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Model Codes of Practice for Enhanced Stormwater Management and Improved Uptake of Low Impact Design

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Model Codes of Practice for Enhanced Stormwater Management and Improved Uptake of Low Impact Design

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Prepared for
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Contents

1 Executive Summary

Previous studies by Auckland Regional Council (ARC) identified a number of limitations or barriers that restrict local authorities from implementing low impact design (LID) and other enhanced stormwater management techniques. The aim of this project was to provide tools to address some of these limitations. Ultimately it was anticipated that this would result in a Model Code of Practice on which individual local authorities can base the drafting or revision of their Codes of Practice.

To understand the current position of the local authorities throughout the Auckland region a thorough stock take of District Plans, current codes of practice, and manuals was undertaken, as was an interview programme with the local authorities to gauge the actual implementation of such documents. The results from this work, focusing on identifying strengths, limitations, and barriers to stormwater and sediment management and LID, were used to determine some suitable tools for increasing uptake of these techniques.

The findings of the study were that, in general, the implementation of enhanced stormwater management techniques and LID across local authorities is not occurring as effectively as it could, and, therefore, the potential benefits for Quadruple Bottom Line Outcomes are not being fully realised. Within this a two-tier system was evident with authorities being either proactive or passive in terms of LID use within their jurisdiction.

It appears that North Shore City Council (NSCC), Waitakere City Council (WCC), Auckland City Council (ACC) and to a lesser extent Rodney District Council (RDC), were proactive in producing LID-related documents; however, it was noted that some of the content of these documents was at odds with regional policy, in particular the Air Land and Water Plan (ALWP). It was also noted that these documents were at times also at odds with the relevant District Plan (DP). The language used within the existing documents to indicate the importance of LID approaches often played down its importance and may ask for LID to be "considered". This lack of specificity was perceived to lead to ambiguity over its intended use.

Other local authorities such as Manukau City Council (MCC), Papakura District Council (PDC) and Franklin District Council (FDC) were found to have little or no LID-related documentation of their own and relied heavily on traditional engineering standards. This was also found to be the case within some departments of some the more proactive authorities previously discussed.

Despite the marked difference between the two groups of authorities there were a number of common barriers which were evident. These included lack of communication between departments, uncertainty surrounding ARC jurisdiction in LID planning, lack of awareness of retrofit potential and LID brownfield use the limiting nature of private stormwater structure ownership, a lack of detail regarding capital costs, and operational costs and performance. A frequent comment stemming from the interviews was that there is a gap between the high-level thinking surrounding LID and its physical implementation on the ground.

When considering the form of tools which could be developed to promote the implementation of LID it was clear that Model Codes of Practice (MCoPs), as originally envisaged, would not effectively address the barriers which exist, largely because of the difference in approach between the local authorities which was identified. Some local authorities have produced useful local documents for their areas and these are identified within this report, however, for all local authorities key gaps remain in the areas of stormwater management through LID associated with roading and parks management. Further guidance on the retrofit of LID into existing development would also be of benefit to all local authorities.

Therefore, the approach recommended is to encourage the sharing of existing best practice information between the local authorities of the Auckland region and to develop a limited number of MCoP and technical information sources to cover areas which are considered deficient across all local authorities.

2 Introduction

URS New Zealand Limited (URS) was commissioned by Auckland Regional Council (ARC) to assist in developing a Model Code of Practice for Enhanced Stormwater Management and Improved Uptake of low impact design (LID).

ARC has identified a number of limitations such as staffing, funding and institutional barriers that restrict local authorities (local authorities) from comprehensively reviewing their own Codes of Practice (CoP) in regard to LID. The aim of this project is to provide tools to address some of these limitations. Ultimately it was anticipated that this will result in a Model Codes of Practice on which individual local authorities could draft or revise their CoPs. It is hoped that this would ensure that source control and on-site stormwater management, including the principles and devices described as LID is enabled, and where possible, promoted.

To understand the current position of the local authorities throughout the Auckland region, a thorough stock take of District Plans, current Codes of Practice, and manuals has been undertaken, as has an interview programme with the local authorities to gauge the actual implementation of such documents.

The results of the literature review and interview process are presented and discussed within this report, with particular focus on identifying strengths, limitations, and barriers to stormwater and sediment management and LID.

2.1 Background

The conclusions of the Stormwater Action Plan (ARC, 2004) identified that renewed effort was required in a number of key areas relating to stormwater management within urban areas. It identified that:

- stormwater is having the single largest environmental impact on the region's streams and coastline;
- there is a relationship between stormwater-related environmental impacts and a reduction in the quality of economic, social and cultural community values;
- an integrated, holistic approach to catchment planning is required, ensuring the work being carried out benefits the catchment as a whole and does not adversely affect other areas; and
- source control is a key measure (structural and non–structural) to reduce or prevent the generation of a flow or pollutant.

Effective Stormwater Management and LID have been identified as key tools to address the majority of the above statements. However, barriers to the implementation of LID demonstrate that it is difficult for local authorities to balance the operational, economic, cultural and environmental aspects when implementing this type of stormwater management.

One proposed methodology for overcoming these barriers and for improving stormwater management within the local authorities is the development of Model Codes of Practice (MCoP) prepared at a regional level.

The LID approach considered for the MCoP considers the design and implementation of land development or re-development in a way that minimises and mitigates the effect of surface water run-off and contaminants that modify and pollute the aquatic environment.

Furthermore, LID is a design philosophy that can be applied at both an individual site, local and catchment level. LID works to include multiple site-specific stormwater controls that work with the natural landscape and are cost effective in the design process. Most LID methods seek to control run-off at the source in order to replicate the pre-development hydrology.

LID is a well established concept which is also known as Water Sensitive Urban Design (WSUD) in Australia and Sustainable Drainage Systems (SUDS) in United Kingdom (See Section 11).

2.2 Regional issues

In advance of this study the ARC explored common issues with respect to the implementation of stormwater management and LID across the region. A project in November 2007 identified the following key issues:

- Incompatibility of regional and local regulations.
- Communication between regional and territorial level.
- Jurisdictional confusion between local authorities and ARC.
- Source control needs to be addressed at regional level.
- Cost benefit of stormwater management approaches needs to be better understood.
- Operation and maintenance of devices.

It is against this context that the ARC and the region's local authorities have produced a range of local documents and materials to assist with the implementation of stormwater management and LID and these documents are the focus of this work.

3 Methodology

3.1 General

The two key stages of work carried out in relation to this study were a comprehensive document review and a series of interviews undertaken with representatives from each of the region's local authorities. This provided the information for the analysis and recommendation phases. A summary of the methodology for each stage is provided.

3.2 Literature review

A comprehensive document review was undertaken, with a number of key documents being reviewed (Table 1 provides a list of key documents).

In addition to these key documents a significant number of other documents were reviewed; a full list is provided in the reference section of this report.

As well as the New Zealand focused literature, international guidance documents and Code of Practices (CoP) from other countries which have adopted LID for stormwater management were examined. In particular, approaches from Australia and Scotland were included as LID use is more progressed in these countries and the documents are therefore able to provide a context, within which experiences of the Auckland region can be considered.

Information gathered from the documents was assessed with regard to relevance and then summarised as appropriate for inclusion in this report. The review focussed on aspects of the documents pertinent to specific policy, design and implementation guidance for stormwater management and LID. Document status was also recorded.

An outline of the key contents of each document is provided in subsequent sections of this report.

Table 1

Key sources of information on stormwater management.

Title	Author
National guidance	
Resource Management Act (1991)	NZ Legislation
Local Government Act (2002, 1974)	NZ Legislation
Local Government (Auckland) Amendment Act (2004)	NZ Legislation
Urban Design Tool Kit/Protocol	MfE
Sustainable Water Programme of Action	MfE
Building Act (2004)	NZ Legislation
NZS 4404:2004	NZ Standards
Regional guidance	
Auckland Regional Policy Statement	ARC
Regional Plans, Coastal, ALWP, Erosion and Sediment Control	ARC
Auckland Regional Council Technical Publications TP108, TP10, TP90, TP124 and TP232	ARC
Local authorities guidance	
ACC On-site Stormwater Management Manual	ACC
ACC Soakage Design Manual	ACC
ACC Watercourse Guidelines	ACC
WCC Countryside and Foothills CoP	WCC
WCC Stormwater Solutions for Residential Sites	WCC
Waitakere City Council (WCC) Draft Northern Strategic Growth Area (NOSGA) Low Impact Design Code of Practice	WCC
North Shore City Council (NSCC) Practice Notes	NSCC
District Plans	All local authorities
Council Building Codes	All local authorities
Other documents	
Christchurch Manual for Design of Waterways, Wetland and Drainage	Christchurch City Council
District Plan Review: Low Impact Design, Beca 2001	Beca
Auckland Regional Issues Summary	ARC
Kapiti Coast Code of Practice for Subdivisions	Kapiti Coast District Council
International sources	
Cooperative Research Centre for Catchment Hydrology	
Water Sensitive Urban Design (WSUD; Australia) and related Engineering Procedures (Melbourne)	
UK Sustainable Design Systems (SUDS) Manual	

3.3 Interview process

A series of meetings were held with local authorities across the region to determine their understanding of LID and enhanced stormwater management approaches, to identify how the available local, regional and national documentation is used, and to identify issues and barriers to the increased uptake of LID and enhanced stormwater management approaches.

Each council was interviewed using standard questionnaire and by the same URS staff member to maximise the consistency of approach. A copy of the questionnaire is provided in Appendix B.

In most cases, one-on-one interviews were conducted with local authority staff members involved in asset management, stormwater management, roading, parks, strategic planning and consenting. However in some cases groups of people were interviewed or some departments were unable to attend. In the case of North Shore City Council a workshop approach was adopted.

A summary of the information gathered for each local authority is provided in Appendix B.

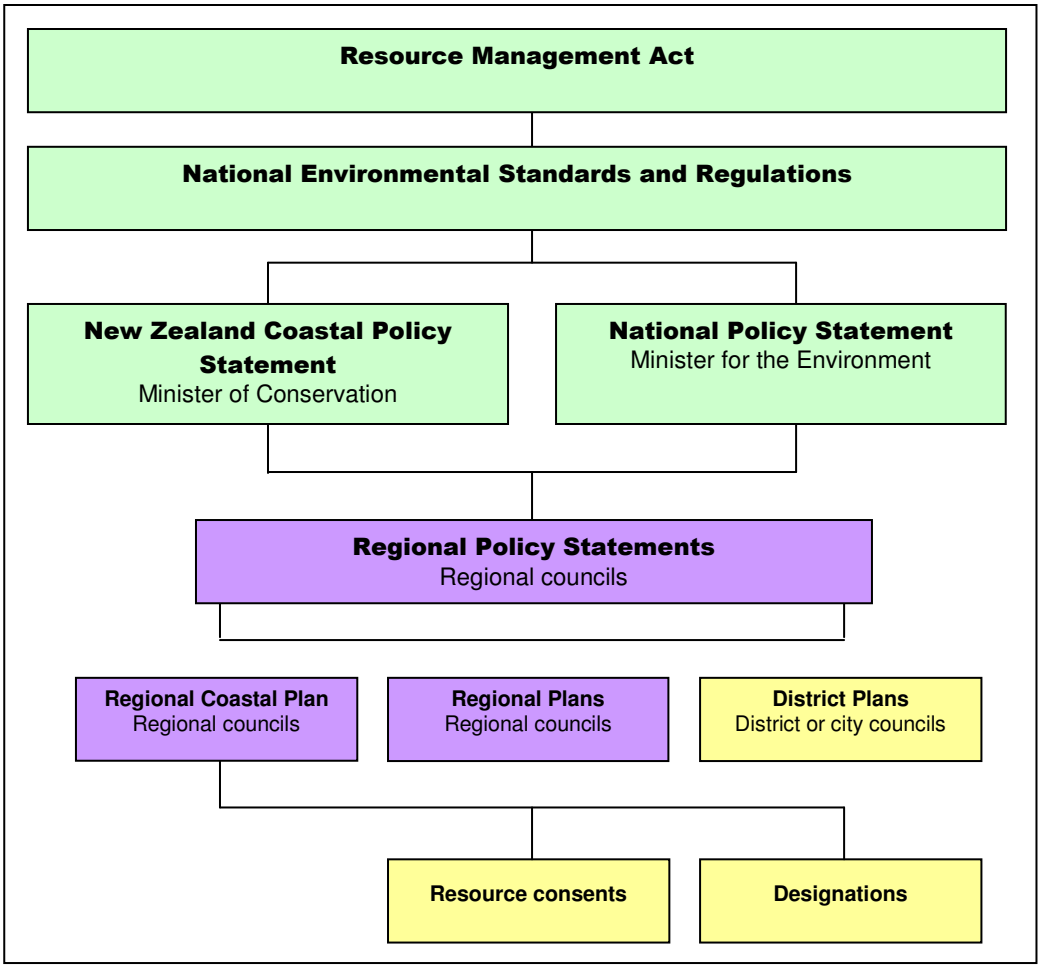
3.4 Analysis

The data from the literature review and interviews was collated and assessed in a qualitative manner to extract the points relating to barriers, strengths and limitations. These points were then examined to determine reoccurring patterns and to determine the reasons behind the identified barriers, strengths and limitations. From this analysis a future direction for the study was determined and an assessment of the likely efficacy of MCoP is provided.

4 New Zealand Policy Setting

New Zealand environmental policy is based around a three-tier system of governance (Figure 1). All policy, regardless of which tier of governance it is implemented at, has the ability to impact upon stormwater management at a local authority level and as such a range of national, regional and city and district documentation requires consideration.

Figure 1
Interactions through the tiers of governance.



Source: MfE Everyday Guide to the RMA Series 1.1

The following literature review is split into a number of sections which reflect the governance structure in New Zealand, with policy and guidance being discussed separately where appropriate.

5 National Requirements and Guidance

5.1 National policy requirements with regard to stormwater

The broad legislative underpinning for stormwater issues and management at a national level is as follows:

- Resource Management Act (1991), in particular s5(2) (a), (b) and (c) in relation to sustainable management.
- Local Government Act (2002, 1974).
- Local Government (Auckland) Amendment Act (2004).
- Land Transport Management Act (2003).
- Transit New Zealand Act (1989).
- Land Drainage Act (1908).
- Soil Conservation and Rivers Control Act (1941).

From an ARC perspective, the main focus with respect to stormwater would be the principles and requirements provided in the RMA, whilst in addition to the RMA, the Local Government Act 1974 and 2002 would be key priorities for local authorities.

Currently, there are no national environmental standards directly pertaining to stormwater management. Rather, MfE and other regulators have concentrated on regional or territorial level controls as a method for achieving action on stormwater and sediment control. Examples include regional plans and local authority subdivision codes. Subdivision guidelines generally cross reference to NZS 4404:2004 Land Development and Subdivision Engineering, or local authorities rely on it in place of their own codes, along with SNZ HB 44:2001 Subdivision for People and the Environment.

Most of the other legislation is subservient to the RMA and is not discussed further in this document. This includes the LGA (1974) as it relates to the Auckland Regional Growth Strategy (s37SE – s37H), and in their entirety the Land Drainage Act (1908) and the Soil Conservation and Rivers Control Act (1941). The subservience of the LGA (2002) to the RMA is not immediately clear, although parts are interrelated. The LGA (2002) is discussed further in Section 5.1.3.

5.1.1 Resource Management Act (1991)

The purpose of the Resource Management Act (RMA) is to promote the sustainable management of our natural and physical resources. This is achieved by managing the use of our resources in a manner that allows for people and communities to provide for their social, economic and cultural wellbeing, while sustaining the potential of natural and physical resource to meet the needs of future generations; safeguarding

the life supporting capacity of air, water, soil and ecosystems; and avoiding, remedying or mitigating adverse effects of activities on the environment.

Section 6 of the RMA outlines Matters of National Importance. In achieving the purpose of the RMA all persons exercising functions and powers under it shall recognise and provide for the following Matters of National Importance:

a) The preservation of the natural character of the coastal environment, wetland, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development.

b) The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.

c) The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers.

d) The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu and other taonga.

Section 7 "Other Matters" states,

> "In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to –
>
> a) The efficient use and development of natural and physical resources.
>
> b) The maintenance and enhancement of amenity values.
>
> c) Maintenance and enhancement of the quality of the environment.
>
> d) Any finite characteristics of natural and physical resources.
>
> e) The effects of climate change."

In turn Section 8 Treaty of Waitangi requires,

> "In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi)."

While there is no comprehensive or authoritative list of the principles of the Treaty, the High Court has adopted a list referred to in paragraph 12 Laws of New Zealand, Treaty of Waitangi. The list was paraphrased into the so-called "central principles" which have been extracted from reports of the Waitangi Tribunal.

Sections 14 and 15 of the RMA place restrictions relating to water and on the discharge of contaminants into the environment.

> 14. Restrictions relating to water
> (1) No person may take, use, dam or divert any –
>
> i.Water
> and

15. Discharge of contaminants into environment
(1) No person may discharge any
(a) Contaminant or water into water; or

Contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water.

In relation to stormwater, the RMA therefore deals with:

- The need to sustainably manage our water resources to meet the needs of future generations.
- The need to preserve the natural character of our coastal environment, wetlands, lakes rivers and their margins.
- Recognising and providing for the relationship of Maori with their ancestral lands and water.
- The control of the use of land for the purpose of the maintenance and enhancement of the quality of water in water bodies and coastal water.
- The control of discharges of contaminants, and water into water.
- The control of the taking, use, damming and diversion of water, and the control of the quantity, level and flow of water in any water body, including:
    - the setting of any maximum or minimum levels or flows of water;
    - the control of the range, or rate of change, of levels or flows of water.

The RMA is not enforced by a dedicated national organisation, but responsibility for its implementation does fall to regional and local authorities. Details of these responsibilities will be discussed later in this report. It should be noted that the RMA does not explicitly mention LID or stormwater management.

5.1.2 Local Government Act (1974)

As stated previously, Section 37SE – s37SH are subservient to the RMA. These relate to the Auckland Regional Growth Strategy, availability of copies of the strategy, the Regional Growth Forum and consultation requirements.

Although the remainder of the Act is largely repealed, Part 26 Sewerage and Drainage has several residual sections still in effect. These relate primarily to drains over private property, and councils' ability to reallocate these private drains as public drains.

5.1.3 Local Government Act (2002)

Part 7 Specific obligations and restrictions on local authorities

The replacement Local Government Act (2002) distinguishes between territorial local authorities (city and district councils) and regional councils, but also uses an omnibus term "local authority" to refer to both groups.

Part 7 sets out the specific obligations and restrictions on local authorities and other persons, defines wastewater to include stormwater, and places an obligation on local authorities to periodically assess water services, including wastewater services. This information must be included in the council's Long-Term Council Community Plan (LTCCP). If it is not, a special consultative procedure must be used.

Information required is set out in Section 126, including the requirement to describe the means by which,

> (1) (a)
>
> (iii) Stormwater is disposed of within the district, including the extent to which drainage works are provided within the district by the local authority and any other person; and
>
> (b) an assessment of any risks to the community relating to the absence in any area of either a water supply or a reticulated wastewater service or both; and
>
> (c) an assessment of –
>
> (ii) the quality and quantity of wastewater discharged from reticulated sewerage…
>
> (d) a statement of current and estimated future demands for water services within its district and a statement of any issues relating to –
>
> (ii) the health and environmental impacts of discharges of stormwater … arising from the current and future demands.

Further subsections require statements of the local authority's options for meeting current and future demand and intentions for meeting that demand.

Section 128 sets out the process for making assessments. These require:

> (2) In making an assessment of current and future demands for water services and options to meet those demands, a local authority must consider –
>
> (a) the full range of options and their environmental and public health impacts, including (but not limited to) –
>
> (i) on-site collection and disposal; and
>
> (ii) grey water and stormwater reuse or recycling; and

(iii) demand-reduction strategies, including public education, information, promotion of appropriate technologies, pricing, and regulation; and

(iv) the full range of technologies available; …

The Act thus provides resources to councils to explore a wide range of stormwater options limited only by the significance of the information, the costs of and difficulty in obtaining it, the extent of each council's resources, and the possibility that the local authority may be directed under the Health Act 1956 to provide the services (s129).

Part 8 Regulatory, enforcement, and coercive powers of local authorities

Part 8 of the Act provides the regulatory, enforcement, and coercive powers of local authorities. Included in this is the power to require development contributions at a number of stages of development. These include at the time of the granting of a resource management consent, building consent or a service connection (s198).

While simplifying the methods for extracting development contributions (as compared to the unwieldy and litigation-producing provisions previously used under the RMA), there is no particular aspect of the regime that supports or detracts from the installation of low impact stormwater systems. Instead, support for that aspect will come from the requirements for district- or community level assessments, which will guide the development contributions process.

5.1.4 Local Government (Auckland) Amendment Act (2004)

The Local Government (Auckland) Amendment Act (2004) (LG (A) AA 2004) requires that planning documents across the region are aligned with the direction set in the Auckland Regional Growth Strategy (1999) and that they integrate land uses and transportation. Of particular relevance is the need to "reduce adverse effects of transport on the environment (including improving air and water quality, reducing noise and stormwater, improving heritage protection and reducing community disruption and transport land use) and reducing the adverse effects and increasing the positive interactions of transport and land use" (Schedule 5 LG(A)AA 2004).

The particular role of transport routes in the production of stormwater is acknowledged and separately provided for in the Proposed Air, Land and Water Plan (PALWP).

Schedule 5 of the Local Government (Auckland) Amendment Act (2004) sets out certain matters to which the Regional Policy Statement (RPS), for the purposes of Section 40(1) (b), must contribute: [Cl. 16]

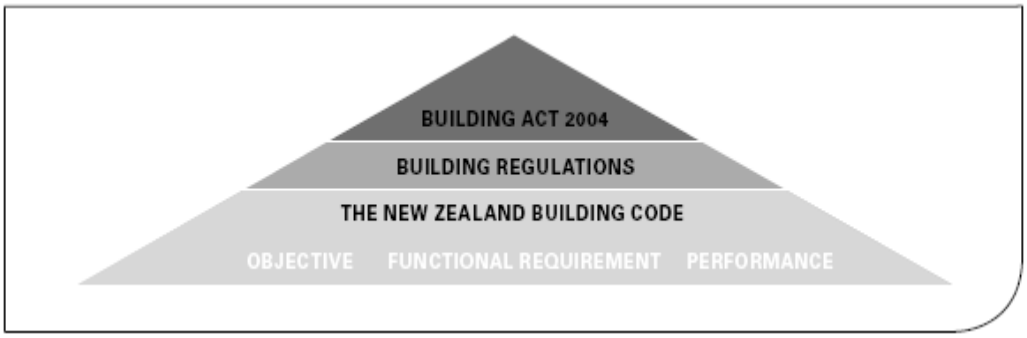
(c) reducing adverse effects of transport on the environment (including improving air and water quality, reducing noise and stormwater, improving heritage protection and reducing community disruption and transport land use), and reducing the adverse effects and increasing the positive interactions of transport and land use; and

(d) supporting compact sustainable urban form and sustainable urban land.

5.2 Building requirements and guidance

Figure 2

The pyramid below illustrates the legislation that is governed by the Building Act (2004).



5.2.1 New Zealand Building Act (2004)

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

Section 3 Purpose

(d) buildings are designed, constructed, and able to be used in ways that promote sustainable development.

In all cases, whether a building requires a building consent or not, buildings must be fit for purpose.

Below are the relevant parts from the New Zealand Building Act (2004) that relate to stormwater and/or stormwater effects. Note, however, the provisions of Schedule 1 Exempt Building Work. This includes,

(ii) the construction of any tank or pool and any structural support of the tank or pool (except a swimming pool as defined in Section 2 of the Fencing of Swimming Pools Act 1987), including any tank or pool that is part of any other building for which a building consent is required, –

(i) not exceeding 35,000 litres capacity and supported by the ground; or

(j) not exceeding 2000 litres capacity and supported not more than 2 metres above the supporting ground; or

(iii) not exceeding 500 litres capacity and supported not more than four metres above the supporting ground.

There are limitations and restrictions on building consents related to the construction of buildings on land subject to natural hazards.

Section 71 Building on land subject to natural hazards

(1) A building consent authority must refuse to grant a building consent for construction of a building, or major alterations to a building, if:

(a) the land on which the building work is to be carried out is subject or is likely to be subject to one or more natural hazards; or

(b) the building work is likely to accelerate, worsen, or result in a natural hazard on that land or any other property.

(3) **natural hazard** means any of the following:

(a) erosion (including coastal erosion, bank erosion, and sheet erosion);

(b) falling debris (including soil, rock, snow, and ice);

(c) subsidence;

(d) inundation (including flooding, overland flow, storm surge, tidal effects and ponding);

(e) slippage.

5.2.2 New Zealand Building Regulations (1992)

The New Zealand Building Regulations (1992) were made under the Building Act (1991) and remain in effect. Schedule 1 sets out the Building Code.

The Building Code contains compulsory rules for all new building work. It contains one section (E1) which specifically refers to stormwater. This section is summarised in Table 2.

Table 2

New Zealand Building Code Clause E1.

Provisions	**Limits on application**
OBJECTIVE	
E1.1 The objective of this provision is to:	
(a) Safeguard people from injury or illness, and other property from damage, caused by surface water, and	
(b) Protect the outfalls of drainage systems.	
FUNCTIONAL REQUIREMENT	
E1.2 Buildings and site work shall be constructed in a way that protects people and other property from the adverse effects of surface water.	
PERFORMANCE	
E1.3.1 [Except as otherwise required under the Resource Management Act 1991 for the protection of other property, surface water**]**,	

resulting from **[**an event**]** having a 10 percent probability of occurring annually and which is collected or concentrated by buildings or sitework, shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property.	
E1.3.2 Surface water, resulting from **[**an event**]** having a 2 percent probability of occurring annually, shall not enter buildings.	Performance E1.3.2 shall apply only to Housing, Communal Residential and Communal Non-residential buildings.
E1.3.3 Drainage systems for the disposal of surface water shall be constructed to:	
(a) Convey surface water to an appropriate outfall using gravity flow where possible,	
(b) Avoid the likelihood of blockages,	
(c) Avoid the likelihood of leakage, penetration of roots, or the entry of ground water where pipes or lined channels are used,	
(d) Provide reasonable access for maintenance and clearing blockages,	
(e) Avoid the likelihood of damage to any outfall, in a manner acceptable to the network utility operator, and	
(f) Avoid the likelihood of damage from superimposed loads or normal ground movements.	

5.2.3 New Zealand Standard 4404:2004 Land Subdivision and Engineering

While the RMA is the principal statute under which development and subdivision is controlled, District Plans typically do not specify technical standards. Instead, reliance is generally placed on NZS 4404:2004 Land Subdivision and Engineering where councils so choose, or in-house developed codes for land development and subdivision engineering, particularly where councils are large. The NZS 4404:2004 allows local authorities to adopt, in whole or in part, a set of guidelines and a means of compliance for various types of infrastructure. Nothing in the standard derogates from the requirements of the Building Code (Schedule 1 Building Regulations 1992).

Outlined below are the provisions within NZS 4404:2004 that relate to stormwater, followed by a summary of the stormwater drainage section of the standard.

Landform and watercourses

2.4.1: The final choice of landform shall represent the most desirable compromise between the development requirements and the preservation of natural features and the natural quality of the landscape including the retention of natural watercourses.

Earthworks, sediment control

2.8.1: Earthworks shall be designed and constructed in such a way as to minimize soil erosion and sediment discharge. Where necessary, permanent provision shall be made to control erosion and sediment discharge from the area of the earthworks.

Most local authorities and regional councils have requirements for erosion, sediment and dust control or these will be set in resource consents for the project. Such conditions must be referred to and taken into account in the early stages of planning a project.

Roads

3.3.1: Urban roads shall be provided with kerbs and channels and be adequately drained unless the local authority approves an alternative.

Stormwater drainage summary

This section of the Standard covers the design and construction requirements of stormwater drainage works for land development and subdivision. The emphasis of the Standard is on piped stormwater networks; however reference to LID such as swales, ponds and wetlands is mentioned. Following is a list of topics covered within the stormwater drainage section:

General – mentions the objectives of a stormwater drainage system, local authorities requirements, catchment management planning, effects of land use, and alternative stormwater systems;

Design – covers requirements in regard to stormwater systems, storm events, freeboard, tidal areas, bridges, pipelines and culverts, manholes, waterways, and stormwater disposal; and

Construction – refers readers to local authorities construction standard specifications.

5.3 National guidance

5.3.1 Urban Design Protocol

The New Zealand Urban Design Protocol (UDP) provides a platform from which New Zealand towns and cities can be improved through quality urban design. It is part of the Government's Sustainable Development Programme of Action and Urban Affairs portfolio.

The Urban Design Protocol is a voluntary commitment by Central and Local Government, property developers and investors, design professionals, educational institutes and other groups to undertake specific urban design initiatives.

It identifies seven essential design elements that provide an opportunity to link LID principles to overall urban design. Listed below is a brief description of the seven UDP design elements plus possible examples of how LID may be incorporated into them.

Context – seeing buildings, places and spaces as part of whole towns and cities

Considering the location of any above ground features of a stormwater system, and how they fit into the surrounding environment, for example, whether a rain garden would be in keeping with the natural context.

Taking into account any heritage features of the site or surrounding area and designing to avoid these.

Taking into account the landscape features of the area and designing and locating devices to be in keeping with the existing landscape.

Character – reflecting and enhancing the distinctive character, heritage and identity of the urban environment

Stormwater systems (LID) improve water quality prior to discharge to water bodies, and provide opportunities to create habitats for plants and animals (eg through riparian planting).

Choice – ensuring diversity and choice for people

Enabling people to design stormwater systems with a range of devices.

Connections – enhancing how different networks link together for people

Consideration as part of stormwater projects the creation of wetlands or detention ponds as part of wider footpath and cycling network or green network. Most would be applicable to larger stormwater projects eg for a large subdivision rather than for small sites. Community connections could be created through construction of amenity areas, green corridors and shared spaces.

Creativity – encouraging innovative and imaginative solutions

Being open to new ways of doing things on projects, and ensuring a wide range of people are involved in the process from the outset. May include being creative by using low impact solutions rather than conventional devices and pipes.

Custodianship – ensuring design is environmentally sustainable, safe, and healthy

Improved stormwater quality meets the custodianship principle by improving the state of waterways. Would provide opportunities to utilise "green" technologies, for example swales would be more preferable than wide concrete drains.

Collaboration – communicating and sharing knowledge across sectors, professions, and with communities

Involve the community and other stakeholders if necessary through community assistance with riparian planting/walkways/maintenance of low impact solutions such as swales, rain gardens and bio-retention devices.

Urban Design Toolkit

The Urban Design Toolkit is one of a number of supporting resources available for helping people involved in urban design to create high-quality urban design outcomes as set out in the Urban Design Protocol. For some, the Toolkit will provide an important resource, assisting them in the application of quality urban design projects. For others, the Toolkit may provide increased insight into the breadth and depth of urban design and a starting point in identifying how to achieve quality design.

The Toolkit has recently introduced the incorporation of LID into urban design. The Toolkit briefly outlines what it is, how it can be useful, how it works and gives

examples of this approach in various contexts. For further information it references the ARC website and TP124 plus the Landcare Research website.[1]

5.3.2 Sustainable Water Programme of Action

The Sustainable Water Programme of Action has been developed so that we, as a nation, can determine how to fairly use, protect and preserve water. It is co-ordinated by the Ministry for the Environment and the Ministry of Agriculture and Forestry.

The Water Programme of Action examines all aspects of water – cultural, economic, environmental and social.

The programme initially consists of a number of projects within three separate strands covering:

- Water allocation and use.
- Water quality.
- Water bodies of national importance.

Within these strands, a series of projects will:

- Examine how to manage water allocation and factors affecting water quality and how to get the best balance.
- Determine what the national interest in water is and how to get the best results from this.
- Identify the water bodies of national importance.
- Develop ways to get sustainable and fair results.

Further information is outlined in various documents listed below, and can be viewed at www.mfe.govt.nz/publications/water/#wpoa.

National Environmental Standards.

Consultation Reports – includes public meetings, Government workshops and hui.

Freshwater for the Future publications.

Note: that the Sustainable Water Programme of Action does not explicitly mention the concept of LID or stormwater management.

6 Regional Requirements

As previously shown in Figure 1, regional requirements follow on from national statutes. This section outlines the current regional policy and requirements that are set out by the ARC with regard to stormwater.

6.1 Auckland Regional Policy Statement

The Auckland Regional Policy Statement (ARPS) is a statement about managing the use, development and protection of the natural and physical resources of the region. The ARPS identifies regional issues and provides a resource management framework under the RMA for managing environmental effects within the region associated with urban and rural development.

The Statement identifies the origins and effects of increased stormwater run-off, and the need to mitigate the effects, particularly with intensification. A key component of the ARPS is the Comprehensive Urban Stormwater Strategy, of which the main objectives are to protect and enhance the quality and quantity of freshwater and marine habitats, and to reduce the adverse effects of point source and non-point source contamination.

The ARPS emphasises the role of local authorities with respect to the control of networks; however it does not provide specific methodologies with regard to this.

ARPS Plan Changes 6 and 7 consider extensions to the Metropolitan Urban Limits of the Auckland region and emphasise the need for a co-ordinated approach between local authorities and the regional authority to progress three waters issues on the basis of a catchment management approach.

6.2 Auckland Regional Plan – Coastal

The purpose of the Auckland Regional Plan: Coastal 2004 (Coastal Plan) is to provide a framework to promote the integrated and sustainable management of Auckland's coastal environment. The Coastal Plan recognises that the coastal environment is an integral feature of living in the Auckland region, and that it is dynamic, diverse and maintained by a complex web of physical and ecological processes. Of particular interest for stormwater management approaches is the following Coastal Plan objective:

> Objective 20.3.2
>
> To adopt the best practicable option for avoiding, remedying or mitigating the adverse effects from stormwater and wastewater discharges on the coastal environment.

To ensure the coastal receiving environment is protected, appropriate controls and management methods must be implemented to protect the inland waterways and terrestrial environment. The Plan states that there is a growing recognition of the need to improve stormwater discharge standards and thereby reduce the overall levels of contaminants entering the coastal marine area.

There are currently six variations to the Coastal Plan, although only one of these, Variation 1 – Stormwater and wastewater network discharges, is applicable to this report and it is awaiting the resolution of appeals.

6.3 Proposed Auckland Regional Plan – Air, Land and Water

The Proposed Air, Land and Water (PALWP) was notified for public submissions in October 2001. Submissions closed in May 2002 and further submissions closed in December 2002. Variation 1 to the PALWP was notified in June 2002. Hearings were held throughout 2003 to consider all the submissions. Decisions on submissions and further submissions were notified on 8 October 2004. Parts of most sections of the PALWP remain under appeal.

The only section relevant to LID Chapter 5 Discharges to Land and Water and Land Management. So far only the issues, objectives and policies sections as they relate to stormwater networks are operative.[2] The rules section of this part of the PAWLP awaits the resolution of appeals.

The section sets out specific provisions relating to the management of stormwater, wastewater and contaminants, and recognises that stormwater and wastewater networks are key components of the infrastructure necessary for any large city or intensively urbanised area. However, the discharges from these networks can cause adverse effects. The PALWP promotes an integrated approach to the management of stormwater discharges and wastewater overflows at the catchment and network level.

The tensions between maintaining aging combined sewer networks, and generally overloaded networks and catchments are recognised, along with the need to rationalise the systems and to accommodate intensification. By implication, lack of capacity will be a significant factor in the intensification anticipated as part of the Regional Growth Strategy. In addition, the Plan recognises the practical difficulties for local authorities in management of stormwater quality and quantity, especially where development has been undertaken in compliance with District Plan provisions. There are also issues of cost, practicality, including space limitations and timing, which limit the upgrading of existing infrastructure on individual sites or necessitate staged upgrading programmes. Where regionally significant infrastructure is required, staging may be needed in order to maintain operations while improvements are made.

Key management tools are identified as the preparation of Integrated Catchment Management Plans and the obtaining of resource consents for discharges and diversions from stormwater and wastewater networks, some discharges and diversions from non-network sources, and discharges of environmentally hazardous substances from industrial or trade activities.

The policies specify the criteria against which applications for non-network and network stormwater discharges are considered, the ARC requires the adoption of a Best Practicable Option. One of the criteria relates specifically to LID,

(i) The extent to which the activity incorporates low impact design and non-structural methods to prevent or minimise adverse effects (including minimising the extent of impervious area and stormwater run-off volumes).

The PALWP defines LID as stated below:

> "With respect to stormwater activities, a design approach for site development that protects and incorporates natural components of the landscape into erosion and sediment control and stormwater management plans and in particular, seeks to minimise changes to pre-development hydrological regimes and watercourses so as to minimise adverse hydrological effects of development such as erosion and sedimentation of Category 1 rivers and streams."

For applications for network stormwater discharges and diversions, the strategic importance of stormwater systems owned or operated as part of regionally significant infrastructure is considered more widely because of the high costs associated with such infrastructure. Considerations in relation to sustainable management and enabling people and communities to meet their needs for economic, social and cultural well-being are examined.

The PALWP cites the development of Integrated Catchment Management Plans (ICMPs). Although ICMPs are non-statutory documents, their usefulness is widely acknowledged, and for this reason the ARC encourage their preparation to support applications for land use intensification in District Plans. As part of the intensification process, increases in demand will need to be managed to remain within existing or upgraded hydraulic capacity.

Through the PALWP, the ARC encourage uptake of LID for stormwater for urban and rural intensification and for land development for urban purposes. The latter will require that council standards and codes reflect these concepts.

Status: key sections under appeal.

6.4 Auckland Regional Plan – Erosion and Sediment Control

This Plan addresses the issue of sediment discharge, and defines mechanisms for avoiding, mitigating or remedying any adverse effect on the environment due to sediment discharge from bare earth surfaces.

Key objectives of this plan include the following:

- To maintain or enhance the quality of water in waterbodies and coastal water.
- To sustain the mauri of water in waterbodies and coastal waters, ancestral lands, sites, waahi tapu and other taonga.

- To reduce the exposure of land to the risk of surface erosion leading to sediment generation.
- To minimize sediment discharge to the receiving environment.

The Plan advocates the use of measures such as sediment retention ponds, silt fences, rows of hay bales, and vegetative buffer strips to filter sediment from run-off drained from work areas to stormwater systems. Any users above limited thresholds intending to engage in activities involving land disturbance are required to apply for consent regarding wastewater and run-off discharge, and provide evidence of steps taken to mitigate the effects of such activities (usually detailed in a submitted Assessment of Environmental Effects). Technical information on the mitigation of erosion and sediment movement arising from various land disturbing activities is provided in the ARC's Technical Publication 90 (TP90), the details of which are discussed in Section 7.2 of this report.

Status: ARC is undertaking a review of sediment management in the Auckland region.

7 Regional Guidance

The following ARC technical publications all refer to stormwater management. Since most or all information in these documents is relevant to this literature review, rather than reproducing all issues, the following sections outline the basic objectives taken directly from each of the relevant publications, plus summarises key information in regard to guidance.

7.1 Technical Publication 10 – Stormwater Treatment Devices: Design Guideline Manual

The primary objective of these guidelines is to outline and demonstrate ARC's preferred design approach for stormwater management devices. This includes design guidance for water quality and water quantity ponds, wetlands, filtration, infiltration and biofiltration practices, and other practices that may be used.

Secondary objectives of the guidelines are as follows:

- to provide a summary of the principles of stormwater management including an outline of environmental effects and management concepts;
- to outline the statutory process and rules in the ARC Proposed Regional Plan: Air, Land, and Water;
- to provide a resource guideline for those involved with the design, construction and operation of stormwater management devices; and
- to minimise adverse environmental effects of stormwater discharges through appropriate design, construction and operation of stormwater management practices.

These guidelines include comprehensive details on the following treatment systems:

- stormwater is having the single largest environmental impact on the region's streams and coastline;
- ponds;
- wetlands;
- filtration and infiltration;
- swale and filter strips;
- oil and water separators;
- rain tanks; and
- green roofs.

Water quality expectations; constraints; design approaches (including objectives and ways to improve effectiveness); design procedures (including requirements, typical

layout/drawings and calculations); construction guidance; operation and maintenance requirements, and case studies are also included in the guidelines.

Status of publication: July 2003, Final. Document currently under review.

7.2 Technical Publication 90 – Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region

These guidelines have three main objectives:

- To provide users, ranging from those directly associated with various Land Disturbing Activities to interest groups, with a series of comprehensive guidelines for erosion and sediment control for land disturbing activities by:
    - outlining the principles of erosion and sediment control and the sediment transfer process; and
    - providing a range of erosion and sediment control practices that can be implemented on various Land Disturbing Activities.
- To detail the rules in the ARC's Proposed Regional Plan: Sediment Control which define when a Land Use Consent is required.
- To minimise adverse environmental effects of Land Disturbing Activities through appropriate use and design of erosion and sediment control techniques.

It goes on to outline the minimum criteria for the design, construction and implementation of a range of erosion and sediment control measures, detailed in Table 3 below.

Table 3

TP90 criteria for erosion and sediment control.

Erosion control criteria	**Sediment control criteria**
Run-off diversion channel/bund	Sediment retention pond
Contour drain	Silt fence
Benched slope	Super silt fence
Rock check dam	Hay bale barrier
Top soiling	Stormwater inlet protection
Stabilised construction entrance	Earth bund
Pipe drop structure	Sump/sediment pit.
Surface roughening.	

Status of publication: Final Version dated March 1999 and changes dated December 2007.

7.3 Technical Publication 108 – Guidelines for Stormwater Run-off Modeling in the Auckland Region

These guidelines present a recommended method for the application of the U.S. Soil Conservation Service rainfall run-off model to catchments in the Auckland region.

The model is recommended for use in stormwater management design in the Auckland region. It has been designed as a standard tool that will provide consistent results from different users. It is suitable for:

- assessing the effects of land use change;
- modelling both frequent and extreme events;
- applying to distributed (a network of sub-catchments) or lumped catchments; and
- simulating natural systems as well as engineered systems (such as pipe networks).

The model can be used to predict run-off volumes, flow rates, and the timing of peak flows using a number of available software packages.

Status of publication: Version April 1999. Currently under review.

7.4 Technical Publication 124 – Low Impact Design Manual for the Auckland Region

The primary purpose of this document is to present an alternative approach to site design and development from a stormwater management context, primarily applicable for residential land development. Its basis is founded in the recognition that the volume of stormwater discharged from a site may be of equal importance to limiting contaminant discharge, especially for residential development. The LID approach is another stormwater management tool for reducing the adverse impacts of stormwater run-off.

There are two primary areas of interest addressed in developing this design approach:

1. Erosion and sediment control.
2. Stormwater management.

The manual is primarily directed toward residential land developers and users. It provides developers with a list of benefits associated with the inclusion of the above design approach. Other information in the manual includes:

- Background information on-site disturbance and the water cycle.
- Details on LID including approaches and techniques such as:
    - clustering;
    - reduction in imperviousness;
    - minimum site disturbance;

- vegetated filter strips
- vegetated swales
- rain gardens;
- water reuse;

- Design procedures.
- Case studies.

Status of publication: April 2000 version.

7.5 Technical Publication 232 – Framework for Monitoring and Assessment of Urban Streams in the Auckland Region

The purpose of this document is to promote consistent application of Chapter 3.5 (Urban Rivers and Stream Management Areas) of the Auckland Regional Plan; Air, Land, and Water across the Auckland region.

The primary focus of this document is on streams that have year-round aquatic habitat and hydrology defined as "Category 1" (eg, perennial) streams. It is important to also recognise that "Category 2" (eg, ephemeral) streams and wetlands are ecologically important freshwater resources, and management techniques developed for Category 1 streams may also apply to them. The enhancement and protection of these is important, and are necessary to protect and enhance estuarine and marine resources downstream. This is also an important issue in the management of stormwater, since the enhancement and protection of streams helps prevent erosion and flooding issues which can affect the upstream catchment.

The overall intent is to provide local authorities (local authorities) with a technically sound framework they can use to develop specific assessment methods and management actions. It is an initial effort to standardise the assessment and management of urban streams in the Auckland region. Minimum requirements for assessment, classification, and management of urban streams are provided, while selection of specific methods is the responsibility of the local authorities.

Status of publication: August 2004 version.

8 District Plan Review

In April 2001, BECA Planning on behalf of the ARC undertook an overview of the provisions of District Plans of the local authorities in the Auckland region, as they relate to LID.

A key aspect of the assessment was on urban growth and stormwater management. As such, the issue, objectives, policies and rules in relation to stormwater management as contained in the various District Plans in the Auckland region were assessed.

The key findings of the BECA study were that:

- At a policy level District Plan documents meet many of the principles and practices associated with sustainable development and whilst they do not preclude the use of LID, because they operate within the effects based framework of the RMA, do not specifically encourage it either.
- The current District Plan approach tends to lend its self to a mitigative rather than preventative approach to stormwater management and environmental effects.
- It is common practice for District Plan rules to refer to and require compliance with infrastructure design standards. These tend to focus on traditional stormwater management approaches.

More specifically the BECA study recommended the following:

- The Papakura and Manukau City District Plans should be reviewed from Objective and Policy level through to rules and assessment criteria to provide more flexibility to enable LID to occur.
- The Franklin District Plan should be reviewed as a second priority. While some good objectives and policies relating to stormwater disposal exist, a more comprehensive approach to stormwater management would be beneficial.
- The Auckland, Rodney and Waitakere plans include good objectives and policies, however, some attention needs to be directed at the detailed level of providing for LID practices.
- The North Shore District Plan provides good guidance on most LID principles and practices, assuming that the proposed variation proceeds in substantially the format it has been notified. Some improvement on flexibility for alterative lot configuration could be made.

URS has reviewed the report produced by BECA in 2001 to ensure that it accounts for the provisions currently featured in the District Plans, and have updated the assessment accordingly. Based on the District Plans that have been reviewed, it can be noted that some of the councils have made changes to the provisions of their District Plans with regards to stormwater management. Some of the changes involve

rephrasing of the wordings, deletion of some clauses and introduction of new issues, objectives, policies and rules.

Table 4 below summarises the changes to the District Plans since the 2001 BECA report. A full list of relevant issues, objectives, policies and rules can be found in Appendix A.

Table 4

District Plan changes since 2001.

Issues	Objectives	Policies	Rules
Auckland City Council – Isthmus section			
7. Residential Activity		By regulating the intensity of new residential development according to the availability of public utilities and services and to foster their efficient use.	
11. Subdivisions			11.5.6.2 (D) Network Utility Services – Stormwater Drainage design
Auckland City Council – Hauraki Gulf Islands section			
4.2.3 Resource Management Issues 4. The provision of services and infrastructure to meet community needs within the context of sustainable development			
8.2 Resource Management Issues Maintaining and enhancing water quality through adequate wastewater and effluent treatment and disposal, and stormwater disposal and dispersion.			

Issues	Objectives	Policies	Rules
Franklin District Council			
16. Rural	17.1.1 Land and soil resources management To manage land and soil resources in such a way that their accessibility, versatility and life-supporting capacity are sustained for present and future generations.	1.That the land and soil resource are maintained in a title structure that safeguards their accessibility, versatility and life-supporting capacity and enables a wide range of activities to establish and operate on a long-term sustainable basis. 2. That subdivision and subsequent development avoids remedies or mitigates any adverse effects on the present and future accessibility of land and soil resources.	
	17.1.2 Sustaining soil resources To safeguard the life-supporting capacity of the soil.	1. That the loss or reduction of the versatility and life-supporting capacity of soils be avoided, remedied or mitigated.	
18. Urban	19.3.5 Residential standards To achieve a consistent standard of on-site amenity and servicing for all residential activities and to facilitate the creation of freehold titles.	1. That the same on-site standard of living amenity and convenience be required for both single house and multiple-unit housing developments through policies and rule. 2. That as far as practicable the private service line of each reticulated service, for each dwelling unit in a residential development, shall run separately from a public line (in the case of water, sewerage or stormwater).	26.6.12 Stormwater Management 27.6.1.17 Earthworks 27.6.1.18 Stormwater Management

Issues	Objectives	Policies	Rules
Manukau City Council			

9.0 Land Modification, Development and Subdivision 9.2.6 Flooding can adversely affect human life and property and cause erosion in vulnerable catchments.	9.3.5 To ensure the provision of an adequate standard of infrastructure and public utility services at the time land is modified, developed or subdivided to avoid, remedy or mitigate any adverse effect on the environment.		9.9.2.7 Vesting of Land for Stormwater Management Purposes

Issues	**Objectives**	**Policies**	**Rules**
North Shore City Council			
8. Natural Environment	**8.3.5 Stormwater Catchment Management** Stream protection: To protect the natural character and ecological amenity and recreational values of rivers, streams and other natural bodies of water.	1. By maintaining and enhancing native vegetated buffers adjacent waterways to avoid or mitigate the effects of surface erosion, stormwater contamination, bank erosion and increased surface water temperature. 2. By requiring revegetation and avoiding impermeable surfaces and earthworks within the margins of waterways. 5. By retaining natural open waterway systems for stormwater run-off, to the greatest extent possible, unless adequate maintenance is not feasible or there is a threat to life and property. 9. By avoiding buildings and structures in proximity to waterway margins. 12. By avoiding the situation where stormwater run-off from new development exceeds the downstream ability to accept the	

Issues	Objectives	Policies	Rules
North Shore City Council			
		water without an increase in downstream flooding or channel erosion.	
	Stormwater control: To adopt a comprehensive approach to river and stream management and avoid, remedy or mitigate stormwater contaminants and sediment discharge from land-based activities.	1. By considering stormwater management (including stormwater quality and quantity) as an integral component of overall site development or redevelopment. 2. By avoiding development in areas that are subject to a one-in-100-year flood for the fully urbanised catchment, and protecting the integrity of the 1% AEP flood plain. 4. By minimising run-off peaks as a result of stormwater disposal. 5. By encouraging stormwater management including biofiltration practices as a means of removing or reducing contaminants contained in stormwater run-off. 7. By clustering site development to protect natural areas, reduce total catchment imperviousness and to reduce the area extent of imperviousness. 8. By requiring water quality treatment for stormwater run-off post development as well as during land development. 9. By ensuring that secondary/overland flow paths and open main drains are unobstructed by development.	

Issues	Objectives	Policies	Rules
North Shore City Council			
		10. By avoiding land disturbance and vegetation removal, particularly in sensitive catchments with high ecological value. 11. By ensuring that land use activities that have potential to produce significant stormwater contaminants control contaminant sources on-site through appropriate stormwater management measures.	
District Plan Change 22 How to manage changes to the ecological, amenity and landscape values associate with streams in the city.	On-site stormwater management: To mange stormwater runoff from impervious areas on-site to protect and enhance the water quality and ecological values of waterways throughout the city (District Plan Change 22).	1. By managing the effects of stormwater runoff within Stormwater Management Areas (SMA)… reflecting the sensitivity of the receiving environment, the ecological, and amenity values of streams, and potential for stream bank erosion and flooding. 2. By having regard to relevant Integrated Catchment Plans or Catchment Management Plans when considering appropriate on-site stormwater techniques. Council may implement further plan changes as required to provide consistency with Integrated Catchment Management Plans as they are developed. 3. By managing the effects of increased impervious areas by addressing annual runoff volumes and peak flow rates for a range of rainfall events. 4. By managing	

Issues	Objectives	Policies	Rules
North Shore City Council			
		stormwater discharged from sites through a treatment train approach, reducing impervious surface areas. 5. By ensuring that spare capacity in the piped stormwater network is not relied upon as a reason for increased impervious areas on a site, or for avoiding the implementation of appropriate on-site stormwater management. 6. By ensuring that proposal for multiple-site or community owned stormwater mitigation measures are determined in terms if their consistency with the council's Stormwater Management Practice Notes. 7. By limiting impervious areas to avoid or mitigate adverse effects on urban amenity, ensuring that on each site there is opportunity for green space comprising lawns, soft landscaping and vegetation.	
9. Subdivision and Development	9.3.3 Servicing Development To ensure that the servicing of new development is planned and implemented in an efficient manner and such as to avoid or mitigate any adverse environmental effects.	4. By requiring the provision of water to, and the disposal of sewage and stormwater from, each lot in a subdivision in a manner and design approved by the council. 7. By ensuring provision of the necessary infrastructure in advance of, or concurrent with, any subdivision or building work.	9.4.4.12 (b) Standards for the Provision of Utility Services 9.6.5 (3) Geotechnical and Hydrological Reports 9.7.1.1 1 (k) The Design and Implementation

Issues	Objectives	Policies	Rules
North Shore City Council			
			of Site Works 9.7.1.1 5 (b) (c) Utility Services, Drainage, Water, Wastewater, Electricity, Roads
16. Residential			16.6.1.9 Maximum Building Coverage 16.6.1.11 Minimum Permeable Area 16.6.3.10 Stormwater Management Areas ASSESSMENT CRITERIA 16.7.2 (g) Infrastructure (j) Stormwater Connections (k) Stormwater Management

Issues	Objectives	Policies	Rules
Papakura District Council			
Section 2 – Rural	6.1.13 To contain urban development with urban areas as defined by urban zoning.	6.1.14(a) The council will direct future urban growth of the District into the CBD.	
Section 3 – Urban Part 9 Subdivision			9.8.5 (1) Controlled Activities 9.8.5 (5) Controlled Activities 9.8.5 (6) Controlled Activities 9.8.5 (11) Controlled Activities 9.9 Services

Issues	Objectives	Policies	Rules
Rodney District Council			
7. Rural 7.2.2 Rural amenity values can be adversely affected by subdivision and land use activities. 7.2.5 Subdivision, land use and development can have adverse effects on riparian margins. 7.2.8 Water quality can be adversely affected by subdivision and land use.	7.3.4 To avoid or minimise conflict between different land uses which can result in adverse effects upon amenity values. 7.3.10 To avoid, remedy or mitigate the adverse effects of subdivision and land use, including vegetation clearance, earthworks, stormwater and wastewater treatment and disposal on water quality.	7.4.4 Amenity values – Subdivision and activities should be undertaken so that adverse effects, including cumulative effects, on amenity values are avoided, remedied or mitigated and in particular that: j) subdivisions and land uses do not adversely affect water quality through landform modification, earthworks and vegetation removal and any other land use or associated activity. k) activities do not generate adverse effects on the health and safety of people.	Rule 7.10 Development Controls and Performance Standards 7.10.4 Maximum Site Coverage 7.14.2 General Requirements for Subdivision

Issues	Objectives	Policies	Rules
Rodney District Council			
		7.4.15 Earthworks – Subdivision and land use activities should be undertaken so that: e) effects of land uses on water quality, in particular waste water and stormwater treatment and disposal, are minimised.	
8. Residential 8.2.5 The intensity, type of development and subdivision environmental impacts and development pressure in different areas of the district.	8.3.1 To maintain and enhance amenity values within residential sites. 8.3.3 To allow higher intensity development only where both the local and the more wide-ranging adverse effects of such development can be avoided, remedied or mitigated.	8.4.1 Effects of buildings within a site – Buildings should be located and designed so as to minimise adverse effects on the same site, including effects on: d) the ability of the site to provide for adequate stormwater and waste water drainage. 8.4.2 Effects of buildings on other sites – Buildings and other development should be located and designed to avoid or mitigate their adverse effects on other residential sites, including effects on: c) stormwater and waste water drainage. 8.4.7 Mitigation of high intensity development – In dealing with the adverse effects of high intensity development the following mitigation measures may be considered: b) allowance for the concentration of higher intensity development in defined areas so that beneficial measures such as sufficient	Rule 8.10 Development Controls and Performance Standards 8.10.4 Maximum Site Coverage

Issues	Objectives	Policies	Rules
Rodney District Council			
		infrastructure, local services and alternative modes of transport may be put in place, or enhanced, to offset any adverse environmental effects. 8.4.8 Infrastructure – High intensity residential development is not appropriate in areas where suitable supporting infrastructure is not available. 8.4.15 Natural hazards – Residential subdivision and development should be located and designed to avoid, remedy or mitigate and not exacerbate the on-site or off-site adverse effects (including cumulative effects) of natural hazards such as geological instability, erosion and siltation.	
13. Future Development and Structure Plan 13.2.3The development of land to accommodate urban growth and enable urban activities can have adverse effects on the natural and physical environment and on the amenity values of the District.	13.3.3 To avoid, remedy or mitigate the adverse effects of urbanisation on natural and physical resources.	13.4.1 Accommodating growth – Sufficient land for projected future urban growth, for future residential activities … should be identified ahead of demand in specified locations where the effects of development have been identified and can be avoided, remedied or mitigated.	ASSESSMENT CRITERIA 13.8.1.8 Discretionary Activity 13.9 Structure Plans
23. Subdivision and Servicing 23.2.2 Land uses and land use intensification including subdivision can have adverse effects on the environment, where	23.3.2 To ensure that human activity, and particularly urban development, occurs without significant adverse effects upon the environment, through the appropriate provision of utilities or on-site	23.4.2 Provision of infrastructure – Land subdividers should demonstrate how infrastructure services, in particular: c) stormwater collection, treatment and disposal facilities…can be	23.8 General Standards and Assessment Criteria for Subdivisions

Issues	Objectives	Policies	Rules
Rodney District Council			
appropriate infrastructure services including utilities or on-site servicing, are not provided or where those provided are inadequate.	services.	provided to remedy or mitigate adverse effects on the environment. 23.4.4 Effects on infrastructure beyond the subdivision – Land subdivision should avoid, remedy, or mitigate adverse effects on infrastructure services beyond the site of the subdivision by requiring subdividers to make a contribution towards the cost of providing and/or constructing and/or upgrading and/or extending and/or purchasing surplus capacity in infrastructure services – in particular: c) public stormwater collection, treatment and disposal facilities. The contribution should be in proportion to the adverse effects on the environment generated by the activity.	

Issues	Objectives	Policies	Rules
Waitakere City Council			
5.1 Effects on Water Quality		1.2 Location of activities.	

The changes made to the Papakura and Manukau District Plans since 2001 have not further addressed LID and enhanced stormwater management at a policy or rules level. These District Plans continue to do little to advocate the use of LID approaches.

The amendments made to the Franklin District Plan have added emphasis to sustainable soil management in rural areas through objectives and policies but does not specifically suggest approaches such as LID.

The Auckland City District Plan has been amended to include a policy to regulate the intensity of residential development on the Isthmus and to include sustainable development and water management in the issues listed in the Hauraki Gulf section. Once again LID and enhanced stormwater and sediment management approaches are not specifically mentioned.

The Rodney District Plan has been amended to include new objectives and policies with regard to amenity, water quality, landform, natural vegetation and landform in rural areas. Rules have been included with regard to development standards and performance and maximum site coverage. These changes indirectly affect sustainable stormwater and sediment management but do not specify.

The North Shore City District Plan has been further enhanced through the inclusion of objectives and policies in Section 8, Natural Environment, regarding stream protection and stormwater control. The stormwater control policies advocate the early consideration of stormwater management approaches and specifically mentioning the use of biofiltration methods and clustering of buildings. Plan Change 22 addressing the effects of stormwater run-off on stream health was notified in 2007 and hearings are scheduled for August 2008. If the proposed plan change is implemented in its current form it will specifically address on-site stormwater management, link to relevant integrated catchment management plans and apply rules for maximum building coverage, minimum permeable area, stormwater management and assessment criteria.

No significant changes to the Waitakere District Plan have been made.

From the changes described above it can be seen that, with the exception North Shore City Council, District Plans continue to lack specific reference to LID, enhanced stormwater and sediment management and emphasis on the avoidance and minimisation of environmental effects that can be achieved using such approaches.

9 Territorial Guidance – Auckland Region

The following section sets out and summarises documents sourced from each local authority. These documents are not mandatory; rather they are intended to provide guidance to those applying for resource consent.

9.1 Auckland City Council

9.1.1 Stormwater Bylaw

Auckland City Council currently operates the Auckland City Consolidated Bylaw, Section 18 of which is the Stormwater Bylaw which has been in place since 2000.

Stormwater is disposed of within Auckland City by public and private stormwater drains (eg open watercourses and pipes), combined sewers which carry stormwater and wastewater, and ground soakage. This Bylaw controls the stormwater management aspects of these systems.

At the time of this Bylaw coming into force, the council was only responsible for maintaining Oakley Creek, Meola Creek, Motions Creek, Remuera Stream and Newmarket Stream, and any other stream when it passes through council owned property.

Watercourses passing through or serving private land are generally considered private. Private drains are the responsibility of the owner of the land they serve, and each section of a private watercourse (including a privately piped watercourse) is generally the responsibility of the owner of the land it passes beside or through.

The intentions of the Bylaw are:

- ensuring the safe and efficient management, operation, maintenance and modification of stormwater systems;
- ensuring development proposals take account of stormwater and stormwater hazard management;
- controlling erosion;
- maintaining and where possible enhancing freshwater biodiversity;
- maintaining and where possible enhancing riparian vegetation.

It includes requirements for operation and maintenance of on-site devices, overland flow path management, control of siltation and erosion, litter control, drain clearance and vegetation protection.

The current Stormwater Management bylaw is out of date with some new policies and catchment information and requires updating, particularly in relation to providing for on-site stormwater management methods.

The Local Government Act (2002) requires a local authority to review its existing bylaws by 1 July 2008 unless they cease to have effect before that date. Auckland City Council is reviewing its Stormwater Management Bylaw (Part 18 of the Auckland City Consolidated Bylaw 1998) and proposes revoking it and replacing it with a new Stormwater Management Bylaw, to facilitate better management of stormwater services. The proposed Bylaw will provide for the regulation of stormwater run-off to minimise its adverse effects on people, property and the environment.

To ensure that the effects of land use development and intensification are effectively managed, the council has developed land use policies related to stormwater management. One area of change involves the use of low impact stormwater design methods such as rain tanks and rain gardens in high-density housing areas. The council introduced its On-Site Stormwater Management Design Manual in 2002 that allows for mitigating the impacts of development in specified District Plan zones through the use of such on-site management methods, eg rain tanks and rain gardens. The ongoing operation and maintenance of the on-site methods are provided for in the proposed new bylaw.

The proposed Bylaw:

- requires the consenting of the construction of new stormwater works;
- provides for overland flow paths to be kept clear;
- controls the effects of development on water quality by imposing measures for the mitigation of sediment and heavy metals in stormwater through the provision of appropriate consenting conditions;
- provides for stormwater retention for new developments in some parts of the city to ensure flooding in a catchment is not increased;
- provides for managing ground soakage systems as a means of stormwater disposal in parts of the district where soil conditions permit this; and
- provides for the keeping of open watercourses clear of obstructions to prevent flooding.

9.1.2 On-Site Stormwater Management Manual

The On-Site Stormwater Management Manual (OSM Manual) provides design professionals with specific requirements for reducing the impacts of water quantity and water quality resulting from applications to exceed the impermeable surface controls in the City. It is intended for use for all types of development.

The Manual's requirements apply only in the case of developments where the proposed impervious area coverage exceeds a figure of 60 per cent up to a maximum figure as set out in Table 5.

Table 5

Maximum allowable impervious cover.

Auckland City zones	**Upper limit of impervious surface**
Residential 8a/8b	70% site coverage
Residential 8c	80% site coverage

For areas with adequate soakage, no OSM device is required, unless one is used to attenuate flows prior to disposal by soakage.

The manual describes a number of different OSM devices that may be used in reducing the impacts of stormwater. These can typically be split into either:

Detention-type devices. These are applied in areas where there is a stormwater system (eg pipes, watercourse) to receive the discharge from the OSM device – this typically applies in areas where soakage to groundwater is not feasible.

Retention-type infiltration devices. These are applied in areas where soakage to groundwater is feasible – these areas typically have no formal stormwater conveyance system.

The latter is touched on in this manual but it is suggested that for detailed information on sizing and design details that reference is made to the ACC Soakage Design Manual (see Section 9.1.3).

The manual outlines details on the following to assist users to select the appropriate OSM device. Key aspects are outlined below.

Considerations – gives guidance notes on various aspects that should be taken into account during decision-making such as:

- size and shape;
- landscaping and aesthetics;
- ownership and number/type of devices;
- siting and ease of installation OSM; and
- cost.

Consent submittal requirements – outlines the steps and details of what is required for both building consent and resource consents if required.

Water quality considerations – explains the general water quality standards that must be met by the OSM device followed by a summary of how these standards are to be met for each device.

Guidance on the design approach for each OSM device – Devices included are:

- rainwater tanks;
- stormwater planter;
- filter strips;
- rock swale/trench;
- catchpit filter;
- sand filter;
- roof gardens; and
- detention ponds.

Status of publication: December 2002, Final Version.

9.1.3 Soakage Design Manual

The purpose of this Manual is to provide guidance in the design of stormwater soakage devices for residential and commercial properties in soakage areas of Auckland City. The Manual is intended for use on properties that are not able to be connected to a piped stormwater system. Public soakage devices are provided for run-off from roadways in these areas, but individual property owners must construct and maintain their own soakage devices for run-off from private properties. The soakage devices allow stormwater to percolate into the ground, and generally consist of either boreholes inserted into fractured rock or large soak holes filled with scoria.

The installation of new soakage devices requires a building consent from Auckland City Environments (ACE). The Manual explains the site plans, calculations and documented maintenance procedures that must be included in the building consent application.

In some circumstances resource consents are required to install soakage devices and in these instances the Manual should not be used as the sole source of information. The situations that require resource consents are summarised below, along with additional manuals that should be consulted and the authority responsible in each case is identified.

If more than 60 per cent of the property is covered with impervious surfaces. In this situation, the Soakage Manual should be used in conjunction with the On-Site Stormwater Management Manual (see Section 9.1.2). If the property has an impervious area less than 1000 m^2 in total, a resource consent must be obtained from ACC. For properties with impervious areas greater than 1000 m^2 (see below), a resource consent may also be required from the ARC.

If the stormwater originates from an impervious area that is greater than 1000 m^2 in total. For these properties, a resource consent is normally required from the ARC (unless there is a comprehensive catchment wide consent; check the Regional Plan and District Plan for the latest controls). Calculations of soakage capacity should still be

carried out according to the Soakage Manual, but pre-treatment requirements may be different.

If the stormwater originates from an industrial or trade process. These properties also require a resource consent from the ARC. Calculations of soakage capacity should still be carried out according to the Soakage Manual, but pre-treatment requirements may be different. The ARC should be consulted for further information on the consenting process.

If soakage bore drilling cannot comply with the range of permitted activities listed in the Regional Plan. In this case a resource consent is required from the ARC for the actual drilling of the bore. The rock bore soak hole itself (and any associated pre-treatment devices) can still be designed according to the Soakage Manual.

Experience has shown that soakage devices have a high failure rate, often caused by clogging the media that the stormwater soaks into. This Manual addresses this problem in three ways. Firstly, if the total paved area on the site exceeds 20 m^2 then run-off from these areas must be treated before it enters the soakage device, and worksheets are included for sizing pre-treatment devices. Secondly, all run-off from roof areas must pass through a settling device. Thirdly, guidelines are given to assist with the operation and maintenance of all these devices.

The manual continues by detailing the steps that are involved in designing a soakage device and submitting a building consent application. A summary of the main steps are given below:

- **Preliminary considerations** – consider flooding risks, stability issues, ownership issues and planning suitable locations to carry out percolation tests.
- **Percolation tests** – this is the rate at which the stormwater will soak into the ground. It is needed so that the soakage device can be sized correctly. Percolation tests must be carried out on-site, and involve adding water into either a test-pit or a borehole, then either measuring the maximum flow rate at which the water can be added (constant head test) or switching the water off and measuring the rate at which the water falls (falling head test). If the percolation rate is near or below 0.5 litres/m^2/min then it will be difficult to obtain a building consent.
- **Selecting soakage systems** – soakage systems must meet council regulations, fit in the available space and provide the best long-term performance at a reasonable cost. The designer must also decide whether rainwater tanks will be used to reduce the size of the soakage system.
- Sizing of soakage devices – involves determining the volume (depth and area) of the soakage device that is needed to allow the stormwater to soak away, given the percolation rate. Design details such as roof area and paved area are needed to carry out the sizing.
- Sizing of rainwater tanks and on-site storage – when soakage devices are under sized, incorporation of a rainwater tank (or on-site storage) is needed so that the soakage device will still be able to provide acceptable performance. If the rainwater tank is to be used to supply household water as well, the volume of water needed for this purpose can also determined.

- **Sizing of pre-treatment devices** – when the total paved area exceeds 20 m^2, the area for the pre-treatment device needed so that run-off can pass through the device must be determined.
- **Preparing a building consent application** – involves documenting.

It goes on to describe guidelines for the correct positioning of soakage devices so that they work effectively and that they comply with flood hazards. These are listed below:

- Soakage devices must not be located within a 10 per cent AEP storm flood plain.
- Soakage devices must be located where there is adequate access for maintenance.
- Soakage devices must not be located close to buildings.
- Soakage devices must not be located close to property boundaries.
- Soakage devices should not be located beside retaining walls.
- Soakage devices must not be located within 2 m of sanitary sewers
- Soakage devices should not be positioned on unstable slopes.
- Soakage devices should be positioned above the winter water table.
- Soakage devices should not be shared between properties.
- Consideration should be given to the path that water will follow during storms that exceed the design capacity of the soakage device.
- Locate the soakage devices so that all site run-off can be fed to them.

Status of publication: February 2003, Final Version.

9.1.4 ACC Watercourse Guidelines

Most of the streams in Auckland City are private watercourses. These Guidelines are intended to help increase knowledge, raise awareness, and encourage the use of sustainable stream management practices on private watercourses. They are designed to provide information to property owners whose land has a stream running through or near it and to help people choose appropriate options and tools to manage these streams.

The Guidelines outline a range of stream management solutions – including simple care and maintenance, conceptual engineering works, planting and maintenance. They also aim to advise the property owner on finding appropriate professional help when tackling problems with streams on their property and outline what resource consents and permits may be required for any work that they need to undertake.

The Guidelines aim to improve the safety and health of Auckland City's streams by setting out appropriate techniques for managing problems such as flooding, bank instability, erosion, sedimentation, and poor water quality.

A list of specific aspects outlined in the Guidelines that can be undertaken by the land owner to improve stream management is provided below.

Monitoring – in order to identify solutions to problems, it is important to identify what is causing the problem. The guidelines suggest monitoring of both flooding and erosion is undertaken to help identify any patterns and long-term processes.

Maintenance – it is suggested that where possible, property owners should:

- Keep the waterway clear of obstruction which might have a significant effect on the stream flow;
- remove litter and rubbish from the stream banks and bed;
- remove plants that may impede flood flows;
- where possible, maintain stream bank planting;
- remove excessive woody weed growth, but take care to leave cover on stream banks and beds; and
- keep overflow pathways clear.

Improvements – these are carried out to protect property and ensure people's safety. The Guidelines identify that typically works will fall into the following categories:

Flood risk management

This refers to improvements which help increase the area available for floodwaters to fill during heavy rains. This includes removing debris, raising or removing fences or changing planting in the overflow area. When faced with higher-risk flooding problems, altering the shape and size of the overflow area is suggested as a key to solving these issues.

Erosion prevention

The Guidelines suggest a variety of techniques for property owners to reduce erosion depending on the type of stream encountered. This includes reducing flow, increasing roughness of the banks, and strengthening stream banks.

Bank stabilisation

This refers to slippage of stream banks under the influence of gravity. The guidelines suggest the introduction of vegetation, rocks, retaining walls, or buttress and horizontal drains as various options of control dependant on the nature of the slippage.

Sedimentation control

The Guidelines identify that sediment contributions from any single private property owner is relatively small, however the cumulative effect from site works on individual properties can be considerable. It is suggested that any soil and waste materials be contained or protected from rainfall and flooding, so that they cannot enter the stream.

The Guidelines suggest that while an affected property owner may be capable of undertaking some of the simpler works outlined above, it may be appropriate to seek professional advice for more complex situations. In some cases consents and permits may also be required to undertake some of the works mentioned above.

Status of publication: October 2003, Final Version.

9.1.5 Building guidance

Auckland City Council refers to the New Zealand Building Act (2004) in regard to all building guidance (see Section 5.2.1).

There is however, specific guidance in the form of Standard Engineering Details for Traffic and Roading Services which covers road stormwater drainage. It is for use by developers, consultants, contractors, service/utility operators, and others working on roads, footpaths and associated drainage services. They are designed to provide minimum standards of work.

It consists of typical design drawings that cover all aspects of stormwater drainage including some limited information on incorporation of LID systems into road construction. Reference is made to Metrowater's "Development and Connection Standards".

9.1.6 Code of Urban Subdivision and Development

The Code of Urban Subdivision provides a guide to the service quality and standards for subdivision and development. It applies only to the Isthmus District Plan. A short section on stormwater drainage is included. It states that stormwater drainage system shall be designed and constructed to the requirements and standards set out in the "Development and Connection Standards". A road design section specifies minimum carriageway width, places restrictions on the use of road reserve and states that parking areas should consist of permeable surfaces.

Status of publication: December 1999 Edition.

9.1.7 Development and Connection Standards

Development and Connection Standards is a manual administered by Metrowater. Its aims are as follows:

- To meet the objectives of Auckland City's Code of Subdivision and Development (Stormwater, Wastewater and Water Supply Sections.
- To provide customers with clear policies, guidelines and procedures on drainage and water assets in relation to development.
- To provide a mechanism for feedback and consultation with developers, contractors and consultants involved with development.

- To ensure consistency of standards for all development involving drainage and water assets.

The manual contains a section on stormwater which outlines the objectives of the stormwater drainage system. This includes the regulation of natural run-off so as to minimise the effects of stormwater on property and people. This is to be achieved by providing a system comprising a primary system of pipes and a secondary system of overland flow paths, together with natural or designed detention areas so as to minimise peak discharges downstream.

Contained within this section are details on the following issues:

- Approved discharge points.
- Design standards including.
- Minimum requirements.
- Information on primary and secondary systems.
- Flooding.
- Overland flow paths.
- Stormwater quality.
- Catchpits.
- Stormwater storage devices.
- Kerb discharges.
- Soakage.
- Watercourses.
- On-site stormwater management.
- Stormwater treatment.

Reference is made to the "Soakage Design Manual" (Section 9.1.3), the "On-Site Stormwater Management Manual" (Section 9.1.2), TP10 (Section 7.1) and TP124 (Section 7.4) for further details.

Status of publication: May 2006, 3rd Edition (available from www.metrowater.co.nz).

9.2 Waitakere City Council

9.2.1 Bylaws

Waitakere City Council's current bylaws do not include one for stormwater management.

9.2.2 Code of Practice for City Services and Land Development – Engineering Standards

This document forms the Land Development Module of the Engineering Standards Manual and has the following characteristics:

- It is modelled on NZS 4404 "Code of Practice for Urban Land Subdivision" and maintains the general principles and requirements thereof.
- Gives the design and construction requirements for all land development and infrastructural projects within Waitakere City.
- Provides a means of compliance therewith.
- Defines the requirements relating to particular types of services and utilities to be provided with land subdivision and development projects.

Waitakere City Council (WCC) encourages and supports strong focus on water quality, habitat values and LID features in the design and management of stormwater.

The Code of Practice sets out similar guidance to that in the New Zealand Standard 4404:2004 on:

- Hydrology
- Hydraulics
- Flood protection
- Open watercourses, and
- Piped systems.

It is noted in the code that WCC is open to considering innovative and sustainable design. LID could be addressed in this manner. The recent revision has also introduced a specific section on LID which outlines the fact that WCC encourages use of such devices not only for new development but also for redevelopment of existing areas and property alterations. Examples of when this approach can be used are given, but are very limited on design and construction information, instead referring applicants back to ARC documents.

The need to maintain the natural water balance, especially in developing and rural areas, is also touched on. This approach also extends to ensuring minimal natural flows in streams and receiving environments are maintained to protect existing habitats.

The code provides guidance for developers with regard to WCC consent application processes, design performance criteria and engineering specifications for a range of stormwater management approaches including stormwater networks, wetland design, flood plain and overland flow management. The contents of the relevant sections of the code are outlined below:

Section 1 – General provisions.

Section 2 – Includes requirements for earthworks activities.

Section 3 – Transportation and roading requirements including design specifications.

Section 4 – Drainage.

Section 7 – Parks and reserves.

In addition to these sections the code includes a range of standard design details for pipes, manholes, catchpits, road carriageway, road berm, road layout, stormwater pond design details and planting guides.

Status of publication: February 2007, Version 4.4.

9.2.3 Stormwater Solutions for Residential Sites

This document promotes methodologies for on-site control of stormwater that are designed to control the effects of development in an existing urban environment. It is intended to provide guidance to landowners, developers, engineers and surveyors on the stormwater management methods applicable to urban residential sites located in Waitakere City.

The document focuses on the management practices applicable to developments on individual residential lots. This includes new houses, house extensions, new garages and driveways. Methodologies described in the document generally apply to residential properties of 1000 m^2 area or less and primarily cover situations where there is no existing drainage system to connect into, or connection to an existing drainage system is difficult due to limitations with the capacity of an existing network or other problems (eg access to a connection).

The key design objectives applied to this document are as follows:

- To prevent downstream flooding.
- To prevent increased erosion and change to the hydrologic regime of downstream watercourses.
- To minimise the potential for increased discharge of contaminants associated with stormwater run-off from a site following development, to streams and coastal receiving environments.

The design information in this document has been developed to provide various stormwater management options and details how a combination of options can be used to achieve the key design objectives above. These include details on the following:

- Minimising impervious areas – outlines techniques to achieve this.
- Roof tanks – gives basic design drawings and orifice pipe diameters for typical detention and water reuse tanks.
- Rain gardens – design drawings of rain gardens plus calculations to determine rain garden size.
- Permeable paving – design drawings, examples, limitations checklist and material specifications given.

- Swales – various design drawings for different applications.
- Green roofs – basic design drawing.

Status of publication: November 2004, Final Version 1.0.

9.2.4 Countryside and Foothills Stormwater Management Code of Practice

The stormwater management methods presented in this manual are intended to provide landowners, developers, engineers and surveyors with a selection of methods capable of achieving the appropriate on-site management of stormwater run-off in new residential subdivisions within the Countryside Living Zones of Rodney District and the Countryside and Foothills areas of Waitakere City.

The guidance outlined in this code of practice is designed for residential sites with lot sizes greater than 4000 m^2. It requires limiting the total amount of new impervious surface that can be constructed to 600 m^2 per lot and as the title suggests typically applies to a relatively rural context.

The key design objectives outlined in this document are the same as those applied to the "Stormwater Solutions for Residential Sites" (Section 9.2.3) and are as follows:

- To prevent downstream flooding.
- To prevent increased erosion and change to the hydrologic regime of downstream watercourses.
- To minimise the potential for increased discharge of contaminants associated with stormwater run-off from a site following development, to streams and coastal receiving environments.

Other key aspects of the Code are as follows:

- Design Approach – the Code supports two design approaches defined as:
    - Flood protection approach: preventing an increase in peak flows and volumes for events up to 1 per cent AEP post development.
    - Stream channel protection approach: provide detention, storage and release of the first 34.5 mm of rainfall over a 24-hour period.
- A resource consent may be required from the ARC in certain conditions such as:
    - Impervious surface of greater than 1000 m^2.
    - Any lot greater than 4000 m^2.
    - Where proposed devices are not approved specific application by ARC then they are considered by the ARC on a case-by-case basis.

- Preliminary design considerations for stormwater (eg drainage plans), wastewater (eg potential disposal areas), water supply (eg potable source), and riparian margins (eg minimum margin width).
- Detailed design information and drawings on various stormwater management devices and practices based on managing flows and run-off for the 50 per cent AEP rainfall event and 1 per cent AEP rainfall event. These include:
    - minimising impervious areas;
    - planting bush vegetation;
    - rain water tanks;
    - rain gardens;
    - wetland areas;
    - detention ponds;
    - dispersal devices;
    - swales; and
    - green roofs.

Status of publication: July 2005, Final Version 3.0 (currently under review).

9.2.5 Permeable Pavement Design Guidelines

These Guidelines were developed to provide guidance for designers of permeable paving, and in order to assist councils with the design and review of proposed permeable paving systems.

The following list outlines the recommended process for designing permeable paving systems:

Step 1 – Check the local rules and regulations.

Step 2 – Determine the design objectives/requirements and use of the permeable paving.

Step 3 – Review site characteristics and check constraints.

Step 4 – Determine ultimate discharge point for stormwater.

Step 5 – Decide on type of paving to use.

Step 6 – Establish structural specifications of paving based on use/location.

Step 7 – Check/alter specifications to fit design perspective.

Step 8 – Consider construction steps.

Step 9 – Develop a maintenance plan.

The Guidelines point out that where permeable pavement is the primary stormwater treatment option, then the design will need to comply with ARC TP10 and flow calculations will need to use ARC TP108 as a basis.

Detailed information on constraints and limitations, paving types, structural design, flow attenuation, water quality, construction, maintenance and monitoring is included in the Guidelines.

Status of publication: Draft. Guidelines are now incorporated as Section 7 of Stormwater Solutions for Residential Sites.

9.2.6 Northern Strategic Growth Area – Low Impact Design Code of Practice

This Code of Practice (CoP) was drafted to support developers and council staff with the implementation of the Integrated Catchment Management Plans associated with the Network Discharge Consent applications for the Totara Creek, Waiarohia Stream and Hobsonville Peninsula catchments in Waitakere's Northern Strategic Growth Area (NOSGA). The CoP covers the following information relevant to the implementation and uptake of LID:

Section 2.0	Overview of why stormwater management is required and introduction to LID.
Section 3.0	Development rules for the NOSGA catchments.
Section 4.0	Stormwater management options and design considerations for various landuse types.
Section 5.0	Design guidance.
Appendix A	Plant species for rain gardens and treepits.
Appendix B	Example site layouts.
Appendix C	Developers and consenting checklists for rating LID approaches proposed.

Status of publication: Draft. Due to be finalised once Network Discharge Consents are granted.

9.2.7 The Better Building Code

The Better Building Code was developed by Waitakere City Council as the minimum standard for its own buildings, but is equally applicable to other public buildings and private commercial buildings. The aim of the Better Building Code is to provide standard clauses for tendering and briefing documents for the design and construction of public buildings. It can be found at:

http://waitakere.govt.nz/abtcit/ec/bldsus/betterbuilding.asp#Introduction

It is noted that it is not a legally binding document and that all buildings still have to comply with relevant legislation.

Detailed below are some of the aspects that are covered in the code that relate to stormwater management:

Section 2 – Concept design stage

- Minimise stormwater run-off from the site by reducing impermeable surfaces and by providing innovative stormwater retention and treatment.
- The amount of earthworks and vegetation clearance should be minimised as far as practicable.
- Roof water should be collected and used for non-potable purposes, such as toilet flushing and irrigation.

Section 4 – Construction stage

- Site Management must ensure that the impact on the surrounding environment is minimised. Safety of all construction staff and the public must be ensured at all times.

Status of publication: Final (no date given).

9.2.8 Developers Design Guide

These guidelines have been prepared to help developers and residents understand the means by which the council assesses residential subdivisions and comprehensive housing developments. This assessment is based on:

- an ecologically sustainable approach that limits the amount of earthwork that disturbs the natural landform and affects the water table and trees;
- working with the natural characteristics of the site and enhancing or emphasizing natural features such as streams and trees;
- reducing stormwater run-off by limiting impermeable surfaces and including permeable road and parking surfaces where possible;
- improving the quality of stormwater before it reaches streams by allowing it to flow over grass areas (such as swales) and through constructed wetlands; and
- retaining streams in their natural state.

The document can be found on the council website – http://waitakere.govt.nz/abtcit/ec/bldsus/dvlprsdesgngde.asp#Principles

Status of publication: Final (no publication date given).

9.3 Rodney District Council

9.3.1 Stormwater Bylaw (2006)

The Rodney District Council Stormwater Bylaw is Chapter 29 of the General Bylaw 1998. Implemented in 2006, the Stormwater Bylaw:

- ensures the safe and efficient creation, operation, maintenance and renewal of all public stormwater drainage networks;
- ensures proper hazard management to prevent or minimise flooding and erosion;
- minimises adverse effects on the local environment particularly freshwater ecological systems and beach water quality, and assists in maintaining receiving water quality;
- ensures that watercourses are properly maintained;
- ensures protection of council stormwater drainage assets and the health and safety of employees;
- sets out acceptable types of connection to public stormwater networks.

The Bylaw makes clear that the terms and conditions of any connection to the public stormwater drainage network, including fees and charges payable are set out in the completed council application form and constitute a contract under this bylaw between the parties. It does not address LID.

9.3.2 Countryside and Foothills Stormwater Management Code of Practice

This publication was a jointly commissioned project for Waitakere City Council and Rodney District Council. Details can be found in Section 9.2.4.

9.3.3 Permeable Pavement Design Guidelines

These Guidelines are a jointly commissioned project for Rodney District Council (RDC), North Shore City Council (NSCC) and Waitakere City Council (WCC). Details can be found in Section 9.2.5.

9.3.4 Engineering Design and Construction Standards

The Engineering Design and Construction Standards developed by Rodney District Council (RDC) provide a means of compliance with the rules and performance criteria of the District Plan, and specify minimum acceptable requirements to be followed in all practical circumstances.

The Engineering Design and Construction Standards consists of stormwater guidance and general requirements. Like NZS 4404:2004, this includes but is not limited to, basic guidance on land drainage, flooding, pipelines, and manholes.

Rodney District Council has also included guidance on stormwater devices and accepts that these are an integral part of the social and environmental community. They are described as providing for public amenity and wildlife habitat as well as for stormwater detention and/or treatment.

Below are specific examples of where RDC has included LID guidance in the Engineering Design & Construction standard:

- On-site treatment and disposal is encouraged to reduce the volume of run-off to downstream catchments. Impervious areas shall be kept to a minimum.
- For all sites greater than 1000 m^2 created impervious area, on-site stormwater treatment must be provided.
- A detailed section on Detention and Treatment Devices which is broken into:
    - Ponds and wetlands.
    - Sand filters and similar devices.
    - Inlet, outlet and manhole details.

Where further guidance is required, the standard refers applicants to the Countryside and Foothills Stormwater Management CoP (Section 9.2.4) and ARC publications such as TP10 (Section 7.1), TP90 (Section 7.2) and TP108 (Section 7.3).

Status of publication: First Edition November 2005 with amendments issued December 2006.

9.4 North Shore City Council

9.4.1 Stormwater Bylaw

Part 22 of the North Shore City Consolidated Bylaw (2000) concerns stormwater and sets out detailed requirements for stormwater management associated with existing properties and new developments.

The Bylaw guides effective stormwater management, helping protect people, property and the environment by minimising the impact of flooding, erosion and environmental pollution resulting from stormwater.

The Bylaw aims to:

- Ensure the safe and efficient creation, operation, maintenance, and renewal of stormwater systems.

- Ensure that development proposals fully take into account stormwater hazard management ie flooding and erosion, and environmental protection.
- Minimise the adverse effects on the local environment, particularly freshwater ecological systems and beach water quality.
- Ensure that private stormwater systems are properly maintained.

The Bylaw requests that where ever possible LID stormwater management solutions are implemented. It also requires that natural watercourses are maintained and riparian vegetation protected whilst contaminant generation is minimised and chemical discharges are prohibited.

A prioritised list of possible stormwater connection points is also included.

9.4.2 Infrastructure Design Standards

The Infrastructure Design Standards Manual is modelled on the New Zealand Standard 4404:2004 and gives the engineering design requirements for all land development and new infrastructure projects in North Shore City.

The transportation section provides some guidance on swales, biofiltration or other storm water mitigation measures for use along roads. This includes that:

- in new local road development swales, biofiltration or other mitigation measures for treatment of storm water from the roads are to be provided. Where this is not appropriate (eg steep gradient roads) alternative treatment will be considered;
- where swales are used, the road edge shall have a flush concrete edge to continue the carriageway formation;
- that installation of "check dams" to reduce flow velocities should be installed across the swale if the gradient exceeds 5 per cent.

Reference is made to TP10 for further information and design guidance.

The stormwater strategy outlined in the Infrastructure Design Standards promotes the following basic approach:

- Prevention rather than mitigation by requiring the integration of stormwater management objectives in all new development.
- Requiring the incorporation of stormwater management initiatives in existing urban areas and when redevelopment occurs.
- Retrofitting stormwater management solutions in existing urban areas where this will result in significant and measurable benefits.

Included in the Infrastructure Design Standards is a specific section on LID. This outlines the principles of LID and "Best Management Practices" which are described as:

- Rainwater harvesting – The use of rainwater tanks for the collection of roof run-off for non-potable uses such as toilet flushing, clothes washing and garden watering.

- Bush revegetation.
- Preservation of existing riparian vegetation and riparian planting.
- Permeable paving.
- Rain gardens.
- Swales and filter strips.
- Biofiltration trenches.
- Green roofs.
- Detention practices such as wet ponds, wetlands and detention tanks.
- Contaminant filters and separators such as sand filters and oil and grease separators.
- Proprietary devices.

A brief description and selection criteria of each is included however for further detail on design, installation and maintenance applicants are directed to documents such as TP10 and the NSCC Practice Notes (see Section 9.4.5).

The document is available at: www.northshorecity.govt.nz.

Status of publication: April 2006, Issue 9.

9.4.3 Design Guide for Conventional Underground Detention Tanks for Small Sites

This guideline document is offered to assist applicants, and to standardise design approaches for the design and use of underground detention tanks.

On-site detention tanks can be used for:

- Pipes or channels where there are existing flooding problems caused by lack of capacity.
- Pipes or channels having less capacity than that required for a 10 per cent AEP (10-year ARI) critical storm, together with poor secondary flow paths.
- All discharges to street channels where this is likely to cause or aggravate downstream flooding problems.

The guidelines require that the following standard details be incorporated into the design of underground detention tanks:

- Provide manhole access directly above the tank outlets for inspection and cleaning, using a standard NSCC approved manhole frame and cover.
- All discharges to the detention tank must be routed through a fully trapped catchpit or mini-chamber to minimise the amount of sediment and debris entering the tank. The trap should be external to the pit to prevent it being removed or damaged.

- Provide a 150 mm sump below the lowest tank orifice as an extra sediment trap. This will reduce the frequency of blockages and the frequency of maintenance.
- Provide an overflow pipe from the top of the tank.
- Provide a removable mesh screen made of stainless or galvanised steel, or plastic over a steel frame, over the orifice outlets to protect them from blockage. Mesh size shall be no more than half the diameter of the smallest orifice.
- Orifice outlets shall consist of small diameter pipes of 32, 38, 50, 65 or 80 mm diameter, terminating with a glued-on plastic cap drilled accurately to the required orifice diameter. The outlet pipes shall be made of the nearest standard pipe size that is just larger than the required orifice diameter, and connected outside the tank to the main overflow pipe using reducing bushes and a 90° square junction.

Status of publication: February 2002, Final Version.

9.4.4 Permeable Pavement Design Guidelines

These Guidelines are a jointly commissioned project for Rodney District Council (RDC), North Shore City Council (NSCC) and Waitakere City Council (WCC). Details can be found in Section 9.2.5.

9.4.5 Practice Notes

A number of Practice Notes have been developed by North Shore City Council to be used in addition to water quality requirements set out in TP10. They concentrate on stream erosion and flooding and it is believed that, while TP10 guidelines set out minimum requirements, additional requirements may be needed depending on the sensitivity of the receiving environment. It should be noted that they are developed to provide guidance and assistance to developers and applicants with respect to stormwater management and to guide them through the requirements of a "Permitted Activity" for an NSCC Land Use Consent.

To aid in the introduction and understanding of these Practice Notes, North Shore City has been divided into five different Stormwater Management Areas (SMAs) based on the sensitivity of the receiving environment. Below is a brief description of the SMAs.

SMA 1: Protection and Enhancement – Upper catchments with high-quality streams where ecological and amenity values are present, and where increased run-off would have a significant effect on stream health.

SMA 2: Enhancement Areas – Upper or middle catchments with high-quality streams where ecological values are declining but amenity values are high, and/or where there is potential to restore and upgrade stream values.

SMA 3: Avoidance Areas – Upper or middle catchments where ecological and amenity values are moderate to good, and where there is a potential to maintain current values but further run-off would degrade these qualities.

SMA 4: Mitigation Areas – Catchments or sub-catchments where stormwater discharges into streams with few amenity or ecological values present, but where significant hazard areas (such as flooding or major bank erosion) are present or where piped capacity is constrained.

SMA 5: Coastal Areas – Cover parts of the city where stormwater is discharged directly to the coast or into stream reaches affected by tides.

The allocation of management areas assists with provision of guidance for the appropriate control of the average annual volume of stormwater run-off, as well as peak flows from 10 per cent and 50 per cent AEP rainfall events so that these flows represent pre-development conditions.

Below is a list of the Practice Notes that have been developed to assist the selection and design process for stormwater management devices.

NSC 01: Stormwater Mitigation Overview.

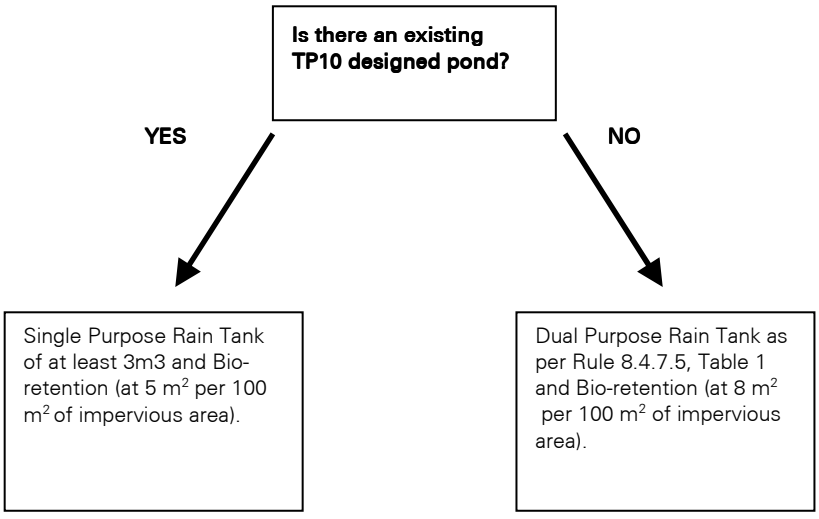
NSC 02: Calculating Site Imperviousness – gives details of what to include and exclude from total site imperviousness.

NSC 03: Methods for Minimising imperviousness – outlines benefits from minimising impervious area.

NSC 04: Permitted Residential Activity, SMA 1, 2 and 3 provides step-by-step instructions on size of rain tank and bio-retention required, dependant on whether a current TP10 pond exists. This is summarised in Figure 3.

Figure 3

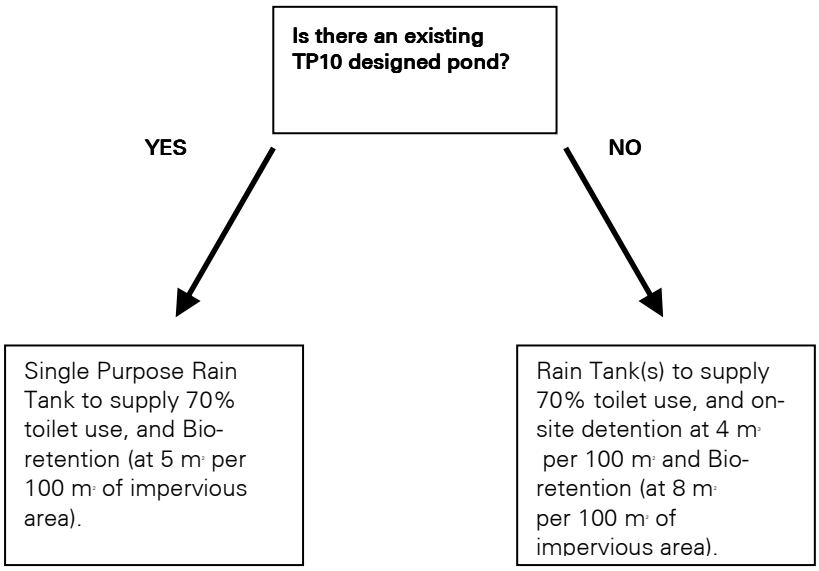
Schematic of Permitted Residential Activity in SMA 1, 2 and 3.



NSC 05: Permitted Non-Residential Activity, SMA 1, 2 and 3 – provides step-by-step instructions on size of rain tank and bio-retention required, dependant on whether a current TP10 pond exists. This is summarised in Figure 4.

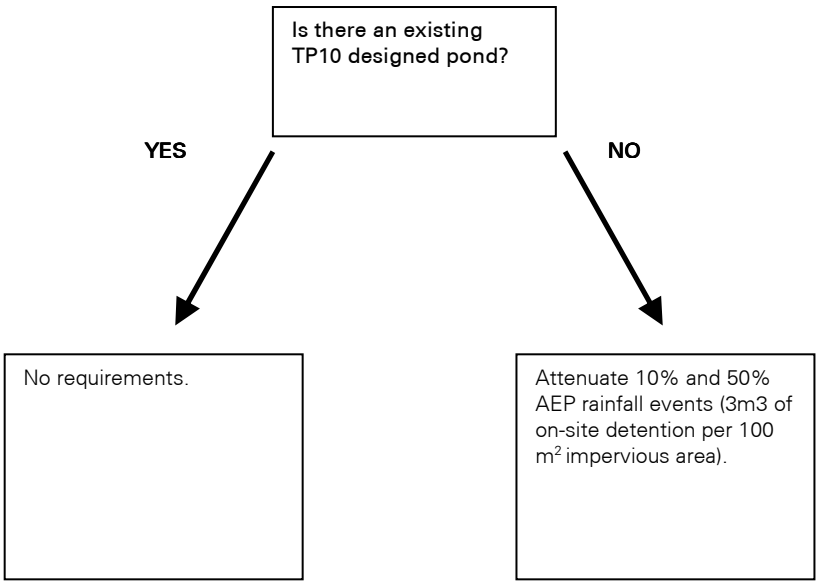
Figure 4

Schematic of Permitted Non-Residential Activity in SMA 1, 2 and 3



NSC 06: Permitted Residential or Non-Residential Activity, SMA 4 – provides step-by-step instructions on stormwater pond requirements, dependant on whether a current TP10 pond exists. This is summarised in Figure 5.

Figure 5
Schematic of Permitted Residential or Non-Residential Activity in SMA 4.



NSC 20: Single Purpose Rain Tanks – outlines minimum design requirements, maintenance requirements and provides "typical" tank arrangement drawings.

NSC 21: Dual Purpose Rain Tanks – outlines minimum design requirements, maintenance requirements and provides "typical" tank arrangement drawings.

NSC 22: Detention Tanks – gives details on minimum design and maintenance requirements.

NSC 23: Bio-Retention (Rain Gardens) – gives details on advantages, minimum design requirements, size and shape, location, and maintenance requirements.

Through clarification of "Permitted Activity" requirements, the Practice Notes help applications move through the consenting system as easily as possible and if followed can negate the need to apply for resource consent, however if an applicant is unable to comply with the "Permitted Activity" requirements then a resource consent will be required.

9.4.6 Rain Tank Guidelines

These Guidelines were developed to assist property owners, land developers and rain tank designers on rain tanks sizing, installation and maintenance requirements applicable to rural and urban areas located in North Shore City.

The following lists four different types of rain tanks which are used in North Shore City and includes the key objectives on utilising the rain tanks:

- Water supply rain tank – provides the main water supply to a household (especially in rural) in areas where a potable water supply is not accessible.
- Single purpose rain tank – reduces the annual volume of stormwater run-off from a site, especially from frequent small rainfall events but not so effective during larger rainfall events, while also providing an alternative non-potable water supply to a household (saves water bills).
- Detention tank – reduces the peak flow stormwater so that the peak flows are no more than they were before the development took place. Hence reduces the impact on downstream infrastructure and/or streams.
- Dual-purpose rain tank – to combine the benefits from both rainwater harvesting and detention into one combined tank. The purpose is to reduce the impact on downstream infrastructure and/or streams while providing alternative non-potable water supply to household and water savings.

The detailed design information and key aspects when designing and installing of the four types of rain tanks are provided in the document.

A resource consent and/or building consent may be required from the NSCC during installation of rain tanks.

Inspection and maintenance of rainwater systems, public health and safety issues, and costs associated with the rain tank system installation and also included in the document.

Status of publication: July 2008, First Edition.

9.5 Manukau City Council

9.5.1 Bylaws

The Manukau City Stormwater Bylaw (1992) does not include a chapter on stormwater management.

9.5.2 Engineering Quality Standards

Manukau City Council (MCC) acknowledges the New Zealand Building Act (2004); however it has also produced its own Engineering Quality Standards.

The Engineering Quality Standards provide the developer with a specification for compliance when producing engineering plans and constructing the physical works that are required to implement the engineering aspects of the conditions set down a resource consent.

Included within these standards are specific details referring to stormwater:

- Minimum information and performance requirements.

- Means of compliance including:
    - design standards;
    - discharge permits;
    - reticulation layout;
    - stormwater ponds;
    - pipes and manholes; and
    - testing and acceptance.

A small amount of design detail is provided in the form of typical drawings for a number of assets but where further guidance is required the standard refers people to ARC publications such as TP10, TP108 and TP90.

Status of publication: Current Version, February 2007.

9.6 Papakura District Council

Other than relevant District Plan rules and reference to a proposed stormwater bylaw, no further documented guidance was found for this council. Papakura District Council (PDC) refers to the New Zealand Building Act (2004) in regard to all building guidance (see Section 5.2.1).

9.7 Franklin District Council

Limited guidance was found for this council. The District Plan refers people to New Zealand Standard 4404:2004 in regard to all building guidance (see Section 5.2.3).

District Plan Variations 6 and 7 (May 2007), Part 19 refers to Urban Growth and specifies the use of ARC publication "Low Impact Design Manual for the Auckland Region – Auckland Regional Council Technical Publication 124" in subdivisional design.

Franklin District Council (FDC) does not currently administer a stormwater management bylaw.

9.7.1 Wastewater Management Plan

Some reference to stormwater was found within the Waste Management Plan (2006). It describes council and private property owners' responsibilities in regard to stormwater. This includes providing and maintaining an adequate private stormwater drainage system, maintaining any open/piped private watercourses; and accepting and making provision for any natural run-off.

Status of publication: Current Version, 2006. Reviewed 6 yearly.

10 Territorial Guidance – Outside Auckland Region

10.1 Kapiti Coast

10.1.1 Code for Subdivision and Development

This document has been included to give an example as to what other local authorities outside the Auckland region are developing in terms of Code of Practices for stormwater. This code extensively explains and encourages the development of alternative stormwater systems. It promotes utilisation and enhancement of natural systems for stormwater treatment and when assessing proposals for subdivisions, favours those that follow LID stormwater management practices.

Construction of stormwater systems refers to the New Zealand Standard 4404:2004 but amended where necessary to meet the Kapiti Coast individual requirements. Amendments include:

- system design;
- pipe materials;
- pipe sizes;
- minimum cover;
- soak pits; and
- means of compliance.

For the design and construction of LID treatment devices the Code refers applicants to ARC publications such as TP10 and TP124.

Status of publication: 2005 Version, Final.

10.2 Christchurch

10.2.1 Manual for the Design of Waterways, Wetlands and Drainage

This Manual provides a brief overview of the effects of development, urban and rural, on waterways and natural wetlands. Chapter six of the Manual suggest methods of reducing these impacts through stormwater treatment and elsewhere the Manual

defines and provides for the six values identified by council which are: ecology, landscape, recreation, heritage, culture and drainage.

The Manual contains information on:

- A multi-disciplinary approach to design and management.
- Advice on-site assessment using a values-based approach.
- Procedure to follow when consulting with local communities and tāngata whenua.
- Advice on developing and implementing environmentally sensitive design.
- Specific engineering and ecological criteria for design of waterways, wetlands, stormwater pipes and other structures.

The Manual contains some very detailed information on stormwater treatment systems. Some of the current objectives of the Christchurch City Council for water management or treatment systems are:

- To make provisions to protect waterways from high short-term sediment discharge in any new development with significant earthworks.
- To reproduce as near as possible, the existing hydrological conditions inflows from the site.
- To provide a system for pollutant removal to reduce existing pollutant concentrations in the receiving environment.
- To have a positive, or at least a neutral impact on the natural and human environment.

The document states this can be achieved by the introduction of stormwater treatment devices such as those listed below.

- Litter traps:
    - Swales
    - Grills
    - Grates.
- Soakage systems:
    - Soakage swales
    - Soakage chambers
    - Soakage basins.
- Detention basins:
    - Wet ponds
    - Dry basins.
- Constructed wetlands:

- Surface flow wetlands
- Subsurface flow wetlands.

The manual describes the main functions and additional values (such as recreation, streetscape) of each of these treatment devices. It outlines the removal capabilities, restrictions, benefits and amenity values in table form for each of the devices which have been included in Tables 6, 7, 8 and 9. These tables are included in the document to assist developers and applicants with their chose of treatment device. Further details and uses of each treatment device are given, along with calculations, design drawings, examples and recommendations.

Table 6

Representative removal capability of treatment systems.

Pollutant removal efficiency (%)							
Treatment system	**Solids**	**Phosphorus**	**Nitrogen**	**BOD**	**Trace metals**	**Bacteria**	**Comments**
Grassed swale	20 – 60	20 – 40	20 – 40	20 – 40	20 – 60	20 – 40	High potential for re-suspension of sediment with any storm flow.
Soakage basin	60 – 100	40 – 80	40 – 80	20 – 60	40 – 100	60 – 100	Dependant on extent of overflow permitted.
Dry detention basin	40 – 80	40 – 60	20 – 40	20 – 40	20 – 60	0 – 40	Efficiency in trace metal reduction is reduced for more soluble elements.
Extended detention wet pond	60 – 80	40 – 80	40 – 60	20 – 60	40 – 80	40 – 80	Sizing relative to run-off is volume dependant. Bacteria removal dependant on bird population for the system.
Wetlands	60 – 80	40 – 80	20 – 60	20 – 40	40 – 80	60 – 100	Removal includes soluble trace metals. Bacteria removal dependant on bird population attached to system.

Source: Manual for the Design of Waterways, Wetlands and Drainage.

Note: The level of pollutant removal will be subject to the level of provision of treatment system volume or surface areas relative to catchment run-off. As a general rule, the higher the concentration of inflowing pollutants, the greater the percentage removal.

Table 7

Common restrictions associated with various treatment systems.

Treatment system	Slope	High water table	Close to bedrock	Space consumption	Maximum depth	High sediment input	Thermal impact downstream
Grassed swale	☹	☹	😐	😐	☺	☹	☺
Soakage basin	😐	☹	☹	😐	☹	☹	☺
Dry detention basin	☺	😐	😐	☹	☺	😐	☺
Extended detention wet pond	☺	☺	😐	☹	☹	😐	☹
Wetlands	☹	☺	☺	☹	☹	😐	☹

Source: Manual for the Design of Waterways, Wetlands and Drainage.

☺ – Generally not a restriction
😐 – Can be overcome with careful site design
☹ – May preclude the use of the treatment system

Table 8

Comparative stormwater benefits of various stormwater.

Treatment system	Peak discharge flow			Volume control	Ground water recharge	Stream bank erosion control
	2-yr storm	10-yr storm	100-yr storm			
Grassed swale	☺	☹	☹	😐	😐	☹
Soakage basin*	☺	☺	😐	☺	☺	☺
Dry detention basin	☺	😐	😐	☹	☹	☺
Extended detention wet pond	☺	😐	😐	😐	😐	☺
Wetlands	☺	☹	☹	☹	☹	😐

Source Manual for the Design of Waterways, Wetlands and Drainage.

*First flush capture will not usually suppress peak discharge flow from storm events greater than a 2-year frequency.

☺ – Usually provided
😐 – Sometimes provided with careful site design
☹ – Seldom or never provided

Table 9

Natural or human amenity values.

Treatment system	Low flow maintenance	Stream bank erosion control	Aquatic habitat creation	Wildlife habitat creation	Landscape enhancement	Recreational enefits	Hazard reduction	Community acceptance
Grassed swale	😐	☹	☹	😐	😐	😐	☺	😐
Soakage basin	😐	☺	☹	☺	😐	😐	☺	😐
Dry detention basin	☹	☺	☹	☺	😐	😐	😐	😐
Extended detention wet pond	☹	☺	☺	☺	☺	☺	😐	😐
Wetlands	☹	😐	☺	☺	☺	😐	😐	😐

Source: Manual for the Design of Waterways, Wetlands and Drainage.

☺ – Usually achieved
😐 – Sometimes achieved
☹ – Seldom achieved

The document is available for purchase from the Christchurch City Council's website: www.ccc.govt.nz.

Status of publication: Final, dated 2003.

11 International

The following policies and approaches are included to convey a sense of the current international perspective on LID methods and their implementation. Both the Australian and Scottish systems have been in the implementation stage for a significant period of time, and applied across various political, economic and environmental contexts. The apparent versatility and practical benefits of such systems means that they are potentially valuable as examples to use in the development of a similar system for Auckland region and other areas of New Zealand.

11.1 Australian policies

The following policies, implemented in Australia, were chosen as examples within this report because they have an Asia-Pacific focus and therefore are relevant to New Zealand. Strategies like Water Sensitive Urban Design (WSUD) have been employed across a wide variety of contexts within Australia, including major urban centres like Melbourne and Sydney and urban-rural settings such as those in South and Western Australia. This applicability demonstrates that the systems can be easily adapted and such a characteristic would be very beneficial in a New Zealand context.

11.1.1 Integrated Stormwater and Reuse Systems – Inventory of Australian Practice

This document considers the design, construction, operation and maintenance of integrated stormwater treatment and reuse systems, and provides information on regulations that support the adoption of such systems. It examines costs and benefits, implementation issues and performance, and sets priorities for future research. Aspects of stormwater systems considered include a range of technologies available for the collection, treatment, storage and distribution of urban stormwater run-off, and reuse of non-potable water. Treatment options featured are based on Water Sensitive Urban Design (WSUD) techniques (see Table 10-1 below).

11.1.2 Water Sensitive Urban Design (WSUD)

This initiative is used in a number of Australian cities, including Sydney, Melbourne, Brisbane, Gold Coast, Hobart, and Adelaide. It involves the integration of urban water cycle management with urban planning and design. The key principles (CSIRO, 1999) are detailed below.

Key Principles of Water Sensitive Urban Design:

- Protect natural systems.
- Integrate stormwater treatment into the landscape.
- Protect water quality.
- Reduce run-off and peak flows.
- Add value while minimising development costs.

Techniques from WSUD can be incorporated into site planning, residential, commercial and industrial design, and construction site management. Several economic, social and environmental benefits and constraints associated with WSUD are also identified. This concept is utilised by many cities, with some variations. For example, some cities have developed technical and/or engineering guidelines based upon the WSUD principles yet tailored to their specific economic, social and environmental contexts. The WSUD document published by CSIRO (1999) also details the following "residential design tools" and "commercial/industrial design tools", including suggested measures for their implementation.

These are detailed in Table 10-1.

Table 10

Design tools and implementation methods.

Residential design tool	**Suggested measures for implementation**
Local public open space networks	Buffer strips, filtration/retention basins, networked public open spaces, drainage corridors, natural drainage.
Housing layout	Increase public open space, setbacks, buffer zones, orientation, reduced paving, lot geometry, housing run-off.
Road layout	Road alignment, access places and ways, reduce impervious surfaces, roadside detention, road location, minor and major flows (using swales).
Streetscape layout and design	Reduced paved areas, localised filtration/detention, underground services, setbacks, landscaping, crossovers, stormwater recycling.
Commercial/Industrial design tool	**Suggested measures for implementation**
Parking area storage	Porous pavement, carpark storage and detention, infiltration, retain natural drainage paths, landscape.
On-site detention for large sites	Cut kerbs, wetland/pond systems, pollutant traps, recessed landscape areas, infiltration systems.

WSUD elements covered in various versions of engineering guidelines (from different cities) include the following:

- swales (including bio retention swales) and buffers;
- sedimentation and bio retention basins;
- constructed wetlands;
- infiltration measures;
- sand filters;
- ponds and lakes;
- porous and permeable paving;
- gross pollutant traps;
- rain gardens;
- greywater reuse.

Refer to sources noted in Section 11.1.3 below for detailed information regarding utilisation of these elements. An example of how WSUD has been incorporated into council Engineering Guidelines is also featured in Section 11.1.3.

11.1.3 WSUD Engineering Procedures (Melbourne)

The Engineering Procedures set out by City of Melbourne provide an excellent example of how WSUD is used in Australian policy. After visiting several Australian Local Government websites (listed below) it was determined that the format shown in this example is very common in council policies across Australia.

Guidelines are primarily targeted at design engineers and Local and State Government approval officers. They provide step-by-step engineering design procedures (including design calculations) for eight WSUD elements: sediment basins, bio retention swales, bio retention basins, sand filters, swales/buffers, constructed wetlands, ponds and infiltration systems. Worked examples, checking tools, checklists and landscape designs are provided for each element. A list of recommended plant species for elements involving vegetation is also featured. Methodologies for determining storage requirements in rainwater tanks and aquifer storage and recovery feature in a section that focuses on stormwater harvesting and storage.

The following were identified as useful sources for further information regarding WSUD in Australia:

www.planning.sa.gov.au/go/water-sensitive-urban-design (Adelaide WSUD guidelines)

www.hobartcity.com.au/HCC/STANDARD/PC_1124.html (Hobart WSUD)

www.healthywaterways.org/FileLibrary/wsud_tech_guidelines.pdf (WSUD Technical Design Guidelines for South-East Queensland)

www.brisbane.qld.gov.au/BCC:BASE::pc=PC_1898 (Brisbane WSUD)

http://wsud.melbournewater.com.au/ (Melbourne WSUD guidelines)

www.wsud.org/ (Sydney WSUD)

CSIRO, 1999 Urban Stormwater – Best practice environment management guidelines, Chapter 5: Water Sensitive Urban Design.

11.2 Scottish Policy

Scotland has embraced the principles of LID (Sustainable Urban Drainage Systems, SUDS) and has invested significant resources into the research and promotion of LID. Based on this initiative, Scotland has implemented a requirement for all new development and construction projects to use LID. This requirement is enshrined in national environmental legislation regarding the water environment ie; Water Environment (Controlled Activities) (Scotland) Regulations, 2005.

This national legislation (See Figure 6 for relevant rules), is enforced by a national environmental body with similar powers to ARC, but across the whole country and leaves the construction and development sectors in no doubt as to their commitments regarding surface water drainage.

Figure 6

Summary of relevant Scottish regulations. Extracted from Water Environment (Controlled Activities) (Scotland) Regulations 2005, (as amended).

GBR10: Discharge of surface water run-off from a surface water drainage system to the water environment from construction sites, buildings, roads, yards and any other built-up areas.

Rules:

1. If the surface water run-off is from areas constructed after 1 April 2007 or from a construction site operated after 1 April 2007, these sites must be drained by a Sustainable Urban Drainage System (SUDS). The only exceptions are (i) if the run-off is from a single dwelling and its curtailage and (ii) the discharge is to coastal water.
2. All reasonable steps must be taken to ensure that the discharge will not result in pollution of the water environment.
3. The discharge must not contain any trade effluent or sewage and must not result in visible discolouration, iridescence, foaming or sewage fungus in the water environment.
4. The discharge must not result in the destabilisation of the banks or bed of the receiving surface water.
5. The discharge must not contain any water run-off from any of the following areas constructed after 1 April 2007:
   - Fuel delivery areas and areas where vehicles, plant and equipment are refuelled.
   - Vehicle loading or unloading bays where potentially polluting matter is handled.
   - Oil and chemical storage, handling and delivery areas.
6. All treatment systems (including oil interceptors, silt traps and SUDS) must be maintained in a good state of repair.
7. All reasonable steps must be taken to ensure that any matter liable to block, obstruct, or otherwise impair the ability of the surface water drainage system to avoid pollution of the water environment is prevented from entering the drainage system.
8. The construction and maintenance of the outfall must not result in pollution to the environment.

Enforcement of this national legislation is complemented by supporting statements in regional and local strategic plans from each local authority. It is up to the discretion of each local authority as to the standards which should be met in terms of required levels of treatment and extent of attenuation required to protect receiving environments from the deleterious effects of increased run-off.

Very limited technical guidance is offered within the Scottish regulations. The majority of technical guidance, which is extensive in nature, is contained within a large number of documents, published by research bodies, national environment agency and some of the larger local authorities. The benefit of keeping technical data out of and statutory documents is that new advances can be included in best practice without going through the lengthy process of revising legislation.

The main technical document (Woods-Ballard, 2007) provides a very comprehensive guide to Sustainable Urban Design Systems (SUDS), and associated requirements, that are appropriate for all levels of Government (local, regional, central). This document was produced as a Research and Development Report for the Environment Agency.

SUDS involves a number of "components" (similar to the "elements' used in Australia's WSUD) upon which the entire system is based. These are:

- filter strips;
- swales;
- infiltration basins;
- wet ponds;
- extended detention basins;
- constructed wetlands;
- filter drains and perforated pipes;
- infiltration devices;
- pervious surfaces; and
- green roofs.

Of fundamental importance in this regard is the Stormwater Management Train which governs the relative importance of the above devices and directs users to reducing run-off before considering how to deal with it.

The construction, operation and maintenance requirements, contextual applications, physical specifications, landscaping and vegetation details, and practical considerations of each of the components are featured in certain chapters of the document. It also includes detailed information on approaching the operation and maintenance of various components, and guidelines for community engagement. Each design component must comply with certain hydraulic, water quality, amenity and ecological criteria once it is installed.

SUDS encourage mitigation of adverse environmental effects from stormwater run-off by:

- Reducing run-off rates.
- Reducing additional run-off volumes and frequencies.
- Encouraging natural groundwater recharge.
- Reducing pollutant concentrations in stormwater.
- Acting as a buffer for accidental spills.
- Reducing the volume of surface water run-off.
- Contributing to the enhanced amenity and aesthetic value of developed areas.
- Providing habitats for wildlife in urban areas and opportunities for biodiversity enhancement.

The design requirements and specifications provided by the SUDS manual are very detailed and specific, making the concept of sustainable urban design more straightforward for individuals, developers, trades personnel and Government representatives alike. The manual also covers all aspects of SUDS implementation, including community engagement, planning, a "management train", legislation and other controls on surface water drainage, drainage assessment requirements, and a cost-benefit analysis.

12 Interview Feedback

This section provides a summary of the feedback received during interviews with each of the Auckland region's local authorities. A standard questionnaire was used and a copy of this and a more detailed summary from each council is provided in Appendix B.

12.1 Core themes

A number of core themes were prevalent throughout the responses of representatives from local authorities and for the avoidance of repetition these are discussed initially. Local authority specific details are then presented in subsequent sections.

In general representatives from each local authority had an awareness of the key principles of LID, however, awareness of the implications of policy shifts outside direct stormwater management with regards to changes in stormwater quality and quantity was not widespread. Examples of such policies may be any limitations on building materials such as zinc roofing.

There were varying responses within each local authority in relation to how existing documents affected the enhancement of stormwater management and improved uptake of LID through promotion and integration of LID approaches. In general it was felt that the range of available documents lacked consistency and integration. However, common themes emerged when discussing documents which presented barriers to LID implementation. These core themes include:

- The AWLP and local authority level documents on LID were regularly cited as being inconsistent with each other.
- Requirements within transportation documents and housing density targets were cited as being incompatible with LID principles and techniques.
- It was cited that a gap exists between high-level policy documentation and thinking in general and the practical implementation of principles on the ground.

Beyond the referenced documents a number of further barriers were cited which were perceived to limit implementation/effectiveness of LID and the enhancement of stormwater management techniques:

- Lines of communication between each local authority and ARC need to be improved in both directions.
- Needs to be much clearer definition of boundaries between jurisdiction of the local authority and ARC.
- It was clear that each local authority is risk adverse when it comes to Stormwater Management and other key areas. This makes it difficult for them to justify assuming responsibility for the maintenance burden of what is perceived to be a range of untested techniques.

- It was perceived that a lack of technical performance data and proven successful examples with regard to specific LID approaches led to a lack of confidence in their suitability and use.
- Retrofit of LID on brownfield sites was viewed as something which was very hard and not worth following.
- The consenting route for LID-based designs was longer and more costly than for traditional systems therefore there is no incentive for developers to try.
- Lack of operational and capital cost data to support cost-benefit analysis.
- Poor understanding of how to effectively engage planners, landscape architects, ecologists, etc.
- Internal integration between local authority departments could be better.
- Education was recognised as an important tool in the implementation of LID.
- A statement of roles and responsibilities within the LID process would help practitioners through the process.
- Regardless of all of the above, each local authority expressed that they have no legal power to enforce LID.

Other common themes which ran through all representatives responses included:

- The establishment national guidance would provide a useful policy shift to encourage better stormwater management and promote LID.
- Retrofitting of LID or other new stormwater management techniques within brownfield sites was cited as being of very limited potential and not something which was frequently considered.
- The best opportunity for implementation of LID was cited as being with large-scale master planning and plan-change areas.

Regardless of the extent to which LID had been implemented across the region, most authorities were able to recognise the benefits to Quadruple Bottom Line Objectives offered by implementing better stormwater management techniques and LID.

Most but not all of the councils felt that a Code of Practice would be beneficial. A wide range of opinions were expressed as to what such a document would contain. Some wanted high-level principles with maximum flexibility to implement their preferred solutions to their council standards whilst others requested specific design details, performance and cost data. However, all agreed that any MCoP should be a guidance document, and not have statutory standing.

12.2 Waitakere City Council

In general, representatives from Waitakere City Council (WCC) had a good understanding of LID concepts, as would be expected given the volume of LID-related documentation produced by WCC and a recent focus on LID for the Northern Strategic

Growth Area. There was a feeling that although the documents existed within council there remained a gap between high-level thinking and manifestation of the principles through the consenting process and implementation on the ground. That said, many documents were considered to actively promote and encourage LID.

On consistency and integration of documents it was considered that internally there was some consistency (eg DP and Countryside CoP/Stormwater Solutions for Residential Sites), however, from a regional perspective WCC documents were considered to sometimes be at odds with regional documentation. Specifically it was commented that the ALWP needs to be more specific for extrapolation in to WCC documents. Additionally, it was noted that the content of several of the regional technical publications was not fully implementable across the WCC area and was at times at odds with elements of the District Plan such as maximum levels of imperviousness and the ability to provide for high-levels of attenuation within new developments.

Communication was highlighted as one of the key barriers to wider implementation of LID, as was a perceived difficulty in ability to adhere to both the ALWP and LID principles simultaneously.

Overall, WCC are supportive and proactive in the field of LID, however, work internally is required on consistency of application across departments. It was felt that new staff brought into the department often lack the skills and experience required to manage the LID process and this can lead to difficulties.

12.3 Auckland City Council

Representatives from Auckland City Council (ACC) had a generally good awareness of methods for enhanced stormwater management and LID, and in particular understood its close relationship with urban design approaches. It was cited that whilst documents produced by ACC do not preclude the use of LID, they do nothing to actively encourage it. One such example is the ACC roading design requirements. It was also cited that other (regional) documents which do promote LID often lack practical advice.

Representatives from ACC suggested that the ALWP is based around the concept of Best Practicable Option (BPO), however, TP10, which is intended as a guideline document, is used a mandatory minimum standard thus impacting on the development of BPO. It was also noted that the District Plan does not provide a message consistent with other ACC documentation, such as the On-site Stormwater Management Manual. Overall it was considered that the available documents were not used in an integrated manner.

It was highlighted that the inconsistent nature of LID, stormwater and sediment management documentation allowed developers to play one document off against another to meet their own ends and that LID was often presented as a trade off for less desirable elements of a development. There was also a tendency for practitioners, when in doubt, to look up to the District Plan or RMA. These documents were felt to be general and non-prescriptive and thus of little use in such situations.

Some ACC representatives expressed concern around LID-related devices within road corridors as they were perceived to create issues around the management and operation of the road corridor.

Despite the above it was stated that key to the success of LID would be to create a quick and easy permitted activity route for consenting LID.

12.4 North Shore City Council

Similarly to WCC, NSCC representatives had a good understanding of the concepts of LID. They felt that overall there was a mixture of documents helping and hindering enhancement of stormwater management and LID, but that there was no overall integrated approach. The key barriers identified by NSCC, in addition to the generalised comments in s12.1, were that often developers are obligated to demonstrate, at length, compliance with TP10 yet not all features of TP10 are supported by NSCC. There was a comment that TP10 has a large catchment focus with an emphasis on stream management, including ephemeral streams. It was felt that this does not apply well to brownfield redevelopment sites. Regarding some of the TP design examples, some where considered to be sub-optimal designs. Another comment was that geotechnical conditions encountered on sites do not always allow for the use of LID. An interesting comment was that Urban Design Protocol (UDP) needs to be used within LID, a point not raised elsewhere.

One other point raised was whether more use of Section 32 of the RMA was required to demonstrate the cost-benefit of LID, justifying its use.

Overall the use of LID across council departments remained limited, yet the Quadruple Bottom Line (QBL) benefits were understood and opportunities for implementation were identified. In commenting on the proposed MCoP it was cited that any code should be referenced in the District Plan which in turn should reflect a statement regarding LID in the Regional Policy Statement.

12.5 Manukau City Council

The representatives of Manukau City Council (MCC) had some knowledge of LID, with varying interpretations of the key concepts. They commented that the District Plan was very general and open-ended and, therefore, did not lend itself to promoting LID or other techniques to enhance stormwater management. It was cited that MCC documents do not explicitly mention LID and that regional technical documents did not express some elements clearly. It was cited that poor integration exists between MCC departments with respect to LID.

Barriers discussed included a feeling that TP108 was now out of date. Many of the applications received by council used software such as HEC-HMS as the basis for calculations rather than TP108 and staff were unsure how these two approaches related to each other. There appeared to be some debate amongst representatives whether LID represented the best way forward, some found it difficult to incorporate

meeting LID and other environmental targets associated with stormwater quantity and quality. There was also concern that standard documents used by MCC parks and roading limited the scope and effectiveness of potential LID solutions.

12.6 Rodney District Council

Representatives of Rodney District Council (RDC) had mixed views regarding LID, with a generally good knowledge of the concepts but a feeling that it is poorly defined in New Zealand policy. It was cited that RDC does not encourage LID on small residential lots as it is considered to be inapplicable. It was stated that the District Plan and existing design standards make it difficult to consent anything other than traditionally designed systems.

Some of the key barriers were cited as the increased length of time LID applications can take to process, the lack of national advocacy, no clear regional standards, lack of scope for innovation within current documents and lack of power to enforce. RDC representatives felt that conflicts occurred between many documents, include the DP, RMA, Building Act and roading policy, making implementation difficult. Internal issues surrounding parks policy and transport policy made effective implementation more problematic and reduced the opportunities for success.

In terms of policy shift, RDC felt that a change in their own maintenance regimes may be beneficial, as would educational programmes regarding LID. Placing LID in national law was also cited as a way of implementing LID. RDC representatives cited that clear opportunities for implementation of enhanced stormwater management existed, in particular through farm (greenfield) development and plan change areas.

12.7 Papakura District Council

There was a limited degree of awareness of LID amongst Papakura District Council (PDC) representatives. Representatives believed that regional documents and the RMA allow for LID but provide little or no detail. They considered some ARC documents limit the application of LID and innovation by being too specific. As with several of the other local authorities, PDC documents do not discourage LID but do nothing to actively encourage it. Several representatives considered that the District Plan and Structure Plans limited the scope for implementation of non traditional stormwater management solutions.

It was commented that private ownership of drainage structures was unsatisfactory and didn't work well.

Regarding the proposed MCoP most, but not all, representatives were generally supportive of the development of a Model Code of Practice. However, it was stated the any such document would need to be a guideline only, providing more options to consider for any new proposal. It would also need to be detailed and user-friendly, and applicable on a regional scale. It should not become mandatory or a prescriptive

minimum standard for consent approval. It was suggested that it could be called a Practice Manual rather than a Code of Practice

12.8 Franklin District Council

Franklin District Council (FDC) representatives had a reasonable knowledge and understanding of LID. They felt that TP10 was overly prescriptive and that the ALWP was hard to follow. They noted that the FDC code of practice was out of date and that they were considering adoption of a code from Hamilton City Council. There were mixed opinions as to whether an integrated approach to LID existed. Key barriers identified were concerns over the robustness and practicalities of LID, the council's willingness to adopt and the number of planning steps required to consent "non-standard" solutions. There were also concerns over how maintenance and monitoring requirements could be enforced. Again, it was considered that LID was very difficult to apply to retrofit situations and that it was not as applicable in a rural setting. FDC representatives were the only group who mentioned community opposition and cooperation as a potential barrier to implementation.

FDC felt that LID should be an option within stormwater management, rather that a mandatory element and that national, regional and territorial consistency were critical.

13 Analysis

This section provides an analysis of the documentary information gathered and outlined previously in Section 9 and the verbal information provided by each local authority. The aim of this project was to assess the strength of current documentation and policy, and identify barriers and limitations posed to the improved uptake of LID and enhanced stormwater management. The tool proposed to tackle the barriers and limitations identified were Model Codes of Practice (MCoP) for use by local authorities and this is discussed at the end of this section.

13.1 Local authority guidance

In general the implementation of enhanced stormwater management techniques and LID across local authorities is not occurring as effectively as it could, and, therefore, the potential benefits for Quadruple Bottom Line Outcomes are not being fully realised. There is a clear difference in the extent to which some local authorities have been able to implement these techniques compared with others. It is unclear as to the reason for this, however, it could be suggested that given councils' relative budgets and staff resources, the focus for council initiatives may vary across the region, with only some including stormwater management through LID.

Several authorities, such as North Shore City Council, Waitakere City Council, Auckland City Council, and to a lesser extent, Rodney District Council, are producing LID-related documentation for use within their jurisdiction and much of this work is of great value. However, it was noted that these documents can be at odds with existing Codes of Practice and in certain cases the District Plans. There are also some incompatibilities with regional guidance which is discussed in Section 13.2.

The guidance produced by these local authorities is generally designed to sit below the District Plans, as Codes of Practice or Technical Guidance, but their standing is diminished by a lack of explicit reference to their use within the District Plans. Much of the language contained within the documents in relation to their `intended use` is weak, which introduces ambiguity as to when it is appropriate to use the documents and allows consent applicants to avoid their use as a result of their non-statutory status. Only NSCC specifically requires consideration of LID, but again this is a requirement to consider, not to a compulsion to use.

In addition, the effective implementation of enhanced stormwater techniques as defined within these documents is further reduced by conflicts with other local authority Codes of Practice and technical guidance. Roading policies, for example, which specify minimum carriageway widths, limit the ability of LID focused proposals to minimise impermeable surfaces, and the specification of service strips along roads can limit the application of source control devices such as swales and rain gardens. In any MCoP process such conflicts will also need to be addressed to ensure effective

implementation of the MCoP. This may occur by ensuring that design standards are flexible enough to accommodate LID approaches where considered appropriate.

The above is in contrast to the other local authorities such as Manukau City Council, Papakura District Council and Franklin District Council who have little or no LID-related documentation of their own and rely heavily on traditional engineering Codes of Practice and technical publications produced at a regional level. Indeed, the same is true for a number of departments within the first group of local authorities mentioned above who, rather than utilise the emerging LID-based guidance, continue to align themselves with more traditional standards. This limits not only the type of applications they are likely to receive but also their ability to assess and comment on any applications based around LID or other enhanced stormwater management techniques.

Across all of the local authorities, barriers were identified stemming from the lack of integration between key departments. For example, parks were identified as areas having significant potential for the instalment of stormwater management devices, yet this is restricted by a lack of communication and understanding between departments. It is noted that Parks departments did not always agree with this use, however. Given the multi-disciplinary nature of well executed LID examples and demonstration projects it is vital that communication issues are resolved.

Other local authority wide barriers included issues around retrofitting, control of private stormwater management devices and policies dictating planning factors such as housing densities. It was generally perceived that retrofitting of LID principles in existing urban environments or for brownfield sites was not practicable and this is a perception that should be addressed. It is acknowledged that on such sites it will be more difficult to implement LID concepts in full and the same level of outcome may not be achieved as if the site was greenfield. However, the basis of LID lies in sustainability which is something to strive towards rather than a point which can be reached. As such implementing even a few of the most basic LID principles on these sites will achieve a degree of sustainability beyond that of simply re-constructing traditional reticulations systems. This is very much a long-term viewpoint as, only over many numbers of redevelopment cycles, areas will slowly become converted to LID-based stormwater management, reducing the overall impact of the area.

Regarding private ownership of stormwater management devices a general consensus was that this makes systems vulnerable should these devices be removed or left unmaintained. Currently there is little that can be done by local authorities to address this and a centrally co-ordinated approach would assist local authorities in resolving the problem.

The final point, planning factors, is again something which requires consideration of more than just stormwater legislation. The local authorities felt that some of the policies laid down, in relation to housing densities in particular, were fundamentally at odds with LID principles of minimising impermeable areas. This is a point which requires further consideration to determine if the perception is founded and if so, how to address the issue.

Three councils were found to operate stormwater bylaws none of which mention or advocate the use of LID approaches.

13.2 Regional and national guidance

National requirements exist in the form of a range of national statutes including the Resource Management Act (RMA). However, no specific national guidance on the implementation of stormwater and sediment management is available.

Within the responses from local authorities there was a repeated message that national legislation in New Zealand would be one way in which better stormwater management could be encouraged, and indeed this is the way in which it has been approached overseas. Whilst this has worked in countries such as Scotland it is difficult to see the New Zealand Government adopting this route. In general New Zealand governance does not rely on such specific legislation at a national level, preferring rather to rely on the spirit of acts such as the RMA to guide regional and territorial level regulation. As such it is apparent that responsibility falls on the regional councils to provide detailed direction on the matter.

Within the Auckland region a number of regional policy documents discuss stormwater, LID and sediment management in principle but do not provide significant detail on how this should be achieved. In general they allow for LID to be considered but do not give direction as to how this should be achieved at a territorial level. The Auckland Regional Policy Statement makes no reference to enhanced stormwater management techniques, yet this would appear to be a most logical point to begin the focus on such techniques.

The interview process highlighted that local authorities feel it is critical that a consistent message is presented throughout the regulatory framework. The benefits of having LID specifically referenced in District Plans is discussed above and an important way to promote the inclusion of LID in District Plans would be to set a precedent by supporting statements in regional policy.

Regarding the regionally produced technical publications (TP10, 108, 124) there is a perception across the local authorities that parts are restrictive, inapplicable or out of date, and that there is an incompatibility between them and documents produced by the local authorities. It is acknowledged that both TP108 and TP10 are currently under review.

13.3 Conclusions

International context suggests that the successful implementation of best practice stormwater management with the inclusion of LID approaches is possible and has been demonstrated, for example, in Scotland and Australia. Furthermore it has proved to be effective in addressing stormwater management issues.

Much of the information gathered for this project in the Auckland region indicates a general agreement that LID is workable and importantly. There is a good understanding of the benefits to Quadruple Bottom Line Outcomes (QBLO) implementation of LID can bring. However, there is a perception that there is a significant gap between strategic-level principles and practical implementation of ideas. Practice is often influenced more specifically by technical robustness, capital and operating costs and it is important that these variables can be quantified to enable annual and longer term planning, rather than the application of corporate stormwater management objectives and principles which do not always directly align with practice. Such practical information is widely available for traditional stormwater management approaches but not yet readily available and proven for LID approaches.

Additionally, significant variations exist in approach and level of activity within the local authorities and this presents issues in relation to applying a standard set of MCoP across the region such that a single regional MCoP approach is not considered appropriate.

Waitakere City Council, Auckland City Council, North Shore City Council and to a lesser extent Rodney District Council have established their own specific stormwater design standards, codes and guidance documents which provide for a range of LID approaches as described in Section 9. Much of the content of this documentation is valuable and potentially applicable beyond the boundaries of the authority in which they were created. In Manukau City, Papakura District and Franklin District design standards may be available but generally focus on traditional methods and therefore these authorities would rely more directly on design information and guidance available through ARC's technical publications. It is conceivable that these authorities would also find it challenging to assess LID proposals from applicants as a result of MCoP.

In effect there is a two-tier system operating in the Auckland region with respect to enhanced stormwater management and LID. This creates the question; at what level should a comprehensive MCoP be set to be meaningful and effective across the region? In general any MCoP pitched to address issues raised in less active local authorities will be largely duplicating what has already been undertaken in places such as NSCC and WCC for some of their proposed development areas. If such a direction is to be followed there is the option of using what has already been achieved as the basis for a regional MCoP, rather than creating yet another layer of documentation. Naturally, this is dependant on territorial level documents being assessed for their suitability across the region and agreement of local authorities that produced them to share the documents in this way. Documents which could be shared are identified in Section 14.

Another potential approach would be to pick out some of the key barriers expressed across each of the local authorities and focus MCoP on these. Throughout this study a number of areas have repeatedly been cited as key barriers:

1. Definition of jurisdiction and responsibilities between regional council and local authorities.
2. Effective communication and engagement of stakeholders in LID designs and applications.

3. Model operational and maintenance costs for LID.

4. Lack of performance data and successful examples.

5. Techniques for retrofitting LID into brownfield/existing sites.

6. Housing densities.

7. Roads guidance (widths and activities within road reservations).

8. Use of parks and recreational areas as stormwater management areas.

9. Control of private devices contributing to stormwater management.

The production of MCoP for the above items, whilst plugging gaps in the larger local authorities structures, would provide isolated help for the smaller local authorities whereas what they actually require to enhance the uptake of LID is a more comprehensive, up to date and detailed set of codes which either replace or sit alongside existing engineering standards.

As part of the project scope it was intended to determine what Model Codes of Practice could be developed to address the barriers and limitations identified above. Through the work undertaken to date however, it is felt that development of MCoP requires careful consideration as there is a potential risk of further confusing the implementation of LID and enhanced stormwater management techniques in an already inconsistent setting. Should a MCoP be developed there is also the possibility that the more proactive local authorities will not use it as they already have their own versions.

In conclusion, probably the most useful route forward for less active local authorities would be the development of detailed LID guidance documents targeted for their needs and produced based on the adaptation of good examples of codes already existing within other Auckland region local authorities. In addition ARC and the local authorities could continue to resolve some of the key barriers identified and develop codes to fill key gaps such as LID guidance for use in roading, parks and retrofitting in brownfield scenarios.

Relevant information for region wide sharing and key gaps/barriers in terms of region wide territorial guidance are identified and discussed further in Section 14.

14 Route to Improved Uptake

Through the process of undertaking this study it has become clear that a regional Model Codes of Practice (MCoP) in the sense that was proposed at the outset of the study is unlikely to be effective in enhancing the uptake of stormwater management techniques and LID. Therefore an alternative approach is required. To explore an alternative route to improved uptake of LID the data collected throughout this study has been subject to a gap analysis to identify where policy and guidance is deficient and where future work could be focused to achieve improved uptake. Figure 13-1 schematically represents this gap analysis and a route to improved LID uptake.

The work carried out to date, particularly views expressed during the interviews, provides an excellent indication of where gaps either exist or are perceived to exist. A graphical representation of the gap analysis is shown (overleaf) with the gaps shown through shading and filled with suggested future work topics.

MCoP have been used as part of the gap-filling exercise where common barriers were determined across all of the local authorities. The MCoP suggested to fill observed gaps have been ranked (Table 11 and are shown in Figure 13-1) to give an indication of the codes which would offer the most significant benefit to the implementation of LID and enhanced stormwater management techniques. The most critical MCoP is considered to be associated with demonstrating operational and capital costs. This would enable local authorities to think about putting LID costs into their forward budget plans, rather than trying to find ways to pay for LID Implementation on an ad hoc basis. Second priority would be the collection and collation of performance data from successful examples of LID implementation. This would increase confidence in the technologies and approaches and therefore perhaps reduce reliance on traditional engineering standards. Also of significant importance would be a Technical Note (or MCoP if workable) to provide examples to local authorities regarding how other policy areas (such as roading or housing density requirements) can impact on LID implementation and how these policies can be re-written to reduce the number of barriers to LID.

Table 11

Ranked Model Codes of Practice (MCoP).

Rank	MCoP
1	CAPEX/OPEX models for LID and enhanced stormwater management.
2	Performance data and successful case studies.
3	Communication pathways for LID projects.
4	Local authority inter-department interaction in LID eg, stormwater with roading and parks.
5	Management of private stormwater devices.

Rank	MCoP
6	Brownfield and retrofit opportunities in LID.
7	Application of LID in industrial/commercial settings.

The above documents serve to fill gaps in the current LID framework of the more active local authorities, however, they are of less use to the remaining local authorities, namely MCC, PDC, FDC, and to some extent RDC. To remedy this, and to provide these local authorities with a robust regulatory and guidance framework a number of technical documents created by other Auckland region local authorities could be cited as part of a "Best Practice" database linked to the ARC's technical publications/reports. It is considered that by creating a route by which local authorities can share their knowledge, information and guidance documents, a more consistent approach can be created across the region. This could be implemented as part of the ongoing TP document revision. Existing technical documents as produced by the local authorities have been considered in depth with regard to their possible use as part of such a regional "best practice" database and are summarised in Table 12.

Regarding the revision of ARC technical publications, a number of points were raised during the cited interview process and should be considered as part of the update process in order add to the effectiveness of LID uptake, and these are included on the Figure 13-1 (shading represents areas for possible improvement).

In addition to several MCoP, further documents/technical information are suggested which would clarify a number of specific areas for the local authorities. In particular the area of ARC jurisdiction with regard to the proposed use of LID approaches would benefit from clarification and documentation.

Table 12

Summary of available best practice documents (January 2009).[1]

Category	Document	Relevant sections	Description
Subdivision development/On-site stormwater management	ACC On-site Stormwater Manual (All development) – December 2002	- 1.0 3.0 6.0 8.0	All development. Applicability. Device selection. Simplified design. Site specific design.
	WCC Stormwater Solutions for Residential Sites – sites les than or equal to 1000m² – November 2004	- 3.0 4.0 5.0 - 9.0 10.0	Sites less than or equal to 1000m² Device selection. Minimisation of Imperviousness. Design. Monitoring and maintenance.
Rural development	WCC, RDC Countryside and Foothills Stormwater Management CoP – July 2005	- Pt A, 4.0 Pt B, 2.0 Pt B, 4.0 - 9.0	Sites greater than 4000m² List of devices and simplified design. Minimisation of impervious areas. Detailed design approach. Monitoring and maintenance.

Category	Document	Relevant sections	Description
		Pt B,10.0	
Soakage	ACC Soakage Design Manual – February 2003	1.0 2.0/3.0 4.0 5.0	Soakage location/consenting. Feasibility and planning. Soakage devices Design.
Design guidance LID approaches	WCC, NSCC, RDC Permeable Paving Guidelines - now incorporated in WCC's Stormwater Solutions for Residential Sites.	2.0 3.0 4.0 - 11.0	Design stage outline. Compliance with TP10,TP108. Design, monitoring and maintenance.
	WCC NOSGA LID Code of Practice (currently in draft)	All	Background information on LID approaches, approach selection for different land use types, design guidance. Cross reference to ARC TP10 where appropriate.
	NSCC Design Guide for Conventional Underground Tanks- February 2002	2.0 - 10.0	Site application, design, maintenance.
	NSCC Rain Tank Guidelines - July 2008	2.0,3.0 4.0	Rain tank sizing and design. Consenting, inspection, maintenance, health and safety.
	NSCC Practice Notes - various publication dates	Various Sheets	NSC01 Stormwater mitigation overview. NSC02 Site imperviousness. NSC03 Minimisation of imperviousness. NSC 04, 05, 06 Permitted residential and non-residential activity – rain tank/bioretention sizing. NSC 20, 21 Single- and dual-purpose rain tanks. NSC22 Detention tanks. NSC 23 Bioretention devices. NSC 25 Green roof.
Engineering and construction standards	RDC Engineering Design and Construction Standards - December 2006	4.0	Mostly traditional. Some mention of LID approaches. General guidance on minimising imperviousness and limited information on design of stormwater management devices.
	NSCC Infrastructure Design Standards - April 2006	3.0 4.0	Transportation and stormwater management. Traditional approaches and list of LID approaches. General guidance on design of stormwater management devices.
	WCC COP for City Services and Land Development – February 2007	4.0	Allows use of LID and lists examples of where LID could be used. Limited design information. Cross reference to ARC technical publications.

Notes: 1. Whilst every effort has been made to reference current versions of the documents as cited in the table above in is noted that many of the local authorities continually review and improve the documents and therefore the publication dates quoted above will change overtime as documents are updated.

2. These documents remain focussed on traditional engineering approaches but of the engineering standards reviewed are the most "accepting" of LID approaches.

As can be seen by Table 12 local authorities could benefit from the sharing of the above information. Local authorities such as Manukau City, Franklin District and Papakura District may be able to identify and relevant guidance without developing further documents themselves.

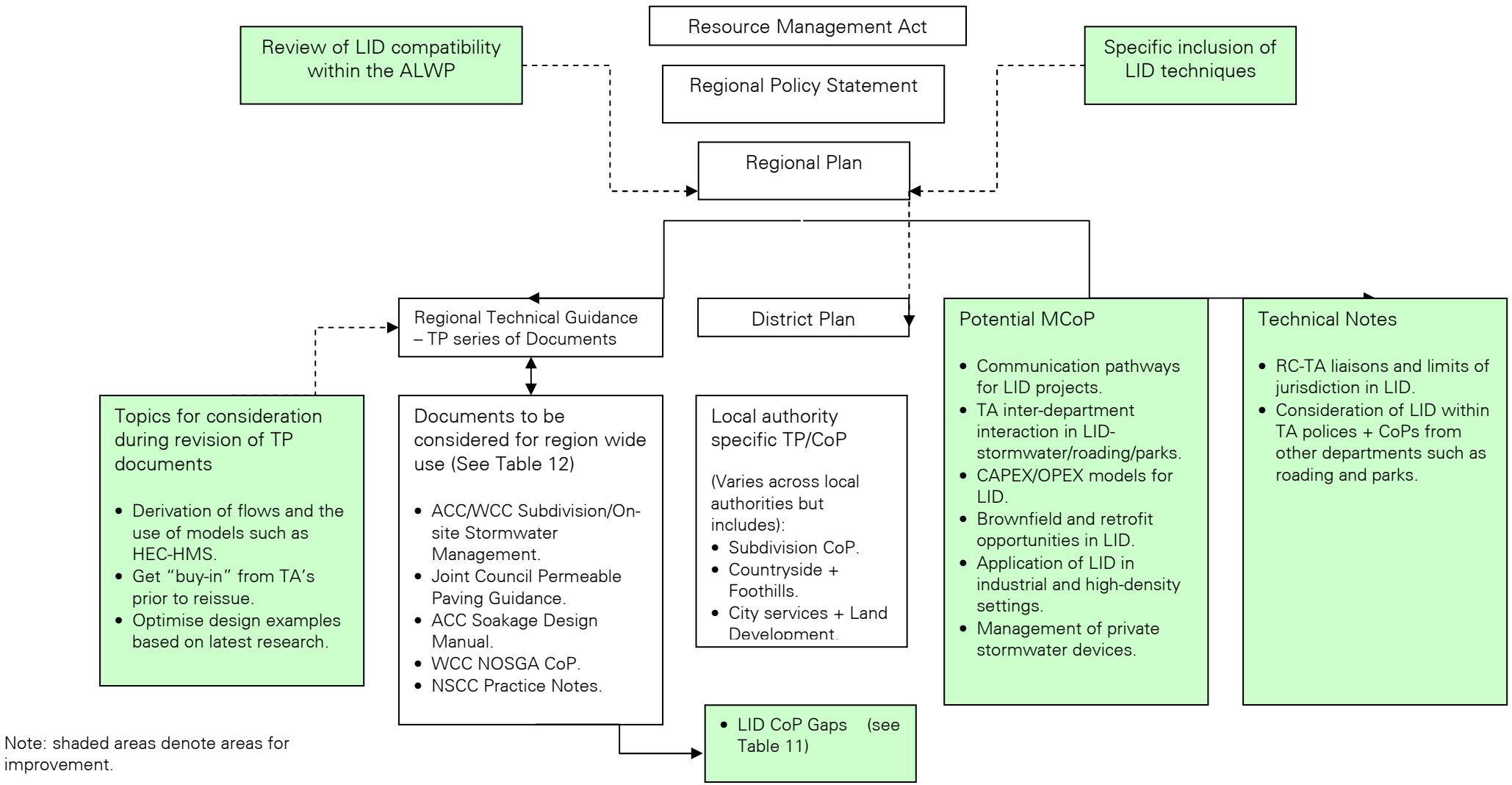
For all local authorities key gaps remain in the areas of stormwater management through LID associated with the following areas:

- roading;
- parks management;
- implementation of LID into industrial/commercial and high-density development;
- management of private stormwater devices; and
- retrofitting LID into brownfields sites.

Further guidance on the retrofit of LID into existing development would also be of benefit to all local authorities. Examples of more general technical advice documents are listed, in addition to the above, in Table 11.

Figure 7

Schematic of route to improved uptake.



Note: shaded areas denote areas for improvement.

15 Limitations

This report was prepared between November 2007 and September 2008 and is based on the conditions encountered and information reviewed at the time of preparation. ARC disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

16 References

[1] www.arc.govt.nz; www.landcareresearch.co.nz

[2] EC A-059/2007

17 Appendix A: LID and District Plan Provisions

The following tables present a summary of the review of the District Plan of the Auckland region, based on the report produced by BECA (2001) and updated for the purposes of this report.

Table 13

Summary of the review of the Auckland District Plan.

Auckland City Council

Issues	Objectives	Polices	Rules
Isthmus section			
5A Natural Resources **Water** • Inappropriate stormwater run-off. • Infiltration of stormwater by contaminants. • Siltation through inappropriate earthworks and vegetation removal. **Groundwater aquifers** Preventing contamination while allowing recharge. **Wetlands** Recognition that these environments are of value for food control and stormwater treatment. **Habitats** Removal of bush can cause greater and faster stormwater run-off with consequent hydraulic impacts and erosion, and an increase in pollutant load carried.	**5A.5** To conserve, protect and enhance the natural environment and resources of the district.	• By developing a systematic approach to the identification of information required to secure the conservation of the districts natural environment. • By ensuring that potential or actual adverse effects on the environment area avoided, remedied or mitigated so as to maintain the quality of the districts environment. **Water** • By imposing controls on earthworks. • By restricting new development to that which can adequately provide for its own drainage needs. • By imposing development controls to protect the stormwater… from contamination and siltation.	

Issues	Objectives	Polices	Rules
		• By having regards to the environmental effects of drainage works associated with watercourses and wetlands. • By recognising the importance of roof run-off and uncontaminated stormwater for aquifer recharge. **Habitats** • By promoting the establishment and maintenance of suitable species of riparian vegetation so as to reduce the run-off of contaminants to stream. **Land** • By controlling earthworks so as to avoid erosion. • By controlling discharges onto land. • By regulating the intensity of new residential development according to the availability of public utilities and services and to foster their efficient use.	
7. Residential Activity 7.2 Residential Management Issues • The need to provide opportunities for innovation and flexibility in accommodating demands for new	7.3.1 To provide opportunities for residential growth in Auckland by encouraging suitable intensification of housing in appropriate locations.	• By developing a systematic approach to the identification of information required to secure the conservation of the districts natural environment.	7.7.1 Earthwork. excavation 7.8.1.4 Maximum building coverage 7.8.1.5 Minimum landscaped permeable

Issues	Objectives	Polices	Rules
housing solutions.		• By ensuring that potential or actual adverse effects on the environment area avoided, remedied or mitigated so as to maintain the quality of the districts environment. **Water** • By imposing controls on earthworks. • By restricting new development to that which can adequately provide for its own drainage needs. • By imposing development controls to protect the stormwater… from contamination and siltation. • By having regards to the environmental effects of drainage works associated with watercourses and wetlands. • By recognising the importance of roof run-off and uncontaminated stormwater for aquifer recharge. **Habitats** • By promoting the establishment and maintenance of suitable species of riparian vegetation so as to reduce the run-off of contaminants to stream. **Land**	surface **7.8.1.6** Maximum paved impermeable surface **7.8.1.7** Yards

Issues	Objectives	Polices	Rules
		• By controlling earthworks so as to avoid erosion. • By controlling discharges onto land. • By regulating the intensity of new residential development according to the availability of public utilities and services and to foster their efficient use.	
11.Subdivisions 11.2 Resource Management Issues • The need to ensure that subdivision takes into account the potential use, development and constraints of land. • The need to recognise and provide for the particular problems associated with developing difficult land in a built environment. • The need to adopt measures that takes account of the effects of the intensification of subdivision patterns on the natural and physical resources of the isthmus.	11.3 To provide for the subdivision of land in a manner which is appropriate for achieving the integrated management of the use, development, and protection of land and associated natural and physical resources of the district.		11.3.6.2 (C) Pavement Edge Design 11.5.6.2 (D) Network Utility Services – Stormwater Drainage design
Hauraki Gulf Islands section			
3.2.2.1 Sustainability In order to achieve sustainable land use of the Hauraki Gulf Islands careful consideration	Part 5 – Strategic Management Areas 5.1.3.1 To protect and preserve significant areas of vegetation,	5.1.3.1, 5.2.3.2, 5.3.3.2, 5.4.3.5, 5.5.3.1, 5.6.3.1, 5.7.3.1, 5.7.3.2, 5.8.3.1, 5.9.3.2, 5.10.3.1, 5.10.3.2, 5.12.3.1, 5.20.3.1: Vegetation protection and removal.	

Issues	Objectives	Polices	Rules
must be given to the need to manage development according to land use capability and the effects of such development. **4.1.3 Resource Management Issues** 4. The need to protect, conserve and enhance the special character of the Outer Island's natural environment. 6. The need to provide appropriate infrastructure… in a manner that is compatible with sustainable land use objectives. 7. The need to consider alternative opportunities for land use activities and development. **4.2.3 Resource Management Issues** 4. The provision of services and infrastructure to meet community needs within the context of sustainable development. 7. The need to protect, conserve and enhance the special characteristics of the natural environment of the Inner Islands.	ecosystems and wildlife habitats. **5.2.3.2** To protect and preserve significant natural features. **5.3.3.3** To preserve the significant ecosystem and wildlife habitat. **5.4.3.1** To preserve the significant vegetation, dune systems, ecosystems and wildlife habitats. **5.4.3.4** To protect and maintain the functions of the wetland systems. **5.4.3.5** To maintain and enhance the natural functions of the steep upper parts of the SMA particularly in terms of the areas natural hydrological… characteristics. **5.6.3.4** To recognise the importance of the steep, upper catchment areas in maintaining appropriate water and soil functions. **5.7.3.1** To maintain and enhance the water quality. **5.9.3.2** To protect the upper catchment areas, the steep vegetated slopes, wetlands. **5.13.3.3** To protect the sensitive areas of the catchment.	5.1.3.1, 5.1.3.1, 5.2.3.2, 5.3.3.3, 5.4.3.1, 5.6.3.1, 5.9.3.2, 5.10.3.1, 5.13.3.3: By limiting the location, scale and intensity of any land use activities. 5.2.3.2, 5.3.3.1, 5.3.3.2, 5.3.3.3, 5.5.3.1, 5.6.3.2, 5.7.3.1, 5.8.3.2, 5.9.3.2, 5.10.3.1, 5.12.3.1, 5.13.3.3, 5.16.3.2: Effects on water systems and water quality. 5.1.3.2, 5.4.3.1, 5.5.3.2, 5.6.3.2, 5.6.3.4, 5.7.3.2, 5.8.3.1, 5.10.3.2, 5.12.3.1, 5.16.3.1, 5.19.3.2: Earthworks. 5.1.3.2, 5.5.3.1, 5.6.3.3, 5.11.3.3, 5.12.3.2, 5.19.3.3 Natural Landforms and landscape.	

Issues	Objectives	Polices	Rules
	5.14.3.1 To preserve and protect the natural environment **5.16.3.2** To enhance the natural environment. **5.17.3.1** To ensure the preservation and enhancement of the natural habitats. **5.18.3.1** To protect and enhance the natural and physical environment when providing for future growth. **5.19.3.3** To protect the physical and natural environment to facilitate sustainable land use.		
	Part 6 – Land Units **6.11.3.1** To provide for residential development which maintains neighbourhood amenities and the quality of the local environment. **6.11.3.4** To ensure that the quality of natural water bodies and potable water sources are not compromised by development.	**6.11.3.1A** By controlling the density of development. **6.11.3.4** A By ensuring that development will not lead to siltation or degradation of natural watercourses.	**6B Standard for Permitted Activities** 6B.1.2.4 Maximum Lot Coverage 6B.1.2.5 Gross Dwelling Area 6B.1.3.3 Indigenous Vegetation Clearance 6B.1.3.6 Earthworks **6C Standards for Discretionary Activities** 6C.1.2.4 Maximum Lot Coverage 6C.1.2.5 Gross Dwelling Areas

Issues	Objectives	Polices	Rules
			6C.1.3.3 Indigenous Vegetation Clearance 6C.1.3.6 Earthworks
8.2 Resource Management Issues • Recognise the inherent constraints of the natural environment. • Maintaining and enhancing water quality through adequate wastewater and effluent treatment and disposal, and stormwater disposal and dispersion.	Part 8 – Subdivision 8.4.2 To provide for and foster subdivision which leads to the protection of areas of high environmental values.	8.4.2C By establishing subdivision rules providing for the creation of lots which protect the natural environment.	

Franklin District Council

Issues	Objectives	Polices	Rules
5B.1 Conservation Issues • Vegetation . • Wetlands.	5.2.1 Ecosystems To avoid, remedy or mitigate the adverse effects of activities on the life support capacity of indigenous ecosystems. 15.1.1.2 To ensure that network and other utilities and essential services are provided in such a manner that: avoids, remedies or mitigate any adverse	1. To control the effects of activities where they compromise, directly or indirectly, the life supporting capacity of any indigenous ecosystems including those ecosystems which cross the boundary of Mean High Water Springs. 2. That priority be given to avoiding any adverse effects of land subdivision, use or development on those areas identified in Schedule 5.A.	15.1.2.2 (L) Stormwater Control and Pollution Prevention

	effects on the natural physical resources.		
16.0 Rural **16.1** Sustainability and productive potentials Land: Fragmentation into smaller lot sizes. Soil: Erosion due to poor cultivation and other management practices. Water: Decline in aquifer levels and pollution by agricultural and horticultural chemicals.	**17.1.1** Land and soil resources management To manage land and soil resources in such a way that their accessibility, versatility and life-supporting capacity are sustained for present and future generations. **17.1.2** Sustaining soil resources To safeguard the life-supporting capacity of the soil **17.2.1** Protecting water resources To avoid, remedy or mitigate the adverse effects of land use activities to ensure that the life-supporting capacity of ground and surface water resources is safeguarded	1.That the land and soil resource are maintained in a title structure that safeguards their accessibility, versatility and life-supporting capacity and enables a wide range of activities to establish and operate on a long-term sustainable basis. 2. That subdivision and subsequent development avoids, remedies or mitigates any adverse effects on the present and future accessibility of land and soil resources… 1. That the loss or reduction of the versatility and life-supporting capacity of soils be avoided, remedied or mitigated. 2. That the consideration of alternative locations or site be part of the assessment of an application where it can be seen that this would result in the avoidance of significant adverse effects. 1. Significant adverse effects shall in the first instance be avoided and where this is not possible remedied or mitigated. 2. Alternative locations	**22.1.6 (2)** Water management and protection of land **22.1.6 (4)** Effects on native bush or wildlife **22.1.6 (6)** An effective stormwater disposal system **23.6 (4)** Earthworks **23.9 (3)** Site Suitability **23.10 (4)** Wastewater and Stormwater Treatment and/or Disposal **23.10.2 (9)** Earthworks

18.0 Urban 18.1 Growth of main urban areas 18.2 Growth of small urban settlements 18.4 Managing residential areas	**19.3.1** Residential choice To provide for a range of residential lifestyle choices in and adjacent to Franklin's existing urban areas. **19.3.5** Residential Standards To achieve a consistent standard of on-site amenity and servicing for all residential activities and to facilitate the creation of freehold titles. **19.3.6** Improve Residential Amenities To improve and enhance the amenities and infrastructural resources of the	or sites should be considered where this would result in avoidance of significant adverse effects. 3. Activities shall not adversely effect the quality and availability of surface and ground waters. 1. That the Plan provides for residential activities on both serviced and un-serviced land within urban areas, and in selected peripheral (rural) areas, as appropriate to the character , attributes and resource constraints of the locality. 2. That the Plan's regime of subdivision and development controls be designed and administered to recognise the differing attributes of urban land and to give scope for innovative residential subdivision, development and house designs. 1. That the same on-site standard of living amenity and convenience be required for both single house and multiple-unit housing developments through policies and rules… 2. That as far as practicable the private service line of each reticulated service, for each dwelling unit in a residential development, shall run separately from … a	**26.6.12** Stormwater Management **27.6.1.17** Earthworks **27.6.1.18** Stormwater Management

	residential areas of the District	public line (in the case of water, sewerage or stormwater). 1. That council continues to investigate new (or upgrade) sewage treatment, stormwater treatment and control and water supply systems.	

Manukau City Council

Issues	**Objectives**	**Policies**	**Rules**
9.0 Land Modification, Development and Subdivision **9.2.1** The process of land modification, development and subdivision can cause adverse effects on the environment, such as alteration of natural features and landscape, deterioration in water quality and destruction or degradation of the amenity values of an area. **9.2.3** Land modification, development and subdivision can create of exacerbate natural hazards, potentially causing adverse effects on human life and property and other aspects of the environment. **9.2.4** Inadequate provision of infrastructure and public utility services does not enable the sustainable management of	**9.3.1** To enable land modification, development and subdivision to proceed in a manner that will maintain of enhance the environmental qualities of the environment. **9.3.4** To ensure that land modification, development and subdivision do not create or exacerbate natural hazards and that they do not increase the potential for natural hazards to adversely affect the environment. **9.3.5** To ensure the provision of an adequate standard of infrastructure and public utility services at the time land is modified, developed or subdivided to avoid, remedy or mitigate any adverse effect on the environment… **9.3.6** To ensure that stormwater management areas are either vested in, or owned by council, so as to:	**9.4.1** Land modification, development and subdivision shall occur in such a way that: (e) enhances natural process and features including drainage patterns, protected streams, and riparian vegetation to avoid, remedy or mitigate adverse water quality, through all phases of the water cycle from waterborne pollutants. **9.4.3** Land modification, development and subdivision in stormwater management areas should occur in such a way that: (a) protects the performance of natural overland flow paths, open watercourse and streams; (b) protect water quality by the use of filtering mechanism such as riparian vegetation, stormwater treatment ponds and retention of wetlands;	**9.5.1.1** Managing Framework for Land Modification, Development and Subdivision in the city. **9.8.3** Stormwater Management Areas **9.9.1.2 (a)** Site Preparation **9.9.1.7** Sediment Control **9.9.1.8** Run-off Control **9.9.1.11** Flooding **9.9.2.2 (c)** Design and Layout of subdivision **9.9.2.7** Vesting of Land for Stormwater Management Purposes **9.9.2.11 (iii)** Width of Carriageways **Appendix 1:** Engineering and Performance Standards: Earthworks Land Drainage

Issues	Objectives	Policies	Rules
natural and physical resources, including land and structures. **9.2.5** Flooding can adversely affect human life and property and cause erosion in vulnerable catchments. **9.2.6** Poor water quality can affect the life supporting capacity of streams and receiving environments.	(a) minimise risk of flooding to life and property; and (b) avoid or remedy effects on water quality of receiving environments.	(c) provides stormwater management in an integrated and cost effective manner.	ASSESSMENT CRITERIA **9.12.6 (a) – (e)** Earthworks **9.12.10** Stormwater Management Areas
12 Rural Areas **12.2.3** Activities in the rural areas can cause a reduction in the productive potential of the land and soil resources from subdivision, soil coverage, and soil modification. 12.2.5 Activities in the rural areas can have adverse effects on the water quality and natural character of rivers and streams.	**12.3.1** To manage the rural land and soil resources in such a way that they retain their productive potential, and minimise soil erosion. **12.3.2** To protect significant areas of indigenous vegetation and fauna occurring in the rural area. **12.3.5** To maintain and enhance the quality of rural water sources including rivers, streams and groundwater.	**12.4.1** The land and soil resources should remain in a title structure that enables a range of activities to occur and operate in a way which efficiently and effectively utilises the soil and land resources. **12.4.4** Buildings, structures, and activities in the rural area should not compromise the future productive potential of the land and soil resources of the city, particularly high-quality soils.	**12.11.1.3** Building Coverage **12.11.1.4** Removal of Topsoil
13 Residential Areas **13.2.1** Residential development has the potential to have adverse effects on the quality of the natural environment.	**13.3.1** To protect the natural environment from the adverse effects of development in residential areas and to promote the efficient use and development of the city's resources.	**13.4.1** Residential areas should be developed in a way that avoids, remedies or mitigate adverse effects of activities on the natural environment… **13.4.3** There should be a diversity of residential subdivision and development provided	**13.11.1.3** Intensity Conditions (a) Density (b) Maximum site (building) coverage

Issues	Objectives	Policies	Rules
		that. 13.4.7 Development in residential areas should occur in a way which respects the contribution that areas of ecological importance, landform, and vegetation.	
16 Future Development Areas 16.2.1 Urbanisation can give rise to adverse effects on the natural resources, amenity and heritage values of the city. 16.2.2 The development of new urban areas can give rise to the inefficient use of land, energy and physical resources.	16.3.1 To avoid or mitigate the adverse effects of urbanisation in natural and physical resource. 16.3.2 To ensure the sustainable use of natural and physical resources as urbanisation occurs. 16.3.5 To ensure land identified for urban development is suitable for such activities.	16.4.3 New urban development shall be designed to achieve a high-level of environmental performance which: protects and where possible enhances water quality, particularly from the effects of sediment in the land conversion process. 16.4.4 New urban development should be designed to achieve a high-level of environmental performance. 16.4.6 New urban development will occur in such a way that: retains natural landforms, vegetation and feature where appropriate; minimise land re-contouring, bulk earthworks and modification of natural streams.	16.6.1.2 Structure Plans

North Shore City Council

Issues	Objectives	Policies	Rules
8. Natural Environment 8.2 Natural	8.3.2 Ecosystem	3. By seeking the	8.4.2 Protection of

Issues	Objectives	Policies	Rules
Environment Issues • How to best protect the integrity of important ecosystems. • How to protect outstanding natural features and landscapes from inappropriate subdivision, use and development. 1. How to retain areas of native bush, coastal pohutukawa and trees where they possess ecological and landscape values. • How to manage stormwater discharges taking account the effects of surrounding land use on the natural environment.	To protect and enhance significant habitat of native fauna and flora to maintain biodiversity, and for their intrinsic, educational and recreational values. **8.3.4** Tree Management To promote amenity values in both the urban and rural areas by maintaining and enhancing the tree cover present in the city. **8.3.5** Stormwater Catchment Management Stream Protection: To protect the natural character and ecological amenity and recreational values of rivers, streams and	provision of suitable buffer of underdeveloped land around water bodies. 6. By avoiding earthworks and vegetation removal affecting ecosystem and habitats. 7. By requiring maximum on-site absorption and vegetation filters to protect receiving waters from the adverse effects of stormwater flow affecting ecosystem and habitats. 1. By protecting areas of native bush which contributes significantly to the landscape. 1. By maintaining and enhancing native vegetated buffers adjacent waterways to avoid or mitigate the effects of surface erosion, stormwater contamination, bank erosion and increased surface water temperature. 2. By requiring revegetation and avoiding impermeable	Habitat **8.4.6** Tree Protection

Issues	Objectives	Policies	Rules
	other natural bodies of water.	surfaces and earthworks within the margins of waterways. 5. By retaining natural open waterway systems for stormwater run-off, to the greatest extent possible, unless adequate maintenance is not feasible or there is a threat to life and property. 9. By avoiding buildings and structures in proximity to waterway margins. 12. By avoiding the situation where stormwater run-off from new development exceeds the downstream ability to accept the water without an increase in downstream flooding or channel erosion.	
	Stormwater Control: To adopt a comprehensive approach to river and stream management and avoid, remedy or mitigate stormwater contaminants and sediment discharge from land-based activities.	1. By considering stormwater management (including stormwater quality and quantity) as an integral component of overall site development or redevelopment. 2. By avoiding development in areas that are subject to a one-in-100-year flood for the fully urbanised catchment, and protecting the integrity of the 1% AEP flood plain. 4. By minimising run-off peaks as a result of	

Issues	Objectives	Policies	Rules
		stormwater disposal. 5. By encouraging stormwater management including biofiltration practices as a means of removing or reducing contaminants contained in stormwater run-off. 7. By clustering site development to protect natural areas, reduce total catchment imperviousness and to reduce the area extent of imperviousness. 8. By requiring water quality treatment for stormwater run-off post development as well as during land development. 9. By ensuring that secondary/overland flow paths and open main drains are unobstructed by development. 10. By avoiding land disturbance and vegetation removal, particularly in sensitive catchments with high ecological value. 11. By ensuring that land use activities that have potential to produce significant stormwater contaminants control contaminant sources on-site through appropriate stormwater management measures.	
	On-site Stormwater Management: To mange stormwater run-	1. By managing the	

Issues	Objectives	Policies	Rules
District Plan Change 22 • How to manage changes to the ecological, amenity and landscape values associate with streams in the city.	off from impervious areas on-site to protect and enhance the water quality and ecological values of waterways throughout the city (District Plan Change 22).	effects of stormwater run-off within Stormwater Management Areas (SMA)… reflecting the sensitivity of the receiving environment, the ecological, and amenity values of streams, and potential for stream bank erosion and flooding. 2. By having regard to relevant Integrated Catchment Plans or Catchment Management Plans when considering appropriate on-site stormwater techniques. council may implement further plan changes as required to provide consistency with Integrated Catchment Management Plans as they are developed. 3. By managing the effects of increased impervious areas by addressing annual run-off volumes and peak flow rates for a range of rainfall events. 4. By managing stormwater discharged from sites through a treatment train approach, reducing impervious surface areas. 5. By ensuring that spare capacity in the piped stormwater network is not relied upon as a reason for increased impervious areas on a site, or for avoiding the implementation of	

Issues	Objectives	Policies	Rules
		appropriate on- site stormwater management. 6. By ensuring that proposal for multiple-site or community owned stormwater mitigation measures are determined in terms if their consistency with the council's Stormwater Management Practice Notes. 7. By limiting impervious areas to avoid or mitigate adverse effects on urban amenity, ensuring that on each site there is opportunity for green space comprising lawns, soft landscaping and vegetation. 2. By ensuring that soil/sediment run-off resulting from vegetation clearance and earthworks is controlled in order to avoid, remedy or mitigate adverse effects on amenity and habitat. 3. By ensuring that new subdivision and development recognises existing natural features and landscapes and that the form of development reflects the character and environmental qualities of the location. 5. By ensuring that subdivision and development is designed and located	

Issues	Objectives	Policies	Rules
		such that it does not cause or contribute to, and/or be significantly affected by, natural hazards such as flooding, subsidence and erosion. 4. By requiring the provision of water to, and the disposal of sewage and stormwater from, each lot in a subdivision in a manner and design approved by the council. 5. By enabling, where appropriate, the provision of alternative means of stormwater and sewage disposal. 7. By ensuring provision of the necessary infrastructure in advance of, or concurrent with, any subdivision or building work.	
9. Subdivision and Development • Loss of vegetation (both native and exotic), resulting in the loss of habitat, amenity values and diversity in the urban landscape. • Increased soil/sediment run-off and changes in hydrology associated with vegetation clearance and earthworks with the consequential	**9.3.1** Protection of the Environment To avoid, remedy or mitigate the adverse effects of subdivision and development on the environment, including the physical environment, biota, amenity values and landscape. **9.3.3** Servicing development To ensure that the servicing of new development is planned and implemented in an efficient manner and such as to avoid or mitigate any adverse environmental effects.		**9.4.1.1 (a)** Site works **9.4.1.3 (d)** Site works **9.4.1.4 (a) (b)** Site works **9.4.3.2** Sediment control **9.4.4.12 (b)** Standards for the provision of utility services

Issues	Objectives	Policies	Rules
adverse effects on amenity values and terrestrial and aquatic ecosystems. • Alteration of landforms due to re-contouring, infilling and realignment of watercourses (including channelisation), resulting in loss of landscape amenity value and diversity in the urban environment, and loss of aquatic habitat. • Where the provision of infrastructure is inadequate or poorly co-ordinated, new development strains or exceeds the capacity and performance of existing infrastructure and has the potential to adversely affect the natural environment and the health and safety of people and communities. • Development contributing to, and/or being significantly affected by, natural hazards such as flooding, subsidence and erosion.			**9.6.4** Site management plans **9.6.5 (3)** Geotechnical and hydrological reports. **9.6.6** Alternative services. **Assessment Criteria** **9.7.1.1 1 (a) (b) (e) (f) (g) (k)** - The design and implementation of site works. **9.7.1.1 5 (b) (c)** - Utility services, drainage, water, wastewater, electricity, roads. **9.7.1.12 (a) (d) (f) (g)** Layout and design of the subdivision. **9.7.1.15 (iii)** Design of stormwater systems. **9.7.3.2 (b)** Soil instability. **9.7.3.2 (v)** Controlling erosion. **9.7.3.2 (vi) (e)** Adverse ecological effects. **9.7.3.2 (vi) (f)** Natural landforms. **9.7.3.2 (vii)** Adverse effects on landscape features.

18 Appendix B: Interview Questionnaire and Summaries

18.1 Questionnaire

URS New Zealand Ltd (URS) have been commissioned by Auckland Regional Council (ARC) to undertake a review of current regulatory requirements, Codes of Practice, design manuals and other guidelines. Through consultation with stakeholders URS will identify how stormwater management is currently implemented and the strengths, limitations and barriers encountered relating to stormwater/sediment management and the implementation of low impact design (LID). Through this review URS are tasked with:

- Finding out how stormwater management is currently approached and what guidance documents are currently used by local authorities.
- Determining whether Model Codes of Practice would be beneficial to local authorities and if so how they could best serve Authorities in the fulfilment of their statutory obligations.
- Identifying what Model Codes of Practice are required and how they can be linked with each other, and other guidance in order to promote enhanced stormwater management and LID use.

The following questionnaire has been established to identify what guidance documents are used within local authorities and importantly how these documents are interpreted and implemented. A number of questions have also been included to determine how best any issues/barriers can be resolved and how best Model Codes of Practice could be used to support local authorities in fulfilling their statutory duties.

It is important to note that this questionnaire represents the first phase of consultation in the preparation of Model Codes of Practice (MCoP) and there will be further opportunities for each of the local authorities involved to contribute to the form of the final MCoP documents.

Given the above we would be grateful if you could respond to the following questions as fully as possible, giving examples where appropriate:

1. How does your role relate to stormwater and sediment management?
2. Have you heard of low impact design (LID)? If so please explain what you understand this term to mean?
3. List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment

management and any relating to LID; these can be national, regional, local and other in-house documents/methods. Please outline how these documents are used.

4. To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?
5. To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?
6. To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?
7. What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?
8. List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?
9. What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?
10. Is there anything that you would prefer to see included in applicants submissions?
11. For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?
12. In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?
13. What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?
14. What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?
15. Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?
16. Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?
17. How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?
18. What is your understanding of:

a. Your team/department's overall current approach to or view of LID?

b. Your organisation's overall current approach to or view of LID?

19. What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?

20. Do you consider that the development of a Model Codes of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?

21. What would you like to see included in a Model Codes of Practice for Enhanced Stormwater Management and the Implementation of LID?

22. Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?

18.2 Auckland City Council/Metrowater

The following transcript contains a summary of views expressed during interviews of staff from various departments within Auckland City Council (ACC) and Metrowater, conducted by URS New Zealand. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. How does your role relate to stormwater and sediment management?

Table 14

Departments interviewed.

Department	**Role**
Metrowater Environmental	Aspects of stormwater management, asset management and catchment management.
Transport	Management of roading assets. Review design components of roading and traffic projects.
Consents/Development Engineering	Development and engineering for approving resource consents.
Parks	Integrating stormwater and sediment management with operation and maintenance of parks.

2. Have you heard of Low Impact Design (LID)? If so please explain what you understand this term to mean?

There was general appreciation of the term LID to mean a stormwater management approach which minimises adverse effects on the environment. Some interviewees went further to describe LID as an urban design approach

which maintains natural topography and drainage and minimises the use of hard engineering structures and surfaces.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

   The following plans, policies, regulations, technical publications and legal documents were cited by the ACC/Metrowater staff interviewed:

   National

   RMA.

   LGA.

   Drainage Act.

   NZS4404 Subdivision Development.

   NZWERF On-site Stormwater Management Guideline (October 2004).

   NZWWA National Modelling Guidelines (June 2004).

   Regional

   Auckland Regional Plan Coastal.

   Auckland Regional Plan Sediment Control.

   Proposed Auckland Regional Plan Air Land and Water.

   ARC Technical Publications (TPs): TP10, TP108, TP124, TP90.

   Local

   ACC District Plan.

   ACC Stormwater Bylaw.

   ACC On-site Stormwater Management Manual.

   ACC Code for Urban Subdivision and Development/

   ACC Asset Management Plans.

   Memorandum of Understanding between ACC Transport, ACC Utility Management and Metrowater.

   ACC and Metrowater Development connection standards.

   ACC Policies on Private use of Public Space.

   ACC Open Space Framework.

   ACC Parks Action Plan (2007).

ACC Urban Forest Plan and Coastal Plan – in progress.

Outputs from the Integrated Catchment Study (ICS) and Catchment Management Plans.

Other in-house documents/methods

Technical material from suppliers of proprietary products.

4. **To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?**

   In general it was felt that most of the documents do not preclude best stormwater practice or LID but they do not actively encourage it either. Those that do seek to encourage in principle are often lacking in practical advice.

   Many of the engineering standards commonly used favour traditional stormwater management approaches.

5. **To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?**

   It was felt that whilst the general principles of stormwater management were reasonable consistent the interpretation and practical implementation of them is very varied.

   Regional documents such as the Regional Plan – Air, Land and Water support a Best Practicable Option (BPO) approach and ARC TP10 was produced as a guideline but is often used a mandatory minimum standard thus impacting on the development of a BPO and justification approach.

   The ACC District Plan is currently under review and, at the moment, does not give a message that is consistent with documents such as the On-site Stormwater Management Manual.

   Devices and management approaches recommended in some of the more technical documents cannot be consistently applied to every situation as they are not suitable for all areas.

   In general the documents are not used in an integrated manner.

6. **To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?**

   A wide range of perceived documentary barriers were listed:

   - Documentary inconsistency leads to developers playing off one document against the other.
   - The provision of minimum standards does
   - No guidelines for Parks.
   - Some documents are out of date with

not require the use of specific methods and tend to favour traditional approaches.

current best practice.

- When in doubt the practitioner will tend to refer upwards to District Plan or RMA requirements which are general and non prescriptive.
- Lack of organisational emphasis on the use of LID.
- The regulatory framework for the use of LID is weak.
- LID is often used a trade off against the less desirable features of a development.

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

   ACC Soakage Manual, Urban Code of Subdivision, Development Connection Standards, TP10, TP108, TP90.

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   TP108, TP10 and the rational method for smaller sites.

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   The most common management approaches for land development projects are:

   - Detention tanks.
   - Pipe upgrades.
   - Line extensions.
   - Connections to the combined system.
   - A few detention ponds.

   For smaller projects and roading issues devices such as storm filters, enviropods and rain gardens are quite common.

   Typical omissions include interpretation of the outputs from models or hydrological calculations. These need to be interpreted with reference to the District Plan and the RMA and demonstrate the Best Practicable Option (BPO).

   Calculations often contain gross errors.

10. **Is there anything that you would prefer to see included in applicants submissions?**

Parks expressed a preference for "softer" stormwater management options within parks and that aesthetics be considered.

ACC has also developed its own catchpit inserts that it would prefer to see used rather than those currently available.

It would be useful for applicants to demonstrate and justify the proposed BPO position.

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    All brownfields.

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    Perceived barriers expressed included:

    - Lack of willingness by developers/applicants to embrace LID.
    - Traditional approach favoured by engineers.
    - Lack of cost and performance data for LID approaches
    - Perceived technical limitations of devices.
    - Lack of technical skills.
    - Perception of increased construction and maintenance costs.
    - Lack of willingness to engage with urban planners and landscape architects.
    - Differences in mindset and skillset of engineers and urban/open space planners.
    - Lack of effective communication between consultants and clients (the applicants).
    - LID approach may increase consenting time and costs.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

    ARC documents that support the use of rain gardens in a roading environment was considered unhelpful.

    The current District Plan and transport policies were felt to limit the uptake of LID.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

A discretionary approach does exist involves considering good engineering practice, peer review, advice from the engineering community and agreement with asset owners.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    Yes.

    First – At a national level it was considered that a regulatory directive to set out minimum requirements. The current regional and local regulatory system is too fragmented to be proactive.

    Secondly – Regional level policies will be required to support the National Directive as will local level codes and standards.

    Improved co-ordination and cooperation between ACC and ARC is also required.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    The potential benefits proposed were:

Advantages	Disadvantages
Water quality improvements.	Harder to maintain planting than mow grass.
Aesthetic improvements.	An take up more space than traditional solutions.
Retain habitats.	Uncertain how to dispose of waste products.
Better amenity.	Increased operating costs.
Lower construction costs.	Closer links with social and cultural objectives.
Closer links with social and cultural objectives.	
Opportunities for development of site specific solutions.	

17. **How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?**

    Maintenance of all stormwater assets is scheduled and contracted out.

18. **What is your understanding of:**

    a. **Your team/department's overall current approach to or view of LID?**

    b. **Your organisation's overall current approach to or view of LID?**

Team views – A range of team views were expressed from sceptical to generally supportive of LID and some felt their team did not have a clear view point.

ACC – It was considered that ACC has a fragmented view, some supported the idea in principle and others felt that practical implementation was problematic.

19. **What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?**

    The best opportunities were perceived to be within new and larger scale developments. These tend to be owned by larger commercial type enterprises which can bear cost of implementation and are relatively easy to check on.

    Parks felt that drainage reserves particularly those that are boggy or known to have flooding problems could be used for stormwater management as they are of little use for other purposes.

    Potentially new park developments could accommodate stormwater management as part of their initial design which is much more effective than retrofitting.

20. **Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?**

    Yes, it would be useful. Especially if it helped with the development of a quick an easy permitted activity route to consenting. Standard design would be useful. It should assist local authorities with the implementation of LID. It should remain a guideline rather than prescriptive document.

21. **What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?**

    Clearly state the roles and responsibilities of the stakeholders including ACC and ARC.

    Specify communication channels between local authorities and ARC.

    Specify agreed processing timeframes for consents.

    Allow for site specific characteristics and maintenance costs to be taken into account in LID approach selection.

    Include performance data obtained over a reasonable time period in a real situation rather than in a laboratory.

    Summarise capital and maintenance costs for each possible approach.

    Provide operation and maintenance guidelines.

    Provide a mechanism for BPO selection and agreement.

    Be similar in format to the NSCC silt control type document.

    Include a soakage section.

Provide standard off the shelf solutions.

Clarify the requirements and suitability of a range of solutions.

General level detail.

Flexible enough to cope with rural and urban catchments.

Include site specific situations.

TP10 is much more stringent than it needs to be.

Practical advice on the implementation of LID.

Include aspects relevant to parks.

Show pictures of successful examples.

Could include design standards.

Could include a range of plant species to enhance diversity.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

Training of local authorities, developers and engineers.

Research design parameters, guidelines and performance data and communicate it.

Sell the benefits of LID to practitioners and developers.

Consider the role of proprietary devices.

Simple installation and maintenance instructions.

It would be useful if ARC were more open to effects based discussions in determination of BPO. Regulators need to be more flexible.

On going co-ordination and communication between local authority and ARC.

18.3 Franklin District Council

The following transcript contains a summary of views expressed during interviews of staff from various departments within Franklin District Council (FDC), conducted by URS New Zealand. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. **How does your role relate to stormwater and sediment management?**

Table 15

Departments interviewed at Franklin District Council.

Department	Role

Department	Role
Stormwater Asset Management	Managing all aspects of stormwater assets and catchment management.
Transport	Design components of roading and traffic.
Planning	Development and planning for urban WCC growth areas.
Consents/Development Engineering	Development and engineering for approving resource consents.
Parks	Integrating stormwater and sediment management with operation and maintenance of parks.

2. **Have you heard of Low Impact Design (LID)? If so please explain what you understand this term to mean?**

   A range of views were expressed and are summarised below:

   To manage the effects and flows of stormwater in a more natural way and to minimise the effects on the environment.

   Close to source treatment, aquifer recharge through soakage and enhancing natural environments and vegetation.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

   The following plans, policies, regulations, technical publications and legal documents were cited by the FDC staff interviewed:

   National

   General response was to refer to no national documents; although the Road Controlling Authorities (RCA) Forum and the LGAAA were mentioned.

   Draft MfE publications with respect to Climate Change were also mentioned but not specifically cited.

   Regional

   General response was to cite the ARC Proposed Regional Plan: Air, Land & Water.

   ARC Auckland Regional Plan: Coastal.

   ARC technical publications with respect the stream management.

   Waikato Regional Plans.

   Local

   General response was to cite the FDC District Plan and the FDC Code of Practice for Subdivision and Development.

FDC Asset Management Plans.

FDC Riparian Management Plan.

Other in-house documents/methods

An FDC Urban Design Guideline document was mentioned by one interviewee. It is currently in draft form.

4. **To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?**

   A range of views were expressed and it was noted that the FDC Code of Practice for Subdivision and Development is now out of date and FDC are considering using Hamilton City Council's engineering standards instead. The code as it stands does not refer to LID.

   Some regional plans refer to LID but are difficult to follow. The ARC TP10 approach can be considered overly prescriptive.

   There is room for innovation in the designs at a local level through negotiation with applicants.

5. **To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?**

   Mixed response – some people felt that there was a good link, whereas others did not. It was noted that LID was mentioned in regional publications but not in any detail.

6. **To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?**

   Barriers mentioned include:

   Questionable robustness and practicality of LID approaches.

   Preference for off the shelf, proven devices.

   The willingness for the council to accept LID systems.

   Communications between and different jurisdiction of ARC and FDC.

   Too many steps in the planning process for non standard solutions.

   Cost of products.

   Lack of staff/resourcing.

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

The approaches that are chosen are often the tried and tested engineering solutions. It is hard for the FDC Regulatory team to consent LID as the current Engineering Code is focused on hard engineering. Approach is often based on FDC design standards as the council will ultimately be more likely to accept these designs.

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   FDC actively encourage infiltration (there are rules in the District Plan) and there is a simplified calculation that FDC has developed associated with this. Applicants often refer to TP108 – supporting hydrological analysis. For small subdivisions only use an ordinary, rational formula.

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   They are often included for infiltration and soakage. They may include a rain garden. There is a reliance on CMPs/ICMPs, particularly for locating larger council managed ponds.

   Detention ponds are common and depending on terrain may be online or offline, shallow or deep. These are often located further upstream than they used to be as sites downstream are often more expensive and harder to find. For an industrial park, ponds may be used to improve aesthetics, which often gets a better response from the community.

   Flood control and overland flow control designs are vital, particularly in areas with high densities.

10. **Is there anything that you would prefer to see included in applicants submissions?**

    Reponses were varied and included: the use of an UpFlo Filter; harvesting rainwater from roofs; and a management plan for each application to show how species or areas will be managed in association with stormwater assets.

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    Reponses were mixed. They ranged from 80 to 95 per cent greenfield to 55 to 80 per cent brownfield.

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    Responses included:

    Cost/expense and funding.

Enforcement of maintenance and monitoring of privately owned devices.

Lifestyle/convenience attitudes of communities and willingness of the community to act cooperatively for large-scale projects.

In-house skills and lines of responsibility within FDC.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

    Reponses were mixed and there are different requirements and objectives from different disciplines. There are often different priorities faced by different disciplines, eg road safety, use of recreational space etc.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

    At the development plan stage there is plenty of scope to consider non-standard approaches, if they work. The applications are handled through the Regulatory team. Innovative methods or products would be encouraged as it is a developing field. There is never just one solution or a standard approach as each project is unique.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    Responses varied and included:

    LID should be considered as an option, it is not "LID at all costs".

    A total change in psyche is required from engineers and the community and this is difficult but it may be feasible if it is well planned.

    National guidance/standards/consistency between regions would assist with the uptake of LID.

    ARC to demonstrate and communicate the factors contributing to successful LID installations.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    Reponses varied and included:

    Improved visual impact and potential to attract wildlife.

    Encouragement of infiltration as there is a benefit to the District.

    LID may only be realistic if included from the beginning in larger projects.

17. **How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?**

There are only a few stormwater treatment systems in the district. The systems do need to be cleared and maintained. Asset management are responsible for the stormwater devices and networks where they exist and roading is responsible for catchpit cleaning.

18. What is your understanding of;

    a. Your team/department's overall current approach to or view of LID?

    b. Your organisation's overall current approach to or view of LID?

    FDC are supportive of the general principles, but are wary of the cost aspects and the ease of maintenance. There needs to be a consistent view across the whole organisation. Mention was made of different requirements for each discipline.

19. What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?

    There are opportunities for LID in FDC; it is a matter of having the right development and technologies in the right area. It would be easier to integrate LID into in greenfield areas as it is very difficult to retrofit. It is important to consider LID as part of a greenfield project right from the beginning.

20. Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?

    There were a few concerns that an MCoP would focus on the urban requirements and would not be appropriate for rural areas. However, a code would be valuable if it was able to accommodate more rural districts. It would be useful for disseminating knowledge. A toolbox approach would be best (ie a non-prescriptive approach).

    One interviewee commented that the use of the term "Code of Practice" is a worry as a Code of Practice should be adhered to. It should be a best practice guideline document that promotes the sharing of information, which also includes good cost-effective solutions for a number of options.

21. What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?

    The Code should deal with small townships (eg 500 to 1000 people) as this will reflect rural attitudes and allow for a choice of the direction in which they should go. Town growth is often unplanned and needs to look at existing and future demands so should include provisions for future growth.

    A template-type approach may be useful for each local authority to plug in the areas that are relevant to them. The Code should include ways to assist in designing low impact features, so that you don't have to be an expert to design something such as a rain garden. It should be simple to follow and easy to use. Maintenance should also be included in the Code for each design feature – how

much it will cost to maintain a product in the future and what access will be available to it.

The Code should incorporate key questions that a developer would need to address, eg showing that there is room for a clean flow diversion etc. The Code should include practical examples, with details on responses with regard to performance and costs.

One interviewee, however, stated that rather than using a template with a standard set of headings that are selected or deleted as appropriate, it should be a "one size fits all" best practice guideline document that acknowledges that there are geographical and developmental differences.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

Generally comments were in regards to staff resourcing, getting help with regional council consenting and speeding up consent processing timeframes.

FDC would like ARC to hold seminars and workshops to bring together staff from different disciplines and councils. The benefit of FDC going to such a workshop was considered questionable as it if is difficult to see how it would benefit FDC given the lack of resources and rural nature of the district. It was mentioned that there was little interaction at the moment with the ARC stormwater team due to staff resourcing issues, as mentioned above.

More liaison where ideas are shared would be welcomed. This would be useful to discuss which stormwater management approaches will work best for a given situation. local authorities have the expertise but should not be hamstrung by a prescriptive approach. There should be regular meetings to share knowledge and learn from each other. However, it is important to avoid overlap or duplication from ARC.

18.4 Manukau City Council

The following transcript contains a summary of views expressed during interviews of staff from various departments within Manukau City Council (MCC), as conducted by URS New Zealand on 18 December 2007. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. **How does your role relate to stormwater and sediment management?**

Table 16

Departments interviewed at Manukau City Council.

Department	Role

Department	Role
Parks	Maintenance of reserve areas including stormwater ponds; providing amenities and ensuring that park users' perception of reserve areas remains positive.
Consents	Applications and engineering for resource consents. Some involvement in building consent approvals. Ensuring that proposals meet the requirements of the Air, Land and Water Plan, District Plan and Engineering Standards.
Asset Management	Asset planning, with reference to (and development of) MCC engineering standards.
Urban Planning	Development of Flat Bush area and brownfield and greenfield areas; integrating stormwater and policy.
Stormwater	Co-ordinating the maintenance of stormwater assets.

2. **Have you heard of low impact design (LID)? If so please explain what you understand this term to mean?**

   All of the interviewees had some knowledge of LID principles, with varying interpretations. Most departments were aware of the focus on minimising impervious surfaces, minimising the effects of development processes (particularly with infrastructure), and reusing water resources. Other comments included the observation that LID is about working with nature, not against it, and is applicable at policy level. It was mentioned that LID devices often require maintenance.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

   The following plans, policies, regulations, technical publications and legal documents were cited by the MCC staff interviewed:

   National

   Some staff have been involved in writing national policy, particularly within the Department of Conservation. The Resource Management Act (1991) and Environmental Quality Standards (EQS) were the only national policies quoted directly, and there was some comment on the lack of specifications for national guidelines (with the exception of the Environmental Quality Standards).

Regional

Technical publications are used as a basis for many operations, particularly Technical Publication 10 (TP10; mainly for swales and ponds), TP90, TP108 (for storm events), and TP148.

Local

The District Plan and MCC Engineering Standards were listed as the primary policies used within the departments present. There has been a strong focus on creating links between national and regional documents and the District Plan, particularly with regards to creating clear standards for developers.

MCC has worked in conjunction with ARC on many projects, particularly during the development of the Flat Bush area. This involved creating an Integrated Catchment Management Plan (ICMP) for the area. The Regional Policy Statement was also consulted.

Other in-house documents/methods

A "mini-District Plan" and catchment plan were created for the Flat bush development.

Most departments recognised technical publications as key regional documents frequently used when considering LID. The District Plan was also very common among departments as a key local document. All departments had consistent knowledge and usage of national, regional and local documents.

4. To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?

   Staff commented that MCC documents were more user-friendly in most cases because they are designed specifically for the local area, however they generally do not feature a specific LID section. The District Plan is very general and open ended (especially for consent applications). With regards to regional policies, it was mentioned that some elements of TP10 are not expressed clearly, and some of the calculations are incorrect. This can be very confusing at times.

5. To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?

   There are many issues with existing city stormwater management systems, particularly with regards to their adequacy (or lack thereof). There is also conflict over the allocation of responsibility for cost (especially between departments). Most departments tend to advocate using ARC technical publications as a guideline for stormwater management, developing LID projects, and MCC Engineering Standards for technical specifications.

6. To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?

Some staff commented that MCC documents tend to have less "policy standing" than ARC guidelines, however others believed that ARC Guidelines are not specific enough. There was considerable concern over the state of TP108, the parameters and rationale of which were considered out of date. Staff had experienced instances where developers had produced two different sets of data (one resulting from TP108 calculations, the other from another source like HEC-HMS modelling) and chosen the one they thought was best. It was suggested that there are now more accurate methods than those offered in TP108. Local and internal documents get updated regularly; some every two months.

Another concern was that there appears to be some reluctance in transferring responsibilities for maintenance from individual or small scale developments. It was stated that LID is quite a challenge because it is hard to distinguish these responsibilities, and there are conflicts over which LID methods are most feasible.

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

   TP10; key principles and processes from ICMP; and the MCC Engineering Standards are most commonly used. However, some developers do prefer using HEC-HMS modelling to TP108.

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   This question was omitted from the Manukau City Council interviews as covered in responses to Question 7.

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   The following devices were identified as frequently included in applicant's submissions:

   Rain gardens.

   [Stormwater] treatment ponds.

   Swales.

   Off-the-shelf devices (ARC approved); a comment was made about how the [MCC] roading department doesn't approve of these because they do not like to treat catchments on an individual level.

   Planting.

   Sand and/or Up-Flo filters; it was mentioned that MCC tries to keep the number of filters to a minimum due to maintenance issues (ie lots of individual devices leads to lots of locations for maintenance).

It was noted that applicants who are new to the consent application process, or those who try to "push the boundaries", are quickly recognised and discussions with council held to clarify requirements.

10. **Is there anything that you would prefer to see included in applicants submissions?**

    A main concern was the number of stormwater ponds proposed in recent consent applications, and the maintenance issues that would arise from the implementation of such a large number of ponds. Also mentioned was the need for more guidelines with regards to consent requirements, and minimising the number of devices used in developments to reduce maintenance effort and costs. There was some concern over the effect of piping almost all water in developments to ponds, as this could potentially have an adverse effect on groundwater. A possible alternative would be draining run-off through biofiltration and back into green areas.

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    The response to this question was varied among the group interviewed, depending on their department. Answers varied between 90 per cent greenfields (with the number of greenfield sites far outweighed the number of brownfield developments), 60 per cent greenfields, and 35 to 40 per cent greenfields (due to the limited amount of greenfield land available).

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    Cost and maintenance associated with installing LID devices was cited as the most significant barrier against the implementation of LID. It was suggested that more information about LID concepts, including pros and cons (for council engineers); how devices work, and maintenance (for property owners) would enable greater use of such concepts. Some staff noted that they were unsure whether LID really is best practice or not, and that they found it difficult to incorporate both LID concepts and environmental standards with regard to stormwater quantity and quality into developments.

    Another barrier identified was the difficulty experienced when trying to get developers to maintain their assets prior to being vested within the council. Often, MCC has to pick up dilapidated assets. Budget is often a limitation on the desire to use LID approaches.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

    The roading and parks policies and standards were identified as possibly having different requirements, stormwater policy and standards.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

    There is no formal process for innovative stormwater management initiatives, bar the conventional consent process with some discretion. Proposals are given consideration, followed by an internal discussion between council departments, and final acceptance or declination by the consents department. An effort is also made to understand the ARC's perspective on any major or unconventional proposals before any decisions are made. The "odds and ends" are treated on a case-by-case basis.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    A policy that reflects a unified approach for MCC with regards to both stormwater management and LID needs to be developed. This may contribute towards resolving the existing conflict between the perspectives of engineering and landscape design-focused departments. More specific criteria (including design criteria), similar to that featured in ARC's technical publications, is required to make the implementation of LID more straightforward. There needs to be a clearer delineation between ARC and the local authorities (local authorities); for example, ARC needs to set policies and guidelines, while local authorities could focus solely on implementation and resource consents. It was suggested that more interaction between local authorities would be very helpful. local authorities could cooperate with each other and share information, while ARC could adopt a co-ordination-type role. Improved internal communication would also be beneficial for the promotion of LID concepts and designs.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    Collectively, the following benefits are considered when making stormwater/sediment management decisions:

    Ecological value.

    Visual amenity.

    Catering for engineering needs.

    Optimising park outcomes.

    Community benefit (for example, wetlands and vegetation growth; balance between hard and soft aspects of the landscape).

    Length of design life (LID is not always beneficial in this respect).

    Cost (LID needs to be simple, affordable and manageable); long-term life cycle cost.

    Making the environment more robust in response to climate change.

Enhancing urban amenity.

17. **How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?**

    There is a definite boundary between the Parks and Stormwater departments, and where responsibilities lie. MCC maintains a robust maintenance schedule, with certain specifications for different aspects of traditional and LID systems (for example, dams and vegetation control).

    Different areas are categorised according to these specifications, and as such some areas require more frequent maintenance than others. Once the maintenance schedule is determined, it is passed on to the contractors, who are usually employed and co-ordinated by Manukau Water. Contractors are told which areas they need to go to, and they are required to check off the maintenance local authoritiesks as they are completed. This is part of a wider reporting initiative. Any complaints received about the condition of assets are also recorded, and Manukau Water conducts an initial assessment to determine whether the problem needs to be inspected by a representative of MCC. Manukau Water is a separate contractor and in future (approximately three years) will need to compete with other consultants to keep the contract with MCC.

    It was mentioned that [MCC] is under-resourced and finds it difficult to achieve the desired water quality values on a catchment-by-catchment basis, as dictated by the Integrated Catchment Management Plans (ICMPs).

18. **What is your understanding of:**

    a. **Your team/department's overall current approach to or view of LID?**

    b. **Your organisation's overall current approach to or view of LID?**

    The following three statements formed the overall consensus of the group interviewed:

    LID offers many benefits for park outcomes.

    LID is great in principle but impractical.

    [MCC] has limited knowledge of LID so it is really too early to form a strong opinion.

19. **What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?**

    MCC is currently doing well with Flat Bush and greenfield developments in particular.

    Large developments.

    More opportunity for LID in new developments rather than modifying existing developments.

    Design infrastructure.

Connectivity between large developments within the wider community.

Consolidation of parks– one or two large, well-designed parks have a better impact than 10 or 15 small parks.

Including LID as a condition of resource consents. LID will be most effective once it is endorsed at a policy level.

20. **Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?**

    All agreed that the development of a Model Code of Practice for Enhanced Stormwater Management and the implementation of LID would be beneficial to MCC and all of its departments. It was noted that local authorities would be very interested in such an initiative, and would definitely follow it up if it is the best, most manageable and cost-effective option.

21. **What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?**

    Overall, the preference of MCC would be to have a document that is flexible, with clear, performance-based outcomes and design criteria. It would be helpful to be able to "plug in" content that is relevant to the local context, and have a diverse range of LID design options available for councils to adopt. This document would need to clearly indicate what needs to be completed to achieve targets, and what is not acceptable. A set of accompanying guidelines would also be very useful.

    It was recommended that any such document would need to clearly explain the benefits of LID and have excellent visual communication through good, explicit diagrams, graphics and cross-sections to effectively "sell the concept". A region-wide document would be most helpful, rather than individual documents for each council.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

    It was suggested that the ARC could assist local authorities by:

    Providing a clear-cut monitoring process for local authorities to follow (ie During implementation, ongoing maintenance; fulfilling consent requirements).

    Assisting with the education of developers regarding monitoring requirements.

    Providing case studies to use for evaluation of methods used to achieve outcomes, and measuring performance.

    Holding a workshop forum for local authorities on the practicalities of the Model Code of Practice. This would allow for local authorities to make suggestions and give feedback on the document before it is finalised.

    Provide documents that are applicable to major developments.

Collaborate with local authorities once the new guidelines are produced. This would hopefully reduce the current shortfalls in information.

Use regulation to influence developers, through local authorities.

18.5 North Shore City Council

The following transcript contains a summary of views expressed during interviews of staff from various departments within North Shore City Council (NSCC), as conducted by URS New Zealand on 6 December 2007. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. How does your role relate to stormwater and sediment management?

Table 17

Departments interviewed at North Shore City Council.

Department	Role
Strategic Planning	Utilising regional stormwater policies, particularly within Three Waters policy. Also use LIUDD programmes developed for MCoP.
Stormwater/CMPs	Stormwater planning; developing city-wide CMPs.
Operations	Operations and maintenance of stormwater assets.
Transport	Liaise with stormwater departments; developing streetscapes.
Stormwater Operations	Consenting.
Parks and Leisure	Planning; liaison with stormwater departments.
Strategy and Policy	Particular interest in strategic planning and approaches to stormwater management, including stream management.

2. Have you heard of low impact design (LID)? If so please explain what you understand this term to mean?

There were several varying responses to this question, with one common thread being that LID involves mitigating stormwater and related effects using approaches that minimise impervious surfaces, and cause the least amount of disturbance to natural systems. Other views that were expressed included the idea that LID involves matching the type of development to the site; retrofitting older sites; integrating transport and structure planning, and providing linkages within the landscape. It was noted that the roading and parks departments have

different needs with regards to LID; and although the amenity value of LID is recognised, it is difficult to achieve.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

   The following plans, policies, regulations, technical publications and legal documents were cited by the NSCC staff interviewed:

   National

   AustRoads Publications (govern road design).

   Resource Management Act, Reserves Act.

   Local Government Act.

   Building Act and Building Code (sustainability in infancy).

   Urban Design Protocol.

   NZCPS (New Zealand Coastal Policy Statement).

   Regional

   ARC Technical Publications (TP) 10, 124, 108, 90, 148, 131.

   ARC Technical Publication 232: Stream Evaluation.

   ARC fact sheets.

   ARC Technical Publication 131: Fish Passage Guidelines for the Auckland Region, (2000).

   ALWP (Air Land and Water Plan).

   Regional Plan – Sediment Plan, Coastal Plan, Regional Policy Statement.

   Local

   Infrastructure Design Standards (IDS) – first preference for stormwater management is biofiltration.

   NSCC Stormwater Strategy and older Catchment Management Plans (CMPs).

   Approval Outfalls Policy (to be superseded by Plan Change (PC) 22).

   NSCC District Plan, plus plan changes.

   Infrastructure Design Manual.

   NSCC Practice Notes – how to achieve outcomes (eg Long Bay and PC22); public use; used by planners for implementation of District Plan.

   Reserve Management Plans, Park Strategy Documents.

Integrated Catchment Management Plans (ICMPs).

Bylaws – particularly for stormwater.

Drainage Act – mainly for wastewater.

Other in-house documents/methods

NSCC is currently working on producing the following:

Streetscape Design document.

Non-Statutory Reserve Department plans for new reserves and stormwater.

Guideline documents focused on developers (will cover bioretention, rain tanks, permeable paving etc.).

4. **To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?**

   The general view expressed was that most of the documents both help and hinder the implementation of LID, and a climate of inertia exists with regards to the effectiveness of District Plan changes. It was mentioned that developers tend to stick to regulations, and it is very difficult to impose more than what is legally required.

5. **To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?**

   Documentation (with regards to NSCC processes) is not yet consistent; more freedom is required on internal projects to adapt practice and use discretion. A comment was made that developers can only be influenced by advocacy and regulation; otherwise it can become difficult to integrate new ideas like many of those featured in LID.

6. **To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?**

   There is a lack of regional consistency in the regulation of road and footpath widths, and parking requirements. Current design guidance tends to focus on maximising paved areas. [NSCC] need to use the Urban Design Protocol to manage the process and incorporate the use of discretion.

   There are several barriers for consent applicants in the form of noticeable tension between ARC Stormwater Consents and NSCC Building Consents; and inconsistencies between the needs of ARC and those of the District Plan. Individual property owners are required to produce lengthy reports to demonstrate compliance with ARC's Technical Publication 10 (TP10), yet many of the TPs feature different concepts to those supported by NSCC. This is particularly evident in the catchment-based focus of TP10, with an emphasis on stream management, including ephemeral streams. This approach does not work well for brownfield sites. It is considered that the Air Land and Water Plan allows

the piping of Category Two streams, whereas NSCC would prefer not to use this course of action. The overall consensus was that inconsistencies between ARC and NSCC requirements make it difficult for applicants to understand and implement stormwater management approaches and LID, therefore there needs to be clearer jurisdiction, and a clearer distinction between urban and rural local authorities (local authorities) in order to tailor different LID approaches for different contexts. Although a lower standard of requirements may receive more support [from the public and developers], standards should be reasonable and manageable in order to allow implementation.

Every new building consent has planning assessment against Plan Change 22 (PC22). NSCC use consent notices under the Outfall Policy to manage the push for the design and sale of lots by subdivision developers. Geotechnical aspects of a site often don't support the use of LID. Lot sizing and building densities specified in District Plan zoning do not always fit with geotechnical information topography.

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

   For larger developments, guidelines such as those provided by TP10, TP108, NSCC Practice Notes and online guidance notes are used. These are also relevant for smaller developments, along with Rational Method calculations and NSCC engineering guidelines. Around 80 per cent of submissions are for single dwellings, and 20 per cent are for larger developments. For small developments NSCC provides a simple advice sheet with easy, step-by-step design processes, eg rain tank size. This process leads the applicant through a permitted activity route. Non-permitted activities can be submitted as alternatives, as long as similar outcomes to permitted activity solutions are demonstrated. Applicants typically apply for NSCC land use consent and ARC stormwater discharge consent. For NSCC land use consent, road treatment becomes very important and bioretention or proprietary devices are encouraged.

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   TP108 – subdivision level.

   Rational Method from Building Code.

   PC22 – step-by-step design methodology (NSCC).

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   Rain tanks and rain gardens as permitted activities; TP90 devices for sediment control; ponds, proprietary devices (eg UpFlo systems) for bigger subdivisions. A recurring theme is the discrepancy between ARC and NSCC. There is a problem

with integration of rain tanks and rain gardens into sites because people don't know where to put them.

10. **Is there anything that you would prefer to see included in applicants submissions?**

    Although not really relevant for submissions, it would be good to see an increase in training for drain layers and members of other industries (landscapers, developers etc.), through regional leadership, professional associations and Unitec (for example).

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    15 per cent brownfields by area. LID approaches are included as permitted activities for redevelopment. Some claim existing rights for on-site activities and therefore are reluctant to provide new stormwater management devices.

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    Barriers to implementation – as in answers to Question 6.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

    The community's perception of LID has been slow to change but has become more positive with an increase in the profile of sustainability. The technical specifications in the ARC TPs are in some cases not optimal, particularly the rain garden specifications featured in TP10. The species included on the species list are not optimal with regards to appearance; it was suggested that flowering plants be added to the list if possible. Another problem is that some LID devices are conveniently-sized for smaller sites (for example, rainwater tanks). NSCC policy features practical sized tanks; however these are different to the specifications in TP10. [NSCC and ARC] need to become more comfortable with LID techniques and allow for some flexibility in design, using real examples to illustrate what LID can achieve for the community.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

    It was noted that the District Plan is quite prescriptive, so in most cases it is left to the experience of stormwater engineers to formulate a subjective approach. Sometimes PC22 is used to assess "deviations" from prescribed solutions (such as those offered in the District Plan). Rain gardens were used as an example of how criteria is often very prescriptive but needs to be adjusted; there are no set outcomes noted for rain gardens and volume control is very hard to quantify. It was expressed that a more subjective process is needed; however historical

tensions [between departments] are now much better with regards to discretionary mechanisms.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    Moving towards clearer, more consistent jurisdiction on a regional level, especially with regards to ephemeral streams and source control of contaminants, was highlighted as a vital shift that needs to occur to enable the promotion of LID. There would also need to be an increase in understanding of LID at a practical scale, on a day-to-day basis; and the implementation of realistic policies. More thorough cost-benefit analysis under Section 32 of the RMA would also help, taking into account costs and benefits for both the community and local authorities. However, it was recognised that it is difficult to put cost and benefits on environmental elements. There is a need to foster a better relationship between ARC and the local authorities, because this would promote consistency.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    Volume issues.

    Quality.

    Amenity value.

    Natural environment – beaches and water quality, alternate water source.

    Sustainability.

    Neighbourhood.

    More liveable.

    Reduced nuisance.

    Walkways.

17. **How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?**

    There is currently no ongoing maintenance of private devices (on private lots) at the moment. Under NSCC bylaws devices installed on at least 2 properties will eventually become vested in council. These public devices are then operated and maintained by NSCC. A database for the location of private devices, and the location of public devices captured via GIS, has been established recently. There are many legal pitfalls associated with the many options for ongoing maintenance that have been considered. Self-certification is the only viable approach, but it has not been implemented. A change in bylaw would be required within the next six months to allow council access to sites for maintenance. No knowledge of the ARC project to develop Construction, Operation and Maintenance Guidelines.

Significantly different views were expressed with regards to the ownership and maintenance of devices located in parks.

18. What is your understanding of;

    a. Your team/department's overall current approach to or view of LID?

    b. Your organisation's overall current approach to or view of LID?

    Use of LID within council departments is very limited; one example provided was the use of LID for the design of carparks at Wainoni Park, Greenhithe.

19. What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?

    Greenfields development in Long Bay.

    Comprehensive areas of development.

    Housing corporation projects.

    Capture and use of rainwater for irrigation (potentially).

20. Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?

    The general opinion was that the development of a MCoP may have limited benefit for NSCC, but would definitely allow for the removal of some barriers to the implementation of LID. It could potentially be very helpful for developers and smaller local authorities. Some suggestions were made as to additional improvements that could potentially be more beneficial to NSCC itself:

    Train practitioners.

    Review TP124, making it easier to use.

    Reference the MCoP in the District Plan.

    Section 32 assessment would allow some changes to the District Plan and enable councils to facilitate LID.

    Put a statement in the Regional Policy Statement that gives effect to the District Plan.

21. What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?

    Interviewees agreed that if [NSCC] was able to put in some details, the development of this document would be OK.

    The following suggestions were put forward:

    - Simple and practical guidelines, with case studies. Must be consistent for developers.
    - Use flowcharts to demonstrate how to get results.

- Focus on common components.
- Needs to be flexible.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

    Proposed ideas included:

    - Support and prove the value of LID in Section 32 of the RMA, using the document to set a standard.
    - Provide successful examples of LID and stormwater management to developers and the general public (for example, models for community education; Sediment Control Day Out).
    - Offer an incentive to developers if they embrace LID.

18.6 Papakura District Council

The following transcript contains a summary of views expressed during interviews of staff from various departments within Papakura District Council (PDC), conducted by URS New Zealand. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. **How does your role relate to stormwater and sediment management?**

Table 18

Departments interviewed at the Papakura District Council.

Department	Role
Stormwater	Managing all aspects of stormwater assets and catchment management.
Transport	Design components of roading and traffic.
Strategic Planning	Development and planning for urban WCC growth areas.
Consents/Development Engineering	Development and engineering for approving resource consents.
Parks	Integrating stormwater and sediment management with operation and maintenance of parks.

2. **Have you heard of low impact design (LID)? If so please explain what you understand this term to mean?**

    Some of the participants in these interviews defined LID as the use of stormwater management approaches in such a way as to minimise the effects on the

environment. It was expressed that this could involve both minimised disturbance of the existing landscape and reduction in contaminants discharged. One or two of those interviewed were only very generally aware of the term LID and were not able to provide examples.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

   The following plans, policies, regulations, technical publications and legal documents were cited by the PDC staff interviewed:

   National

   Resource Management Act (RMA).

   LGA and Land Transport Act.

   Ministry for the Environment website for guidance with respect to natural hazards such as flooding.

   NZS 4404 for Land Development and Subdivision.

   NZS 4431 Earthworks.

   AusRoads.

   Transit New Zealand Guidelines.

   Regional

   ARC Technical Publications (TPs): TP10, TP90, TP108, TP124. used as reference documents; technical content is used a limited amount eg if required for reference by engineers.

   Air, Land and Water Plan (ALWP).

   Auckland Region Policy Statement.

   Local

   District Plan.

   PDC Development Standards (1997 Under Review).

   PDC Open Space Strategy.

   Various Reserve Management Plans.

   PDC Structure Plans and District plan changes.

   PDC Development Agreements.

   Existing Catchment Management Plans.

   Other in-house documents/methods

Other local authority guidance documents are used in some instances Eg: MCC and ACC design standards.

4. **To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?**

   The general consensus was that the RMA and regional documents allow for the use of LID but provide little detail to encourage its use. Some of the ARC technical publications were considered limiting. The PDC documents don't specifically discourage LID and best practice stormwater management but do little to actively encourage.

5. **To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?**

   It was felt that there is little inconsistency between regional and local documentation and requirements.

6. **To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?**

   Several staff had no comment to make on this question. Those that did respond some felt that PDC document did not present any specific barriers whilst others felt that the current PDC District Plan and Structure Plans limited the scope for implementation of non traditional stormwater management solutions.

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

   Relevant District Plan Rules.

   ARC Technical Publications (TP): TP108, TP10.

   Few applicants refer clearly to the techniques used and instead tend to be based on solutions known to satisfy council and obtain consent in the past. These tend to be very traditional approaches.

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   The rational method and TP108.

   Pond sizing is often taken from that described in the relevant catchment management plan.

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   Mostly traditional piped systems.

Soakage in the peat soils of the Takanini area.

Some CDS units.

Some swales.

10. **Is there anything that you would prefer to see included in applicants submissions?**

    Maximised use of soakage where appropriate to recharge the aquifers and the increased use of rain gardens subject to monitoring and collection of performance data.

    It was felt that applicants need to have the courage to propose LID approaches since there is not enough contaminant removal with the more traditional systems. Addison only used LID because they though it would be cheaper for them than the traditional method.

    However this would mean that the developer would be required to provide a lot more justification and proof that the approach would work and not leave council with a large financial burden – especially maintenance costs.

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    In general, most departments identified that there is a high proportion of greenfield development occurring with large scale developments (up to 80 per cent on a land area basis). Most development is occurring in the Takanini and Hingaia areas.

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    The majority of participants agreed that some barriers did exist. These are summarised below:

    Maintenance costs were identified as a major barrier.

    Private ownership of devices did not work as they are often neglected.

    Public and PDC staff mindset.

    Lack of knowledge and performance information for LID approaches.

    Lack of successful examples.

    The lack of a clear mechanism for consenting of LID approaches.

    Lack of clear delineation of responsibilities between Parks and Stormwater teams.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

The only document cited as a possible limitation was the District Plan and various structure plans which specify development concepts.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

    The discretionary process at PDC is currently ad hoc and involves informal discussions between staff and meetings with applicants.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    The following suggestions were made with regards to fundamental policy shifts that could enable the promotion of LID:

    Develop a straightforward consenting process, with education and awareness of procedures.

    Market shift to accept or demand LID as a viable option.

    Change in mindset of developers and some PDC staff.

    The view was expressed that successful examples with relevant performance information should be in place prior to policy changes.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    The view was expressed that many staff, developers and members of the public could not see the benefits of LID at the moment. However, the following potential benefits were listed by interview participants:

    Potential cost savings for developers.

    Improved water quality.

    Better quality receiving environments.

    Less excavation and impact on the existing landscape.

    Public health benefits.

    More integrated urban design in line with the Urban Design Protocol.

    Improved living areas through the use of less concrete and other hard surfaces.

    Increased amenity value.

17. **How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?**

    Maintenance of all stormwater assets is currently scheduled by PDC and contracted out.

18. What is your understanding of;

    a. Your team/department's overall current approach to or view of LID?

    b. Your organisation's overall current approach to or view of LID?

    Most of the teams interviewed were supportive in principle but felt that a lack of data with regard to costs both capital and ongoing and performance is required to enable PDC to support the uptake of LID.

19. What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?

    New subdivisions and greenfield developments were identified as having the highest potential for the implementation of LID, as they involve starting "from scratch". Hence the Takanini and Hingaia areas hold most prospects for the foreseeable future.

20. Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?

    Most departments were generally supportive of the development of a Model Code of Practice but not all. However, it was stated the any such document would need to be a guideline only, providing more options to consider for any new proposal. It would also need to be detailed and user-friendly, and applicable on a regional scale. It should not become mandatory or a prescriptive minimum standard for consent approval.

    It was suggested that it could be called a Practice Manual rather than a Code of Practice.

21. What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?

    The following ideas were suggested as features to be included in the Model CoP, during the interviews:

    Examples of designs.

    Guidance on how to practically implement LID approaches.

    Supporting information such as maintenance schedules and costs.

    Design principles, capital and maintenance costs.

    Comparison of options.

    Performance achieved.

    Where approaches are best suited with regards to site characteristics.

    Development of the document should include local authority participation.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

    Education and courses for those constructing devices, and consultants. Need a consistent regional approach.

    Monitoring and reporting of case study areas and device performance.

18.7 Rodney District Council

The following transcript contains a summary of views expressed during interviews of staff from various departments within Rodney District Council (RDC), conducted by URS New Zealand. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. **How does your role relate to stormwater and sediment management?**

Table 19

Departments interviewed at Rodney District Council.

Department	Role
Water Services Management	Responsibility for overseeing wastewater, potable water and stormwater management.
Asset Management	Management of stormwater assets and engineering standards. Capital works planning.
Development Engineering/Consenting	Development and engineering for approving resource consents.

2. **Have you heard of low impact design (LID)? If so please explain what you understand this term to mean?**

    It was recognised that LID could range from urban design principles to specific stormwater management devices. It was perceived to include the minimisation of infrastructure and hard engineering approaches whilst maintaining or improving water quality.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

    The following plans, policies, regulations, technical publications and legal documents were cited by the NSCC staff interviewed:

National

Resource Management Act (RMA) (eg for projects that overlap with ARC).

Building Act.

Ministry for the Environment climate change documents.

National Policy Statements with regard to stormwater management.

Regional

ARC Technical Publications (TPs): TP10, TP90, TP108, TP232.

Air, Land and Water Plan (ALWP).

Specific studies, eg the Climate Change Study.

Local

RDC Engineering Standards.

Countryside and Foothills Code of Practice .

District Plan.

Stormwater Bylaw.

Various ICMP documents.

Other in-house documents/methods

Other council's standards, LGPLANNERS@LISTSERVE.

4. To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?

   It was felt that, in general, the documents don't really support LID and encourage innovation. In fact it was noted that the District Plan made innovation very difficult and encouraged the use of tradition management approaches. Regional documents such as TP10 were seen to allow for LID but technical inconsistencies in TP10 and TP108 made it difficult to apply with confidence and the detention requirements were too onerous.

5. To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?

   It was felt that the range of regional and local documents were reasonably consistent in terms of overall objectives but did not present an integrated or consistent approach with regards to policy and implementation.

6. To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?

   The following barriers were listed:

There is no clear NZ definition of LID.

The documents do not provide enforcement mechanisms and performance criteria to induce uptake by developers.

The documents need to present successful examples of LID implementation.

Local documents specify carriage way widths that make it difficult to fit anything other than piped systems into berms and road reserves.

The current documents don't lead to innovative solutions they encourage applicants to continue to propose a narrow range of solutions to expedite the consenting process. They do not allow for much flexibility in approach and specific design. They represent a limited and highly conservative view point.

ARC has recently lost technical expertise in this area and it is important that regional documents keep up to date with new technology. It is difficult to see who is now available to undertake such an update process.

There is a clash between Urban Design and its encouragement of connectivity which often leads to increased roading and reduced "green" spaces.

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

   RDC Engineering Standards; ARC TP10.

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   TP108, TP10 (specific volume of water to treat) and other TPs are frequently used, especially for larger proposals.

   Some of the NSCC standards.

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   Stormwater ponds are often used for stormwater treatment and attenuation. (public devices).

   Sand filters and storm filters are often proposed for private stormwater management.

   Rain tanks and water harvesting and swales have been used on small subdivisions.

   Often the detailed hydrological and hydraulic calculations are missing form applications.

10. **Is there anything that you would prefer to see included in applicants submissions?**

At a strategic level RDC would like to see more innovation with reduced reliance on traditional piped systems.

At a more detailed level the following were suggested:

More ponds because they have aesthetic qualities as well as a stormwater function.

Better orifice sizing and overflow devices for rain tanks.

For LID and other less traditional stormwater management approaches to be presented at subdivision consent stage rather than waiting until building consent applications.

Better topographical and geotechnical understanding especially with respect to swale usage in steep areas.

Demonstration that the design is suitable for specific site conditions.

A greater degree of information with regards to flood management in areas that are affected.

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    90 per cent greenfield.

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    The following barriers were listed:

    RDC is not convinced that LID approaches are sustainable and maintainable in the longer term.

    Robust data is not yet available with regard to LID device performance. Overseas information may not be relevant to local conditions.

    More information is required with regard to cost, life span and maintenance.

    There is a lack of technical understanding with respect to LID approaches.

    Current urban design approaches and newer developments tend to have increased building density and less "green space", subsequently there is less room for LID approaches.

    Rain tanks specified purely for detention of roof run-off tend to be large and not reused in reticulated areas.

    RDC's geology is not conducive for soakage. The topography is seep and unstable in many places.

    The applicants' mindset is such that they will tend to provide what has successfully been consented in their previous experience.

Developers will continue to do what's easiest and cheapest for them to get consented and to maximise the number of units within a development.

Developers and councils want a high degree of certainty with respect to the approaches they implement.

LID needs more momentum and a new regional champion to keep abreast of research, case study monitoring and reporting.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

    The following views were expressed:

    The Building Act is silent on LID and flood management.

    Transport system design and mindset is resistant to change.

    Parks policies prefer not to have wetlands and ponds in park spaces.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

    Volunteered non standard solutions are considered by RDC through an internal consultation process involving relevant departments.

    It is not easy for applicants to gain consent for non-standard solutions.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    The Building Act does not accommodate green roofs and would need to be amended to accommodate such initiatives.

    The need to provide assistance and recognition of the LID design features to provide a pull out of the draw design response for proposed developments.

    The need to link stormwater management with urban design approaches.

    The need for legally enforceable mechanisms to protect LID approaches in developments, eg covenants on property titles.

    Development of shared responsibility for LID between ARC and local authorities, ie so if a local authority agrees to try an LID approach ARC assists with monitoring, implementation and remediation if it goes wrong.

    The development of a precinct planning stage midway between structure plans and subdivisions would be helpful in providing a consistency of approach in the region and an overview of stormwater management approaches over a larger area.

    Roading policies need to allow for and accommodate stormwater management.

Major education programmes are required to raise awareness of LID amongst developers, lawyers and the public. This would help them understand how covenants on titles may work to help implement and protect stormwater management approaches. This raising of awareness should be carried out by the ARC and local authorities.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    The following benefits were listed by interview participants:

    Less infrastructure to build and maintain – less impact on rates and a potential reduction in new assets that may become vested in council and therefore reduced operation and maintenance costs.

    More pleasant environments to live in.

    Improved amenity.

    Less cost to communities.

    Improved treatment performance.

    Lower capital and operating costs through an increase in private devices and reduction in municipal stormwater reticulation.

    Increased public accountability through taking responsibility for their own stormwater generation.

17. **How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?**

    Currently maintained under contract with Rodney Water. Some works are schedules and others happen on an ad hoc basis should problems occur.

18. **What is your understanding of;**

    a. **Your team/department's overall current approach to or view of LID?**

    b. **Your organisation's overall current approach to or view of LID?**

    The teams interviewed felt that LID is generally a good idea but people have yet to make it work. The implementation of LID takes enthusiasm and tenacity.

    Overall it was perceived that RDC the degree of awareness and understanding with respect to LID is relatively limited.

19. **What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?**

    Best opportunities with respect to the Urban Design aspects of LID exist in farm redevelopments and greenfield developments subject to plan changes.

Best device focussed opportunities exist with urban subdivisions through the introduction of devices such as rain gardens, swales and permeable/pervious surfaces.

20. **Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?**

    MCoP would be beneficial. It would provide an opportunity to share information on practical and proven design solutions and cost benefit of LID. ARC would need to consult extensively with local authorities to ensure their needs were met.

    RDC would need to know that approaches put forward would be tried and tested and would not pose an excessive maintenance burden.

21. **What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?**

    The following ideas were suggested as features to be included in the Model CoP, during the interviews:

    A regional document be developed through a local authority and ARC working group to achieve a consensus approach for the region. RDC would not welcome the development of a document by ARC alone with which it would then be asked to comply.

    Lots of pictures – typical designs, typical development layouts.

    Possible approaches for developments of different sizes, eg 1 to 5 lots, 6 to 20 lots, 21 to 50 lots, > 50 lots. Most of RDC development is < 50 lots.

    Cost and benefit assessment approach – perhaps a simple spreadsheet model for Developers to use to work this out.

    Guidance regarding timing of implementation of devices to avoid blinding during subdivision construction.

    Inclusion of maintenance procedures.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

    Openly share new information with regard to LID and stormwater management.

    Work in partnership with local authorities rather than adversarial.

    Develop and communicate strategic and flexible approach.

    ARC to provide a wider range of acceptable sediment control methods for small developments.

    ARC to take the initiative to promote LID, gather, present and communicate robust case studies with respect to performance and costs.

18.8 Waitakere City Council

The following transcript contains a summary of views expressed during interviews of staff from various departments within Waitakere City Council (WCC), conducted by URS New Zealand. For convenience, the summary has been categorised under the questions from the questionnaire originally used in the interviews.

1. **How does your role relate to stormwater and sediment management?**

Table 20

Departments interviewed at Waitakere City Council.

Department	Role
Transport	Design components of roading and traffic.
Operations and Maintenance	Operations and maintenance of stormwater and wastewater services, including some LID
Planning	Development and planning for urban WCC growth areas.
Consents	Development and engineering for EcoWater; approving resource consents.
Parks	Integrating stormwater and sediment management with operation and maintenance
Urban Design	Advocating urban design solutions; assessing resource consent applications against the strategic direction, from an urban design point

2. **Have you heard of low impact design (LID)? If so please explain what you understand this term to mean?**

   Most of the participants in these interviews agreed that LID involved effective, innovative and resourceful use of low impact technology. It minimises the use of hard engineering, treatment and control devices (reducing the risk of environmental damage), and creates aesthetics that are complementary to the natural environment. It was suggested that the LID approach considers ecosystem services and the possible downstream effects of stormwater and contaminants on them. LID is working with the environment.

3. **List the plans, policies, regulations, technical publications and legal documents which are used in your team in consideration of stormwater, sediment management and any relating to LID. Please outline how these documents are used.**

National

Resource Management Act (eg for projects that overlap with ARC).

State of the Environment Report (1997, 2007).

Ministry for the Environment Urban Design Toolkit (good reference document) .

Quality Planning website and reference documents – policy based, strategic thinking.

NZ Water Environment Research Foundation (NZWERF) stormwater management design.

Urban Design Protocol; numerous references and new ideas coming through but all are guideline-based.

Regional

ARC Technical Publications (TPs): TP10, TP90, TP108, TP124, TP131; TP148; TP232. used as reference documents; technical content is used a limited amount eg if required for reference by engineers.

Air, Land and Water Plan (ALWP).

Specific studies, eg the Climate Change Study.

Local

WCC Code of Practice (CoP) – used for road design (along with AusRoads).

Other CoPs; eg Countryside CoP, Stormwater CoP, Green CoP, Infrastructure and Development CoP.

WCC Stormwater Solutions for Residential Sites.

Comprehensive Urban Stormwater Strategy Action plan (CUSSAP).

Water and Sanitary Services Assessment (WASSA) Report.

Long-Term Council Community Plan (LTCCP).

Nine WCC strategic goals.

District Plan.

WCC Comprehensive Urban Stormwater Management Action Plan (2000); used for high-level thinking, easier to understand and relate back to strategic vision.

Guidelines; planting guidelines, wetland standards, eg for fencing.

Other in-house documents/methods

Plan changes are starting to reflect changing ideals and visions. ICMPs are beginning to be developed in these areas.

Design of swales (ie for soil and stormwater drainage). Use approved EcoWater designs.

Residential solutions for stormwater.

URS LID CoP – WCC is currently developing a Low Impact Design Code of Practice for the Northern Strategic Growth Area (NOSGA). It is currently draft status.

Websites.

Other CoPs (ie from other local authorities).

Incentive system in the form of Tools for Urban Sustainability Code of Practice (TUSC) provides a valuable on line contribution to eco-design of buildings and use of water tanks fed by roof run-off.

4. To what degree do you feel these documents allow for/encourage good stormwater management and the use of LID?

There were two strong opinions expressed in response to this question:

The documents don't really support LID because they focus on removing stormwater from carriageways and other surfaces as quickly as possible, with minimal effort made to lower environmental impact. LID often "goes wrong" in practice, and this highlights the obvious gap between high-level thinking and actual implementation.

The documents do support and encourage the use of LID in general, and there is some consistency between the District Plan and CoPs (especially Countryside CoP and Stormwater Solutions for Residential Sites). The documents are encouraging because they provide alternatives to conventional measures (eg hard engineering), and their general nature allows for flexibility. However, it was considered that there should be more integration of "good stormwater practice" between departments.

5. To what degree do you feel these documents have a consistent or integrated approach to stormwater or LID? Examples?

It was established that there is some inconsistency between regional and local documentation and requirements. (eg the District Plan doesn't consider riparian margins; ARC needs to recognise stormwater management on a higher level). Suggestions for solving this problem included improving communication between ARC and WCC, and aiming for a more consistent approach. Integrating concepts and practical implementation was a popular recommendation.

The ALWP needs to be more specific, especially for extrapolation into local authority documents. TP standards are not always feasible, depending on context.

For example TP10 and TP124 are not easy to implement across the region and each local authorities' District Plan. Flexibility for specific situations is required.

The WCC District Plan provides a good baseline and all WCC guidance documents can be assumed to be heading in the same direction. It offers useful processes and basic principles of LID that can be applied within proposals.

6. **To what degree do you feel that these documents present barriers to the implementation of stormwater and sediment management systems, in particular LID? Examples?**

There was a polarity between departments as to whether or not documents presented barriers to LID or not, with many varying opinions in between. These ranged from commenting that the designs featured in the documents mentioned were tailored specifically to particular contexts (therefore were not considered a barrier to LID, but perhaps inflexible), to suggesting that current planning and stormwater management are "a bit ad hoc" and therefore allow only limited applications for LID.

It was noted that WCC is relatively good at (implementing) LID because its strategies are based on the Three Waters framework, which embraces urban design. On the contrary, remarks were made with regards to difficulties encountered when trying to implement LID and adhere to the ALWP simultaneously. This could be avoided by improving relationships between regional and local departments, along with the development of a cost and maintenance-focused mindset. Discrepancies between what is supported by various WCC departments, and regulations, were also cited as a significant barrier (with reference to "Beacon Incentives and Barriers" as produced by Beacon Pathway Ltd which is a collaborative research consortium of organisations with a considerable stake in the quality of the residential sector). Some expressed the view that plan changes take too long to process, and are deemed "too much trouble". One participant suggested that stormwater management devices could possibly be managed by the community (eg communal rain gardens) to save on maintenance costs. Positive incentives (eg financial benefits) would also encourage the use of LID.

With reference to specific documents, it was noted that the transport sections of CoPs and high impervious area and high site coverage rules in the District Plan (for example) are significant barriers to the implementation of LID. This is relevant to new developments proposed for the Northern Strategic Growth Area (NOSGA).

7. **What technical publications, design standards or plans are commonly used in applicant submissions? Are they consistent with those listed in Question 3?**

Existing documents (eg URS draft LID Code of Practice and TUSC) are encouraging. They provide alternatives.

CoP (city and infrastructure).

Countryside and Foothills CoP for developments in foothills.

Stormwater solutions for smaller sites and residential sites.

ARC Technical Publications (TPs): TP108, TP10, TP124 (especially if regional discharge consent is required).

8. **List any common hydrological/hydraulic techniques used in applicant submissions in the design of their stormwater water systems. Please state whether these are consistent with technical references used by the council?**

   TP108, TP10 (specific volume of water to treat) and other TPs are frequently used, especially for larger proposals.

   The rational method (in CoP) is used for smaller proposals.

   A [USA] version of TP108 is sometimes used. TP108 is a version of the rational method in terms of volumes.

   A WCC on-site detention spreadsheet is used a lot.

9. **What stormwater and/or sediment management devices are currently being included in applicants' submissions? Are there any reoccurring themes/omissions/errors within applications?**

   Stormwater detention ponds (especially with roading projects).

   Stormwater tanks for detention/attenuation (often on a lot basis; subdivisions often have a larger, common solution like a pond or wetland). Above and below ground tanks.

   Hinds Up-Flo filters.

   Storm filters.

   Rain gardens (although these are perceived to be high-maintenance).

   Sand filters (although not as popular now).

   Very few swales.

   Planting plans are often overlooked as a possible option.

   Engineering designs often have no specifics (eg plant species) and ongoing maintenance is overlooked at this stage of planning.

   It was also noted that applicants often have problems calculating detention volume and understanding detention requirements.

10. **Is there anything that you would prefer to see included in applicants submissions?**

    Above ground tanks are preferred, as underground tanks can be difficult to regulate with regards to safety, and often require a higher degree of maintenance. A wider range of devices (including treepits and wetlands) would be helpful to ensure that the maximum number of options are on offer. This would encourage the analysis of LID options, and would require applicants to demonstrate why other options were not chosen. Need incentive to recognise the benefit of trees.

The urban design factor was also important to those interviewed. They expressed the importance of considering environments individually; different scales of development are involved and the stormwater management devices need to fit within the environment.

11. **For development proposals and consent applications regarding stormwater and sediment management can you provide an estimate of the percentage split between greenfield and brownfield proposals?**

    In general, most departments identified that there is a high proportion of greenfield development occurring with large scale developments (between 60 and 80 per cent), but brownfield developments are still more common for smaller developments. It was noted that greenfield development has not fully evolved yet in the city (with the exception of larger developments) due to the fact that some areas have not "opened up" yet, but this is likely to change once NOSGA is established.

12. **In addition to those identified in Question 6, what other barriers do you consider to exist for the implementation of LID, and which would you consider to be the most significant barrier?**

    The majority of participants agreed that some barriers did exist, but a proportion of these could be addressed by providing more adequate information about the innovative options available and their costs, and making that information widely available.

    Maintenance was identified as a major barrier, especially for private owners of LID devices like stormwater tanks. Accessibility to sites (for council staff) was also a factor to consider with regards to problems with maintenance.

    Other barriers identified included the following:

    Mindset.

    Requirements and specifications of other departments of the local authority, eg design specifications or employment/population targets.

    Lack of knowledge.

    Lack of incentives for the more desirable options (especially meaningful for developers).

    Lack of successful examples.

    Extra effort and length of consenting process with more innovative options therefore developers stick with tried and true methods.

13. **What documents in other areas do you consider limit the effectiveness/implementation of stormwater/sediment management techniques, in particular LID techniques?**

    There are internal problems with different requirements between departments (eg CoP for roading; Parks policies; rules for imperviousness and building coverage in

the District Plan). Departments often need to work together on developments, so this is a significant issue. More consistency between departments is required.

14. **What type of discretionary mechanisms and processes, if any, does the council have to enable the implementation of innovative/non-traditional stormwater management processes?**

    Participants in the interview noted that they would like to see the benefits of treatment, along with cost of maintenance and construction of LID devices, outlined in proposals. Consents can be referred to the transport team for input prior to submission, particularly if LID or something different to the traditional approaches has been planned. Costs and benefits can then be accurately weighed up. Where there is a high cost of maintenance for small benefit, approval would be unlikely.

    Non-standard solutions (eg proposals that are outside the specifications) are assessed on a case-by-case basis whereby any uncertainties are resolved by specific engineers, and occasionally referred to ARC. In some cases a trial may be conducted with a pilot test to assess the application under the CoP.

    Innovative processes are reasonably well covered by the District Plan, and WCC CoPs for City Infrastructure and Land Development, and Countryside and Foothills. However, the District Plan and CoPs are not linked well.

15. **Are there any fundamental policy shifts which you believe would have to occur to facilitate the promotion of LID?**

    The following suggestions were made with regards to fundamental policy shifts that would enable the promotion of LID:

    Help introduce LID by way of a mandatory requirement or incentive/subsidised funds. (Eg in a new subdivision, the developer would pay the initial cost but WCC is responsible for maintenance and the associated costs).

    Develop a straightforward process, with education and awareness of procedures.

    Accept LID as a mainstream, viable option.

    Accept that sustainability is important and needs to be put into practice. This needs to be emphasised within high-level documents, and practiced.

    WCC needs to get permission for plans that do not allow for change and innovation.

    "Checklist" thinking is common (eg put stormwater management in without analysing all the options first). A paradigm shift is required.

16. **Do you consider other potential benefits of systems (social/amenity/cultural) when making stormwater/sediment management decisions? If so, what are they?**

    The following benefits were listed by interview participants:

    A healthier natural environment

- Habitat and water quality; increased biodiversity.
- Stormwater management; reduced flooding and erosion (eg of stream banks).
- Quality aesthetics.
- Minimal human impact on physical environment.
- Sustainable, responsible use of resources.

Social well-being

- Public health and safety.
- Community understanding and participation (eg water conservation projects).
- Amenity.
- Enhanced recreation resources.

Cultural well-being

- Recognition and respect (eg acknowledging the Treaty of Waitangi).
- Partnership (eg with tangata whenua)
- Economic well-being; investment and employment.

17. How is the ongoing maintenance of traditional and LID systems managed in your organisation? Are you aware of the ARC project to develop Construction, Operation and Maintenance Guidelines for such devices?

    Currently, EcoWater are responsible for the maintenance of LID devices, and some work is contracted out to EcoServices. This contract also includes preventative maintenance. All public devices are maintained in accordance with the WCC Operations and Maintenance Manual, whereas private devices are the responsibility of private owners. WCC are aware that Maunsell are currently working on a Construction and Operations and Maintenance project for ARC.

    A major concern exists regarding justification of costs for different LID devices. WCC struggles to meet budgetary requirements and the current push for green infrastructure, and the often high maintenance requirements for certain devices exacerbates this problem. Analysis of the cost-benefit ratio of proposed treatment devices is often the decision-maker when it comes to installing new devices. Any new instalments must also be in line with the capital works policy on new devices. It was suggested that WCC could offer subsidies for private owners with plans to use LID approaches.

18. What is your understanding of;
    a. Your team/department's overall current approach to or view of LID?
    b. Your organisation's overall current approach to or view of LID?

Overall, WCC appears to be very supportive of the concept of LID, its designs and benefits. However, a few interviewees expressed that there is still some uncertainty, and risks associated with maintenance of LID devices. Implementation of LID within departments still needs some work.

There are varied levels of understanding of the LID approach across different departments and the council as a whole, particularly due to high staff turnover. Many new staff are not as well informed about LID as their more "seasoned" counterparts. Many departments lack the "people power" and financial resources to successfully implement LID, even though they support it in theory.

19. **What opportunities do you see for the enhanced stormwater management and the implementation of LID in your area?**

New subdivisions and greenfield developments were identified as having the highest potential for the implementation of LID, as they involve starting "from scratch". It is more difficult to introduce LID within existing developments because this would probably cause significant disruption. It was stated that green roofs and rain gardens could be incorporated into more designs, and it would be beneficial to encourage developers to get involved. Participants suggested that by using the WCC CoP to greater effect (ie in designs, reference to recommendations), they could achieve increased integration between urban design, stormwater management and parks to achieve a desired outcome. It is difficult to push for LID in the private arena, however initiatives could be made more attractive by offering incentives. It would also help to make costing information more widely available.

20. **Do you consider that the development of a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID would be of benefit to you and your organisation? Why?**

All departments were supportive of the development of a Model Code of Practice. However, it was stated the any such document would need to be a guideline only, providing more options to consider for any new proposal. It would also need to be detailed and user-friendly, and applicable on a regional scale. The document should clearly link with the regional ALWP, and be integrated into regulatory requirements so that it has some substance. It would need to be sufficiently comprehensive, and allow for innovation by enabling the inclusion of all design factors. This would provide for flexibility and change.

21. **What would you like to see included in a Model Code of Practice for Enhanced Stormwater Management and the Implementation of LID?**

The following ideas were suggested as features to be included in the Model CoP, during the interviews:

Best practice recommendations and a mechanism for implementation.

Design components.

Some indication of cost.

Needs to be a fair and comparable regional framework.

Link with regional ALWP.

A one day training from ARC would be helpful to educate the public. Does not need to be expensive.

Opportunities for integration.

Provide flexibility and an understanding of the processes involved in implementing LID. Should not be too prescribed but have sufficient detail to explain concepts.

Need a consistent standard across the region.

Another suggestion was that the document should be targeted towards the general public, and be set out accordingly (ie, easy to read). Effective layout of the document might include pictures and examples of LID designs, with clear calculations and requirements (eg, TP10 sizings). The document should also describe the LID techniques and their associated benefits. If it was written as a template, each local authority could include their own requirements.

22. **Besides the Model Codes of Practice, in what ways could the ARC could assist local authorities in promoting enhanced stormwater management and an increased uptake of LID?**

Reduce the cost by offering subsidies, and recommendations.

Encourage the use of cesspit devices and planting. Increase flexibility and allow for change.

Education and courses for those constructing devices, and consultants. Clearly outline the rules of compliance and how best to achieve objectives.

Need a consistent regional approach.

Multiple bottom line assessment.

Life cycle costs of various approaches.

Monitoring of case study areas and device performance.

Make effective urban design a priority so that targets are met. Need to incorporate urban design ideas and principles into Model CoP.

Provide experienced and qualified technical staff to assist with consent processing and queries. This is especially helpful with regards to operations and maintenance.