided with approved galvanised steel step irons, steps or ladders in order to give reasonable access. Step irons shall be of the 'dropper' or 'safety' type such that a foot will not slide off them, and shall be spaced as shown on Papakura District Council Drawing SW16. All fittings used shall be hot-dip galvanised after fabrication.

Step irons and ladders should generally be located above the outlet branch of the manhole provided the outlet does not exceed 400 mm diameter. Where the outlet exceeds 400 mm diameter the step irons and ladders shall be located midway between the inlet and outlet.

4.13.8 Manhole Covers and Frames

Manhole covers and frames shall be of a design approved by the Development Engineer, manufactured from a strong and durable material. Typical examples of heavy duty, light duty, covers supplied in high quality grey or ductile iron, coated with a bituminous protective compound are illustrated in Papakura District Council Drawing SS3.

Non-rock type manhole covers and frames shall be used for manholes situated in trafficable areas for vehicles such as public roads.

The throats of all stormwater manholes shall be painted blue.

4.13.9 Drop Connections

Drop connections on stormwater manholes may be avoided by allowing pipes up to and including 300 mm diameter to have an open 'cascade' inside the manhole, provided that the steps are clear of any cascade. The maximum fall without a drop connection shall be 1.0m.

4.13.10 Manholes in Soft Ground

Where a manhole is to be constructed in soft ground, the area under the manhole shall be undercut down to solid ground (if practicable) and back-filled with suitable hardfill to provide an adequate foundation for the manhole base. Foundations of manholes in peat areas shall be specifically designed to the satisfaction of the Development Engineer.

Manholes in peat areas below the summer water table shall be designed to minimize leakage by using precast flanged bases and water tight joint seal.

4.13.11 Catchpits

Catchpits positioned within public roads shall be in accordance with requirements in 3.3.15.

Catchpits shall generally be constructed in accordance with R17, R18, R19, SW28 and SW29.

Catchpit spacing in public roads shall be designed to limit the spread of flow in a 10% AEP storm event to be:

- 2.0m at all local roads
- 2.0m at all sag points
- 1.5m at all arterial roads

The hydraulic capacity and capture efficiency shall be determined based on Chapter 4 of "Road Drainage Design Manual: (Mainroads, 2002) or "Highway Surface Drainage - A Design Guide for Highways with a Positive Collection System" (NRB: 1977).

4.13.12 Catchpit Lead Pipe

Catchpits should normally be connected to a manhole on the stormwater drainage system by 225 mm diameter pipes, except that if the stormwater drain is of greater diameter than 1200mm and a manhole is not conveniently located the catchpit lead may be saddled direct to that drain. A direct connection of the catchpit lead to a stormwater drain with a diameter between 600 mm and 1200mm diameter will only be permitted in exceptional circumstances, and at the Development Engineer's discretion. A typical catchpit design is shown in Papakura District Council Drawings R17, RR18, R19 and SW13.

Branch lines 300 mm diameter and smaller may be saddled on to pipelines 1.2 m diameter or larger, providing a manhole is supplied on the branching line within 50 m of the main line.

4.13.13 Inlet and Outlet Structures

Structures shall be constructed at the inlets and outlets of pipelines. Provision must be made for energy dissipation unless it can be demonstrated that the exit velocities and soil conditions are such as to make this unnecessary. The design shall ensure that:

1. The energy dissipating blocks shall be made and anchored into the apron in such a way that no structural damage will occur under the design peak discharge rate.
2. The number of dissipating blocks and their locations shall ensure that no flow can go directly from the end of the pipe without hitting at least one block.
3. When stormwater is discharged to a stream, the outfall structure shall be placed to direct the exit flow to merge with the flow in the stream at a sharp angle (<60º) to minimise local scour caused by turbulence. The apron level shall be set with a minimum fall above the low flow level in the stream to minimise the scouring energy. If fish passage through the upstream stormwater pipes is required, specific consideration shall be given to outfall design. The designer shall refer to

the ARC TP131 Fish Passage Guidelines for the Auckland Region (ARC, June 2000).

4. Inlet grilles shall be installed at inlet locations prone to blockage by debris or where entry of children into the stormwater pipes is of concern. The design of inlet screens and grilles will require careful consideration of accumulation of debris at the inlet and the adverse effects on the hydraulic capacity of the inlet.

In general, the inlet and outlet structures shall be designed and constructed in accordance with SW22 and SW23. Energy dissipaters and scour protection beyond the apron slab shall be designed in accordance with Chapter 13 "Stormwater Treatment Devices: Design Guideline Manual" (TP10, ARC)

Inlet and outlet structures (and other stormwater assets) must not display the manufacturer's name or any other advertising.

4.14 TESTING

The pressure testing of stormwater pipelines or branch drains will not normally be required. Acceptance will be on the basis of the quality of materials and the standard and accuracy of construction. However, testing may be required as set out in NZS 4452, if the Engineer has any doubt over the soundness of pipeline construction or if infiltration of groundwater is observed.

A CCTV survey of all new pipes will be required before vesting to Council. The CCTV survey of the pipe shall be undertaken in accordance with requirements in New Zealand Pipe Inspection Manual Issue 2.

Pipelines are to be laid true to design grade, without signs of internal ponding.

4.15 LANDSCAPE ENGINEERING STORMWATER DEVICES

4.15.1 General

This section covers the preparation, installation and maintenance of all new and existing engineered stormwater devices that have a designed landscape component (LESD). This includes, but is not restricted to, stormwater ponds, rain gardens, vegetated filters and swales.

4.15.2 Standard Landscape Specifications

The specifications in this section are supplementary to and take precedence over the other Council Standard Technical Specifications.

4.15.3 Mulch

All LESDs shall be mulched except for areas that are grassed or turfed. All mulch is to be approved by the Engineer prior to spreading. Specific LESD mulch applications are as follows:

Amenity Planting
Landscape planting between the drainage reserve boundary to the Upper Bank Zone shall only be mulched with bark or aged woodchip mulch where there is no possibility of surface ponding, flooding or mulch travel. Where surface ponding, flooding and mulch travel is possible within this area, biodegradable weed matting shall be used for all landscape planting.

Stormwater Ponds
No synthetic geotextile weed matting is to be utilized in the installation of the landscaping portion of landscaping engineered stormwater devices. However, synthetic geotextiles and other materials may be used, as applicable, to meet functional engineering requirements; for example, for inlets, outlets and high velocity channels.

Upper Bank and Lower Bank Zone Mulching
All plants shall be mulched with Council approved 0.5 metre diameter biodegradable weed mat rounds that shall be secured around plants, allowing adequate room around the stem for future growth. Firmly secure fabric mulch with wooden or other biodegradable pegs as per the manufacturer's instructions so that the fabric mulch does not detach from the soil, during inundation and high winds.

Marginal Zone Mulching
Council approved biodegradable weed mat is to be laid in a manner that the mulch will not uplift during inundation. Ensure that plants have adequate room around the stems for future growth.

Wet Zone Mulching
No mulching is required within the Wet Zone.

4.15.4 Rain Gardens

Rain gardens shall be mulched with Council approved biodegradable weed matting. River rocks (with a diameter of between 50mm and 150mm) in gabion mats (100mm to 300mm deep) may be permissible depending on stormwater engineering requirements and long-term maintenance requirements.

4.15.5 Swales

Roll-on turfed swales are not to be mulched.

Non-turfed swales are to be mulched according to the surface treatment and stormwater flow velocities, swale design, site location and long-term maintenance requirements. Mulching shall be installed as per manufacturer's instructions.

Vegetated swales planted with Carex sedges shall be mulched with biodegradable weed mat or secure biodegradable mat rounds.

Swales mulched with river rocks shall either be constructed with:

- Loose 50-150mm diameter river rocks on biodegradable weed mat; or
- River rocks of 50-150mm diameter encased in gabion matting.

4.15.6 Vegetated Filters

Vegetated Filters shall be mulched with biodegradable weed mat. Grassing and roll-on turfing does not require mulching.

4.15.7 Planting

All LESD landscaping shall be designed and installed according to Council and ARC requirements.

Grassing
All areas of engineered stormwater devices that are to be permanently grassed instead of vegetated with shrubs and/or trees shall be established according to the Council and ARC requirements.

During establishment and maintenance, ensure that no grass debris enters any water body or watercourse.

Stormwater Pond Planting
Permanent stormwater ponds shall be planted up as soon as possible after the completion of civil works construction. Where site conditions such as unstable soil structures require a more rapid groundcover than shrubs and trees provide, pond slopes shall be stabilised with grassing first and a Staged Pond Planting is permitted as detailed in this code.

Staged Pond Planting Stage 1: Grassing
Pond banks shall be prepared and sown with grass seed to establish rapid ground stabilization.

Grassing and Turfing Specifications
Where ponds are to be established in nitrogen-deficient soils and at the Engineers discretion, the seed mixture shall be:

- Annual Rye Grass 150 kg/ha
- Sweet Clover 100 kg/ha

All seed shall be certified and less than 12 months old at the time of sowing. The Ryegrass component is to be certified as having greater than 80% live endophyte content. The Engineer may prohibit the use of seed that has deteriorated because of wetting, fertiliser burning etc.

The site shall be grassed for at least three months and meet establishment requirements for sown areas prior to landscaping.

Staged Pond Planting Stage 2: Landscape Planting
Stage 2 Planting shall occur within the Council planting season (2 April to 30 September) once Stage 1 sown grass has established. Ensure that no weed species exist throughout the site. Where weed species need to be eradicated either carefully spot spray and/or hand-pull in such a manner that erosion is minimised and surrounding groundcover remains undamaged. The sown grass groundcover shall be spot sprayed to 0.50m diameter for each location where individual plants are to be planted 4 weeks prior to planting, ensuring that the established grass between spot sprays remains undamaged. Maintain sprayed areas so that no new weed growth

exists at time of planting. Install and establish planting and mulching in accordance with Council and ARC requirements.

Rain Gardens and Vegetated Filters
Rain gardens and Vegetated Filters are to be planted up according to Council and ARC requirements.

Swales
Turfed swales shall be prepared, established and maintained as per Council and ARC requirements. Both during and post-establishment, the height of the turf shall be consistently maintained at least fortnightly to designed stormwater engineering requirements. Turf shall be of a drought-resistant hard-wearing rye-grass based variety with no weeds species. Swales planted with Carex species shall be planted according to Council and ARC requirements.

Spraying and Weed Control
Ensure that no spray enters any water body or watercourse. In respect to stormwater ponds, where weed species exist both on and within 2.5m adjacent to the normal standard waterline, weeds shall be controlled by either hand-pulling or weed-eating in such a manner that no debris enters any water body or watercourse.

Tree Staking and Protection
Trees shall be tied to two stakes on opposite sides to the tree using biodegradable flexible ties made from either cloth or flax. The ties are to be positioned one third up the tree's main stem and with enough give to move in the wind to ensure adequate trunk development.

4.15.8 Maintenance Requirements

The Developer shall be responsible for the routine maintenance of the landscape planting works including weeding, mulching, replacement of plants and watering during the defects liability period.

4.15.9 Defects Liability Period

The planting defects liability period for all LESDs, except Stormwater Ponds, shall be two (2) years from practical completion and Council acceptance of landscape planting works or upon release of any implementation bond held for uncompleted landscaping, except when planting is carried out between October 1 and April 1 the defects liability shall be extended for an additional 6 months.

Where stormwater ponds are to be permanently grassed, the defects liability period is a minimum 6 months if sown between April 2 and September 30. If sown between October 1 and April 1 the period is extended for a further 6 months.

Where a stormwater pond is planted directly after completion of civil works construction, the landscaping defects liability period shall be a minimum 12 month period, except when planting is carried out between October 1 and April 1 the defects liability shall be extended for an additional 6 months.

Where a stormwater pond planting is implemented according to the Staged Pond Planting, the Stage 1 defects liability period will extend for a minimum of 6 months or until such time as the Stage 2 planting is instigated.

8.1.5 Power Transformers, Switching Stations and Other Services

Power, telecom, gas or other service boxes, transformers, valves, switches or similar devises larger than 300mm x 300mm are to be placed within private property clear of Councils stormwater and sewer pipes and access is to be provided by way of an easement over the private property for the Utility Companies.

8.1.6 Conversion to Underground on Existing Roads

Where a proposed development fronts on to an existing road, the conversion of overhead reticulation to underground will in some instances be desirable. Agreement on the feasibility and benefit will first be agreed between the network company and the Council.

8.1.7 Industrial and Commercial Developments

The servicing requirements for industrial and commercial areas are often indeterminate. Close liaison between the developer and the network company is advisable, particularly immediately before cabling is installed so that changes can be incorporated to accommodate extra sites or the requirements of a particular industry.

8.2 LOCATION AND BACKFILLING OF SERVICES

8.2.1 Location

The position of services in the road shall conform to Papakura District Council Drawing R2. All services shall be within 100mm of the recommended location.

8.2.2 Backfilling of Trenches

Trenches shall be built up with an approved backfill material in 150mm layers placed and compacted simultaneously on each side of the pipes, in order to give a balanced loading. Full use shall be made of hand operated compaction tools.