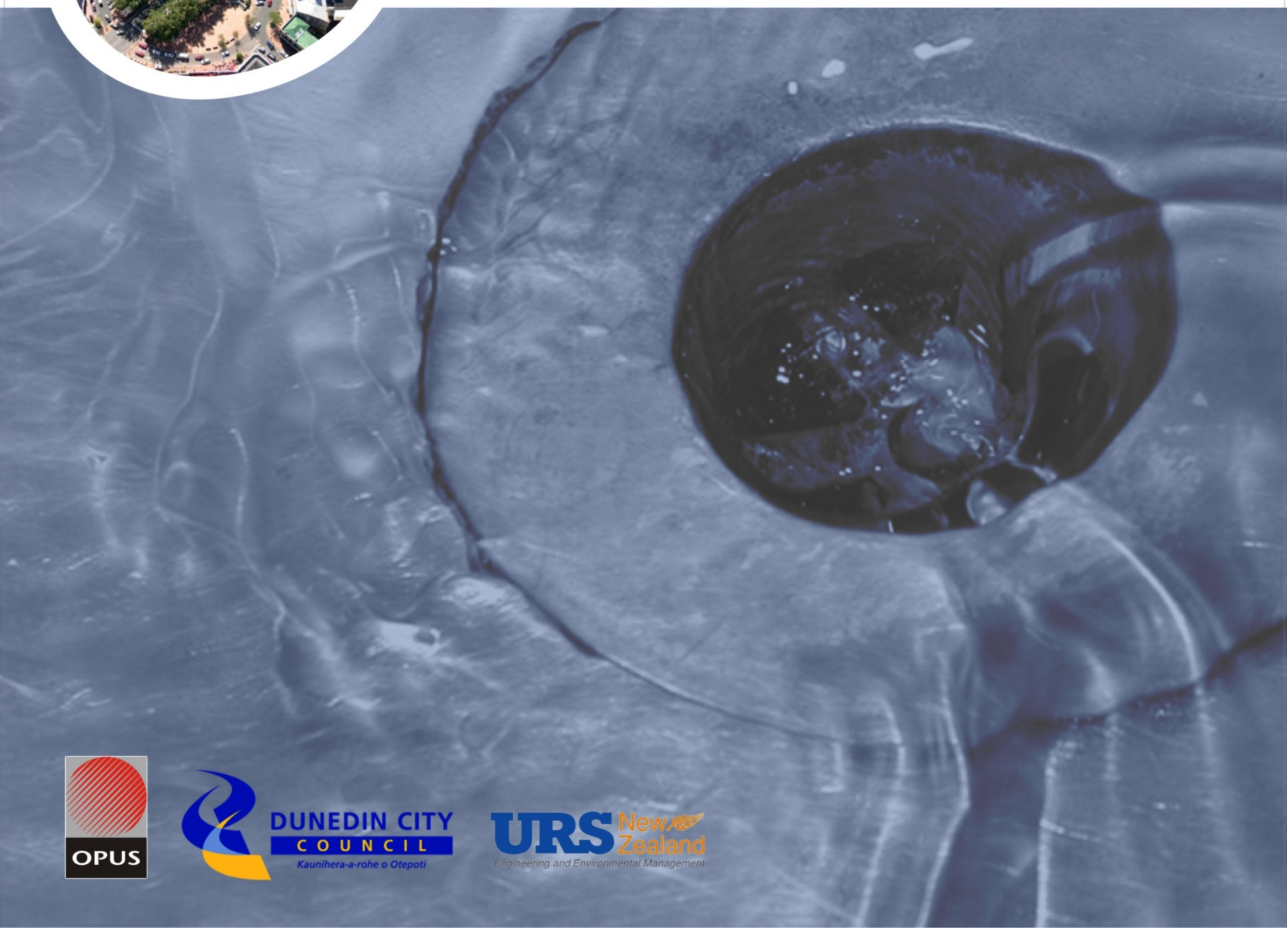
Dunedin 3 Waters Strategy

Kitchener Street Integrated Catchment Management Plan



OPUS

DUNEDIN CITY COUNCIL
Kaunihera-a-rohe o Otepoti

URS New Zealand
Engineering and Environmental Management

Kitchener Street Integrated Catchment Management Plan 2010-2060

Contract No. 3206
Dunedin 3 Waters Strategy

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Executive Summary

The Kitchener Street Integrated Catchment Management Plan 2010-2060 (ICMP) is one of ten long term ICMPs developed as part of the 3 Waters Strategy recently undertaken by Dunedin City Council (DCC).

In 2007, short term (5 year) stormwater discharge consents were granted by the Otago Regional Council (ORC) permitting stormwater discharges into the Otago Harbour pending the development of stormwater catchment management plans. The emphasis of such plans is on monitoring stormwater quality and mitigating adverse stormwater effects on the harbour receiving environment. These short term consents will be replaced with long term (35 year) consents following the completion of ICMPs.

Strategic objectives of stormwater management provide the overarching objectives that guide the development of this ICMP. These objectives are at the core of the relevant statutory and non-statutory documents addressing stormwater management, including the 3 Waters Strategic Direction Statement. These objectives have been developed with the aim of achieving benefits across the four 'wellbeings' (environmental, social, economic and cultural), within the context of a 50 year timeframe, and cover the following:

- Development;
- Levels of service;
- Environmental outcomes;
- Tangata whenua values;
- Natural hazards; and
- Affordability.

The Kitchener Street stormwater catchment covers an area of approximately 1.4 km^2 (137 ha), west of the Otago harbour. The catchment includes much of central Dunedin, and is surrounded by the suburbs of Mornington and Kensington. The east half of the catchment lies on flat, reclaimed land adjacent to the harbour where the majority of the industrial and port land is located. The material used for the fill is likely to be made up of material from the Bell Hill cutting, and harbour dredgings, however port and industrial activities in this area may have resulted in contamination of land in the past.

Since its first period of development in the early 1900's, the Kitchener Street catchment has primarily comprised a mixture of industrial, commercial, port, and residential land uses, with nearly 47 % of the catchment zoned as residential, although this includes a large portion of the Town Belt. The catchment contains sections of four Townscape and Heritage Precincts. These include the High Street, Vogel Street, and Queens Gardens Heritage Precincts and the South Princes Street and Crawford Street Townscape Precincts.

Overall, imperviousness of the Kitchener Street catchment is estimated to be approximately 65 %, with approximately half of the catchment being fully impervious (due to industrial and commercial use). With the exception of possible development of vacant lots, the Kitchener Street catchment is not expected to undergo significant changes to the existing land use practice types over the next 50 years based on the current understanding of the growth demands on the city and the existing district plan provisions.

The Kitchener Street catchment stormwater system has one main branch draining more than 80 % of the catchment, with ten small independent sub-networks draining the remaining area, predominantly

surrounding the wharf. The network is entirely piped, except for a short (approximately 60 m) section of open channel from the Town Belt through to the piped network on Maitland Street.

Structures of note in the catchment include three points at which the network links with the Mason Street catchment network, and a large chamber on Cumberland Street, originally intended as a pump station chamber (but never commissioned).

Based on the current forecasts of theoretical asset life for stormwater mains, the majority of which have been assigned a theoretical life of 100 years, 68 % of the pipe network in the Kitchener Street catchment will be subject to inspection/condition assessment or be renewed by 2060. Remaining life forecasts will be improved based on condition assessment and related work on refining expected lives, and renewals planning adjusted accordingly.

No information on groundwater quality or levels is available, due to a lack of monitoring sites.

There are a number of ‘wellbeing’ locations identified in the Kitchener Street catchment. The Town Belt is identified as a social wellbeing location, and a number of the historic sites mentioned in Section 4.5.2 are identified as cultural wellbeing locations. Transport routes (both road and rail), and a number of economically significant sites lead to a number of stormwater pipelines in the lower part of the catchment being assigned a criticality of 2. Particularly, these pipelines are in the vicinity of Princes Street, and extend from Jervois Street to the outfall.

There are approximately 20 km of water supply pipes within the Kitchener Street catchment, most of which are between 20 mm and 600 mm in diameter, and constructed from cast iron. DCC Network Management and Maintenance staff indicated that there is a cross connection between the water supply system and the stormwater network to the east of Cumberland Street, on the main Stormwater outfall line. This is for flushing purposes, and is operated via a valve, reported to be closed.

The wastewater system within the Kitchener Street catchment comprises approximately 13 km of wastewater pipeline, approximately 85 % of which are between 150 mm and 300 mm in diameter. There are no known significant issues with the wastewater system in the Kitchener Street catchment.

A linked 1 and 2-dimensional hydrological and hydraulic model of the Kitchener Street catchment and stormwater network was developed to replicate the stormwater system performance, and to predict flood extents during a number of different land use, climate change and storm event scenarios. The model was calibrated, and confidence in the model output is considered to be moderate, and the model is considered to be an adequate tool for the purposes of indicating areas with a potential to flood, and allowing the comparative effects of the different rainstorms and climate change scenarios to be assessed.

An assessment of environmental effects, based on the interpretation of the outcomes of the stormwater network hydraulic modelling and the associated flood maps; the marine and stream assessments; information gathered during catchment walkovers; DCC flood complaints records; and information gathered during workshops with DCC Network Management and Maintenance staff, identified a number of stormwater related issues in the Kitchener Street catchment.

The area across the road from The Oval, and the Oval itself, is an area known to flood. Modelling indicates that a large proportion of the flooding is overland flow from system restrictions or unreticulated areas, resulting in water collecting in low points in this area.

Stormwater quality information gathered in the catchment indicates that the levels of all contaminants discharged from the Kitchener Street outfall are typical of stormwater quality from urban catchments. Although variable, heavy metal concentrations have been below detectable levels in a number of samples taken from the outfall. Conversely, analysis of the harbour sediments has found some evidence of heavy metal and PAH contamination. This could indicate historical contamination, or be the result of contamination from other sources.

Stormwater issues were prioritised, and management targets and catchment specific approaches were developed for the Kitchener Street catchment based on each issue, and the strategic objectives for stormwater management. Table ES-1 below summarises the key issues, effects, targets and catchment specific approaches for the Kitchener Street catchment.

The prioritisation score assigned to each issue indicates whether active or passive management is required. Active management indicates that DCC will seek to implement changes to stormwater management in the catchment, whereas passive management would tend more towards monitoring and review of existing management practices to ensure that the targets set can be met.

Tables ES-2 to ES-4 below outline the recommendations, split into further studies, planning and education, and operation and maintenance tasks. The further studies recommended will assist in improving certainty around catchment management targets, or provide further information in order to develop options. Note that where a recommendation is to be resourced internally at DCC, a cost of $ 0 has been assigned.

The implementation of these recommendations will be determined by the 3 Waters Strategic Plan, which will assess all of the ICMPs developed by DCC, and develop a prioritised programme of works across the city.

Table ES-1: Kitchener Street Issues, Approach and Targets Summary

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results	High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear, however results to date indicate typical contaminant concentrations in stormwater discharge. Poor information on actual effects of stormwater on harbour environment. Lack of data to assess linkages between pipe discharge and harbour environment quality.	Improve the quality of stormwater discharges to minimise the impact on the environment. Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges. No recorded breaches of the Resource Management Act. Ensure stormwater discharge quality does not deteriorate.	***Manage Actively*** Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. Develop method for determining linkages between stormwater management and harbour environment. Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. Require source control of stormwater contaminants in new development of high-contaminant generating land uses. Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. Undertake monitoring to ensure stormwater quality does not deteriorate over time. Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges.	Robust city-wide monitoring framework developed and implemented by 2012. Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Potential Wastewater Contamination	Single stormwater measurement in 2010 indicating potential wastewater contamination. No ongoing effects or discharge recorded.	Improve the quality of stormwater discharges to minimise the impact on the environment. Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges. > 75 % compliance with stormwater discharge consents. Ensure stormwater discharge quality does not deteriorate.	***Manage Actively*** Use improved monitoring programme to enable better understanding of potential catchment contamination.	Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. Implement management options to remediate problem where necessary.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Deep Flooding	Model results indicate 2 parcels affected by deep flooding during 1 in 10 yr Average Recurrence Interval (ARI) rainfall event; rises to 16 during 1 in 50 yr ARI rainfall event in current, and 21 land parcels in future planning scenarios. The only significant location of deep flooding predicted during the 2010 1 in 50 yr ARI event is surrounding the industrial block next to The Oval, in particular the western side of Princes Street from Lees Street to Jones Street, and in car parks within the associated industrial block. Based on the modelling results, it is possible that floodwaters will enter a small number of buildings during large events, due to breaks in the kerb and doorsteps flush with the pavement.	Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event. Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.	***Manage Actively*** Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. Enhance understanding of effects of deep flooding, particularly on private property. Undertake pipe renewals programme as scheduled (with older pipes prioritised).	< 16 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. Undertake habitable floor survey and / or damage assessment of potentially flooded properties. > 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Low Level of Service in Lower Catchment	Significant proportion of the lower network is predicted to surcharges during a modelled 1 in 2 yr ARI rainfall event, with 11.2 % of catchment manholes overflowing, however most are in the wharf area near to a harbour outfall. 43 % of catchment manholes overflow during a 1 in 10 yr ARI rainfall event.	Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives. Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event. 95 % of customer emergency response times met. > 60 % residents' satisfaction with the stormwater collection service.	***Manage Passively*** Maintain or improve existing level of service in network. Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). Undertake pipe renewals programme as scheduled (with older pipes prioritised). Use customer complaints and residents' opinion survey (ROS) to gauge satisfaction with the stormwater system performance.	> 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. > 60 % residents' satisfaction with the stormwater collection service (ongoing).
Network Maintenance	Flooding extents and durations in the Kitchener Street catchment are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance. City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.	Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives. > 60 % residents' satisfaction with the stormwater collection service.	***Manage Passively*** Ensure consistency city-wide of stormwater structure cleaning and maintenance. Ensure cleaning and maintenance schedules and contracts are sufficiently robust. Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk.	Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. Develop list of key stormwater assets in Kitchener Street catchment requiring additional cleaning and maintenance checks by 2013.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Flood Hazard – Current and Future 1 in 100 yr ARI	Flood hazard issues in this catchment are considered to be fairly minor, with hazard being identified in areas predicted to have deep flooding during a number of events. Transport routes are not predicted to be severely affected – inundation across roads is predicted to be shallow or confined to the sides of the road. Small parts of lower catchment at risk of direct tidal inundation.	Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.	***Manage Passively*** Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances).	Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan.
Nuisance flooding	Nuisance flooding is predicted and confirmed during small events in two main areas; South Road at the intersections of Maitland Street, Lees Street and Jones Street, and in the central area near Crawford Street at the intersections with Jervois Street and Police Street. Not expected to inundate roads or be experienced for long periods of time.	Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network. > 60 % residents' satisfaction with the stormwater collection service.	***Manage Passively*** Maintain or improve existing level of service in network. Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). Undertake pipe renewals programme as scheduled (with older pipes prioritised). Monitor customer complaints and / or undertake site visits to confirm locations of flooding.	> 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Ongoing Stormwater Discharge	Could exacerbate historical contaminant issues in the harbour. Extent to which this is likely to occur is unconfirmed. Key stakeholder issue. Based on available data, consequence currently believed to be minor.	Improve the quality of stormwater discharges to minimise the impact on the environment. Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges. > 75 % compliance with stormwater discharge consents. Ensure stormwater discharge quality does not deteriorate.	***Manage Passively*** Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. Require source control of stormwater contaminants in new development of high-contaminant generating land uses. Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality.	No deterioration of stormwater quality due to land use change or development in the catchment. Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.

Table ES-2: Further Study Recommendations

Risk Matrix Score	Task	Budget Cost	Work Period
160	Redesign the city-wide framework for stormwater quality and harbour environment monitoring.	$ 20 k	3 - 6 months
50	Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.	$ 0	Ongoing
20	Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).	$ 20 k	3 - 6 months

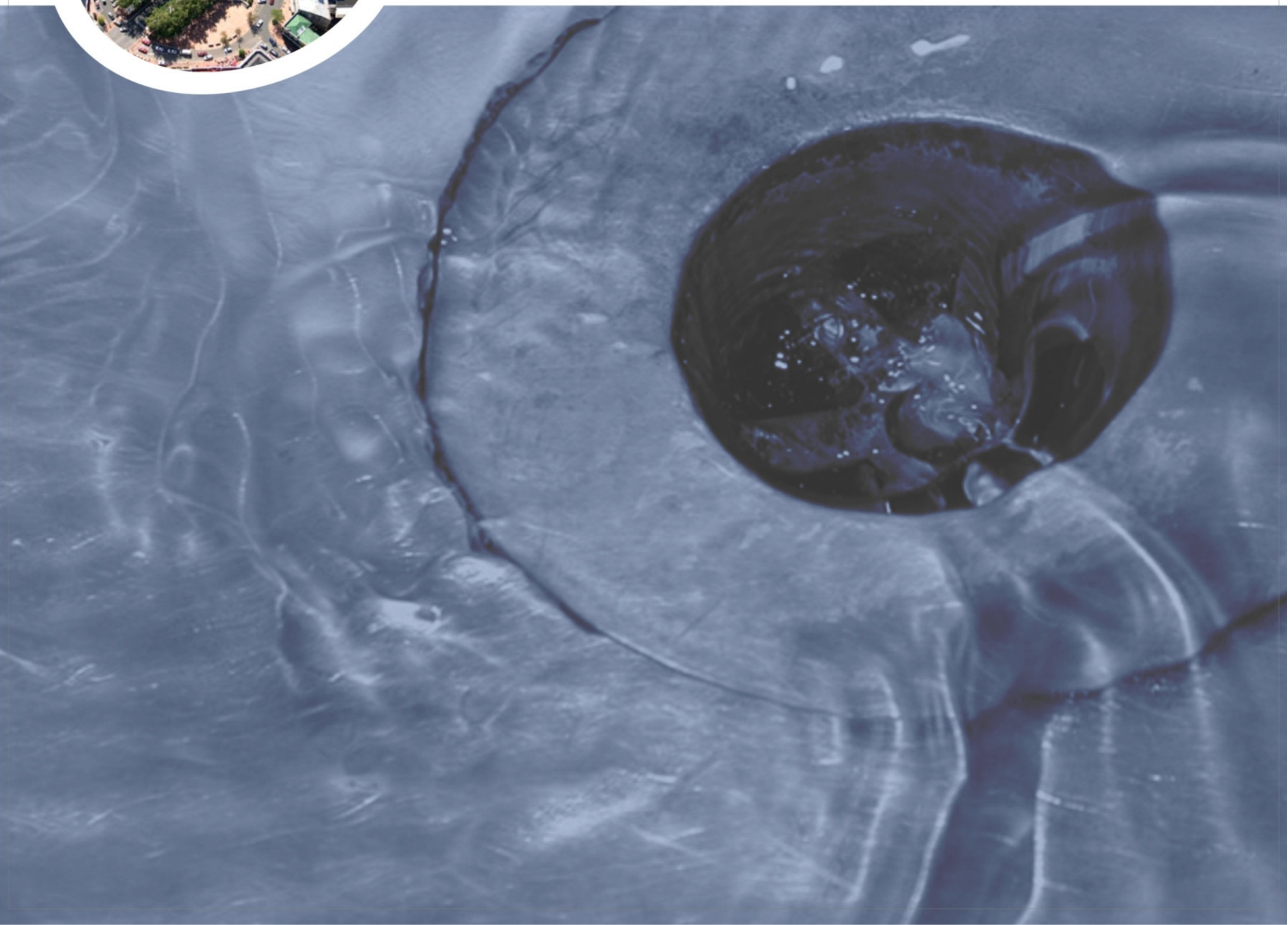
Table ES-3: Planning and Education Recommendations

Risk Matrix Score	Task	Budget Cost	Work Period
40	Contribute information to a city-wide climate change adaptation plan.	$ 0	6 - 12 months
40	Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.	$ 0	2 months
40	Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.	$ 20 k	6 months

Table ES-4: Operation and Maintenance Recommendations

Risk Matrix Score	Task	Budget Cost	Work Period
160	Implement the revised city-wide monitoring framework.	$ 25 k	Annual
50	Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.	$ 5 k	2 months
50	Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.	$ 20 k	2 months

Part 1
Introduction



1 Introduction

1.1 Background

Dunedin City Council (DCC) is currently in the process of implementing an integrated approach to asset management, and a business improvement project in order to meet capital and operational delivery targets. The process has two main components. The first; review of the existing business structure was completed in 2009. This established a better alignment between people, processes and outcomes. The second; to undertake a significant strategy development project incorporating the three water networks; water supply, wastewater and stormwater. The 3 Waters Strategy project Phases 1 and 2 were completed in 2011, and included the development of hydraulic models examining the entire water cycle within Dunedin's urban catchments, providing critical information on the performance of the networks. The 3 Waters Strategy outcomes are used to inform decisions on future capital expenditure programmes to address the following:

- Current known issues in the networks;
- Urban growth;
- Climate change; and
- Environmental sustainability (particularly in relation to new stormwater consents).

As part of this future strategy the 3 Waters Strategy project has been developed with the aim of providing an integrated decision making process for DCC.

The objectives of the 3 Waters Strategy are:

- Determine required levels of service for each of the three waters networks.
- Determine capital and operational costs associated with improvements to the three waters networks, including priorities and phasing for investment.
- Develop a greater understanding of the operations of the three waters networks through targeted asset and flow data collection.
- Develop decision support tools including network models.
- Develop Integrated Stormwater Catchment Management Plans.
- Provide sufficient data to support the development of council's Annual Plan and Long Term Plan (LTP).

To achieve the objectives of the Strategy the project comprises a three phase process:

Phase 1: Development of capital and operational investment needs at a macro level, determine the needs for more detailed investigations to be carried out in Phase 2, and determine high priority capital and operational works for major infrastructure items to be carried out in Phase 3.

Phase 2: Detailed investigations to determine capital and operational needs at a catchment or zonal level.

Phase 3: Implementation of capital and operational works to realise the required level of service improvements.

1.2 Context

The development of the Kitchener Street Integrated Catchment Management Plan 2010-2060 (ICMP) is part of the 3 Waters Strategy being undertaken by DCC, as described above. This ICMP is one of ten long term plans to be developed to fulfil consent requirements relating to the discharge of stormwater to the Otago Harbour, as well as to provide future direction for DCC's stormwater management at a catchment specific scale.

In 2007, short term (5 year) stormwater discharge consents were granted by the Otago Regional Council (ORC) permitting stormwater discharges into the Otago Harbour pending the development of stormwater catchment management plans. The emphasis of such plans is on monitoring stormwater quality and mitigating adverse stormwater effects on the harbour's receiving environment. These short term consents will be replaced with long term (35 year) consents following the completion of ICMPs.

Appendix A contains the short term stormwater discharge consents granted for the Kitchener Street catchment (via Kitchener Street outfall). These consents (Consent Nos. 2002.087, 2002.088, 2002.089, 2002.090, 2002.091, and 2002.092), granted in November 2007, are for a period of five years. A condition in of the consents states:

> *"In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment…"*

In 2008, a high level Quadruple Bottom Line (QBL) assessment of the nine largest stormwater catchments was undertaken, and identified the South Dunedin catchment as the highest priority catchment in terms of stormwater issues (refer to the *'Dunedin 3 Waters Strategy, Stormwater Catchment Prioritisation Framework'*; URS, April 2008). Following the development of an ICMP for the South Dunedin catchment, the remaining stormwater catchments were re-prioritised, whereby the economic, social, cultural and environmental aspects of the catchments' assets were gauged based on 12 QBL indicators. The four QBL 'wellbeings' (categories) and 12 indicators were each defined and weighted in consultation with DCC Water and Waste Business Unit branch representatives to ensure that indicators which are considered most important have a greater impact on the final score than indicators which are considered less important at this stage. Each of the nine catchments were then scored against the indicators on a scale of zero to five (zero representing 'no issue' and five, a 'significant issue'), thus producing a final weighted score and ranking of the catchments. The results of this QBL prioritisation assessment are presented in Table 1-1 and further details can be found in the report: *'Phase 2 Stormwater Catchment Prioritisation Framework'* (URS, July 2009).

The Kitchener Street stormwater catchment ranked fourth out of the nine catchments scored, indicating a moderately high number of issues in the catchment. No one indicator stood out as a key issue in the catchment, which scored moderately across most indicators. Notably, Kitchener Street scored low in sediment generating / erosion areas and reported flooding incidents.

The scope of works for this ICMP was developed to collect sufficient information about current stormwater management in the catchment, as well as the effects of current practices. Objectives for stormwater management have been set by the 3 Waters Strategic Direction Statement in conjunction with objectives for water supply and wastewater management. Recommendations for future stormwater management are required to meet these objectives, based around avoiding, remedying or mitigating adverse effects of stormwater discharges on both the catchment itself and the receiving environment. Integration of stormwater, wastewater and water supply management is a key consideration throughout this ICMP, and further opportunities for integrated solutions in this catchment between the water supply, wastewater and stormwater networks, is likely to be in the co-ordination of the DCC capital works programme.

Table 1-1: Phase 2 Catchment Prioritisation

QBL Category	Label	Indicator	Main Weighting (%)	Sub Weighting (%)	Halsey Street	Orari Street	Mason Street	Kitchener Street	Shore Street	Port Chalmers	Portsmouth Drive	Ravensbourne Road	St Clair
Economic	1A	Annual OPEX	35	100	3	2	0	0	0	0	0	0	0
Social	2A	Community Pressures	-	-	-	-	-	-	-	-	-	-	-
Cultural	3A	Iwi (Käi Tahu) considerations	20	100	4	4	4	4	4	4	4	4	3
Environmental	4A	Sensitivity of Receiving Environment	45	10	3	3	3	3	4	3	3	3	1
	4B	Asset condition/age/capacity restraints		25	3	3	3	3	3	3	1	1	3
	4C	Reported Flooding incidents		10	4	2	3	1	2	1	1	3	2
	4D	Reported Water Quality incidents		10	4	2	4	3	1	3	1	0	2
	4E	Presence of point source pollution sources		20	3	2	3	3	1	2	4	4	1
	4F	Presence of diffuse pollution sources		10	3	2	3	3	2	0	5	3	1
	4G	Development proposed within catchment		-	-	-	-	-	-	-	-	-	-
	4H	Sediment generating / erosion areas		10	3	2	2	1	2	1	0	0	2
	4I	Potential for waste / stormwater system interaction		5	4	3	4	2	2	4	1	1	2
				Weighted Score:	**3.31**	**2.58**	**2.17**	**1.95**	**1.77**	**1.77**	**1.75**	**1.7**	**1.43**
				Rank:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

1.3 Overview

This ICMP comprises six parts:

Part 1 – Introduction. This section provides the background to the study, and outlines the planning and statutory requirements of DCC with respect to stormwater discharge management.

Part 2 – Baseline. This part of the report describes the stormwater catchment as it is now – topography, land use, receiving environments, stormwater discharge quantity and quality. The stormwater network is also described and current operational and capacity issues discussed.

Part 3 – Analysis. Stormwater management problems and issues are identified in this section, by analysing the results of contaminant and network modelling, flood hazard mapping and other information collated in previous sections.

Part 4 – Targets. Catchment stormwater management approaches and SMART targets are outlined in this section, as determined by the priority of each issue, and DCC's stormwater management objectives.

Part 5 – Solutions. This section describes a number of potential solutions to the issues identified (stormwater quantity and quality).

Part 6 – Way Forward. A prioritised programme of works is outlined, based on the Optimised Decision Making Framework developed for the DCC 3 Waters Strategy.

Figure 1-1 presents the scope of work for the stormwater component of the 3 Waters Strategy, including prioritisation of the catchments.

Figure 1-2 provides a process diagram of the ICMP process used for this project. The figure also indicates the position and influence of stakeholder consultation within this process. Ongoing consultation ensures that the project advances in a way that meets the needs and expectations of all parties involved. It can also significantly benefit the project by providing invaluable local knowledge and assist in identifying significant issues. Furthermore, successful consultation during development stages can often assist implementation of the ICMP.

An ICMP document is designed to accommodate a number of changes during its useful life, via monitoring and review processes (refer Section 17). Changes within the catchment, results of monitoring, or improved system knowledge are a number of things that may prompt a change in the ICMP.

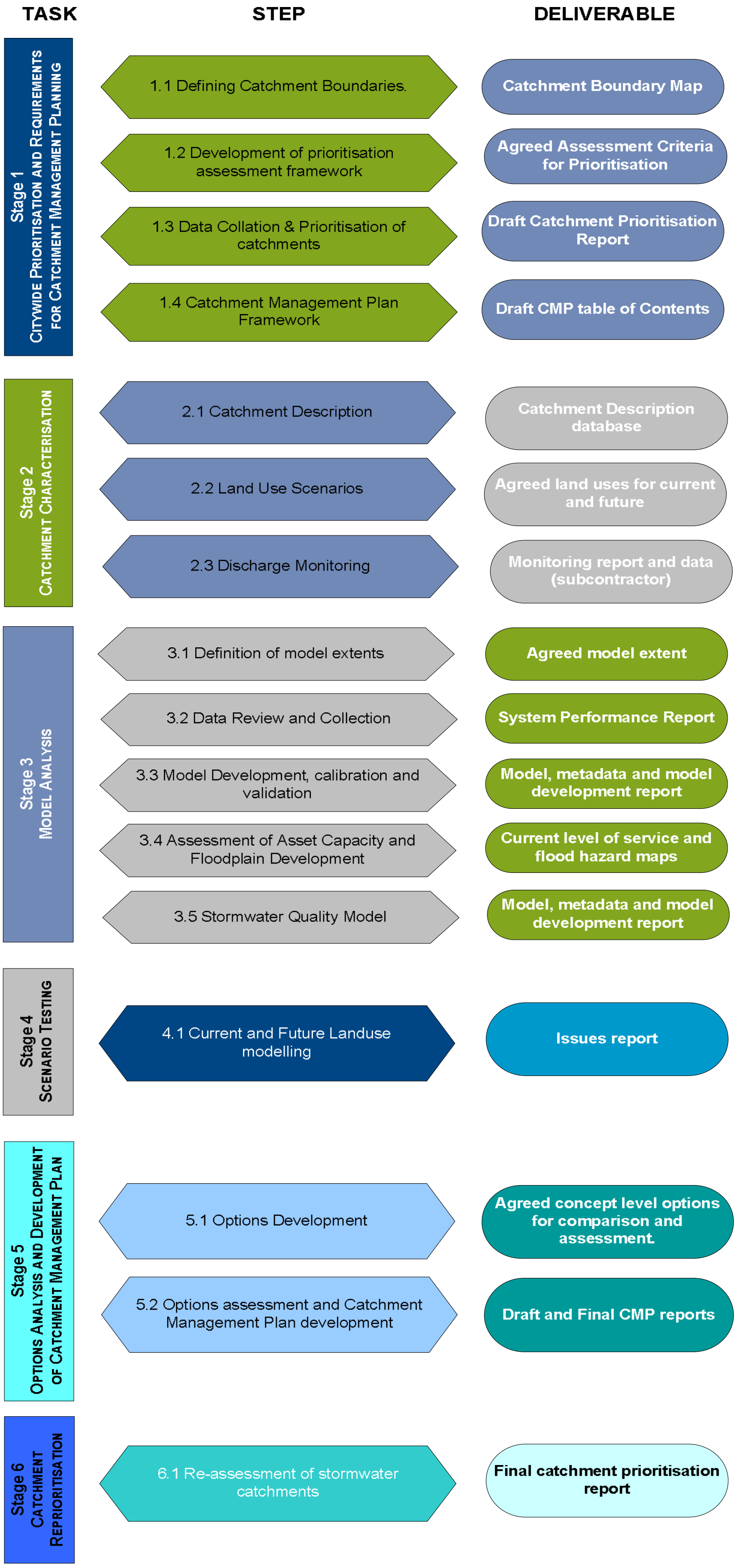


Figure 1-1: Scope of Work

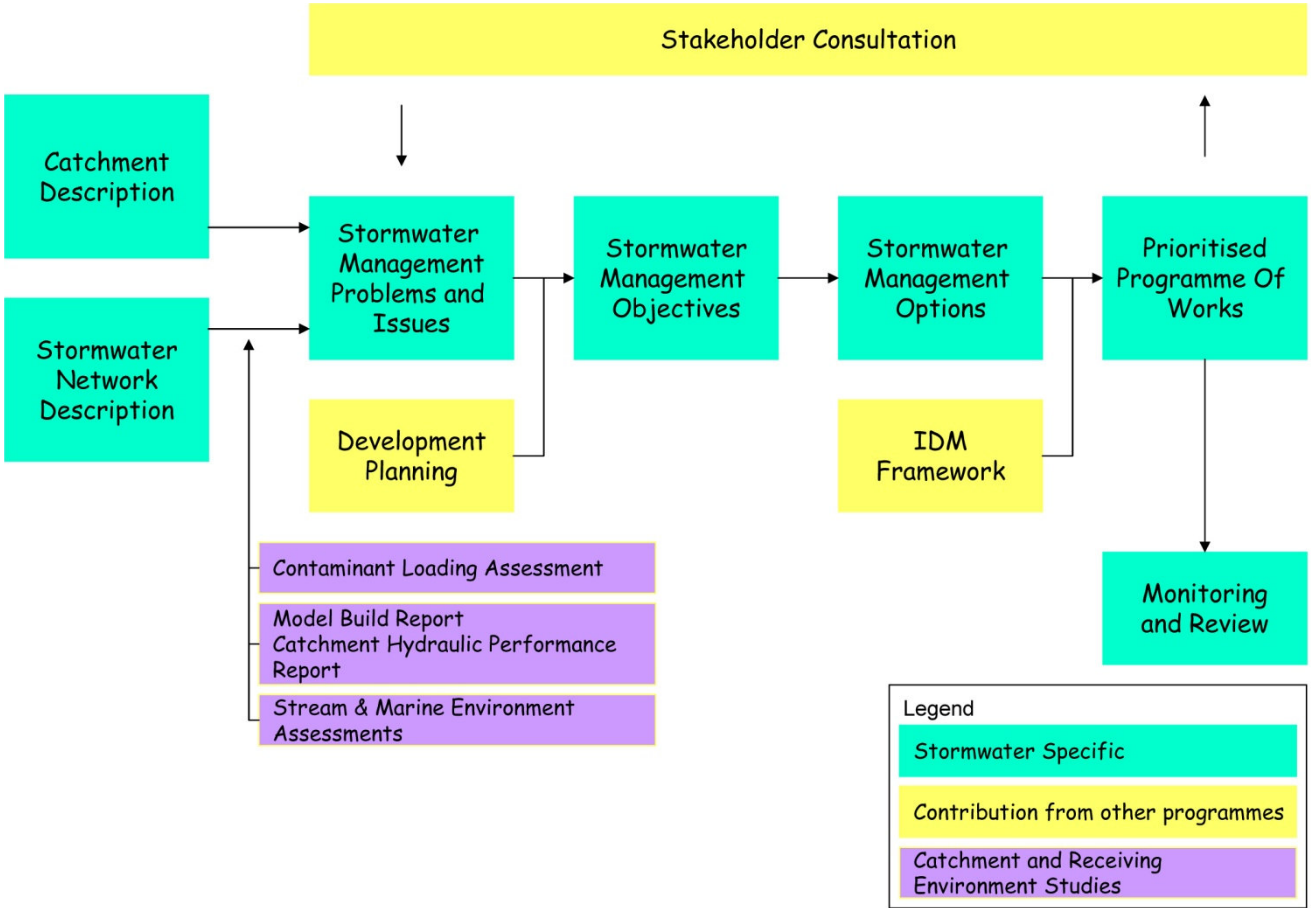


Figure 1-2: ICMP Development Process

2 Planning and Statutory Background

2.1 Planning Framework

An ICMP and any stormwater development undertaken where the ICMP is applied should be consistent with the objectives of central, regional and district planning documents and key non-statutory strategic documents. Figure 2-1 below provides the hierarchies of legislative and planning documents, both statutory and non-statutory which interact with the ICMP. As shown by the double ended arrows, there is often a two way interaction between the ICMP and these documents.

The influence of each of the key current statutory and non-statutory documents relating to stormwater management and the development of an ICMP are discussed in Sections 2.2 to 2.7. It is important to note that these documents are subject to review and change. Therefore, the ICMP needs to be sufficiently flexible to endure variations to these documents while remaining relevant. In some cases the ICMP may provide direction to these variations.

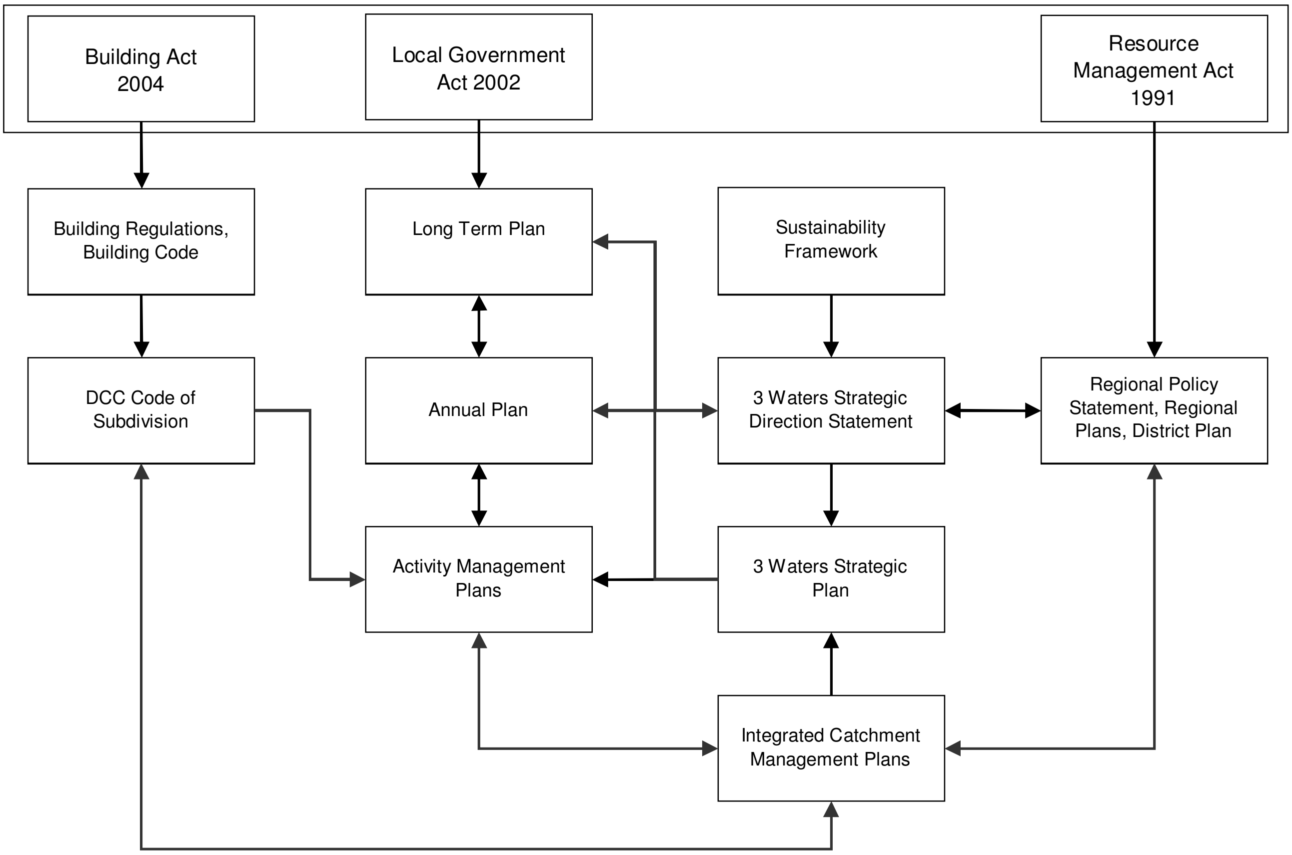


Figure 2-1: Legislative and Planning Document Hierarchies

2.2 The Local Government Act (2002)

The purpose of the Local Government Act 2002 (LGA) is to provide for democratic and effective local government that recognises the diversity of New Zealand communities and, to that end, this Act—

(a) *States the purpose of local government; and*

(b) *Provides a framework and powers for local authorities to decide which activities they undertake and the manner in which they will undertake them; and*

(c) *Promotes the accountability of local authorities to their communities; and*

(d) *Provides for local authorities to play a broad role in promoting the social, economic, environmental, and cultural wellbeing of their communities, taking a sustainable development approach.*

There are a number of responsibilities outlined within the LGA which are relevant to the ICMP. These include:

- Section 93, LTP;
- Section 95 Annual Plan; and
- Compliance with performance measures set by the Secretary of Local Government.

These are discussed below.

An ICMP needs to be consistent with the LGA. This can be achieved by promoting consultation with all parties affected by stormwater management decisions and accounting for and managing the stormwater infrastructure for Dunedin City in a manner that provides for the present and future needs of the public and the environment.

2.2.1 Long Term Plan (LTP)

Section 93 of the LGA requires a local authority to produce a LTP for the following purposes:

"to describe the activities of the local authority; to describe community outcomes; to provide integrated decision making and co-ordination of resources; to provide a long term focus for decisions and activities; and provide a basis for the accountability of the local authority to the community.'; and to provide an opportunity for participation by the public in decision making processes."

2.2.2 Annual Plan

The Annual Plan required under Section 95 of the LGA supports the LTP by providing for the co-ordination of local authority resources, contributing to the accountability of the local authority to the community, and extending the opportunities for participation by the public in decision making relating to costs and the funding of local authority activities.

2.2.3 Performance Measures

The Secretary of Local Government is required to provide regulations that establish rules specifying performance measures for water supply; sewerage treatment / disposal; stormwater; flood protection and the provision of roads and footpaths. The performance measures relating to stormwater, wastewater and flood protection will need to be taken into account when developing solutions under the ICMP.

2.2.4 Trade Waste Bylaw

The DCC Trade Waste Bylaw 2008 regulates the discharge of Trade Waste to a Sewerage System operated by DCC. The purpose of the Bylaw is:

> *"to control and monitor trade waste discharges into public sewers in order to … (v) protect the stormwater system."*

Section 4A of the Bylaw states that it is an offence to discharge stormwater into the stormwater system that does not satisfy the discharge acceptance standards outlined in Schedule 1E of the Bylaw. Schedule 1E contains a number of acceptance standards, including limitations on the quality of the stormwater.

2.3 Resource Management Act (1991)

The purpose of the Resource Management Act (RMA), as defined in Section 5 of the Act, is to promote the sustainable management of New Zealand's natural and physical resources. This is to be achieved by managing the use of 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; Matters of National Importance, Section 7; Other Matters and Section 8; Treaty of Waitangi outline values which all persons exercising functions and powers under the RMA shall recognise and provide for, have particular regard to and take into account when achieving the purpose of the RMA.

Sections 14 and 15 of the RMA place restrictions on taking and using water, and on the discharge of contaminants into the environment.

In relation to stormwater management, the RMA therefore addresses the following:

- 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 Māori 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; and
- 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:
    - i) The setting of any maximum or minimum levels or flows of water; and
    - ii) The control of the range, or rate of change, of levels or flows of water.

It is considered that the development and implementation of an ICMP which is consistent with the purpose and principles of the RMA, will allow for the identification of in-catchment values, such as drainage patterns and sensitive receiving environments. Management recommendations are then made based on the best practicable option, to ensure that the natural and physical environment within a stormwater catchment and its receiving environment are managed sustainably. This approach helps to ensure that the natural and physical resources within Dunedin's stormwater catchments are used in a way that provides for the community's social, economic and cultural wellbeing.

2.3.1 The New Zealand Coastal Policy Statement (2010)

The purpose of the New Zealand Coastal Policy Statement 2010 (NZCPS) is to outline policies relevant to the coastal environment to achieve the purpose of the RMA. The term 'coastal environment' is broad, and although undefined in the RMA, it is generally considered an environment in which the coast is a significant element or part.

The NZCPS requires persons exercising functions and powers under the RMA to:

- Safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land;
- Preserve the natural character of the coastal environment and protect natural features and landscape values;
- Take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in management of the coastal environment;
- Maintain and enhance the public open space qualities and recreation opportunities of the coastal environment, enable people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through subdivision, use, and development; and
- Ensure that management of the coastal environment recognises and provides for New Zealand's international obligations regarding the coastal environment, including the coastal marine area (CMA).

Policies within the NZCPS contain potential restrictions on the activities likely to be undertaken in relation to stormwater management and have been considered when making recommendations within this ICMP. Policy 23 (2) and (4), addressing the discharge of contaminants has particular relevance for Dunedin City.

Policy 23(2)(a) does not allow discharges of human sewage directly to water in the coastal environment without treatment unless there has been adequate consideration of alternative methods, sites and routes for undertaking the discharge that have been informed by an understanding of tangata whenua values and the effects on them. DCC does not currently have any planned direct sewage discharges. However the wastewater infrastructure network does have emergency overflow facilities to the coastal environment. These facilities are to accommodate emergency overflow discharges only. All discharges during non emergency events are provided for through the existing wastewater network. Adequate consideration has been given to alternatives to a coastal discharge by providing an alternative for any non emergency events therefore the current discharge scenario is consistent with this policy.

Policy 23(4) outlines steps to be taken to avoid the effects of a stormwater discharge on water in the coastal environment. These steps include:

- Avoiding where practicable and otherwise remedying cross contamination of sewage and stormwater systems;
- Reducing contaminant and sediment loadings in stormwater at source, through contaminant treatment and by controls on land use activities;
- Promoting integrated management of catchments and stormwater networks; and
- Promoting design options that reduce flows to stormwater reticulation systems at source.

The ICMP process by definition promotes the integrated management of catchments. Recommendations made within the ICMP will incorporate the other steps outlined where appropriate or required as determined by the results of stormwater quality and quantity monitoring.

The Kitchener Street catchment discharges into the Upper Otago Harbour, which links with the Pacific Ocean, therefore the NZCPS must be considered when developing and implementing the ICMP. The ICMP provides a detailed assessment of the effects of current land use and development within the Kitchener Street catchment on the Otago Harbour. It is considered that the ICMP approach is consistent with the holistic nature of the NZCPS in particular Policy 23(4)(c), and that the stormwater management options considered by the ICMP regarding stormwater management options such as source control, treatment devices, low impact design, and community education will ensure that the adverse effects of stormwater runoff on the coastal environment will be avoided, remedied or mitigated.

2.3.2 Marine and Coastal Area Act (2011)

The Marine and Coastal Area Act repeals the Foreshore and Seabed Act 2004, and removes Crown ownership of the public foreshore and seabed.

The Act provides that any part of the common marine and coastal area owned by a local authority will form part of the common marine and coastal area, divesting local authorities of those areas. Current freehold title in existing reclamations would remain.

The Act states that resource consents in the common marine and coastal area that were in existence immediately before the commencement of the Act are not limited or affected by the Act. Existing leases, licences, and permits will run their course until expiry. Coastal permits will be available for the recognition of these interests after expiry.

The Act provides that, while there is no owner of the common marine and coastal area, existing ownership of structures and roads in the area will continue. New structures can be privately owned. Structures that have been abandoned will vest in the Crown so that it can ensure that health and safety laws are complied with.

The Marine and Coastal Area Bill was enacted on 24 March 2011. Stakeholder consultation will incorporate discussion on the Marine and Coastal Area Act.

2.3.3 National Environmental Standards

While there are currently no National Environmental Standards (NES) relevant to this ICMP, it is assumed that NES will be developed in time for the type of activities covered under this ICMP. As local or regional councils must enforce standards imposed by a NES, the ICMP must be flexible enough to incorporate these standards.

2.3.4 The Otago Regional Policy Statement (1998)

The Otago Regional Policy Statement (ORPS) is an operative document giving effect to the RMA. The ORPS discusses issues, objectives and policies relating to managing the use, development and protection of the natural and physical resources of the region. The ORPS identifies regional issues and provides a policy framework for managing environmental effects associated with urban and rural development.

The ICMP is influenced by the ORPS and the planning documents which sit below it (i.e. the Regional Plans). There are a number of policies contained within the ORPS which are relevant to the ICMP. Of particular relevance are Policies 6.5.5, 7.5.3, 8.5.6, 9.5.4 which seek to reduce the adverse effects on the environment of contaminant discharges through the management of land use, air discharges, coastal discharges and the built environment. The management options discussed include adopting baseline water quality standards and where possible improving the quality of water to a level above these baselines. The policies mentioned give general guidance to any stormwater management initiatives within the Region by identifying anticipated environmental outcomes. This general guidance is the main starting point for determining the direction of the ICMP.

The ORPS also addresses natural hazards in Policies 11.5.2, 11.5.3 and 11.5.4. These policies give direction to hazard management through outlining steps that should be taken to avoid or mitigate the effects of natural hazards. These over arching policies may play a significant role in providing direction for the ICMP if natural hazards (such as flooding) are determined to be a priority.

The ORPS was due for full review in October 2008 however at the time this report was written the review process had not been initiated.

2.3.5 The Regional Plan: Coast for Otago

The purpose of the operative Regional Plan: Coast for Otago (Coastal Plan) is to provide a framework to promote the integrated and sustainable management of Otago's coastal environment. The Coastal Plan recognises that the coastal environment is one of the integral features of the Otago Region, and that it is dynamic, diverse and maintained by a complex web of physical and ecological processes. One of the principle considerations for this ICMP is the discharge of contaminants into the CMA.

Chapter 10 of the Coastal Plan addresses the discharge of contaminants to the CMA. This chapter contains a number of policies addressing issues such as: the effects of any discharge on Käi Tahu values; avoiding effects on coastal recreation areas; areas of significant landscape or wildlife habitat value; water quality; mixing zones; and discharge alternatives.

Policy 10.4.1 states that for any discharges to the CMA that are likely to have an adverse effect on cultural values Käi Tahu will be treated as an affected party. Details relating to issues of particular significance are contained within the Käi Tahu ki Otago Natural Resource Management Plan which is addressed below.

Objective 10.3.1 seeks *"to maintain existing water quality within Otago's coastal marine area and to seek to achieve water quality within the coastal marine area that is, at a minimum, suitable for contact recreation and the eating of shellfish within 10 years of the date of approval of this plan"*. Further, Policy 10.4.3 states that where water quality already exceeds these standards, water quality should not be degraded beyond the limits of a mixing zone associated with each discharge.

2.3.6 The Regional Plan: Water for Otago

The operative Regional Plan: Water for Otago (Water Plan) considers the use, development and protection of the fresh water resources of the Otago region, including the beds and margins of water bodies. Chapter 7 of the Water Plan outlines objectives and policies to address those issues relating to water quality and discharges.

Policies 7.7.3, 7.7.4, 7.7.5 and 7.7.7 outline matters which need to be considered when assessing resource consents for discharges including cumulative effects, the sensitivity of the receiving environment and any relevant standards. Policies 7.7.10 and 7.7.11 address stormwater systems directly, identifying required outcomes for new systems and requiring the progressive upgrade of older systems. These policies provide both general and specific guidance for any stormwater system or associated discharge within the Kitchener Street catchment and play a strong role in determining the suitability, consentability and priority of any management option chosen under the ICMP.

2.3.7 The Dunedin City District Plan

The operative Dunedin City District Plan identifies issues and states objectives, policies and methods to manage the effects of land use activities on the environment.

The Dunedin City District Plan applies to all users of land and the surface of water bodies within the city; it is concerned with all areas above the line of mean high water springs (MHWS). Issues pertaining to those areas below the line of MHWS, including coastal waters, are addressed in the Otago Regional Plan: Coast for Otago and the NZCPS.

Policy 21.3.1 seeks to protect the harvest potential and quality of water within catchments. Policy 21.3.8 seeks to avoid or otherwise remedy or mitigate the adverse effect of activities which discharge to water, land or air. While standards relating to water quality are the jurisdiction of ORC, the policies contained within the Dunedin City District Plan address the effects of land use on water quality for example through the consideration of matters such as stormwater runoff from subdivisions.

The Dunedin City District Plan also uses land use zoning as a method of regulating activities under DCC jurisdiction. These land uses will play an integral part in determining the quantity and quality of any stormwater runoff. The Kitchener Street catchment includes areas of Residential 1, Residential 4, Industrial 1, Central Activity Area, Large Scale Retail, and Port 2 zones.

Careful consideration will need to be given to the Industrial 1, Port 2, Central Activity, and Large Scale Retail land use zones when looking at management options under the ICMP, as these land uses are likely to produce different stormwater quantities and quality outputs to the residential zones.

Activities which are permitted to occur within the Industrial 1 zone include: industrial activity, service activity, retail activity specific to and complimentary to industrial or service activity, recreational activity, service stations, vehicle and boat yards and garden centres. The Port 2 zone also permits industrial, service and related retail activities along with activities specific to a port such as the unloading and storage of cargo.

It may also be that data obtained during the development of the ICMP provides input into future land use zoning within the Dunedin City District Plan.

2.4 Building Act (2004)

The Building Act 2004 includes Sections 71 to 74 which relate to limitations and restrictions on building consents and the construction of buildings on land subject to natural hazards. Flooding is a natural hazard of concern within the Kitchener Street catchment therefore the ICMP needs to ensure that any development within the catchment will not exacerbate the risk of flooding.

The Building Regulations 1992 include the Building Code, which provides guidance as to the implementation of the Building Act. Section E of the Building Code includes various performance criteria relating to stormwater systems which are relevant to the ICMP. These criteria are specific to managing natural hazards and include drainage system design and inundation probability criteria. The ICMP will need to reference the performance criteria outlined within the code when identifying management options.

2.5 Civil Defence Emergency Management Act (2002)

The Civil Defence Emergency Management Act 2002 (CDEMA) addresses the management of emergencies including flooding. Section 64(1) of the CDEMA outlines the duties of local authorities and states:

> *"A local authority must plan and provide for civil defence emergency management within its district."*

Producing flood maps as part of the ICMP process may be one method of providing for civil defence emergency management however this method is not specifically prescribed by the CDEMA and therefore is at the discretion of the local authority concerned.

2.6 Non Statutory Documents

2.6.1 Käi Tahu ki Otago Natural Resource Management Plan

Käi Tahu ki Otago Natural Resource Management Plan (Käi Tahu Plan) provides a background to Käi Tahu's resource management issues in the Otago Region. The Käi Tahu Plan contains management guidelines and objectives relating to freshwater fisheries and coastal resources. Käi Tahu are particularly concerned with the destruction of the freshwater resource as a result of piping and channelisation, the mauri and life supporting capacity of water being compromised by structures and point source discharges, and the depletion of coastal fisheries due to discharges to the CMA.

The ICMP should consider the specific concerns of Käi Tahu where they are not addressed by the regional or district statutory planning documents, and should ensure that Käi Tahu are considered as a potentially affected party where appropriate.

2.6.2 Code of Subdivision and Development

Chapter 18, Subdivision of the Dunedin City District Plan, contains Method 18.4.1 which makes reference to the Dunedin Code of Subdivision and Development. This code is not part of the Dunedin City District Plan but does contain guidelines, including levels of service, for any physical works (such as kerb and channel design) associated with subdivision activity, which are considered when assessing consent applications. Stormwater targets and management approaches proposed by the ICMP should ensure this code is complied with. It is also likely that the content of the ICMP may also help shape the future direction of the Code.

2.6.3 The Dunedin City Council Sustainability Framework

The DCC Sustainability Framework is a relatively new non-statutory document which has an overarching influence on all aspects of DCC's operations and decision making through the following sustainability principles:

- Affordable: reasonable cost, value for money, today / future costs.
- Environmental Care: clean energy, bio-diversity, safe.
- Enduring: forward looking, whole of life, long term, future generations.
- Supporting People: social connectivity, social equity, quality of life, safe.
- Efficient: using less, creating less waste, smarter use.

These sustainability principles will influence the content of this ICMP and any recommendations with regard to future capital works.

2.6.4 3 Waters Strategic Direction Statement and 3 Waters Strategic Plan

The purpose of the 3 Waters Strategic Direction Statement is to align the management of Dunedin's three waters activities with the city's sustainability principles. This document provides direction for the detailed 3 Waters Strategic Plan which will be largely influenced by the content of all of the ICMPs. It is through the 3 Waters Strategic Plan that the ICMPs will provide input to long term community planning objectives and ultimately, Activity Management Plans (AMPs) and capital works programmes for stormwater.

2.6.5 Activity Management Plans

The DCC stormwater, wastewater and water supply AMPs contain objectives, levels of service, methods for delivering this service, asset management and levels of funding in relation to each activity. These plans are developed through the long term community planning process. The ICMP provides input to the content of the AMPs through its contribution to the 3 Waters Strategic Plan.

2.7 Resource Consents

This section outlines the classifying rules in the Dunedin City District Plan and the Regional Water and Coastal Plans which are relevant to the activities likely to occur under the ICMP.

While there are no rules within the Dunedin City District Plan classifying the discharge of stormwater, the ICMP needs to be consistent with the policies and objectives of the Dunedin City District Plan as described in Section 2.3.7, by incorporating further investigations of the system and environment and monitoring any discharges that are occurring.

Most consent requirements will be addressed by The Regional Plan: Water for Otago and The Regional Plan: Coast for Otago. The Dunedin City District Plan however, contains methods for addressing water quality issues through investigations, monitoring, education, consultation and the creation of management plans such as this ICMP.

Rule 10.5.3 of the Regional Plan: Coast for Otago classifies the discharge of stormwater into the CMA as a permitted activity provided certain conditions are met. These conditions include restrictions on the type of discharge, the receiving environment and any effects of the discharge.

Stormwater discharge from the Kitchener Street Catchment is unlikely to comply with the conditions of rule 10.5.3 due to the catchment containing industrial or trade land uses. Any stormwater discharge would therefore be classified as controlled under Rule 10.5.3.2 and would require a resource consent with ORC exercising its control over matters such as; the location, volume, rate and nature of the discharge.

It is recommended that the objectives of the ICMP align as closely as possible with the permitted activity rules to enable the objectives of the Coastal Plan to be met, where possible.

Rules 12.4 and 12.5 of the Regional Plan: Water for Otago classify the discharge of stormwater and the discharge of drainage water to water.

Rule 12.4.1 classifies the discharge of stormwater to water as a permitted activity provided that certain conditions are met. These conditions, among others include that; the discharge does not contain any human sewage, the discharge does not cause flooding of any other person's property, erosion, land instability, sedimentation or property damage and does not produce any conspicuous oil or grease films, scums or foams, or floatable or suspended materials or objectionable odours.

Should the conditions outlined in this rule not be met then the discharge of stormwater to water will be classified as a restricted discretionary activity requiring resource consent.

Rule 12.5.1 classifies the discharge of drainage water to water as a permitted activity provided the discharge does not cause flooding of any other person's property, erosion, land instability, sedimentation or property damage and does not produce any conspicuous oil or grease films, scums or foams, floatable or suspended materials or objectionable odours.

If the conditions outlined in Rule 12.5.1 cannot be satisfied, then the discharge of stormwater to water will be classified as a restricted discretionary activity requiring resource consent.

The objectives of the ICMP should be aligned as closely as possible to the permitted activity rules to enable the objectives of the Water Plan to be met where possible.

2.8 Objectives of Stormwater Management

2.8.1 Strategic Objectives

The strategic objectives of stormwater management are outlined in Table 2-1 below and provide the overarching objectives that guide the development of this ICMP. These objectives are at the core of the relevant statutory and non-statutory documents addressing stormwater management, including the 3 Waters Strategic Direction Statement. These objectives have been developed with the aim of achieving benefits across the four wellbeings (environmental, social, economic and cultural), and have been set within the context of a 50 year timeframe.

Table 2-1: Strategic Stormwater Management Objectives

Strategic Objectives
Development: Adapt to fluctuations in population while achieving key levels of service and improving the quality of stormwater discharges. Ensure new development provides a 1 in 10 year level of service, and avoids habitable floor flooding during a 1 in 50 year event.
Levels of service: Maintaining key levels of service of the stormwater network into the future by adapting to climate change and fluctuations in population, while meeting all other objectives.
Environmental outcomes: Improve the quality of stormwater discharges to minimise the impact on the environment and reduce reliance on non-renewable energy sources and oil based products.
Tangata whenua values: Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.
Natural hazards: Ensure there will be no increase in the numbers of properties at risk of flooding from the stormwater network.
Affordability: To meet strategic objectives while limiting cost increases to current affordability levels where practical.

2.8.2 Activity Management Plan / LTP Objectives and Targets

Table 2-2 outlines shorter term objectives, performance measures and targets derived from DCC's stormwater AMP and LTP. These objectives are to be reviewed annually but are set within the context of a 10 year timeframe. Therefore the measures and targets below may be subject to development or change based on findings from the ICMP development process. Influencing factors may include stormwater modelling results, or further research into costs surrounding changes to levels of service.

DCC also hope to begin reporting on a number of additional measures and targets relating to service provision. The ICMP development should inform this process, and help to identify the most appropriate measures and provide baseline information. It is intended that the following areas will be able to be reported on following the ICMP completion if appropriate and necessary:

- Number of written complaints;
- Number of properties with habitable floor stormwater flooding;
- Percentage of customers with stormwater provision that meets current design standards;
- Percentage of modelled network able to meet a 1 in 10 storm event; and
- Number of properties at risk of stormwater flooding in a 1 in 10 year event.

Table 2-2: Activity Management Plan Measures and Targets

Objective	Performance Measure	2010 / 2011 Target	2021 Target
Stormwater Quality	Residents' satisfaction with the stormwater collection service	≥ 60 %	≥ 70 %
	Number of blockages in the stormwater network per 100km of mains per annum	< 15	< 10
	Number of beach closures	0	0
Service Availability	Percentage of customer emergency response times met (Stormwater)	≥ 95 %	≥ 95 %
Demand Management	Completion of stormwater catchment management plans	as plan	X (should be completed by 2013)
Environmental Consent Compliance	Percentage compliance with stormwater discharge consents	≥ 75 %	tbc
	Number of prosecutions or infringement notices for non-compliance with resource consents	0	0
	Number of recorded breaches of RMA conditions	0	0
Asset Serviceability	Number of breaks per 100km of stormwater sewer per annum	< 1	< 1
	< x % of critical network assets in condition grade 4 or 5	To increase % of known data	tbc
Supply Cost per m^3	Drainage uniform annual charge as a percentage of median income	≤ 1 %	≤ 1 %
	Total operational cost of stormwater service per rated household	$ 76.70	tbc

tbc: to be confirmed.

3 Consultation

During the application for coastal discharge consents in 2005, through Annual Plan consultation and through specific consultation in relation to the 3 Waters Strategy, a number of stakeholders have been identified as affected by, or interested in stormwater management in Dunedin. The following provides a summary of values identified through the consultative processes mentioned. These values have been considered when developing objectives and options for stormwater management of identified issues.

3.1 3 Waters Strategy Consultation – Stakeholder Workshops and Community Survey

For specific consultation relating to the 3 Waters Strategy, stakeholders were divided into three groups: environmental, economic / business and social / cultural. The outcomes of the specific consultation workshops were used to inform a community telephone survey to gauge the views of the wider community including catchment residents. Specific groups were also consulted directly, including: Käi Tahu ki Otago, ORC and East Otago Taiapure Management Committee. From all consultation relating to the 3 Waters Strategy there was a general recognition that stormwater requirements and standards will need to increase, in terms of both quality and volume management.

A coordinated approach to stormwater management between ORC and DCC is desired; with the responsibilities for each organisation being clarified.

Overall, increasing the sustainability and efficiency of the network is also desired.

Views Relating to Quality

- A high awareness that stormwater contains many contaminants, and thus its management is not just a matter of transportation to the coast;
- That quality involves household drains and farm runoff as well as road runoff and sewage contamination;
- Recognise that the stormwater system does include recreational places, which underlines the need for better quality stormwater;
- Improving quality of disposed stormwater is a key issue – the higher the quality, the better.

Views Relating to Volume

- Recognition that climate change may result in more frequent storm events, thus putting a greater episodic demand on the system; and thus likely to require increased capacity. This may be compounded by decreases in permeable land resulting from increased property development in certain areas;
- That managing volumes (which is partially related to quality) requires a more encompassing view of the system and its management.

In summary, the consultation identified that the key points in relation to stormwater management were:

- Legislative changes, e.g. changing planning or building consents standards to further reduce the impact of new developments on stormwater;

- Passive changes, e.g. increasing the use of swales and soakholes to better manage storm events, using landscaping to reduce the visual pollution of outfalls;

- Active changes, e.g. increasing outfall pipe numbers to reduce the impact in any given area; increasing treatment standards; installing low-flow regulators;

- Doing more than simply increasing pipe capacity – i.e. review requirements for new property developments, in order to reduce runoff volumes and minimise the loss of permeable land; and

- Consideration of sustainable options e.g. stormwater captured and used by households; implementing alternative energy sources for pump stations (such as wind turbines or micro hydro-electricity generators). In rural areas, also capture stormwater in detention ponds, both to slow flows and prevent flooding but also to balance with demand for other water-use activities e.g. irrigation.

During the development of the 3 Waters Strategic Direction Statement, objective setting took the results of the community consultation into account, for example by incorporating statements relating to the use of source control for stormwater management. The ICMP approach to stormwater management also considers a range of management options for stormwater, described as 'legislative, passive and active' changes above.

3.2 Resource Consent Submissions

The resource consent process for the coastal discharge permits identified the residents within the affected catchments as interested parties. Matters raised by submitters in relation to coastal stormwater discharge permit applications are also a valuable source of stakeholder opinion. A majority of the submissions echo the views outlined above however the Käi Tahu cultural impact assessment (CIA) outlined below goes into more detail. As part of the consent conditions for stormwater discharges, annual meetings are held with Save the Otago Peninsula Society Incorporated and the Department of Conservation (DOC) Otago Conservancy.

3.2.1 Käi Tahu Cultural Impact Assessment

In October 2005, DCC commissioned Käi Tahu ki Otago Limited (KTKO Ltd.) to undertake a CIA (KTKO Ltd., 2005) on the discharge of stormwater into Otago Harbour and at Second Beach. This report was commissioned as part of the consent application process for the current discharge consent held for this catchment.

The report details historical use of the Otago Harbour by Käi Tahu and their descendents, particularly for transport and as a food resource (mahika kai).

The report studies the reported levels of contaminants in the stormwater discharged to the harbour, and also in sediments within the harbour, and states that runanga are concerned about the lack of information on biological impacts, on effects further afield than the immediate area of discharge, and that they are also concerned about the possibility of wastewater discharge into the harbour. Resource consent conditions for the current stormwater discharges include sampling and monitoring of sediments within the wider harbour, and biological monitoring. At present, given the size of the receiving environment, sampling and monitoring as part of the resource consent conditions is limited, and restricted to once per year and in a small number of locations. As sampling continues, understanding of the biological impacts of the stormwater discharges should increase.

Discharge of stormwater and associated contaminants has the potential to significantly impact Käi Tahu values and beliefs. These adverse impacts are associated with effects on the spiritual value of water, mahika kai, aquatic biota and water quality.

The traditional resource management methods of Käi Tahu require coordinated and holistic management of the interrelated elements of a catchment, from the air to the water, the land and the coast. The CIA notes that it is accepted by Käi Tahu that removal of all contaminants from stormwater is not possible. However, it is also considered that more could be done to reduce the level of contaminants discharged. Recommended management measures for consideration are as follows:

- Reducing the area of impervious land;
- Use of grass swales to filter stormwater;
- Covering car-parking areas and other areas where increased contaminants may be found;
- Sediment/grease traps to be installed at all industrial premises, petrol stations and car parks;
- Management plans for industrial and commercial facilities to minimise the contaminant loading into stormwater, including the management of spills;
- Ensuring industrial waste is not discharged to the stormwater system;
- Ensuring there is no discharge of human sewage to the stormwater system; and
- Ongoing awareness of best management practices and technological improvements that will reduce contaminant levels and a willingness to implement these as appropriate.

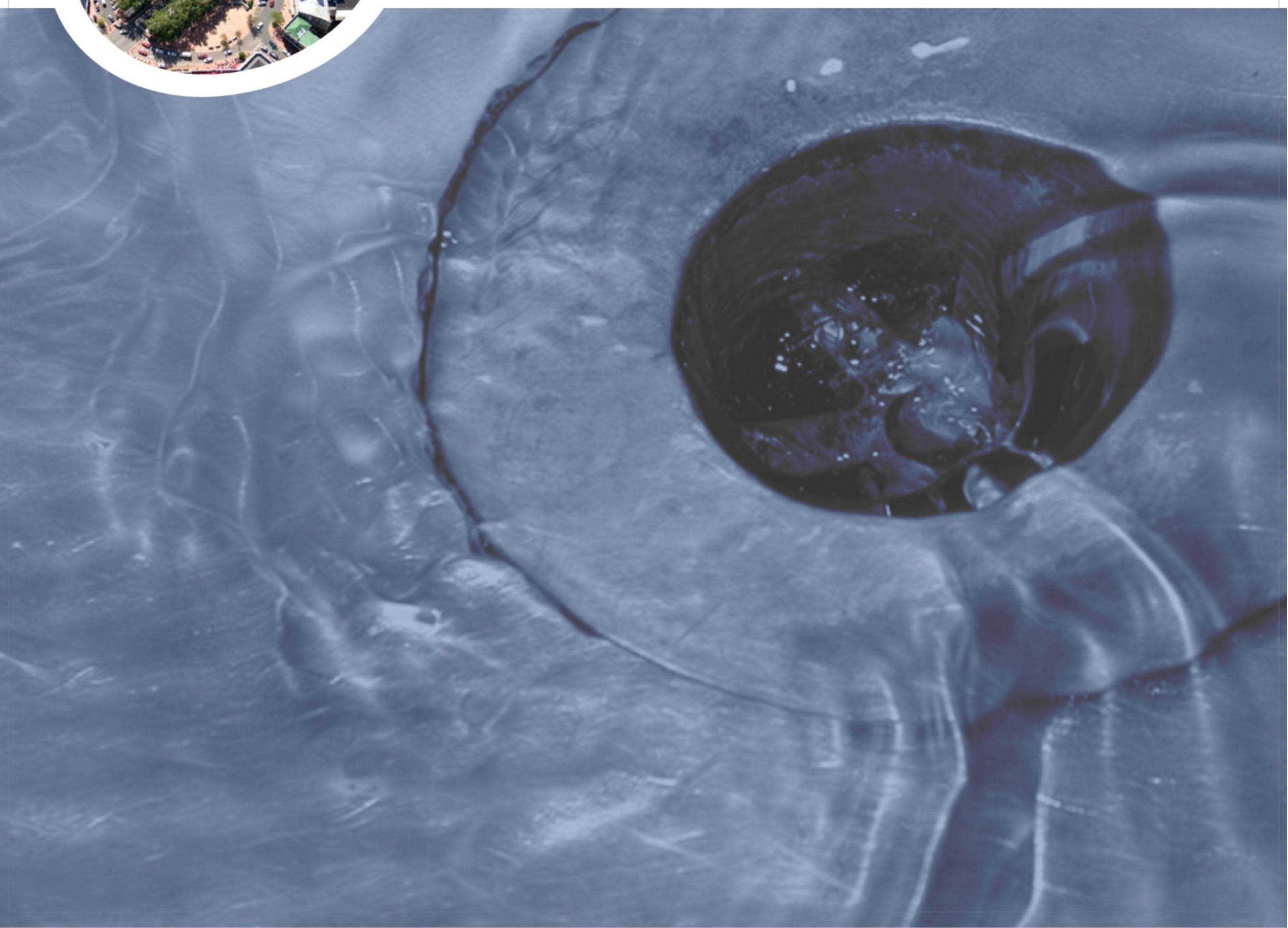
As with the wider community consultation results, it is considered that the ICMP approach to stormwater management encompasses much of what is desired by Käi Tahu, as described above. The 3 Waters Strategic Direction statement objectives used by this ICMP support the use of source control and low impact design options for stormwater management, as suggested above by Käi Tahu, as well as looking to reduce the incidence of wastewater discharge into the receiving environment.

3.3 Annual Plan Submissions

A number of submissions were made with respect to stormwater issues through the 2009 Annual Plan consultation process. These submissions mainly centred on the maintenance and upgrade of the existing system so to ensure adequate treatment and filtration of the stormwater prior to it being discharged. The issue of infrastructure capacity was also raised.

Part 2

Baseline



4 Catchment Description

4.1 Catchment Location

Figure 4-1 shows the location of the Kitchener stormwater catchment. The catchment covers an area of approximately 137 ha, adjacent to the Otago harbour, and approximately 10-15 % of the central urban area of Dunedin.

The catchment is relatively flat, includes much of central Dunedin, and is surrounded by the suburbs of Mornington and Kensington. It consists of a variety of land uses including large areas of residential and industrial but also zones of retail, central activity and Port. The east half of the catchment lies on flat, reclaimed land adjacent to the harbour where the majority of the industrial and port land is located. The rising hills on the west of the catchment provide a scenic spot for urban residence.

The residential region in the catchment is predominantly zoned as Residential 1; a medium density zoning, however a large proportion of this area is currently Town Belt. There is a significant area of Residential 4 in the centre of the catchment, and typically these areas have high site coverage, high population density and competition for parking.

Located so close to the city centre and being one of the first developed areas in Dunedin, the Kitchener Street catchment is host to a number of heritage structures. Primarily in the north of the catchment, most of the historic sites in the area can be found around Princes Street and High Street. There is also a heritage precinct centred on Vogel Street.

The catchment boundary has been determined for stormwater management purposes based on the area served by the pipe network and discharged to the Otago harbour via the main Kitchener Street outfall and 10 smaller port-side outfalls.

4.2 Topography and Geology

Figure 4-2 is a contour map of the Kitchener Street catchment and surrounding area based on 2 m contours. The catchment lies between 0 and 120 m above mean sea level, with approximately 50 % of the catchment no more than 20 m above sea level. This area has a significant area of flat land in the east, providing the opportunity for flooding due to slow moving surface water; issues may occur where fast moving water from the west of the catchment meets the gently graded pipes in the east. A digital terrain model has been generated as part of the model build process, and recent LiDAR (light detection and ranging) survey of the city provides much more definition of the catchment topography.

Figure 4-3 provides a soils map of the catchment (Bishop and Turnbull, 1996). From Figure 4-3, it is clear that two main soil types exist in the catchment; these are soil type Q1an and Md1e, described as follows:

- Q1an: Approximately half of the catchment, on the harbour side, is a zone of gravel based reclaimed land. A sub rock mixture of sand, mud, industrial and domestic waste could also be found here – the reclamation of this area included materials from the Bell Hill cutting, as well as harbour dredgings.

- Md1e: The west half of the catchment, Md1e is a basaltic rock arising from historic lava flows. Drainage in these locations can be unpredictable and would depend on the degree of rock fracture.

- A small area of Q1al gravel is present in the area of The Oval, which is on the southern boundary of the catchment. This is described as 'a well sorted gravel and sand, formed from sandstone, schist and volcanic rock'. This material is likely to be relatively well drained; however high groundwater in the area may limit drainage opportunities.

4.3 Surface Water

The Kitchener Street catchment stormwater network is comprised solely of piped reticulation, except for a short section of open channel (approximately 60 m in length) that runs from the bottom of the Town Belt down the north side of the property at 73 Maitland Street.

An assessment of the main streams in the 3 Waters Strategy catchments was undertaken by Ryder Consulting Ltd in 2010, however the ephemeral nature and short length of the only stream in the Kitchener Street catchment rendered it unsuitable for assessment.

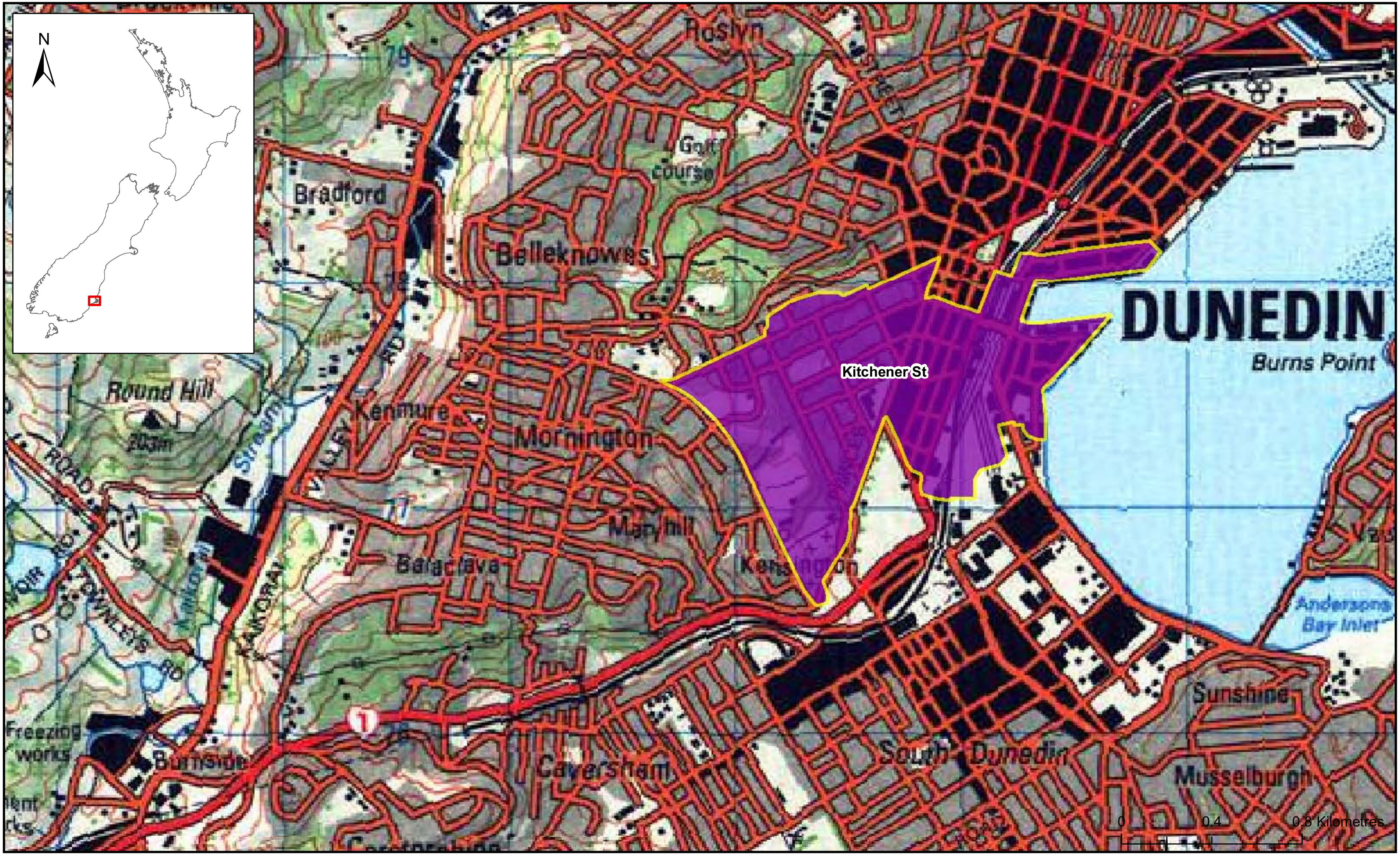
4.4 Groundwater

There is limited information relating to groundwater surface levels in the Kitchener Street catchment, and over much of the Dunedin urban area adjacent to the harbour. ORC do not currently require groundwater monitoring in the area for consent purposes. However, based on the site geology, a conceptual understanding of the groundwater system has been developed.

The basalt which makes up the western half of the catchment may contain a fractured rock groundwater system. However, as there are no wells drilled in the catchment area, it is difficult to ascertain the extent of any fractured rock groundwater. Nevertheless, water that infiltrates the basalt is expected to move vertically down through fractures until it intercepts the quaternary groundwater system.

The tidal levels / range is likely to be representative of the groundwater elevation in the coastal area, however the variability of the material associated with the reclaimed land suggests that groundwater may be perched in some areas where marine sediments have been deposited. Where gravels and sands are present in the lithology the groundwater flow is expected to be towards the coast.

There is no information currently available on the quality of the groundwater resource in this catchment. However, given the reclaimed nature of the land adjacent to the harbour, which has been used extensively for industrial purposes since the 1950s, it is possible that contamination of the groundwater system may have occurred. The extent of any potential contamination is not known.



DUNEDIN CITY COUNCIL / OPUS / URS	Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-1 Kitchener Street Catchment Location	DISCIPLINE Stormwater	Drawn: KC	Status: Final		
				Checked: HES	Scale: 1:15,000	Plot Date: Sep 2011	
				Approved: SDH	Job. No: 42173227	Map No: Figure 4-1	Revision: -
				Date: Sep 2011			

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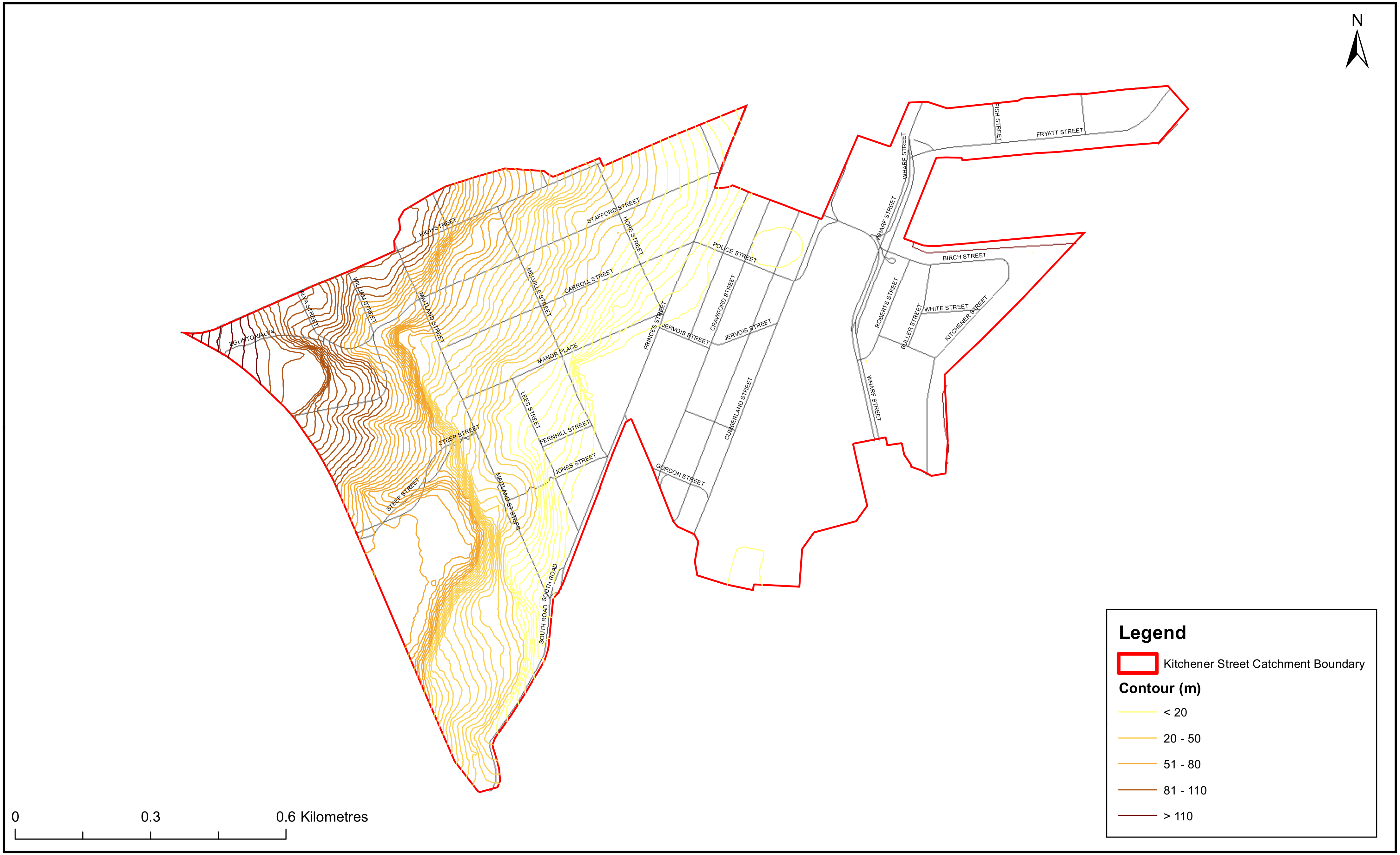

Dunedin 3 Waters Strategy	**KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN** **Figure 4-2** **Kitchener Street Catchment Contour Map**	**DISCIPLINE** **Stormwater**	Drawn: KC	Status: Final	
			Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011
			Approved: SDH	Job. No: 42173227	Map No: Figure 4-2 / Revision: -
			Date: Sep 2011		

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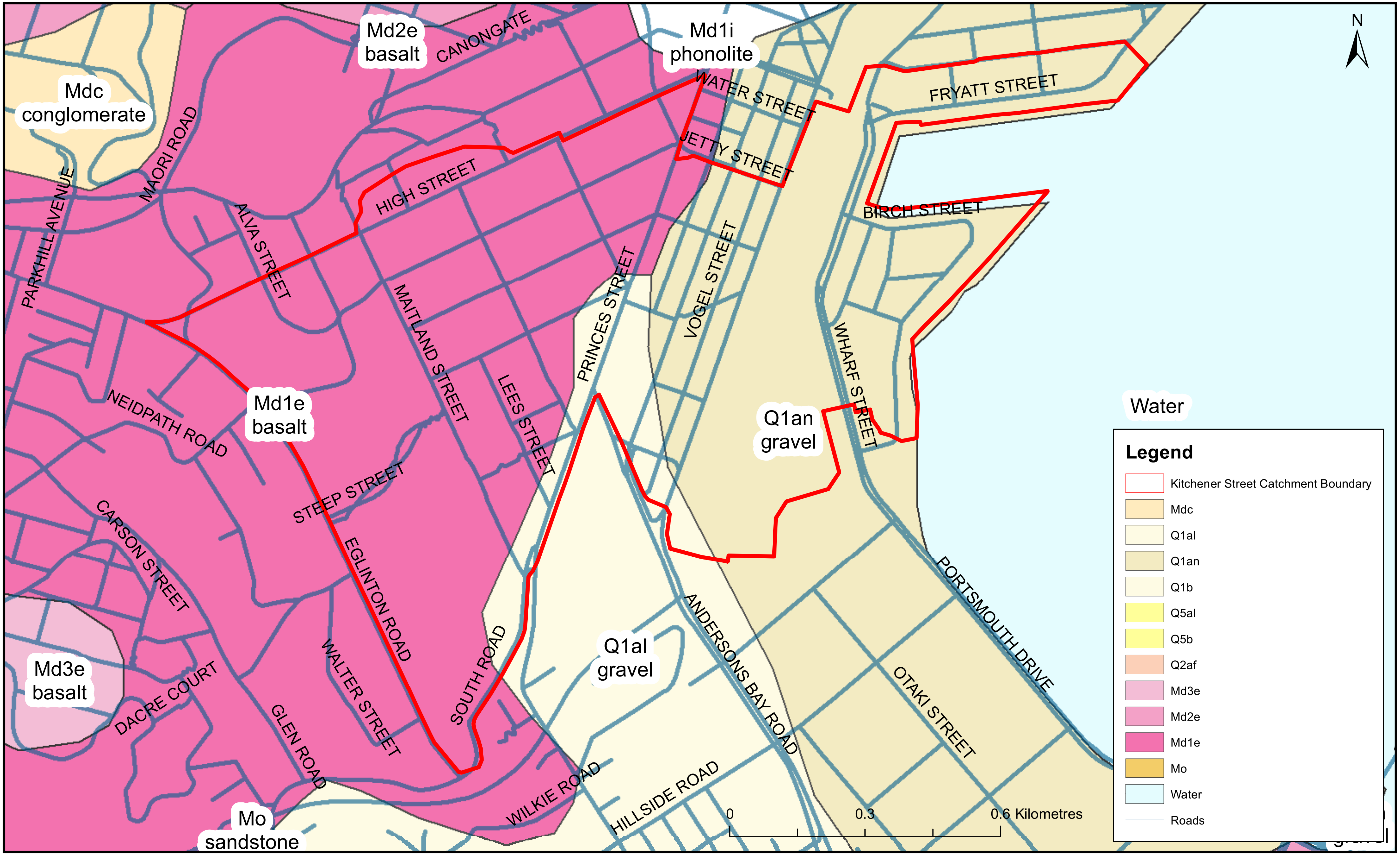

Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-3 Kitchener Street Catchment Geology Map	DISCIPLINE Stormwater	Drawn: KC	Status: Final	
			Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011
			Approved: SDH	Job. No: 42173227	Map No: Figure 4-3 / Revision: -
			Date: Sep 2011		

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4.5 Land Use

4.5.1 Historical and Current Land Use

Table 4-1 and Figure 4-4 describe the current land use in the Kitchener Street catchment. Current land use reflects, to a large extent, historic land use in the area.

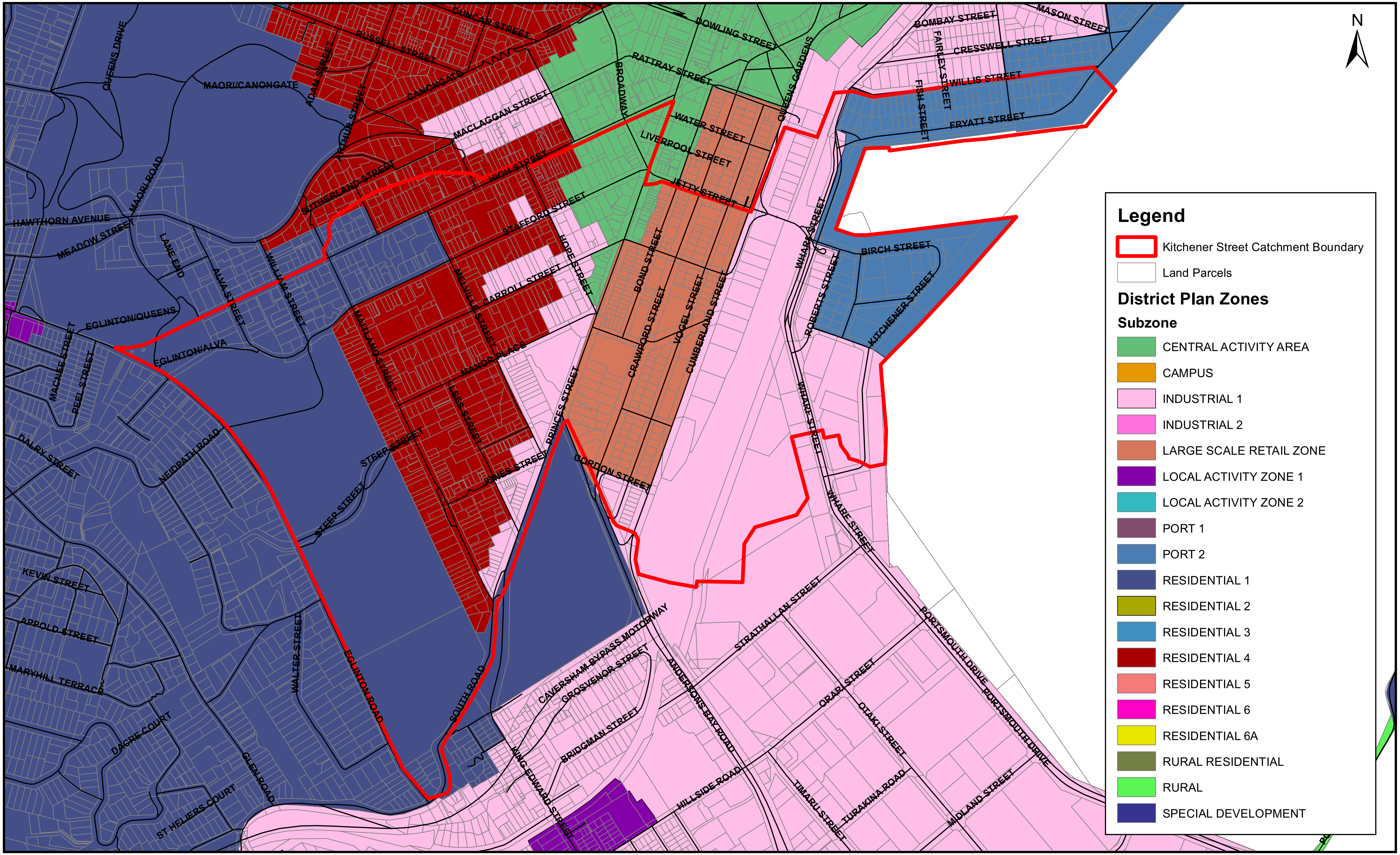
After intense growth of what is now the 'city centre' of Dunedin during the late 19th century, demand for new land spread the development into the surrounding areas, creating new suburbs. Since its first period of development in the early 1900's, the Kitchener Street catchment has primarily comprised a mixture of industrial, commercial and residential land uses (refer Figure 4-4), with nearly 47 % of the catchment zoned as residential, although this includes a large portion of the Town Belt.

The harbour side area is reclaimed, much of it with material from the cutting of Bell Hill (commenced in 1858), or with harbour dredgings. This area is used for industrial and Port purposes, and has both the railway (laid in the mid 1870s) and main transport route to Port Chalmers running through it.

The Kitchener Street catchment includes parts of the suburbs of Fernhill, Mornington, Dunedin (central) and Kensington.

Table 4-1: Current Land Use in the Kitchener Street Catchment

DCC Zone	Proportion of Catchment
Residential 1	27 %
Residential 4	20 %
Industrial 1	27 %
Central Activity Area	4 %
Large Scale Retail	11 %
Port 2	11 %



DUNEDIN CITY COUNCIL · OPUS · URS	Dunedin 3 Waters Strategy	**KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN** **Figure 4-4** **Kitchener Street Catchment Land Use Zones**	**DISCIPLINE** **Stormwater**	Drawn: KC · Status: Final Checked: HES · Scale: 1:7,500 · Plot Date: Sep 2011 Approved: SDH · Job. No: 42173227 · Map No: Figure 4-4 · Revision: - Date: Sep 2011

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4.5.2 Cultural / Heritage Sites

According to DCC records of significant archaeological and heritage sites within Dunedin city, the Kitchener Street catchment contains sections of four Townscape and Heritage Precincts. These include: the High Street, Vogel Street, and Queens Gardens Heritage Precincts and the South Princes Street and Crawford Street Townscape Precincts.

Historic houses and buildings are located primarily within the High Street Precinct and scattered throughout the western half of the catchment. The former St Andrew's Church is also located in this area. The Bluestone steps and wall are located in the Vogel Street Precinct. There are also two historic commercial buildings in the Queens Gardens Precinct area. Other heritage structures in the catchment include The Dunedin Club on Lees Street and the Southern Cemetery, situated between Eglington Road and South Road. These cultural and heritage sites are indicated in Figure 4-5.

There are no archaeological sites within the catchment recorded in the District Plan.

Käi Tahu have been identified as a key stakeholder. It should be noted that coastal and freshwater environments hold particularly high values for Käi Tahu. Māori cultural values, along with those of other stakeholders throughout Dunedin's community, are discussed in Section 3.2.1.

4.5.3 Resource Consents and Designations within the Catchment

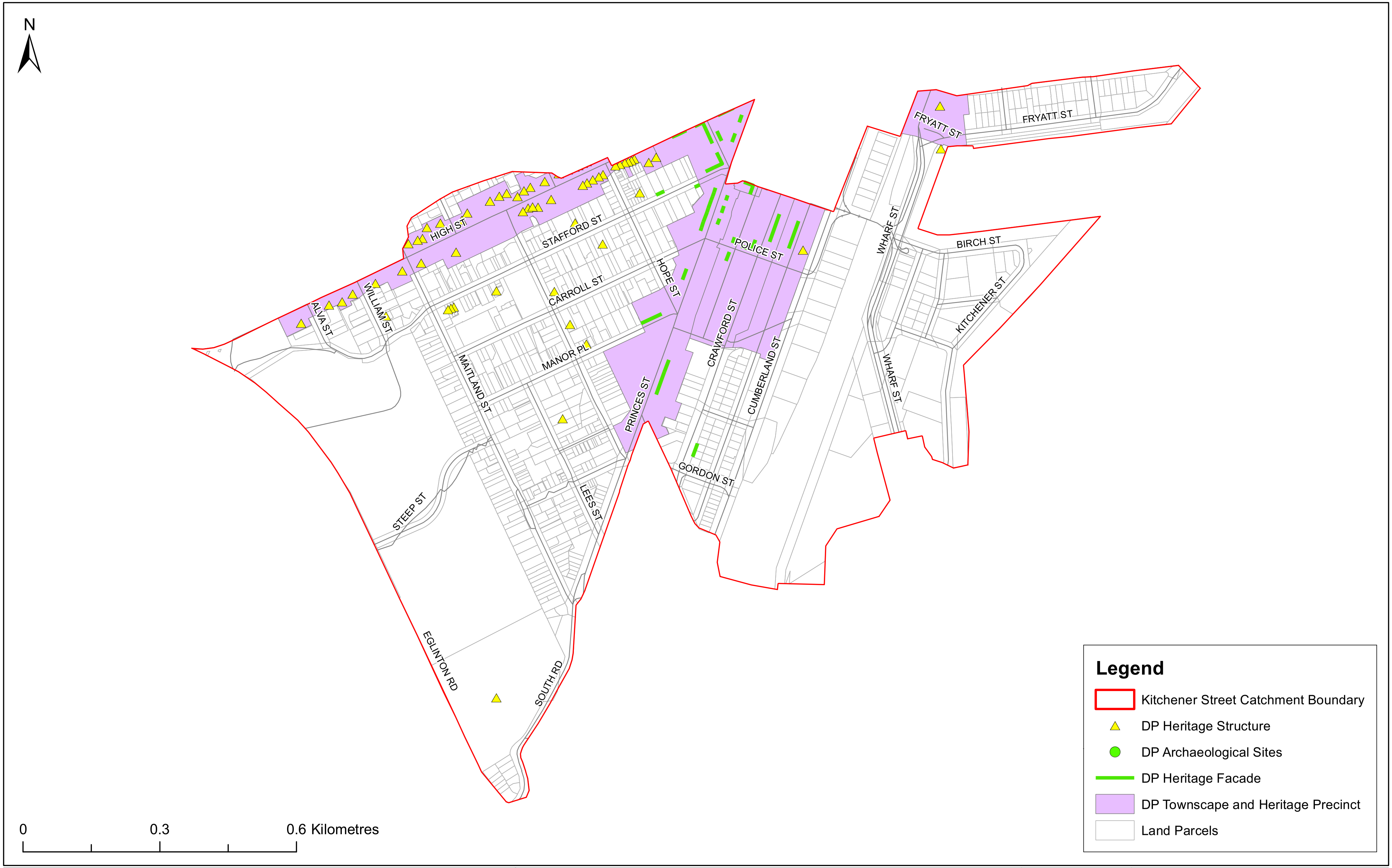
Information has been provided by ORC and DCC with respect to resource consents granted in Dunedin City and city-wide District Plan Designations.

A number of consents have been granted, by ORC and DCC, within the Kitchener Street catchment. However, there are no significant resource consents granted relating to stormwater management.

DCC has granted a number of land use consents, the effects of which have been incorporated into the future catchment imperviousness calculations (Appendix B).

A number of District Plan Designations exist within this catchment. Some are for transport purposes and include the existing Main South Railway and State Highway. Other designated sites scattered throughout the catchment include the Montecillo water supply reservoir, Dunedin heliport and regional council premises.

Figure 4-6 provides the location of the resource consents granted by DCC and District Plan Designations within the Kitchener Street catchment.



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Dunedin 3 Waters Strategy

KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-5

Kitchener Street Catchment Archaeological and Heritage Sites

DISCIPLINE

Stormwater

Drawn: JMH	Status: Final		
Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011	
Approved: HES	Job. No: 42173227	Map No: Figure 4-5	Revision: -
Date: Sep 2011			

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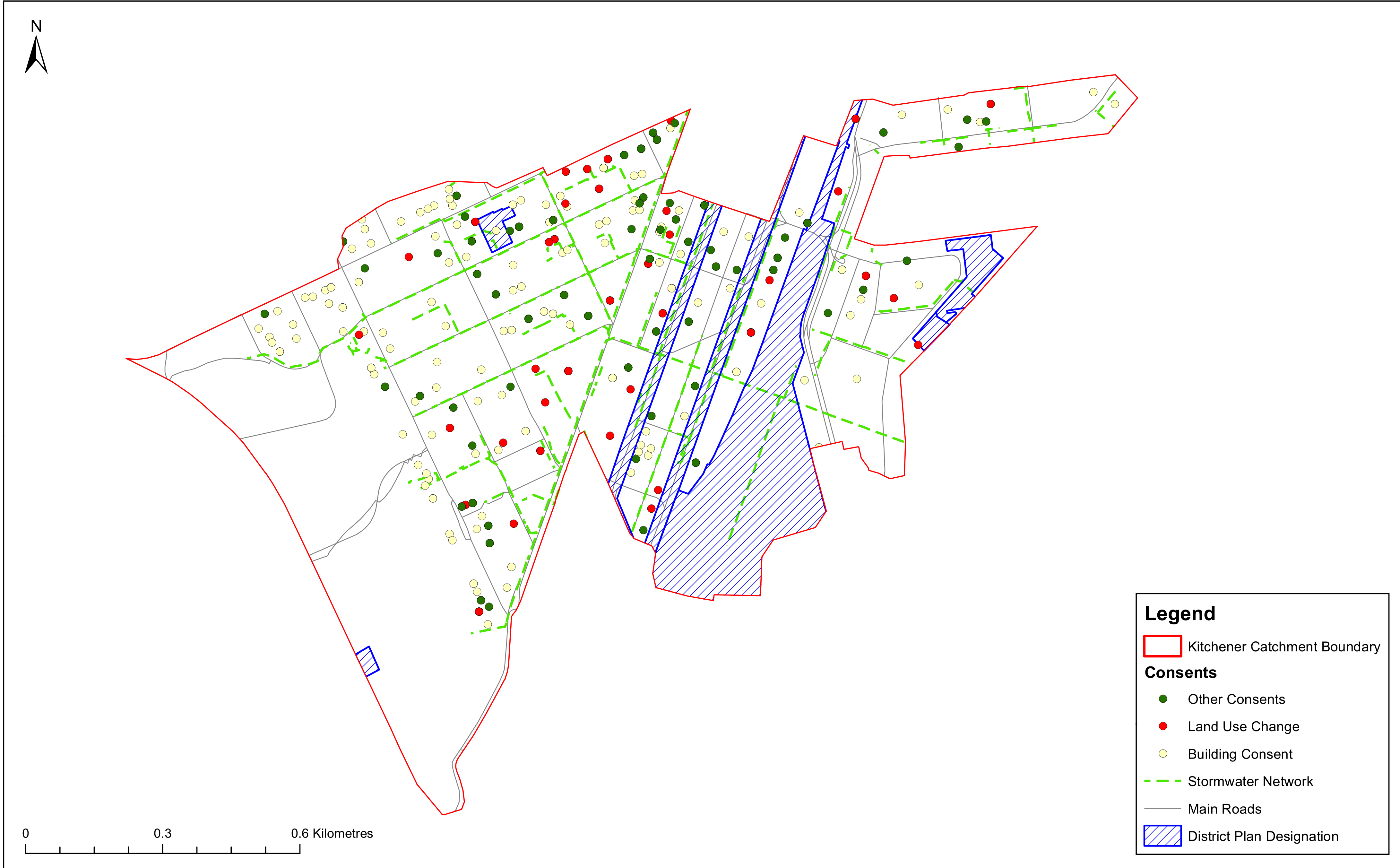

Dunedin 3 Waters Strategy

KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-6
Kitchener Street Catchment Recent Consents and Designations

DISCIPLINE	Drawn: KC	Status: Final		
Stormwater	Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011	
	Approved: SDH	Job. No: 42173227	Map No: Figure 4-6	Revision: -
	Date: Sep 2011			

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4.5.4 Contaminated Land

Data was collated from both ORC and DCC with respect to contaminated land around Dunedin City. It should be noted that the information available on contaminated land sites may be incomplete and the extent of remediation is unknown in some instances.

The eastern half of the catchment is reclaimed land adjacent to the harbour. Various and unknown types of fill may have been used during land reclamation, the fill material may contain contaminants, as discussed in Section 4.2, however is likely to be made up of material from the Bell Hill cutting, and harbour dredgings. Port and industrial activities in this area may have resulted in contamination of land in the past.

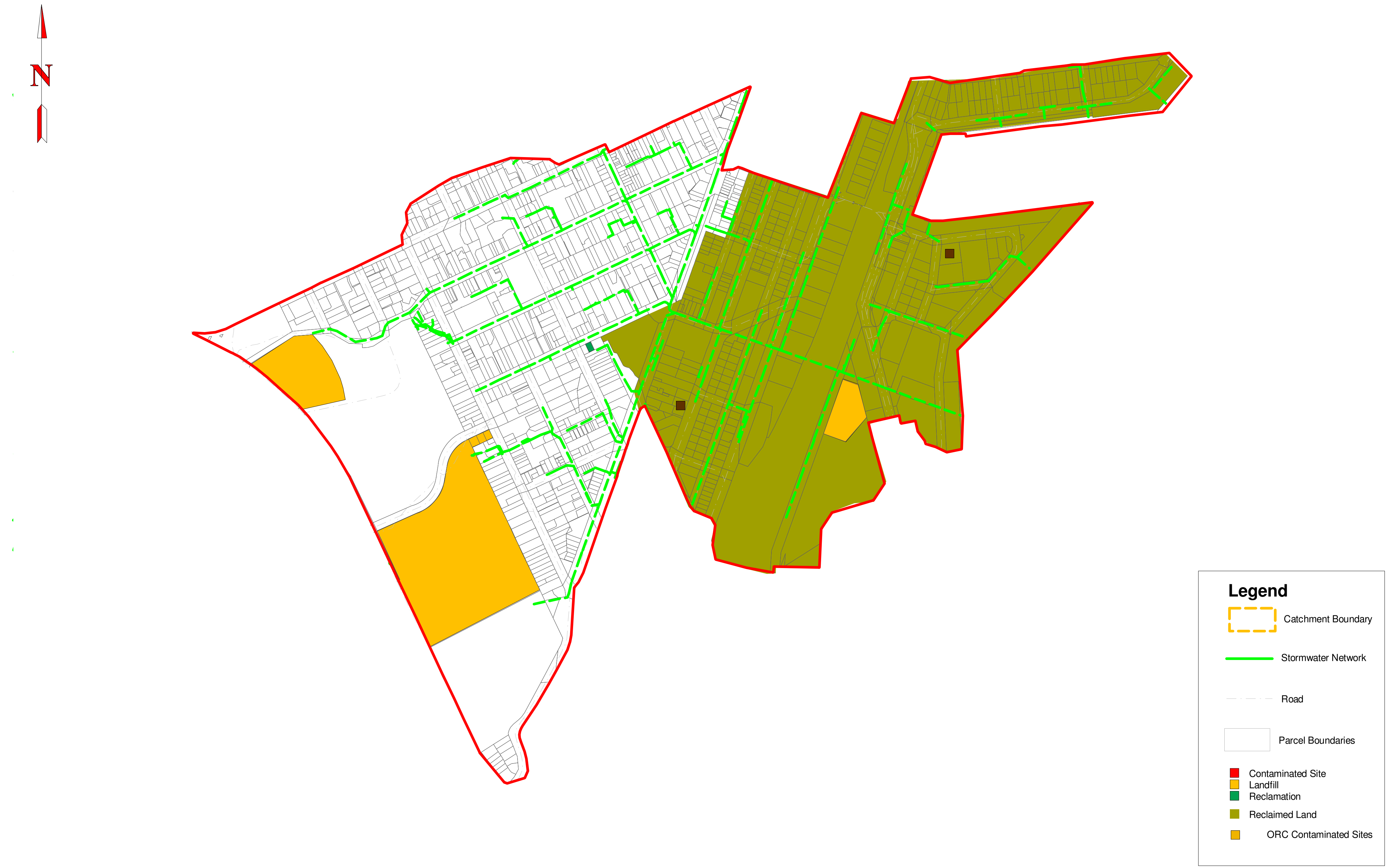
Three landfill sites also exist in the catchment: the Unity landfill off Eglinton Road, Montecillo landfill off Steep Street, and the Wharf Street landfill.

Figure 4-7 provides the location of the known contaminated land sites within the Kitchener Street catchment.

4.5.5 Future Land Use

Three future land use scenarios are being considered within the DCC 3 Waters Strategy along with the current situation. The scenarios are; 2008 (current), 2021, 2031 and 2060. For the purposes of stormwater modelling, the 2031 scenario contains the maximum allowable imperviousness for each zone, consistent with the planning horizon of the district plan (2036). The 2060 scenario also uses the maximum allowable imperviousness.

The Kitchener Street catchment is not expected to undergo significant changes to the existing land use practice types over the next 50 years based on the current understanding of the growth demands on the city and the existing district plan provisions. There are a small number of vacant or large land parcels in the Kitchener Street catchment; due to the zoning, these can potentially be developed or subdivided in the future. It is not anticipated that the currently occupied sites will experience significant change in imperviousness into the future.



Dunedin 3 Waters Strategy	KITCHENER ST INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-7 Contaminated Land Sites	Discipline: Stormwater

MG	Final		
LB	NTS	April 11	
HS	3-d1040.07		
April 11			

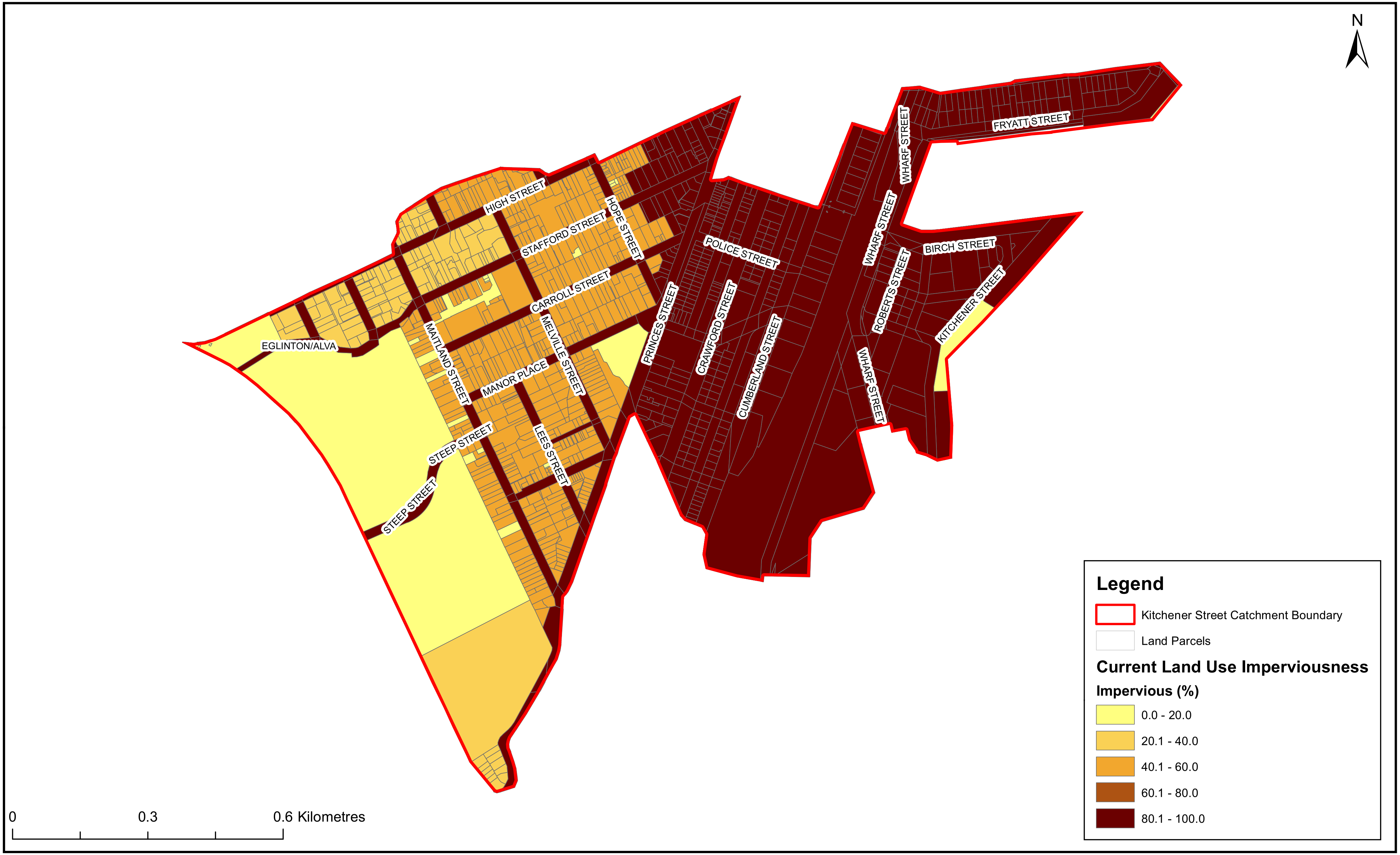
4.6 Catchment Imperviousness

Figure 4-8 provides a map of current imperviousness for the Kitchener Street catchment (refer Appendix B for calculation methods). The land use in the catchment is zoned for residential, commercial, industrial and port purposes, as illustrated in Figure 4-4. Overall, catchment imperviousness is calculated to currently be approximately 65 %.

The existing commercial, industrial and port zones within the catchment are characterised by very high (often complete) site coverage, as illustrated in Figure 4-8. These areas total more than 50 % of the Kitchener Street catchment area.

Housing in the Residential 1 zone typically has lower site coverage than other residential zones; the imperviousness study (Appendix B) calculated that Residential 1 zones typically had a total imperviousness of approximately 39 %, of which about 23 % was estimated to be houses and driveways (with the remainder representing areas such as unconnected paving etc). Note however, that in the Kitchener Street catchment, the Town Belt accounts for approximately 22 ha, constituting 60 % of the Residential 1 area in the catchment.

Conversely, Residential 4 areas (comprising 20 % of the catchment area) are estimated to have a much higher site coverage and, accordingly, imperviousness (approximately 53 % across all catchments, and 62 % in the Kitchener Street catchment).



DUNEDIN CITY COUNCIL / OPUS / URS	Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-8 Kitchener Street Catchment Current Imperviousness	DISCIPLINE Stormwater	Drawn: KC Checked: HES Approved: SDH Date: Sep 2011	Status: Final Scale: 1:7,500 Plot Date: Sep 2011 Job. No: 42173227 Map No: Figure 4-8 Revision: -

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4.7 Stormwater Drainage Network

4.7.1 Network Description

Figure 4-10 provides details of the stormwater network in the catchment, based on DCC GIS (geographic information system) data.

The Kitchener Street catchment stormwater system has one main branch draining more than 80 % of the catchment, with ten small independent sub-networks draining the remaining area, predominantly surrounding the wharf. The network is entirely piped, except for a short (approximately 60 m) section of open channel from the Town Belt through to the piped network on Maitland Street.

Significant network features included in the hydraulic model of the Kitchener Street stormwater network are as follows:

- Kitchener Street outfall – the main catchment outfall, located near 6 Kitchener Street, is a 1500 mm diameter concrete pipe fitted with a flap valve.

- Two bifurcations on Hope Street, splitting stormwater flows between the Kitchener catchment and the adjacent Mason Street catchment. These result in a small area of the Kitchener Street catchment draining into the Mason Street catchment.

- A summit point in a stormwater pipe on 372 Princes Street – a high point in the road separates the topographical catchments of Mason Street and Kitchener Street, however the corresponding stormwater pipe is open along its length, creating a direct link between the two catchments' networks.

- Cumberland Street Chambers - the site of two large chambers that were originally designed as a pump station, however the pumps were never installed and a pump station was never commissioned at this site. The chambers are separated by a flap valve.

Figure 4-9 provides the frequency distribution of the pipe diameters in the Kitchener Street catchment. There is a relatively even spread across the typical pipe sizes between 150 mm and 600 mm in diameter (inclusive), with 600 mm being the most common and nearly 1.4 km of pipes being larger than this.

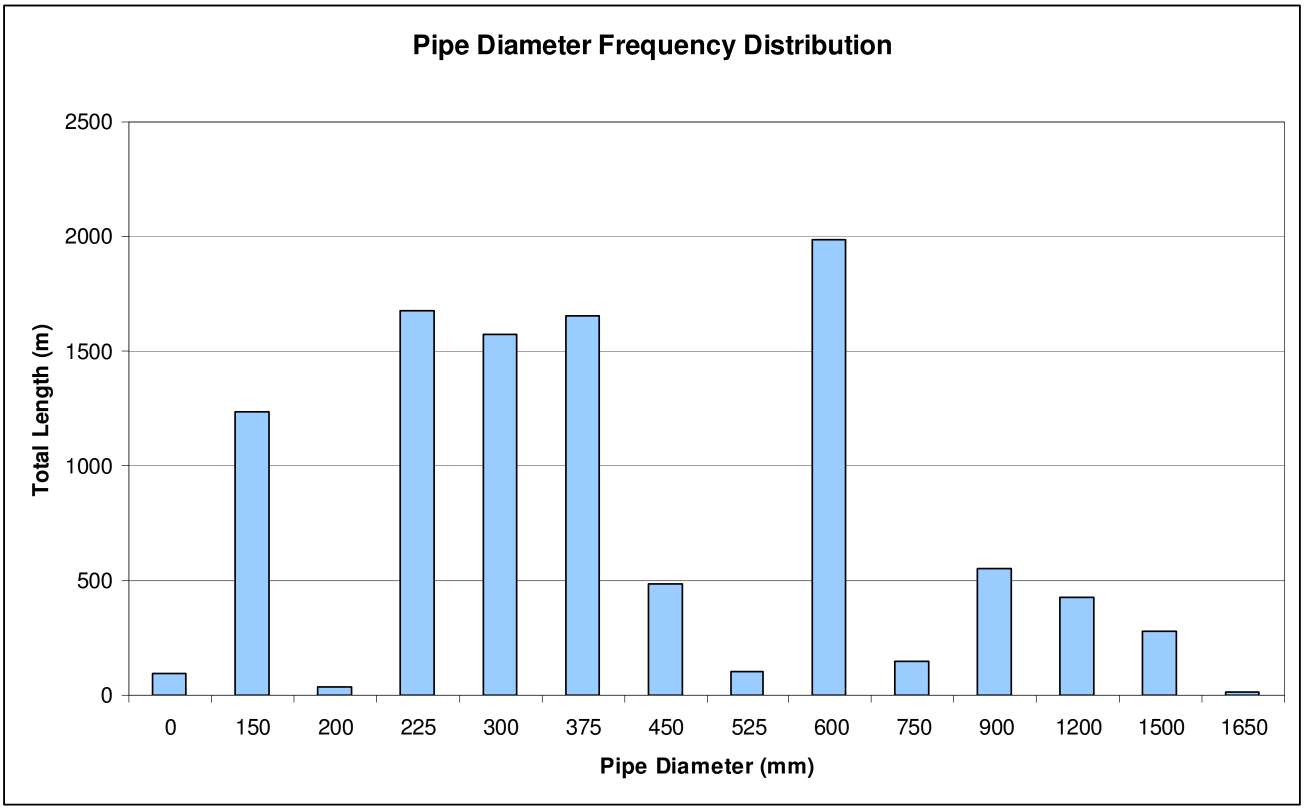
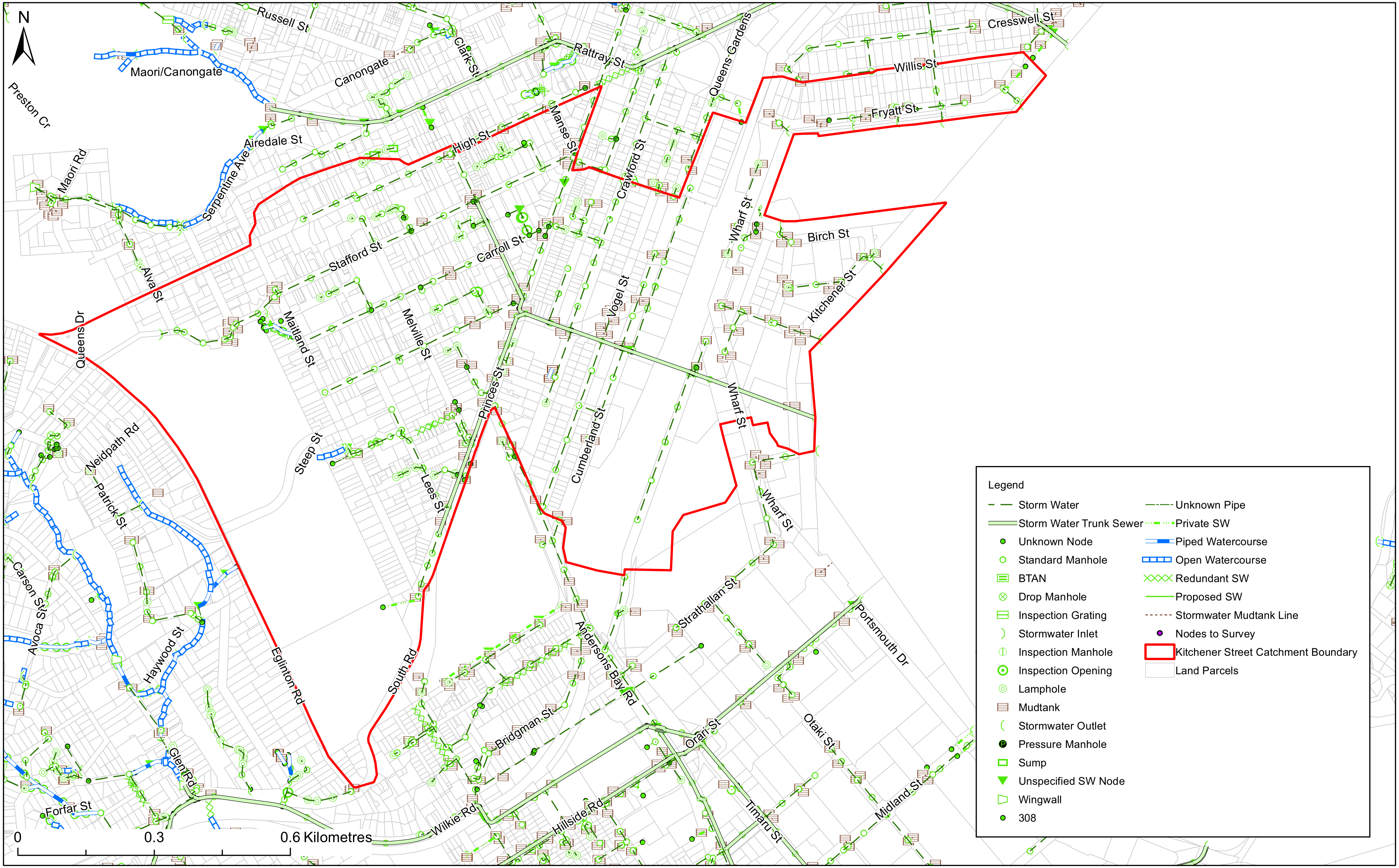


Figure 4-9: Pipe Diameter Frequency Distribution



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Dunedin 3 Waters Strategy

KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-10

Kitchener Street Catchment Stormwater Drainage Network

DISCIPLINE	Drawn: KC	Status: Final	
Stormwater	Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011
	Approved: SDH	Job. No: 42173227	Map No: Figure 4-10 / Revision: A
	Date: Sep 2011		

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4.7.2 Network Age

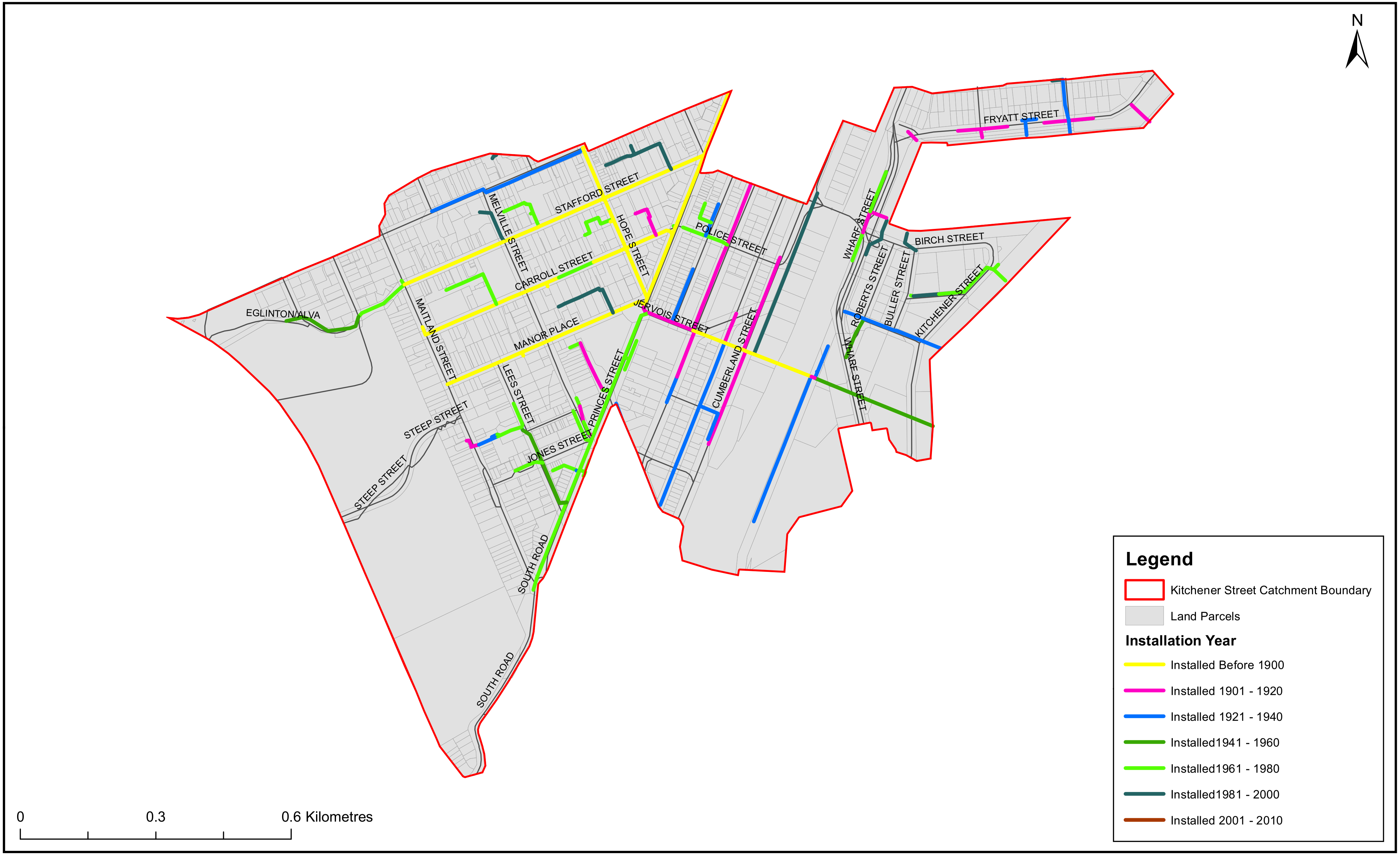
Table 4-2 below provides a breakdown of pipe age in the Kitchener Street catchment. Figure 4-11 provides a map of pipe age based on location.

The data shows that a significant proportion of the pipework in the Kitchener Street catchment was laid in the late 1800s to early 1900s, and as such will still be the original infrastructure.

Based on the current forecasts of theoretical asset life for stormwater mains, the majority of which have been assigned a theoretical life of 100 years, 68 % of the pipe network will be subject to inspection/condition assessment or be renewed by 2060. Remaining life forecasts will be improved based on condition assessment and related work on refining expected lives, and renewals planning adjusted accordingly.

Table 4-2: Pipe Network Age and Length Composition

Installation Date	Approximate Age	Number of Pipelines	Length of Pipe (m)	% of Pipe Length
Installed before 1900	> 110 years	59	2490	25
Installed 1901 to 1920	90-110 years	48	1880	18
Installed 1921 to 1940	70-90 years	39	1781	17
Installed 1941 to 1960	50-70 years	18	808	8
Installed 1961 to 1980	30-50 years	94	2433	24
Installed 1981 to 2000	10-30 years	26	869	8
Installed 2001 to 2009	< 10 years	0	0	0



Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-11 Kitchener Street Catchment Pipe Network Ages	DISCIPLINE Stormwater	Drawn: KC	Status: Final	
			Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011
			Approved: SDH	Job. No: 42173227	Map No: Figure 4-11; Revision: -
			Date: Sep 2011		

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4.7.3 Asset Condition and Criticality

DCC has developed and applied a first cut criticality assessment to all water, wastewater, and stormwater network assets across the city. The criticality score has been calculated based on three weighted criteria: extent, cost, and location. For the full version of the methodology used, the DCC methodology document (available on request) should be referred to. Table 4-3 summarises the first cut version used for stormwater assets as of November 2010. Note that stormwater intakes were rated slightly differently to remaining assets, with 20 % of the weighting assigned to cost and 20 % to each of the four wellbeings, given that the consequences of failure of an intake would be largely localised in nature due to area flooding.

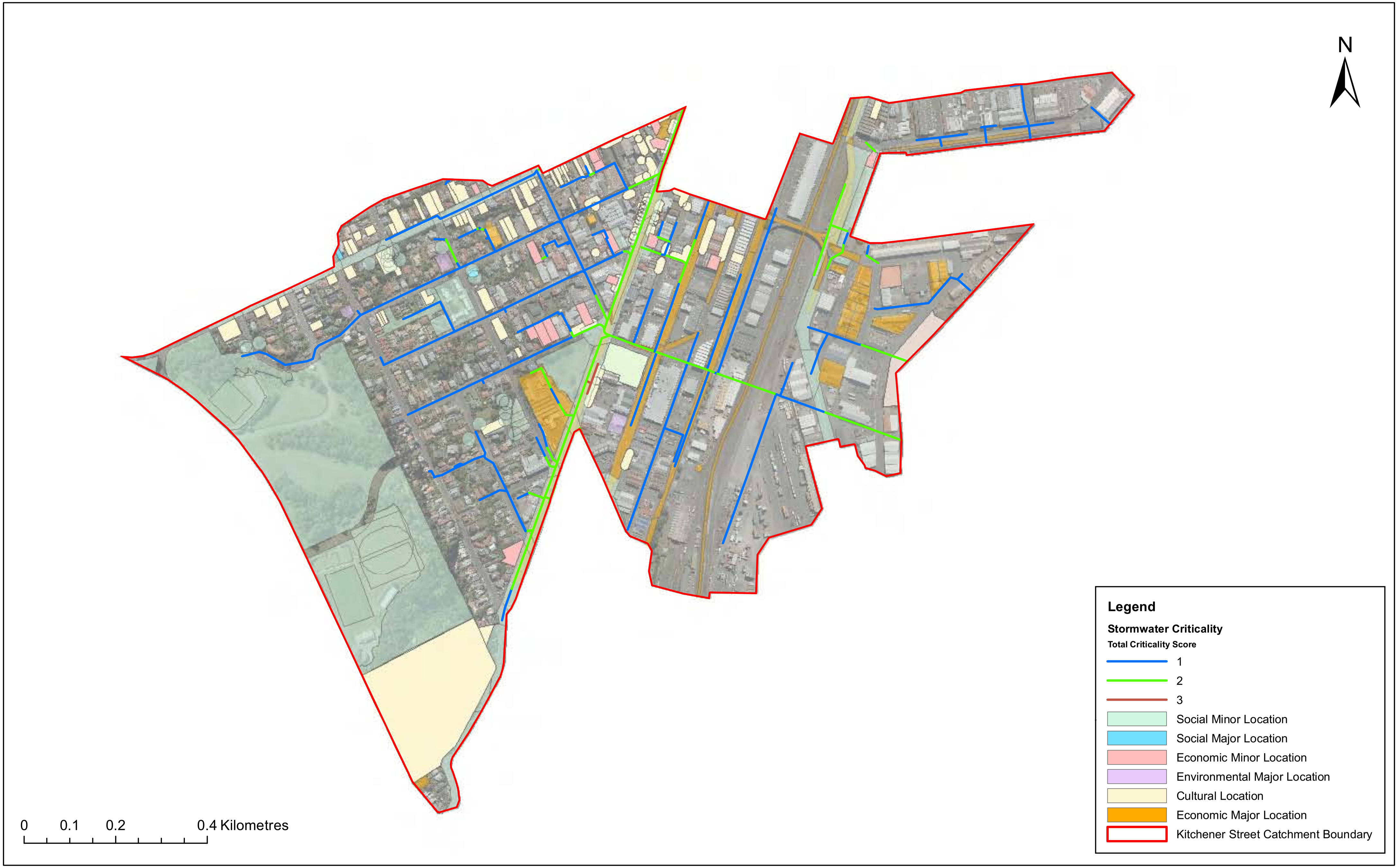
Figure 4-12 shows a map of the Kitchener Street catchment, with criticality and the four wellbeing locations identified. This map shows pipe criticality only. Pipe condition assessment is currently being undertaken throughout the city on selected pipes, however to date little information is available on pipes in the Kitchener Street catchment.

There are a number of ‘wellbeing’ locations identified in the Kitchener Street catchment. The Town Belt is identified as a social wellbeing location, and a number of the historic sites mentioned in Section 4.5.2 above are identified as cultural wellbeing locations. Transport routes (both road and rail), and a number of economically significant sites lead to a number of stormwater pipelines in the lower part of the catchment being assigned a criticality of 2. Particularly, these pipelines are in the vicinity of Princes Street, and extend from Jervois Street to the outfall.

Table 4-3: Asset Criticality Score Criteria

Factor	Score	Rating Scale	Proxy Used - Pipes	Proxy Used - Manholes	Proxy Used - Outlets
Extent (20 %)	1	Insignificant function failure			Assigned same rating as upstream pipe
	2	Minor (delivery) failure – Small population	<= 600 mm diameter	Manholes on non-pressurised pipes	Assigned same rating as upstream pipe
	3	Major (delivery) failure – Large population	> 600 mm diameter	Manholes on pressurised pipes	Assigned same rating as upstream pipe
	4	Major (safety, supply, containment) failure – Small population			Assigned same rating as upstream pipe
	5	Major (safety, supply, containment) failure – Large population			Assigned same rating as upstream pipe
Cost (20 %)	1	Up to $ 20,000	All pipes	< 3.5 m deep	< 3.5 m deep
	2	$ 20,000 - $ 150,000		> 3.5 m deep	> 3.5 m deep
	3	$ 150,000 - $ 400,000			
	4	$ 400,000 - $ 1,000,000			
	5	Over $ 1 M			
Location (15 % to each of wellbeings)	1	Within 10 m of a 'minor' social, environmental, cultural, or economic wellbeing location			
	2	Within 5 m of a 'minor' social, environmental, cultural, or economic wellbeing location			
	3	Within 10 m of a 'major', or within 1 m of a 'minor' social, environmental, cultural, or economic wellbeing location			
	4	Within 5 m of a 'major' social, environmental, cultural, or economic wellbeing location			
	5	Within 1 m of a 'major' social, environmental, cultural, or economic wellbeing location			
Weighted Criticality Score	= (Extent Rating x 20 %) + (Cost Rating x 20 %) + (Social Rating x 15 %) + (Environmental Rating x 15 %) + (Cultural Rating x 15 %) + (Economic Rating x 15 %) = Criticality Rating				

Criticality 1 = Not Critical *Criticality 5 = Very Critical*



DUNEDIN CITY COUNCIL / OPUS / URS	Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-12 Kitchener Street Catchment Stormwater Network Criticality	DISCIPLINE Stormwater	Drawn: MM Checked: HS Approved: HS Date: Sep 2011	Status: Final Scale: 1:7,500 Job. No: 42173227	Plot Date: Sep 2011 Map No: Figure 4-12 Revision: A

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4.7.4 Salt Water / Saline Groundwater Intrusion

The intrusion of salt water into wastewater pipelines is a major concern for DCC, due to effects on pipe condition, and more particularly, wastewater treatment plant (WWTP) processes.

In terms of the stormwater system, salt water intrusion via the outfall pipes occurs regularly, however ingress of saline groundwater along the pipelines could further reduce the capacity of the network during high tides.

An investigation by Van Valkengoed & Wright (2009) examined the regions adjacent to the Otago Harbour and highlighted the key locations where salt water is entering the wastewater system. This investigation did not, however, examine the stormwater system, therefore the extent of saline groundwater intrusion into the stormwater network is unknown. Tidal influence on the system via the harbour outfalls is discussed further in Section 8.

4.7.5 Operational Issues

Discussions were held with DCC Network Management and Maintenance personnel during the catchment walkover (27th September 2010) in order to identify known operational issues or locations of historical flooding. Further discussions were held during a workshop with DCC Water and Waste Business Unit staff in March 2011. The following issues were highlighted:

- Flooding at The Oval and along South Road, between Lees Street and Jones Street. This area is a local depression and the destination of surface water that flows down South Road from as far up as the Cemetery.

- There appear to be no catchpits down this stretch of road, until the intersection of Maitland Street and South Road. Catchpits at this location are therefore considered to be critical to the operation of the network. Flooding has been witnessed at this intersection, resulting in water across South Road and Princes Street.

- The open channel behind 73 Maitland Street is ill-defined and water has been known to spill over into the adjacent driveway. The associated manhole on the footpath is also said to have overflowed in the past, however vigilant cleaning and maintenance reduces the frequency of overflow.

- Flooding in the area of Crawford Street, Bond Street, Police Street and Jervois Street has been observed. The Spotlight carpark on the corner of Vogel Street and Jervois Street is also a confirmed flooding location.

4.7.6 Network Maintenance and Cleaning

The maintenance of catchpits is perceived to be a general issue across Dunedin city according to the Water and Waste Business Unit. It was noted by the Network Management and Maintenance team that during autumn months heavy rainfall can result in blocked catchpits or inlet screens regardless of how well maintained they are. Failure to remove silt and gravel from the catchpits can also lead to siltation and hence capacity reduction of the pipe network; siltation has been identified as an issue in some areas of Dunedin by the Network Management and Maintenance team, and this is currently being investigated as part of a city-wide CCTV (closed circuit television) programme.

The responsibility for the cleaning and maintenance of stormwater catchpits and other structures is divided between three DCC departments, Network Management and Maintenance (Water and Waste Business Unit), Transportation Operations and Community and Recreation Services (CARS).

Network Management

Stormwater structures under Network Management supervision are inspected on a weekly basis, after a rainfall event and before forecast bad weather. The specification for these inspections is as follows:

- Check access to the site in respect to Health and Safety requirements.
- Check the screen intake to ensure screen is 95 % or more clear.
- Check upstream channel is clear of debris (approximately first 5 metres).
- Check for any recent signs of overflow since last visit.
- If debris blocking intake screen, remove to achieve 95 % clearance. Type of material and approximate volume and weight to be recorded on the Screen / Intake Checklist.

In addition to the weekly inspections, condition assessments are completed every six months.

Transportation Operations

DCC Transportation Operations are responsible for stormwater structures within the road reserve (except State Highways, which are the responsibility of the New Zealand Transport Agency (NZTA)).

The cleaning and maintenance of these structures is contracted to a main contractor, managed by Transportation Operations. The main contractor then subcontracts the work to a third party.

Under the Transportation Operations cleaning and maintenance contract, with the main contractor, the asset cleaning and frequency levels of service are listed as follows:

- At any time at least 95 % of mud tanks shall have available 90 % of their grate waterway area clear of debris.
- At least 95 % of mud tanks, catchpits and sumps shall have at least 150 mm below the level of the outlet invert clear of debris.
- At least 95 % of culverts shall have at least 90 % of their waterway area clear of debris throughout the entire length of the structure including 5 m upstream and downstream.
- At least 90 % of all other stormwater structures shall have 90 % of the waterway area clear of debris.

Included in the contract is an initial six month cycle to bring all stormwater structures up to specification. Once up to specification, they must be maintained to the specified level of service. Information relating to the way that compliance with the required level of service is measured was unavailable.

The cleaning and maintenance of stormwater structures in the road is currently perceived by Water and Waste Business Unit Network Management and Maintenance team to be inadequate. DCC have concerns that the cleaning and maintenance contract is not specific enough and therefore the stormwater structures within the roads are not maintained to a satisfactory standard.

Community and Recreation Services

The maintenance and cleaning of stormwater structures located within parks and reserves, other than those listed under Network Management supervision, are the responsibility of CARS.

At the time of writing this plan, CARS did not have a maintenance schedule for stormwater structures within parks and reserves. They were unable to confirm the location of such stormwater structures or whether any existed within the parks and reserves.

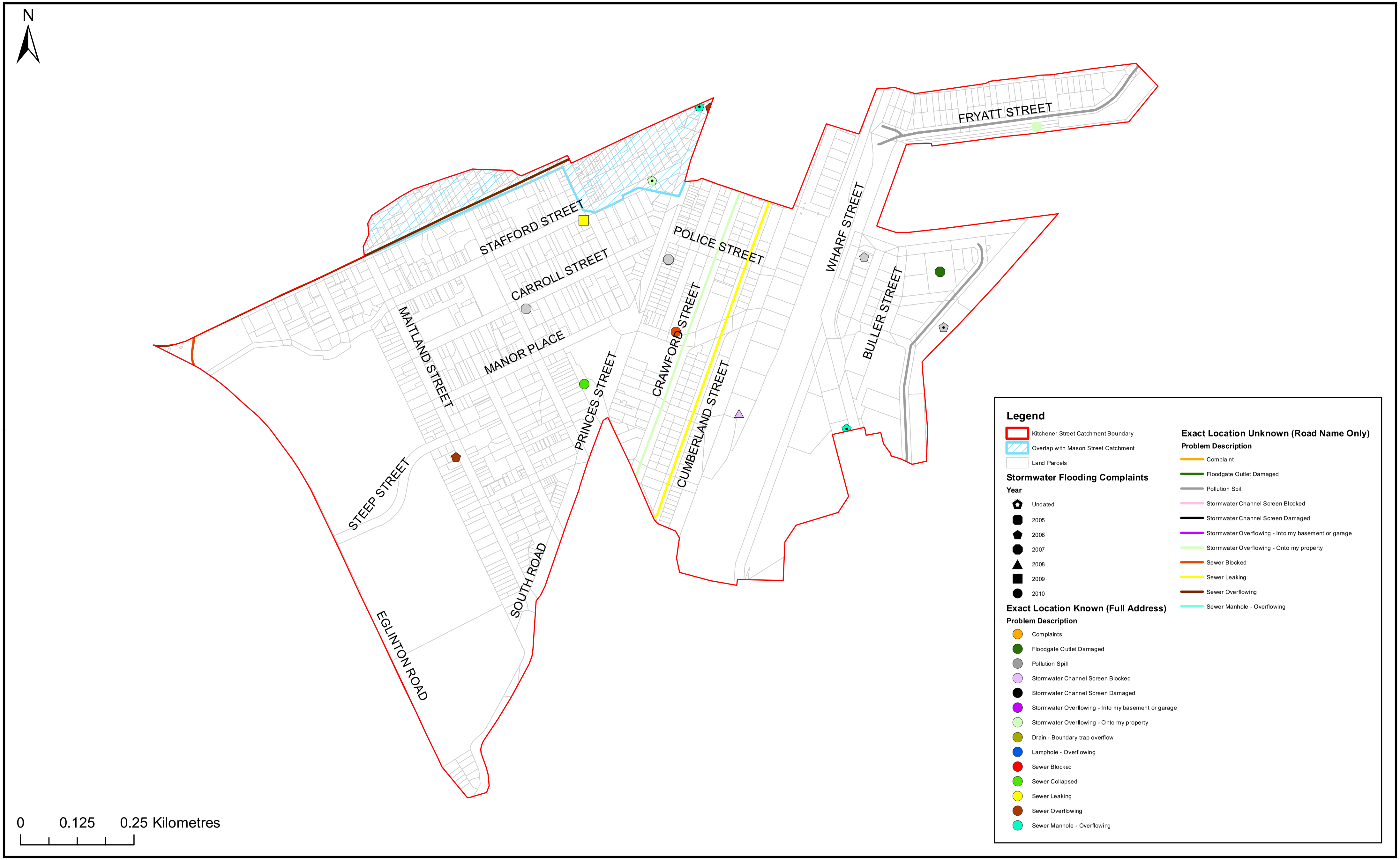
4.8 Customer Complaints

Based on DCC customer complaints information collated between 2005 and 2010, there were 22 recorded stormwater complaints in the Kitchener Street catchment that relate to blockages, leaks or overflows, or that are unspecified. A map of stormwater complaints is provided as Figure 4-13. Seven of these have imprecise locations and could only be identified by road name.

Stormwater flooding complaints are generally scattered around the catchment, however a number of these are concentrated near the intersection of High Street and Princes Street – there is the possibility that the Mason Street catchment stormwater network also has an influence on flooding at this location, particularly given the cross connections between the two.

Wastewater customer complaints information compiled between 2005 and 2010 (Figure 4-14) show a number of complaints in the Kitchener Street catchment, particularly in the residential zone. These complaints appear to be fairly evenly distributed across the western half of the catchment, apart from a small cluster surrounding the Carroll Street – Hope Street intersection. Several complaints are scattered across the flatter eastern half of the catchment.

As discussed in Section 4.9.2, there are no known issues with the wastewater system in the Kitchener Street catchment, suggesting that these complaints are the result of localised issues in the network or private drainage lines.



DUNEDIN CITY COUNCIL / OPUS / URS	Dunedin 3 Waters Strategy	**KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN**	DISCIPLINE	Drawn: MM
		Figure 4-13	Stormwater	Status: Final
		Kitchener Street Catchment Reported Stormwater Flooding		Checked: HS
				Scale: 1:7,500
				Plot Date: Sep 2011
				Approved: HS
				Job. No: 42173227
				Map No: Figure 4-13
				Revision: -
				Date: Sep 2011

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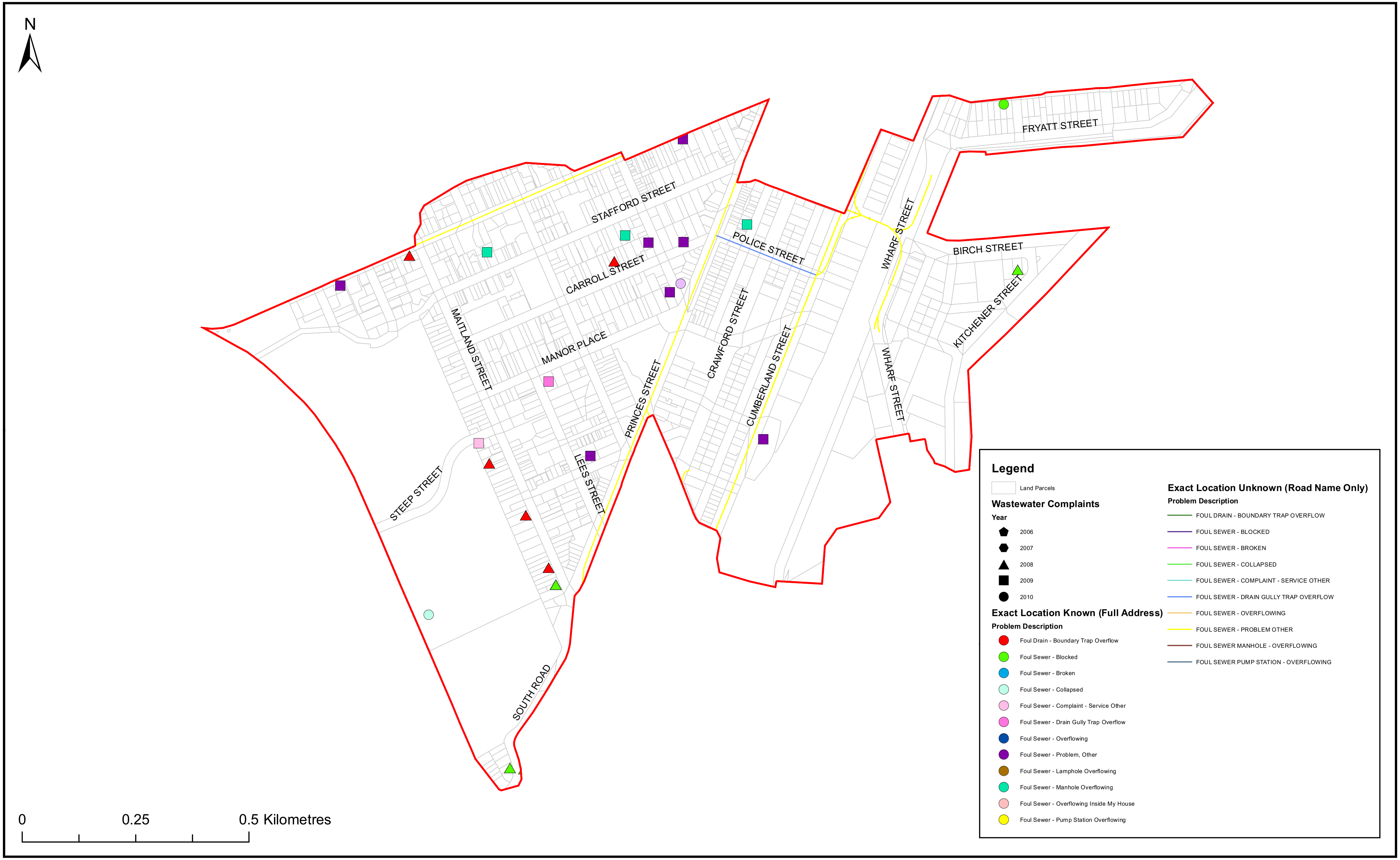

Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN Figure 4-14 Kitchener Street Catchment Reported Wastewater Flooding	DISCIPLINE Stormwater	Drawn: KC	Status: Final	
			Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011
			Approved: SDH	Job. No: 42173227	Map No: Figure 4-14 / Revision: -
			Date: Sep 2011		

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4.9 Water and Wastewater Systems

Figure 4-15 provides a layout of the three waters networks in the Kitchener Street catchment.

Both the wastewater and water networks have been studied at a macro scale as part of the 3 Waters Strategy Phase 1, and in more detail during Phase 2. Section 12 further discusses modelling work undertaken on the water and wastewater systems throughout the city. Issues discovered in the Kitchener Street catchment during Phase 1 and 2 are highlighted below.

4.9.1 Water Supply System

The Dunedin water supply network was investigated for Phase 1 at a distribution mains level only, with further investigations focussing on key areas during Phase 2. A raw water study investigated the sources and reliability of water supply to the city.

The results indicated that the Dunedin water supply distribution (trunk mains) network provides sufficient treated water capacity and raw water storage, on a daily and weekly basis, to meet peak summer demands. It is recognised that there is a lack of strategic raw water storage during severe drought conditions.

The Dunedin water supply network receives treated water from the Mount Grand WTP to the north west of the city and the Southern WTP to the south west of the city. A number of sources supply raw water to the WTPs. Treated water from the WTPs is supplied to the city primarily by gravity, with the distribution mains, reservoirs and pressure reducing valves controlling the pressure and flow to most of the water supply zones in the city. A number of pump stations are also required to boost water pressure to reservoirs at high points or at the extremities of the system.

The water for the Kitchener Street catchment is supplied from the North End and Monticello reservoirs, located to the north and south of the catchment respectively. There are approximately 20 km of water supply pipes within the Kitchener Street catchment, ranging from 20 mm to 600 mm diameter. The majority of the supply pipes in this catchment are constructed from cast iron.

The Kitchener Street catchment straddles two water supply zones, with part supplied from the Central Business District (CBD) and some supplied from the South Dunedin water supply zone. Leakage is higher in the CBD than in South Dunedin, which is close to the Dunedin average. There is a potential, particularly within the CBD area, for some infiltration into the stormwater network.

DCC Network Management and Maintenance staff indicated that there is a cross connection between the water supply system and the stormwater network to the east of Cumberland Street, on the main Stormwater outfall line. This is operated via a valve, which is reported to be closed. A baseflow was recorded at the stormwater flow monitoring site, however, which is downstream from this location.

4.9.2 Wastewater System

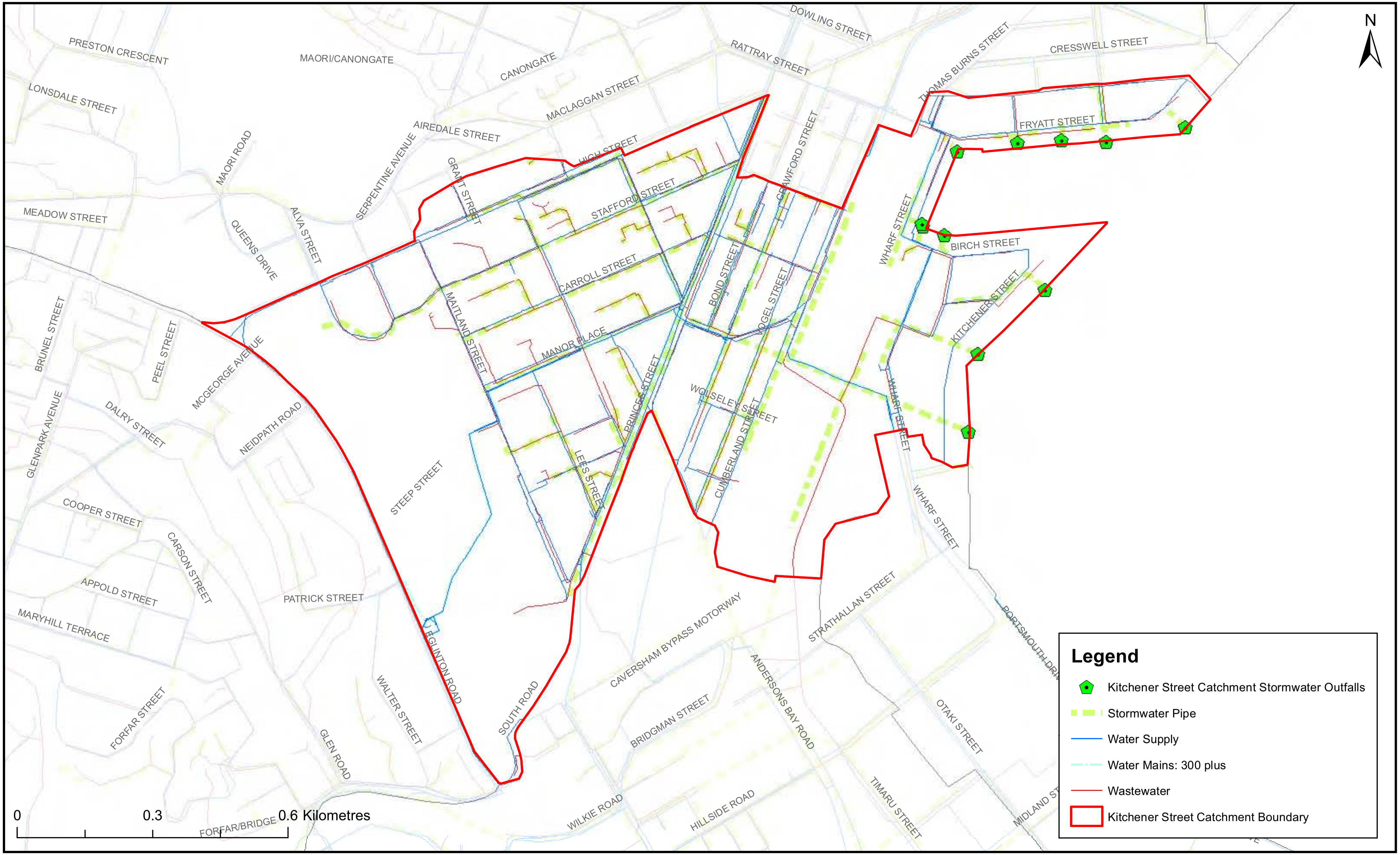
The main areas of investigation into the Dunedin City wastewater system for Phase 1 were system capacity, hydraulic performance, wastewater overflows and pumping stations. Current and future anticipated issues within the system at a macro level were identified. Flow survey and modelling from Phase 1 revealed a strong wet weather influence on the wastewater system city-wide, caused by both direct and indirect entry of stormwater via storm induced inflow and infiltration (I&I). This indicated that the Dunedin City wastewater system remains at least partially combined with a clear and significant response to rainfall. A number of manhole overflows were also predicted by the modelling whereby wastewater may then enter the stormwater system via kerb and channel and stormwater sumps and contribute to stormwater flows. Investigations also revealed that a number of wastewater overflows to the natural environment have been found to operate during rainfall events within Dunedin City.

The Dunedin City wastewater system collects wastewater from commercial, industrial and residential customers in Dunedin City. It is split into three distinct schemes: the Dunedin Metropolitan Scheme, the Mosgiel Scheme and the Green island Scheme.

The wastewater system within the Kitchener Street catchment is part of the Dunedin Metropolitan Scheme. The Metropolitan Scheme provides wastewater services to the urban area of Dunedin, West Harbour communities, Ocean Grove and the Peninsula down to Portobello. The main interceptor sewer (MIS) is the main sewer line that collects wastewater flows from the Metropolitan Scheme. It conveys flows to the pumping station at Musselburgh where they are then pumped to the Tahuna WWTP. The MIS extends from the Harrow Street / Frederick Street intersection in the city centre to the Musselburgh pump station.

The wastewater system within the Kitchener Street catchment comprises approximately 13 km of pipeline, approximately 85 % of which are between 150 mm and 300 mm in diameter.

The 3 Waters Strategy Project wastewater study did not identify any significant issues with the wastewater system within the Kitchener Street catchment.



DUNEDIN CITY COUNCIL / OPUS / URS	Dunedin 3 Waters Strategy	**KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN** **Figure 4-15** **Kitchener Street Catchment Three Waters Networks**	**DISCIPLINE** **Stormwater**	Drawn: KC Checked: HES Approved: SDH Date: Sep 2011 Status: Final Scale: 1:7,500 Job. No: 42173227 Plot Date: Sep 2011 Map No: Figure 4-15 Revision: -

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5 Receiving Environment

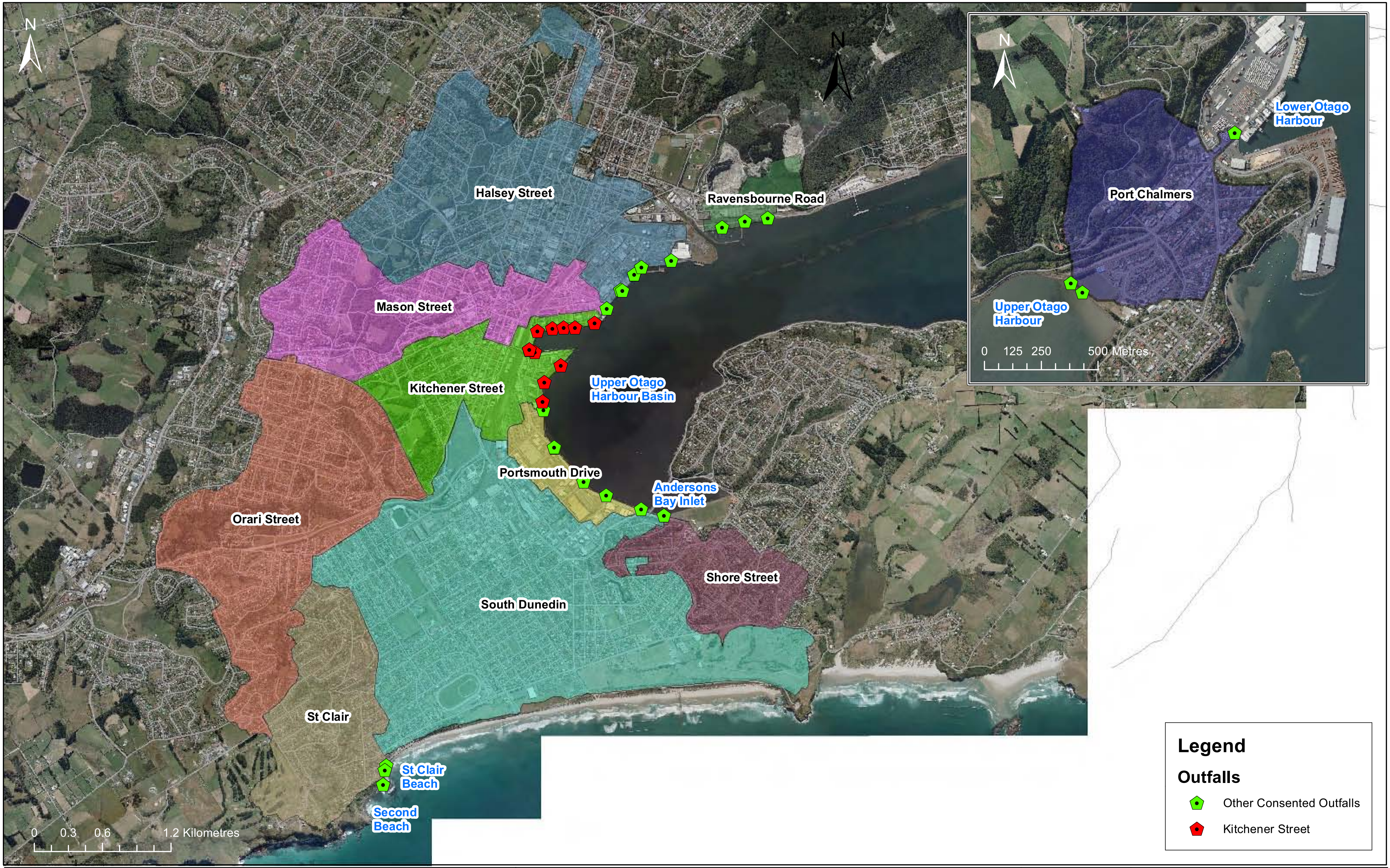
This section identifies and describes the stormwater receiving environment for the Kitchener Street catchment. An overview of the quality and value of the receiving environment is provided. It is acknowledged that both historical and current stormwater management, as well as many other activities not related to stormwater management within the catchment, have contributed to the state of this environment.

Part 3 of this report identifies and analyses the effects that specific stormwater management practices are considered to be having on the receiving environment of the catchment. Where the effects are considered to be unacceptable, options for avoiding, remedying or mitigating the effects are discussed in Part 5 of this report.

The stormwater network in the Kitchener Street catchment discharges directly to the marine environment of the Otago Harbour basin via 11 outfalls along Kitchener Street and surrounding the wharf. The main outfall, located near 6 Kitchener Street, is illustrated in Figure 5-1 and the location of all of the outfalls relative to other DCC stormwater outfalls and the Otago Harbour receiving environment, is shown in Figure 5-2.

There are no notable natural streams in the Kitchener Street catchment; discharges from the stormwater network are piped and discharged to the harbour environment.

Figure 5-1: Main Kitchener Street Stormwater Catchment Outfall



Dunedin 3 Waters Strategy	KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN	DISCIPLINE	Drawn: MM	Status: Final
	Figure 5-2	Stormwater	Checked: HES	Scale: 1:30,000; Plot Date: Sep 2011
	Kitchener Street Catchment Marine Receiving Environment		Approved: HES	Job. No: 42173227; Map No: Figure 5-2; Revision: -
			Date: Sep 2011	

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5.1 Marine Receiving Environment

Monitoring of the harbour environment is undertaken on an annual basis in accordance with the conditions of resource consent for DCC's stormwater discharges. To date, four rounds of monitoring have been undertaken (2007, 2008, 2009, and 2010). The annual monitoring in the Otago Harbour involves the following, and while intended to identify the effects of stormwater discharges, as noted above, may be measuring the effects of historical contamination (particularly in the case of sediment monitoring where annual deposition rates are thought to be low), as well as the effects of contaminant sources other than stormwater:

- Biological monitoring: Macroalgae, epifauna and infauna are surveyed at low tide from four sites; two within 20 m and two a minimum of 50 m from each outfall monitored. Shellfish and octopus are collected from within 20 m of the confluence of the stormwater outfall and waters edge at low tide; and fish (variable triplefins) are collected within 50 m of the stormwater outfalls. The flesh of the animals is then analysed for heavy metals and polycyclic aromatic hydrocarbons (PAHs).

- Sediment monitoring: Replicate samples are collected from the top 20 mm of sediment within 20 m of each outfall monitored. The sediment is analysed for a suite of contaminants including heavy metals, bacteria and PAHs. In addition to the annual sampling, sediment is also analysed from four transects across the centre of the upper harbour, every 5 years.

- Stormwater monitoring: Stormwater grab samples are taken from a number of outfalls, within 1 hour of the commencement of a rain event greater than 2.5 mm, in an attempt to capture the first flush stormwater. The stormwater is then analysed for a suite of contaminants. Stormwater quality is discussed further in Section 6.

There have been a number of studies carried out to establish the condition of the Otago Harbour receiving environment. A study of Dunedin's marine stormwater outfalls was completed in 2010 by Ryder Consulting Ltd (Ryder, 2010a), for the purpose of assessing the current quality of the receiving environments and the potential effects of stormwater on the environments. This study comprises an assessment of the stormwater, sediments, and ecology in the vicinity of the major outfalls within the harbour using sites and methods generally in accordance with those carried out for the annual monitoring. The results of this study were compared with past surveys and historical data in order to determine the condition of the harbour receiving environment.

The following reports are provided for reference in Appendix C:

- Ryder (2010a). Ecological Assessment of Dunedin's Marine Stormwater Outfalls.
- Ryder (2010b). Compliance Monitoring 2010. Stormwater Discharges from Dunedin City.
- Ryder (2009). Compliance Monitoring 2009. Stormwater Discharges from Dunedin City.
- Ryder (2008). Compliance Monitoring 2008. Stormwater Discharges from Dunedin City.
- Ryder (2007). Compliance Monitoring 2007. Stormwater Discharges from Dunedin City.
- Ryder (2006). Remediation of Contaminated Sediments off the South Dunedin Stormwater Outfall: A proposed course of action.
- Ryder (2005a). Characterisation of Dunedin's Urban Stormwater Discharges & Their Effect on the Upper Harbour Basin Coastal Environment.
- Ryder (2005b). Spatial Distribution of Contaminants in Sediments off the South Dunedin Stormwater Outfall.

5.1.1 Upper Harbour Basin

The upper harbour basin is a highly modified environment as a result of reclamation, road works and dredging activities (Smith, 2007). Stormwater is received from the greater Dunedin urban area and surrounding rural catchments and discharged via outfalls into the Otago Harbour at a number of locations, shown in Figure 5-2.

The tidal range in the Otago Harbour is approximately 2.2 m. Tidal current water velocities range from zero to 0.25 m/s (Ryder 2005b), and estimates for harbour flushing times range from 4 to 15 days (Grove and Probert, 1999).

A study by Smith and Croot (1993), describes the circulation of water in the Otago Harbour as being dominated by the tide and inputs of heavy rainfall (see Figure 5-3). Smith and Croot (1993) report that flushing times in the harbour are hard to establish as heavy rainfall has a dramatic effect on dilution displacement of the water in the upper harbour. Harbour flushing times, therefore, may vary and be greatly reduced during rainfall events.

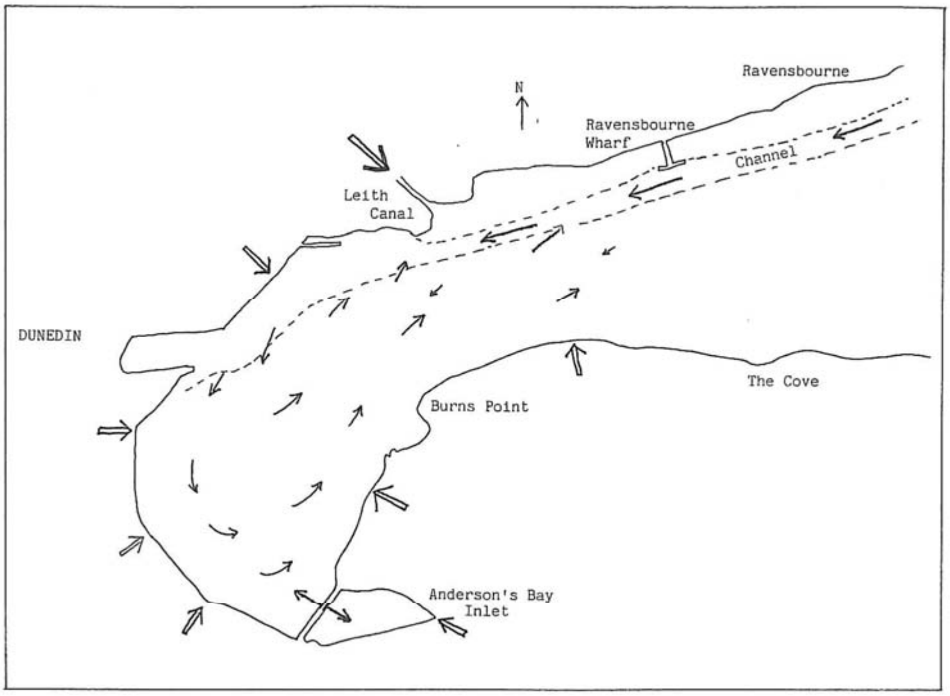

Figure 6
Schematic diagram of circulation in Upper Otago Harbour
Single arrows indicate tidal flows
Double arrows indicate freshwater inputs

Figure 5-3: Circulation of Water in the Upper Otago Harbour (from Smith and Croot, 1993)

5.1.2 Recreational and Cultural Significance

The harbour is considered an important area for recreation. It is frequently used by wind surfers, fishers and hobby sailors. There are a number of boat clubs and tourism operators in the area that make use of the harbour.

The CIA undertaken by KTKO Ltd. (2005), relating to the initial applications for consent by DCC, to discharge stormwater into the marine environment, describes the strong relationship that Käi Tahu ki Otago have with the coastal environment. Evidence of Māori use of the harbour extends back to Māori earliest tribal history when the harbour was a valued food resource and used for transport. The report states that the increasing degradation of the harbour environment has affected Māori in many ways and its place as a mahika kai had been dramatically altered. Further consultation with Käi Tahu is discussed in Section 3 of this report.

5.1.3 Harbour Ecology

Two of the resource consents associated with the Kitchener Street catchment outfalls have conditions requiring biological monitoring. This includes the monitoring of epifauna, infauna and macroflora, as well as sampling of cockle flesh.

The biological investigations undertaken to date look at the effects of the presence / absence of particular stormwater associated contaminants on the ecological communities of the harbour. The diversity of benthic flora and fauna is generally accepted as a reasonable indicator of environmental health. The presence of pollution tolerant species, and an absence of pollution intolerant species, can be used to indicate contamination. However, significant amounts of data are required to link the presence or absence of indicator species with contamination. Table 5-1 below provides typical sources of urban stormwater contaminants.

Several large outfalls discharging stormwater from other urban and industrial catchments exist within approximately 500 m of the Kitchener Street outfalls. Due to the proximity of the outfalls and the common receiving environment it is difficult to distinguish between the potential effects of any particular catchment. Additionally, the harbour ecology is likely to be affected by a number of other factors including other discharges and freshwater input to the harbour (for example the Water of Leith) and historical sediment contamination from sites such as the city gasworks, operational in the South Dunedin catchment up until the 1980s. Shipping and other activities associated with the wharf in the Kitchener Street catchment are also potential sources of contaminants at this location.

Table 5-1: Sources of Stormwater Contaminants

Contaminant	Potential Sources
Total Suspended Solids (TSS)	Erosion, including stream-bank erosion. Can be intensified by vegetation stripping and construction activities.
Arsenic (As)	Naturally occurring in soils / rocks of New Zealand; combustion of fossil fuels; industrial activities, including primary production of iron, steel, copper, nickel, and zinc.
Cadmium (Cd)	Zinc products (Cd occurs as a contaminant), soldering for aluminium, ink, batteries, paints, oils spills, industrial activities.
Chromium (Cr)	Pigments for paints and dyes; vehicle brake lining wear; corrosion of welded metal plating; wear of moving parts in engines; pesticides; fertilisers; industrial activities.
Copper (Cu)	Vehicle brake linings; plumbing (including gutters and downpipes); pesticides and fungicides; industrial activities.
Nickel (Ni)	Corrosion of welded metal plating; wear of moving parts in engines; electroplating and alloy manufacture
Lead (Pb)	Residues from historic paint and petrol (exhaust emissions), pipes, guttering and roof flashing; industrial activities.
Zinc (Zn)	Vehicle tyre wear and exhausts, galvanised building materials (e.g. roofs), paints, industrial activities
PAHs	Vehicle / engine oil; vehicle exhaust emissions; erosion of road surfaces; pesticides.
Faecal coliforms / E.coli	Animals (birds, rodents, domestic pets, livestock), sewage.
Fluorescent Whitening Agents (FWAs)	Constituent of domestic cleaning products, indicator of human sewage contamination.
References: ARC (2005); ROU (2007); Williamson (1993).	

The results of the biological monitoring for the Kitchener Street consent requirements (2007 to 2010) can be summarized as follows:

- Macroalgae: The monitoring results indicate that macroalgal percentage cover at sites at 20 m and greater than 50 m from the Kitchener Street outfall monitored (2007-2010) was generally low but has increased slightly in 2009 and 2010 from earlier sampling. Percentage cover was found to be higher closer to the outfalls for all years monitored.

- There was reasonable diversity of mainly red algae at all Kitchener Street sample sites with diversity being higher closer to the outfalls in all years monitored.

- Epifauna: Epifauna was found to be moderately abundant in all monitoring years, with *Micrelenchus tenebrosus* and cockles comprising the majority of animals. Epifaunal abundance was found to be higher closer to the outfalls 2008-2010.

- The diversity of animal communities was variable across all monitoring years with greater diversity near the outfall than further away.

- Infauna: The monitoring results 2007-2010 indicate that abundance of infauna has fluctuated over the monitoring period (2007-2010) but there has been no significant change in diversity, the exception being at sample sites > 50 m from the outfall, during 2010 the diversity was found to be significantly higher at this location

- The infauna was generally dominated by polychaete worms and glyceriids at sites adjacent to the Kitchener Street outfalls for all monitoring years. Tanaid crustaceans, which have not been common in the past, were found in moderate numbers during 2010.

- Cockle Flesh: The concentration of heavy metals measured in cockle flesh between 2007 and 2010, have remained well below the New Zealand accepted food guidelines levels for shellfish flesh (ANZ Food Standards Code 2002; NZ Food Regulations 1984).

- Faecal coliform levels measured in cockle flesh have fluctuated between years. In 2007 and 2009 faecal coliforms were less than 18 MPN/100 g. The 2010 result of 220 MPN/100 g is the highest level to date recorded at this outfall.

- The PAH levels in cockle flesh, measured between 2007 and 2010, were found to be considerably lower than other sites within the harbour. There are no specific guidelines for PAHs in shellfish flesh for New Zealand.

The fluctuations in analysis presented above show that the monitoring period has not yet been sufficient to determine any clear trends in the state of the ecology in the receiving environment.

The benthic and infaunal communities in the vicinity of the outfalls assessed in this catchment generally show moderate abundance and diversity. This is unlikely to be attributed to any single outfall or catchment. Animals present are typical of other soft bottom intertidal areas in the upper harbour basin.

The 2010 monitoring report notes that, whilst not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to the major stormwater outfalls appear not to be undergoing any significant further degradation as a result of the stormwater inputs during the monitoring period (2007-2010).

5.1.4 Harbour Sediments

The resource consents associated with two of the outfalls from the Kitchener Street catchment have sediment monitoring requirements. Sediments have been collected from sample sites less than 20 m from the outfalls for the monitoring years 2007-2010. In addition, for the 2010 study conducted by Ryder Consulting Ltd, the contaminant levels in sediment samples taken from greater than 20 m from the outfalls were measured. As noted above, the influence of other urban and industrial stormwater discharges, and discharges from a variety of other activities, both current and historical, are also expected to be evident in harbour sediments at this location, and throughout the upper harbour.

The upper harbour bed has been classified, in general, as muddy sands/sandy muds, with varying proportions of fine gravels (Ryder, 2005b). The harbour bed at the Kitchener Street outfall generally consists of fine silts to coarse gravel further away from the outfalls. Sediments near the outfalls were generally clean, but with a layer of dead leaves and drift algae further from the outfall (Ryder, 2010a).

A range of historic data is available regarding contamination levels within harbour sediments. However, historic values should be viewed with caution as sampling in previous years may have used different protocols and sediments may have been collected from different substrate depths and by different methods.

The stormwater catchments and associated outfalls into the Otago harbour are located close together, and a certain amount of dispersion and mixing occurs in the harbour environment. It is difficult to associate any sediment contamination with any one outfall, and as noted above, the influence of other urban stormwater discharges, and discharges from a variety of other activities, both current and historical, are also expected to be evident in harbour sediments.

The sediment analysis results for consent monitoring 2007-2010, and the 2010 study, are presented in Table 5-2 alongside Australian and New Zealand Environment and Conservation Council (ANZECC 2000) sediment quality guidelines and are discussed below.

ANZECC (2000) sediment quality guidelines provide low and high trigger values. The low values are indicative of contaminant concentrations where the onset of adverse biological effects may occur, thus providing early warning and the potential for adverse environmental effects to be prevented or minimised. The high values are indicative of contaminant concentrations where significant adverse biological effects may be observed. Exceedence of these values could therefore indicate that adverse environmental effects may already be occurring. Contaminant concentrations below the ANZECC (2000) low trigger values therefore, are unlikely to result in the onset of adverse biological effects.

Within the 20 mm samples collected and analysed for monitoring purposes, there may a number of years' worth of sediment deposition and a chance that any contamination measured in the samples may be historic. Each sample should not therefore be considered as indicative of the contamination deposited in any given year.

Contaminant levels in much of the harbour have been found to be highly variable but are generally higher closer to the outfalls than further away. However, this is not true for all contaminants or for all outfalls in any given year (Ryder, 2010b). For example, in 2010 copper, zinc, arsenic, chromium and PAH levels were found to increase with distance from the Kitchener Street outfalls.

The monitoring results presented in Table 5-2 show that lead, zinc and copper levels within the sediments have exceeded ANZECC low trigger values, with one instance of levels of PAHs exceeding high trigger values in 2008. Zinc and PAHs were also found to exceed high trigger values in 2010 but at sample sites located further away from the outfall only (> 20 m).

Copper was been found to exceed ANZECC low trigger values in 2007 and 2009 at sample sites within 20 m from the outfall and in 2010 at the sample sites greater than 20 m from the outfalls. These appear to have been isolated occurrences that do not appear to indicate any trend at the sites for these contaminants.

The 2010 monitoring report noted that, for all outfalls monitored harbour wide, whilst copper, lead, nickel and zinc levels were generally elevated in the sediments in previous years, overall there was a general reduction in the concentration of these contaminants in sediments at most sites, including Kitchener Street. However, ANZECC low trigger values were still found to be exceeded by lead, zinc and PAHs at the majority of the sites, including Kitchener Street.

Sections 6 and 8 of this report discuss stormwater quality and assess the effects on the environment in further detail.

Table 5-2: Marine Sediment Guideline Values and Measured Contaminant Levels

Contaminant	ANZECC Trigger Value[1]		Kitchener Street Outfall					Comment
			< 20 m				> 20 m	
	Low	High	2007	2008	2009	2010	2010	
Arsenic (As)	20	70	4.6	7.5	7.0	9.0	13.3	All samples below ANZECC low trigger value.
Cadmium (Cd)	1.5	10	0.4	0.4	0.3	0.3	0.2	All samples below ANZECC low trigger value.
Chromium (Cr)	80	370	22.6	18.0	98.0	22.0	24.0	One isolated exceedence of ANZECC low trigger value, all other results below low trigger.
Copper (Cu)	65	270	70	56	90	37	83	Some samples above ANZECC low trigger values, no trend.
Nickel (Ni)	21	52	10.6	12.0	15.0	12.0	12.1	All samples below ANZECC low trigger value.
Lead (Pb)	50	220	117.9	97	130	155	75	All samples above ANZECC low trigger value, with one exception below low trigger value.
Zinc (Zn)	200	410	249	280	300	280	570	All samples above ANZECC low trigger value with one sample above high trigger value.
PAHs	4	45	8.9	140.5	4.8	5.0	57.0	All samples above ANZECC low trigger value with two samples above high trigger value.
Enterococci*	-	-	66	920	5	< 3	13	All samples below ANZECC low trigger value.
Faecal coliforms*	-	-	20	13	70	< 2	2	All samples below ANZECC low trigger value.

1. All values in units of mg/kg dry weight, except those contaminants marked with an *, which are in MPN/g.
NB. Contaminant concentrations below low trigger values are unlikely to result in the onset of adverse biological effects and therefore are not considered significant.

KEY:

(yellow)	Exceeds Low ANZECC Trigger Value
(orange)	Exceeds High ANZECC Trigger Value

5.2 Freshwater Receiving Environment

The Kitchener Street catchment does not contain any open channels or watercourses; the stormwater network is fully piped, and discharges directly into the marine receiving environment.

6 Stormwater Quality

This section of the report provides a description of stormwater quality monitoring undertaken to date in and around the catchment, and provides a characterisation of the stormwater quality being discharged from the Kitchener Street catchment based on the information available.

6.1 Stormwater Quality Monitoring

Annual water quality sampling of the stormwater discharges in this catchment is required as a condition of the discharge consents. The single outfall from the Kitchener Street catchment has been included in this sampling regime.

The resource consents for stormwater discharge from this catchment require that the water quality sampling shall be undertaken; following one storm event annually, during storms with an intensity of at least 2.5 mm of rainfall in a 24 hour period and the storms must be preceded by at least 72 hours of no measureable rainfall.

Monitoring of the stormwater quality at the outfall has been carried out by Ryder Consulting Ltd. Several rounds of monitoring have been completed to date; 2007, 2008, 2009 and 2010. A grab sample was taken from the stormwater outfall within 1 hour of the commencement of a rainfall event to attempt to ensure that the first flush, and therefore worst case scenario, is captured.

Three time-proportional stormwater quality samples have also been taken across Dunedin as part of the 3 Waters Strategy; one at South Dunedin (2009), one at Bauchop Street (2009), and one at Port Chalmers (2010). These three sites provide stormwater quality representing industrial / residential, commercial / residential, and residential land uses respectively.

6.2 Stormwater Quality Results

Urban stormwater can contain a wide range of contaminants, ranging from suspended sediments and micro-organisms to metals and petroleum compounds, amongst others. The sources of the contaminants are also wide ranging in urban environments with anthropogenic activities significantly contributing to runoff quality.

Table 6-1 presents the results of the annual monitoring at the Kitchener Street outfall, which is undertaken via a grab-sampling technique, providing a ‘snapshot’ of stormwater quality during a storm event.

Table 6-2 shows the results of the time proportional sampling in Dunedin. The results provide an indication of the variations in contaminant concentrations throughout the duration of a rainfall event for catchments with differing urban land uses.

There are no specific guidelines for stormwater discharge quality, either nationally or internationally, however Table 6-3 presents stormwater quality data from a variety of sources. This information provides an indication of ‘typical’ stormwater contaminant concentrations that might be expected from urban catchments.

Considerable variability can be expected in stormwater sampling due to antecedent conditions (the number of dry days prior to rainfall) and event characteristics (intensity and duration of rainfall) affecting the amount of sediment (and hence contaminants) present in the stormwater. Additionally, the grab-sampling technique employed may have taken a sample at any point during the event.

The annual monitoring results indicate that the level of contaminants in the stormwater is variable between the years monitored, however several contaminants have been measured at or below detectable limits in certain years. With the exception of E.coli and faecal coliforms, all contaminants were measured at or below levels typical for urban stormwater when compared with stormwater data from other catchments in Table 6-3, although because Kitchener Street is a mixed use catchment, it is difficult to make comparisons.

E.coli and faecal coliforms have fluctuated over the four monitoring years and have generally remained within the typical range for urban stormwater (1,000 – 21,000 MPN/100 ml) (Metcalf & Eddy, 1991). However elevated levels of E.coli and faecal coliforms were measured in the 2010 samples, this appears to be an isolated incident.

The presence of FWAs within the stormwater can be an indication of human waste contamination, but FWA concentrations measured in 2010 are not particularly high. Furthermore, the peaks in microbial contamination do not correspond with the peaks in FWA concentrations. This may indicate that the elevated microbial concentrations are not due to wastewater inputs into the stormwater system.

Table 6-1: Stormwater Quality Consent Monitoring Results – Kitchener Street Catchment Outfall

Year	Contaminant												
	pH	As	Cd	Cr	Cu	Ni	Pb	Zn	TSS	Oil and Grease	FWA	E.Coli	Faecal Coliforms
		g/m³									µg/l	MPN/ 100ml	cfu/ 100ml
2007	7.1	BDL	BDL	0.004	0.0340	0.0030	0.0442	0.445	104	9	0.180	13000	13000
2008	7.7	BDL	BDL	0.002	0.0056	BDL	0.0070	0.036	41	BDL	0.029	70	70
2009	7.4	0.0096	BDL	BDL	0.0230	0.0036	0.0180	0.380	45	BDL	0.072	10000	10000
2010	6.9	BDL	BDL	BDL	0.0118	0.0035	0.0020	0.620	50	BDL	0.023	92000	160000

BDL = Below detection limits

Table 6-2: Dunedin Time Proportional Stormwater Monitoring Results, Contaminant Ranges

Location, Date (Land Use)	Contaminant											
	pH	As	Cd	Cr	Cu	Ni	Pb	Zn	TSS	Oil and Grease	E.Coli	Faecal Coliforms
		g/m³									MPN/ 100ml	cfu/ 100ml
South Dunedin, 2009 (Industrial / Residential)	7.0 - 7.7	0.0012 - 0.0052	BDL - 0.00041	0.0011 - 0.0074	BDL - 0.064	0.0067 - 0.0730	0.0008 - 0.0044	0.230 - 0.840	17 - 160	26 - 42	3900 - 14000	5400 - 20000
Bauchop Street, 2009 (Commercial / Residential)	6.7 - 7.9	BDL - 0.0038	BDL - 0.00054	BDL - 0.0500	0.040 - 0.230	BDL - 0.0870	BDL - 0.0870	0.05 - 2.50	26 - 330	7 - 53	n/a	n/a
Port Chalmers, 2010 (Residential)	7.6 - 7.9	BDL	BDL	BDL	BDL	BDL - 0.1080	0.0024 - 0.0077	0.108 - 0.260	8 - 47	6 - 18	n/a	320 - 1000

BDL = below detection limit

Table 6-3: Comparison of Kitchener Street Catchment Stormwater Quality with Other Stormwater Quality Data

Contaminant (g/m^3)	Time Proportional Dunedin	Christchurch Recommended Provisional Mean Values[1]	Pacific Steel, Auckland[2]	Brookhaven Subdivision[3]	Australian Stormwater Mean[4]	Urban Highway, USA[5]	New Zealand Data Range[2]	Kitchener Street 2010
	Residential / Industrial	Christchurch	Industrial	Residential	Australian sites	Highway	Urban	Mixed Use
TSS	8 - 330	33 - 200	124	5 - 49	164	142	-	50
Zinc	0.05 - 2.50	0.40	2.80	0.003 - 0.260	0.910	0.329	0.09 - 0.80	0.62
Copper	BDL - 0.23	0.05	0.08	0.002 - 0.031	0.08	0.054	0.015 - 0.110	0.0118
Lead	BDL - 0.087	0.075	0.23	0.003 - 0.007	0.25	0.4	0.06 - 0.19	0.00196

BDL = below detection limit

[1] Christchurch City Council (2003). [2] Williamson (1993). [3] Zollhoefer (2008). [4] Wendelborn et al. (2005). [5] U.S. Department of Transportation Federal Highway Administration (1990).

7 Stormwater Quantity

7.1 Introduction

A linked 1 and 2-dimensional hydrological and hydraulic model of the Kitchener Street catchment and stormwater network was developed to replicate the stormwater system performance, and to predict flood extents during a number of different scenarios. Two modelling reports were produced for DCC; the '*Kitchener Street Model Build Report'* (URS, 2011a), and the *'Kitchener Street Catchment Hydraulic Performance Report'* (URS, 2011b), and the information presented in this section is sourced from these reports. Figure 7-1 provides a diagram of the model extent.

The modelling analysed a number of influences on the system, as follows:

- Two alternative catchment imperviousness figures; one for the current land use, and one for the future, representing the likely maximum imperviousness.
- Seven different high tide situations; MHWS; MHWS with 2030 and 2060 medium and extreme climate change scenarios; and MHWS with two storm surges (1 in 2 yr Average Recurrence Interval (ARI) applied to current, and 1 in 20 year ARI applied to 2060 extreme climate change).
- Five design rainfall events; 1 in 2 yr, 1 in 5 yr, 1 in 10 yr, 1 in 50 yr and 1 in 100 yr ARI events (refer Rainfall Analysis, Appendix D).
- Three climate change scenarios; no climate change, mean climate change, and extreme climate change (for 2031 and 2060 design horizons).

The model relied in the most part on DCC GIS and Hansen (database) information regarding network configuration and detail. Site visit information, operational knowledge and LiDAR survey data were also incorporated into the model. Catchment hydrological (runoff) parameters were estimated based on the calibrated model built for the adjacent catchment, South Dunedin, and adjusted during calibration.

A single flow monitor was installed in the catchment, approximately 250 m upstream of the main outfall, which enabled the model to be calibrated against observed data.

Confidence in the model output is considered to be moderate; the model calibrated to two out of three selected storm events, and the correlation between predicted and reported flooding from a historic rainfall event was moderate. The model output is not absolute, however it is considered to be an adequate tool for the purposes of indicating areas with a potential to flood, and allowing the comparative effects of the different rainstorms and climate change to be assessed. It has been built using accepted sound methodology by experienced modellers and engineers.

7.2 Model Results

Fourteen scenarios representing different land use, rainfall, climate change and tide combinations have been modelled. Tables 7-1 and 7-2 present the results of the modelling, in relation to information required to assess the performance of the system and enable the environmental effects to be determined.

Section 8 analyses the modelling results in order to identify key issues relating to system capacity and flooding. In general, DCC are particularly concerned with the point at which a manhole is predicted to overflow and cause flooding (particularly to potential habitable floor level); however the pipe surcharge state, and manholes that are 'almost' overflowing are also of relevance when considering available capacity in the system.

With respect to flooding of private property, model results are presented as a 'number of land parcels with flood depth potentially > = 300 mm', and are based on a GIS assessment of DCC cadastral maps, overlaid with modelled flood extents. When targets for protection of private property are set (Section 11) these are set to limit the flood risk to private property and habitable floors. As discussed further in Section 8, the modelled deep flooding of part of a parcel does not necessarily mean that the entire property is inundated; further detail (including survey) is generally required to confirm the risk to habitable floors.

Table 7-1: Kitchener Street Model Results – Current Land Use

Hydraulic Performance Measure	ARI	Current Land Use
Percentage of manholes predicted to overflow	1 in 2[1] yr	11.2
	1 in 5 yr	30.2
	1 in 10 yr	43.2
Number of land parcels with flood depth potentially >= 300 mm[2]	1 in 2[1] yr	0
	1 in 5 yr	1
	1 in 10 yr	2
	1 in 50 yr	16
	1 in 100 yr	21
Estimated flood extent (% of catchment area with flood depth >= 50 mm)	1 in 2[1] yr	< 0.1
	1 in 5 yr	0.5
	1 in 10 yr	1.4
	1 in 50 yr	2.9
	1 in 100 yr	3.9
Modelled percentage (by number) of pipes surcharging	1 in 2[1] yr	54.5
	1 in 5 yr	64.3
	1 in 10 yr	66.2
Percentage of manholes predicted to be close to overflowing (free water level within 300 mm of cover)	1 in 2[1] yr	7.7
	1 in 5 yr	16.0
	1 in 10 yr	8.9

[1] 1 in 2.33 year event (mean annual flood).

[2] On all or part of a land parcel, or against a building void in the 2-D surface.

Table 7-2: Kitchener Street Model Results – Future Land Use / Climate Change

Hydraulic Performance Measure	ARI	Planning Scenario				
		2031			2060	
		Growth Only	Mean Climate Change	Extreme Climate Change	Mean Climate Change	Extreme Climate Change
Percentage of manholes predicted to overflow	1 in 10 yr	43.8	42.6	43.2	43.2	45.6
Number of land parcels with flood depth potentially >= 300 mm[1]	1 in 10 yr	2	6	8	9	19
	1 in 50 yr		20		21	
	1 in 100 yr					38
Estimated Flood Extent (% of catchment area with flood depth >= 50 mm)[2]	1 in 10 yr	1.4	1.9	2.2	2.3	3.0
	1 in 50 yr		3.5		4.0	
	1 in 100 yr					11.1
Modelled percentage (by number) of pipes surcharging	1 in 10 yr	66.2	67.6	68.1	70.0	71.8
Percentage of manholes with free water level within 300 mm of cover	1 in 10 yr	8.3	10.7	10.7	10.7	12.4

[1] On all or part of a land parcel, or against a building void in the 2-D surface.

[2] Includes small areas flooded outside the catchment boundary.

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Dunedin 3 Waters Strategy

KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 7-1

Kitchener Street Catchment Model Extent

DISCIPLINE

Stormwater

Drawn: MM	Status: Final		
Checked: HS	Scale: 1:7,500	Plot Date: Sep 2011	
Approved: HS	Job. No: 42173227	Map No: Figure 7-1	Revision: -
Date: Sep 2011			

Created with ESRI ArcGIS

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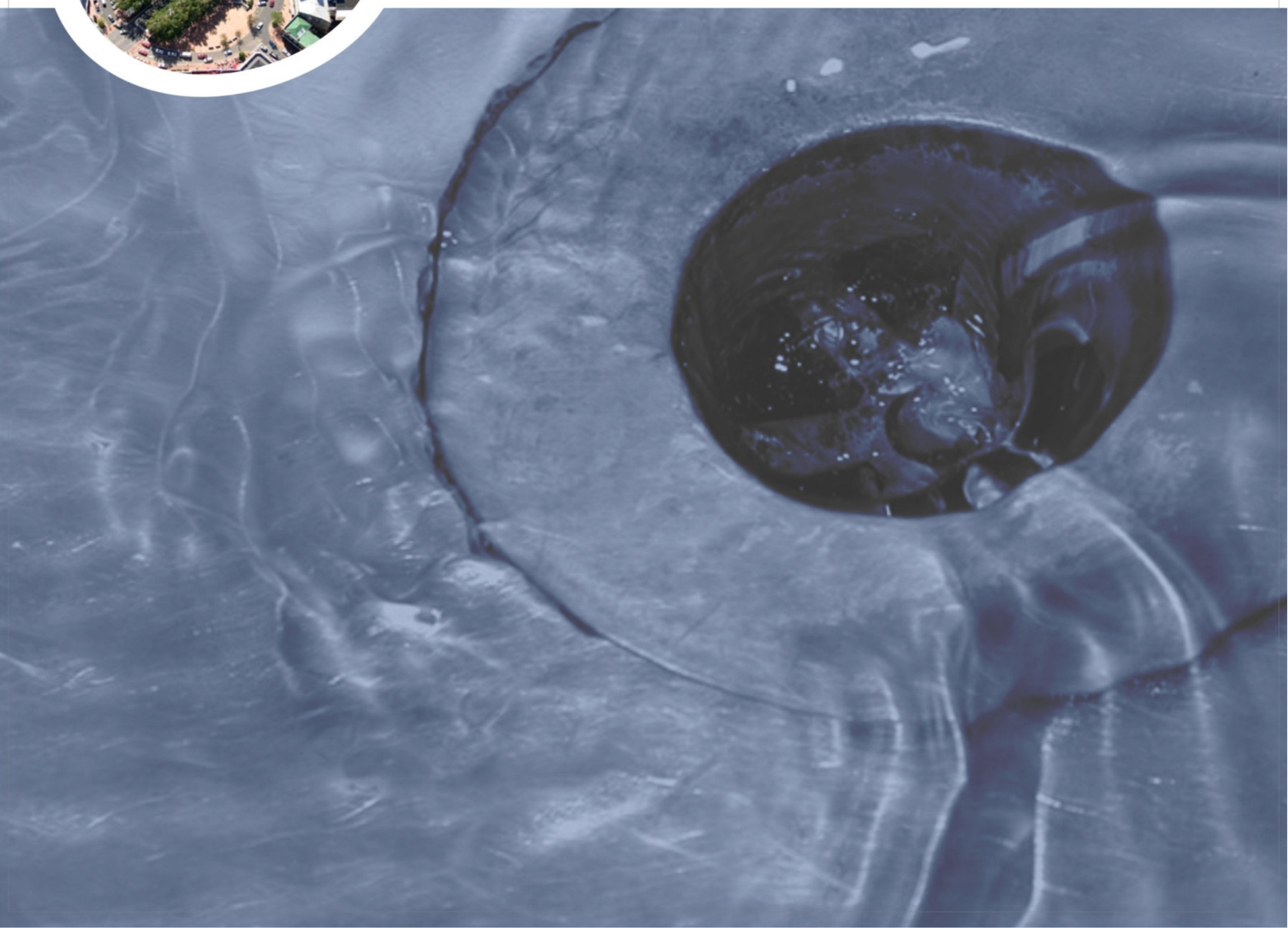
Original Size: A3

Part 3
Analysis



8 Assessment of Environmental Effects

This section identifies and summarises the actual and potential environmental effects on the stormwater network and natural environment relating to stormwater quantity and quality within the catchment.

The effects are summarised based on the interpretation of the outcomes of the stormwater network hydraulic modelling and the associated flood maps; the marine and stream assessments; information gathered during catchment walkovers; DCC flood complaint records; and workshops with DCC Network Management and Maintenance staff.

8.1 Stormwater Quantity

8.1.1 Benefits of the Stormwater Network

Urban development significantly increases the area of impervious surfaces from which rainfall quickly runs off. These surfaces include building roofs, paved areas, roads and car parks, and they can also include, but to a lesser extent, grassed and garden areas. In Dunedin, the stormwater network controls the urban runoff, collecting the flows within the system and directing it to the receiving environment. The stormwater network therefore provides a number of benefits to the community.

DCC is responsible for managing the stormwater system in order to provide the best system possible at a reasonable cost to the ratepayer. The objectives set for stormwater management by DCC are outlined in the stormwater AMP, as follows:

> *"The key objective of the Stormwater Activity is to protect public health and safety by providing clean, safe and reliable stormwater services to every customer connected to the network with minimal impact on the environment and at an acceptable financial cost. In addition to ensuring effective delivery of today's service, we also need to be planning to meet future service requirements and securing our ability to deliver appropriate services to future generations."*

The stormwater activity is particularly focused on providing protection from flooding and erosion, and controlling and reducing the levels of pollution and silt in stormwater discharge to waterways and the sea, and the overall objective is broken down into the individual activity objectives of:

- Ensuring stormwater discharges meet quality standards;
- Ensuring services are available;
- Managing demand;
- Complying with environmental consents;
- Strategic investment;
- Maintaining assets to ensure serviceability; and
- Managing costs.

8.1.2 Stormwater Quantity Effects

The hydraulic model results, summarised in Table 7-1 and 7-2 above, have been used to assess the hydraulic performance of the stormwater network with respect to the criteria shown in the table. This information has been analysed alongside flood maps, observed catchment issues, anecdotal evidence and operational information, to assess the effects of stormwater quantity within this catchment.

Each planning scenario modelled used a range of assumptions which are outlined in Section 7. Minimal model adjustment was required to calibrate the model to the observed flows recorded at the single flow monitor, which was located slightly upstream of the main Kitchener Street catchment outfall. Model results for two out of three defined storm events satisfied the WaPUG criteria for peak flow, maximum depth and total volume. A good level of calibration was achieved which provides a moderate to good level of confidence in the model's ability to broadly estimate the catchment response to extreme rainfall events.

The effects of stormwater quantity on the network within the Kitchener Street catchment are discussed in the following section. The effects on the level of service, flooding and key system structures are identified in relation to current and future land use scenarios and projected climate change.

8.1.3 Infrastructure Capacity

The model results indicate that approximately 57 % of the modelled manholes in the Kitchener Street stormwater catchment can accommodate flows from a 1 in 10 yr ARI rainfall event without overflowing; although the network pipes may be surcharged, manhole overflow is not predicted. Overall, the current level of service of the stormwater network in the Kitchener Street catchment is variable; 89 % of the catchment manholes (150 out of 169 manholes) are able to contain a 1 in 2 yr ARI rainfall event; and 70 % a 1 in 5 yr ARI rainfall event.

It should be noted however, that whilst the stormwater system is able to accept the flows, they may not immediately be conveyed by the network. For example, during a current 1 in 2 yr ARI rainfall event combined with a MHWS tide, some surcharging across the modelled network is predicted, with approximately 45 % of the pipes having no spare capacity and approximately 11 % of all manholes in the catchment predicted to overflow.

System capacity issues begin in the lower parts of the network; Figure 8-1 below provides a map of the network performance during a current 1 in 2 yr ARI rainfall event; pipe surcharging is evident throughout the lower catchment, however manhole overflow is confined to the small sub-networks around the wharf area. The map also shows that the network around South Road / Lees Street is overflowing in places, although not enough to cause observable flooding.

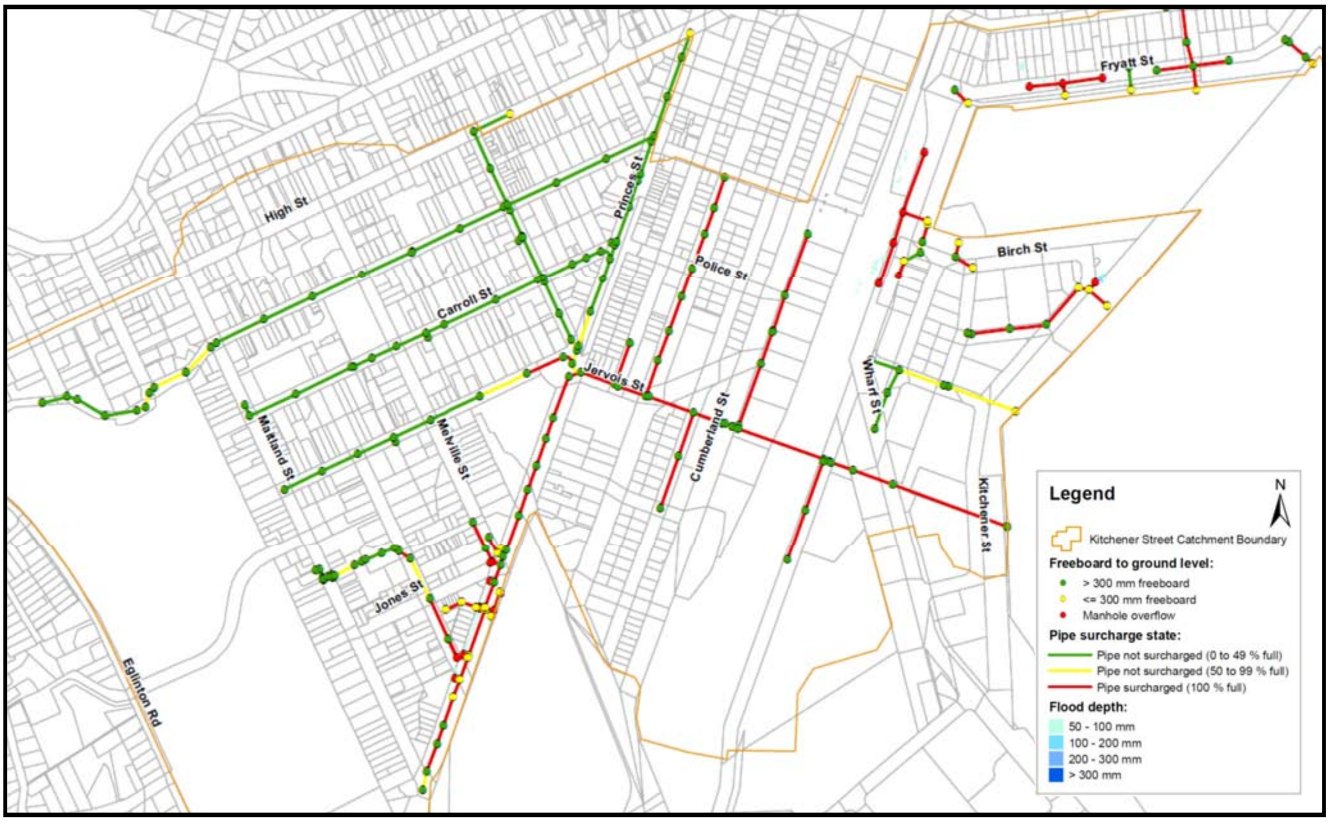


Figure 8-1: Kitchener Street Catchment Stormwater Infrastructure Capacity: Current 1 in 2 yr ARI Rainfall Event

Climate change analysis on predicted system performance indicates that the number of manholes predicted to overflow in a 1 in 10 yr ARI rainfall event increases from 43 % at present to 46 % when the 2060 extreme climate change rainfall and tide levels are taken into account, however the increase in properties at risk of deep flooding is significant (as discussed below).

Analysis for growth effects results in an increase in manhole overflows of 0.6 %, with no change in the number of properties predicted to be susceptible to deep flooding during the 1 in 10 yr ARI rainfall event. Similarly, due to climate change effects the amount of catchment surface predicted to flood increases from approximately 1 % to 3 % during the 1 in 10 yr ARI rainfall event.

This analysis indicates that there is no capacity in the existing network to accommodate increased flows; while the upper catchment network has capacity to convey flows up to a 1 in 10 yr ARI rainfall event, the limitations of the lower network dictate the overall performance of the network.

The hydraulic capacity of the pipe network in Kitchener Street catchment is related not only to the pipe sizes and grades, but also to the tidal influence originating from the harbour outfalls. Analysis of tidal influence on the system indicates that during a 1 in 10 yr ARI rainfall event, a 2010 MHWS tide influences the network capacity in the main line as far upstream as the Jervois Street – Princes Street intersection. Several of the smaller sub-networks also experience a minor tidal influence from this tide level. Figure 8-2 illustrates the parts of the network influenced by the tide, as modelled with and without the MHWS boundary.

Figure 8-2: Extent of Tidal Influence during a 1 in 10 yr ARI Rainfall Event

8.1.4 Flooding

The hydraulic model has been used to indicate areas within the catchment potentially at risk of flooding during a variety of planning scenarios. This includes a range of storm events, current and future land use scenarios and climate change projections, generally modelled with a MHWS tide condition (adjusted for climate change where necessary).

These predictions have been validated, where possible, with anecdotal evidence from DCC Network Management and Maintenance staff, community complaints, and observations made on the catchment walkovers. In a number of instances, predicted flooding remains unconfirmed; in the instances where predicted flooding is significant, further investigation, monitoring and modelling may be required prior to developing solutions.

The accuracy of the flood hazard maps cannot be fully relied on to depict secondary flow paths and flooding extent due to possible inaccuracies within the data. The flooding indicated should therefore be considered as indicative with respect to the exact extent of the flooding, with a higher level of confidence in the location of surcharging manholes and volume of stormwater leaving the pipe network.

The majority of the predicted flooding in the catchment occurs in the flatter industrial, commercial and port zones in the eastern half of the catchment, whereas most of network in the hilly residential zone has capacity beyond the 1 in 10 yr ARI event.

An industrial block adjacent to The Oval, at the southern end of Princes Street, is one of the most flood-prone areas in the catchment and it is predicted that overflows at this location cross over into the South Dunedin catchment during large events, potentially contributing to surface flooding issues identified in and around The Oval.

Predicted nuisance flooding, habitable floor flooding and flood hazard ratings within the catchment have been assessed, and are discussed in the following sections.

8.1.4.1 Nuisance Flooding

Nuisance flooding constitutes predicted flood depths generally between 50 mm and 300 mm, or flooding in locations unlikely to cause habitable floor flooding or serious transport disruption. Flood depths greater than 300 mm deep pose a potential habitable floor flooding risk, and are discussed in the following section. Significant predicted flooding in the Kitchener Street catchment is described in Table 8-1, and illustrated in Figure 8-3.

The area most affected by shallow flooding during small events (with a recurrence interval of less than 1 in 10 yrs) in the Kitchener Street catchment is Princes Street, between Lees Street and Jones Street. Figure 8-4 below provides a long section of this pipeline, illustrating the change in gradient of the pipe, resulting in a sharp reduction in capacity. Whilst catchpits are not generally included in the Kitchener Street network model, they have been included in this area; the low number of catchpits in this area is possibly contributing to the flooding in the area, however additional catchpits would not resolve the issue without the provision of additional network capacity to convey the stormwater.

Other areas experiencing nuisance flooding during small events include several roads in the central commercial / industrial area and a number of roads and yards surrounding the wharf. This is, however, unconfirmed (refer Table 8-2).

Flooding in the South Road and central commercial / industrial area has been confirmed by DCC Network Management and Maintenance staff, as well as through customer complaints. Flooding in the harbour – side area and within the railway designation is less well documented, and flood predictions are highly dependent on the performance of the local networks, for which data accuracy may be limited. For this reason, flooding in this area is presented as modelled only, and may require further investigation or confirmation.

Table 8-1: Predicted Nuisance Flooding – up to 1 in 10 yr ARI, 50 mm – 300 mm deep

Location	Description	Predicted Cause	Minimum Rainfall Event (ARI yr)
South Road / Princes Street	Overflows at most manholes and catchpits along South Road / Princes Street in the vicinity of The Oval, as well as overland contributions from manholes overflows up Lees Street. Moderate to deep flooding accumulates in local depression.	Large sub-catchment upstream of the network, minimal catchpits in area, insufficient pipe capacity, with sharp reduction in pipe gradient.	1 in 2
Central Commercial / Industrial Area	Overflows at multiple manholes along lateral pipes from (and at junctions with) the main stormwater pipe to Kitchener Street outfall. Resulting shallow flooding ponds largely in roads and nearby car parks.	Insufficient pipe capacity, potential land subsidence (reclaimed land). Tidal influence.	1 in 10

Table 8-2: Modelled Flood Areas (Unconfirmed)

Location	Description	Predicted Cause	Minimum Rainfall Event (ARI yr)
Wharf Area	Overflows at multiple manholes (in several sub-networks), particularly those at or upstream of pipe junctions and bends. Resulting shallow flooding ponds largely in roads and industrial hardstand areas.	Insufficient pipe capacity, tidal influences.	1 in 5

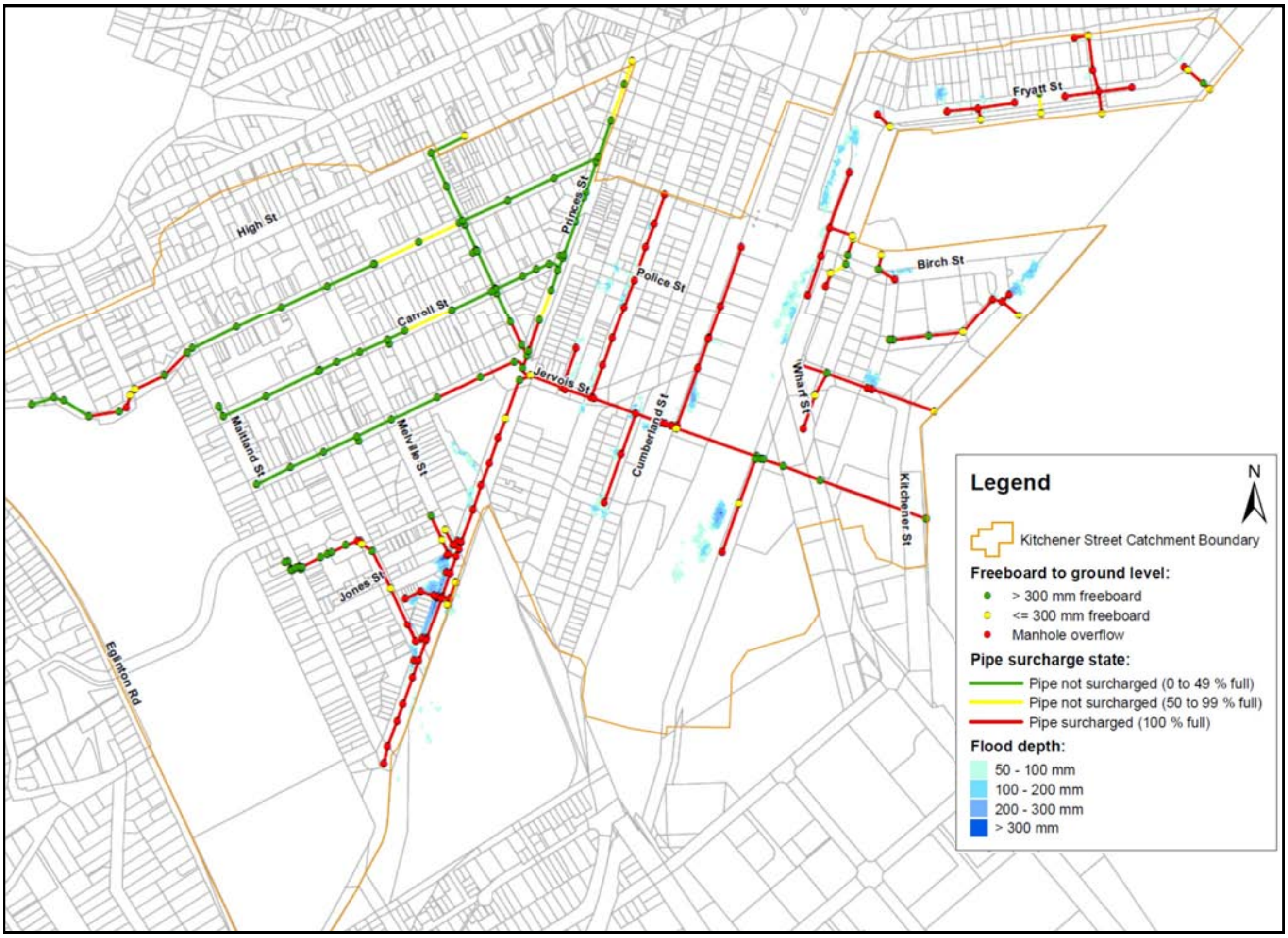


Figure 8-3: Surcharging Pipes and Manholes Causing Nuisance Flooding in the Kitchener Street Catchment Predicted During a 1 in 10 yr ARI Rainfall Event

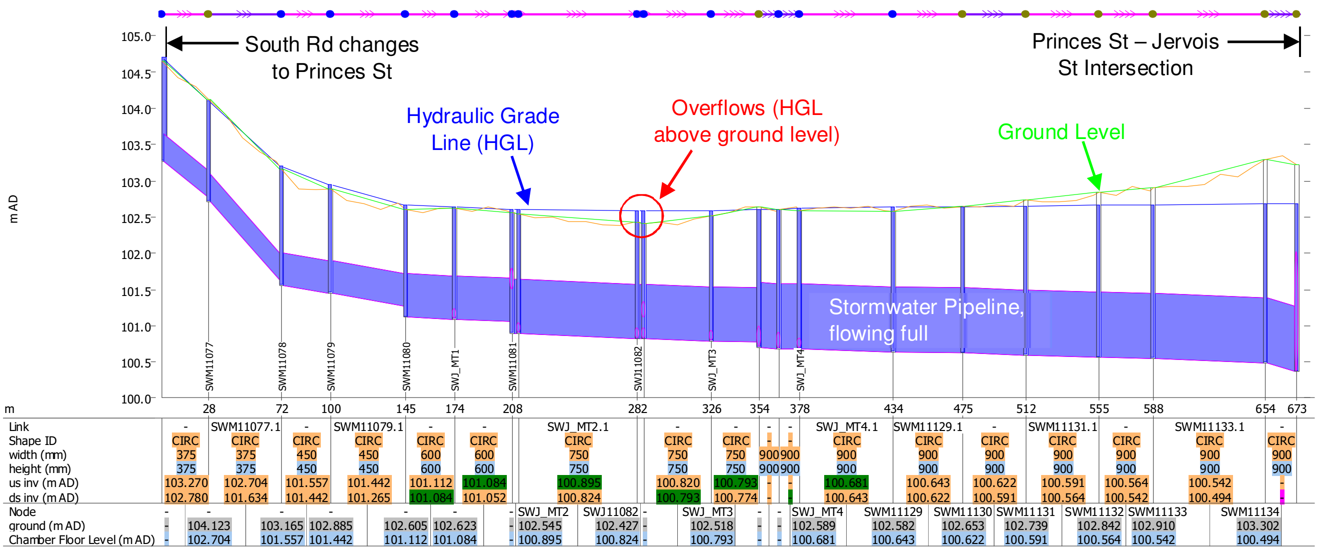


Figure 8-4: Longitudinal Profile along Princes Street, adjacent to The Oval, Showing a Surcharged Network (1 in 5 yr ARI rainfall event)

8.1.4.2 Habitable Floor Flooding

Flood depths equal to or greater than 300 mm present a risk of habitable floor flooding. Habitable floor flooding is the flooding of 'useful floor space' for any zoning (including industrial). This is defined as the floor space of a dwelling or premises inside the outer wall, excluding cellars and non-habitable basements. Land parcels (properties) have been defined as 'at risk' of habitable floor flooding where the property boundary is intersected by a flood plain depth of equal to or greater than 300 mm. It should be noted however, that the exact location of buildings and corresponding floor levels are not documented so it is not usually known whether flooding may only occur within the property boundary or affect the building.

New stormwater systems are designed to avoid habitable floor flooding during a 1 in 50 yr ARI rainfall event. For existing systems, assessment of all rainfall events is undertaken in order to assess the risk of flooding.

During the 1 in 50 yr ARI events modelled, 16 parcels in the Kitchener Street stormwater catchment are predicted to experience flooding on part of their parcel to depths greater than 300 mm for the current land use. Most of these areas are commercial or industrial in use; multiple parcels often combine to a single commercial property, and therefore the number of properties affected is significantly less than the 16 parcels estimated.

Mean climate change (2031) and the maximum land use increased the number of parcels affected to 20; whereas mean climate change in the 2060 scenario increases this to 21. It should be noted, however, that although no survey has been undertaken, it appears unlikely from the aerial photos that this flooding will enter habitable floors; most of the parcels are only predicted to experience flooding on part of the parcel, adjacent to the road corridor.

Flood depths exceeding 300 mm are predicted on 2 parcels during a 1 in 10 yr ARI rainfall event, and on 1 property during a 1 in 5 yr ARI rainfall event. No properties are predicted to be at risk during a 1 in 2 yr ARI rainfall event.

The only significant location of deep flooding predicted during the 2010 1 in 50 yr ARI event is surrounding the industrial block opposite The Oval, in particular the western side of Princes Street from Lees Street to Jones Street, and in car parks within the associated industrial block. This predicted flooding is a result of overflows from nearly all manholes in the vicinity, in addition to shallow overland flow from manholes near the intersection of Lees Street with Fernhill Street. Based on the modelling results, it is possible that floodwaters will enter a small number of buildings during large events, due to breaks in the kerb and floor levels flush with the pavement.

This section of the network (down to Melville Street) drains a large sub-catchment, approximately 35 hectares in size, albeit consisting of 70 % pervious town belt area. Furthermore, the flood-affected area is a local depression in the ground.

Figure 8-5 illustrates the predicted flooding in this vicinity. Flooding at this location has been confirmed by DCC Network Management and Maintenance staff.

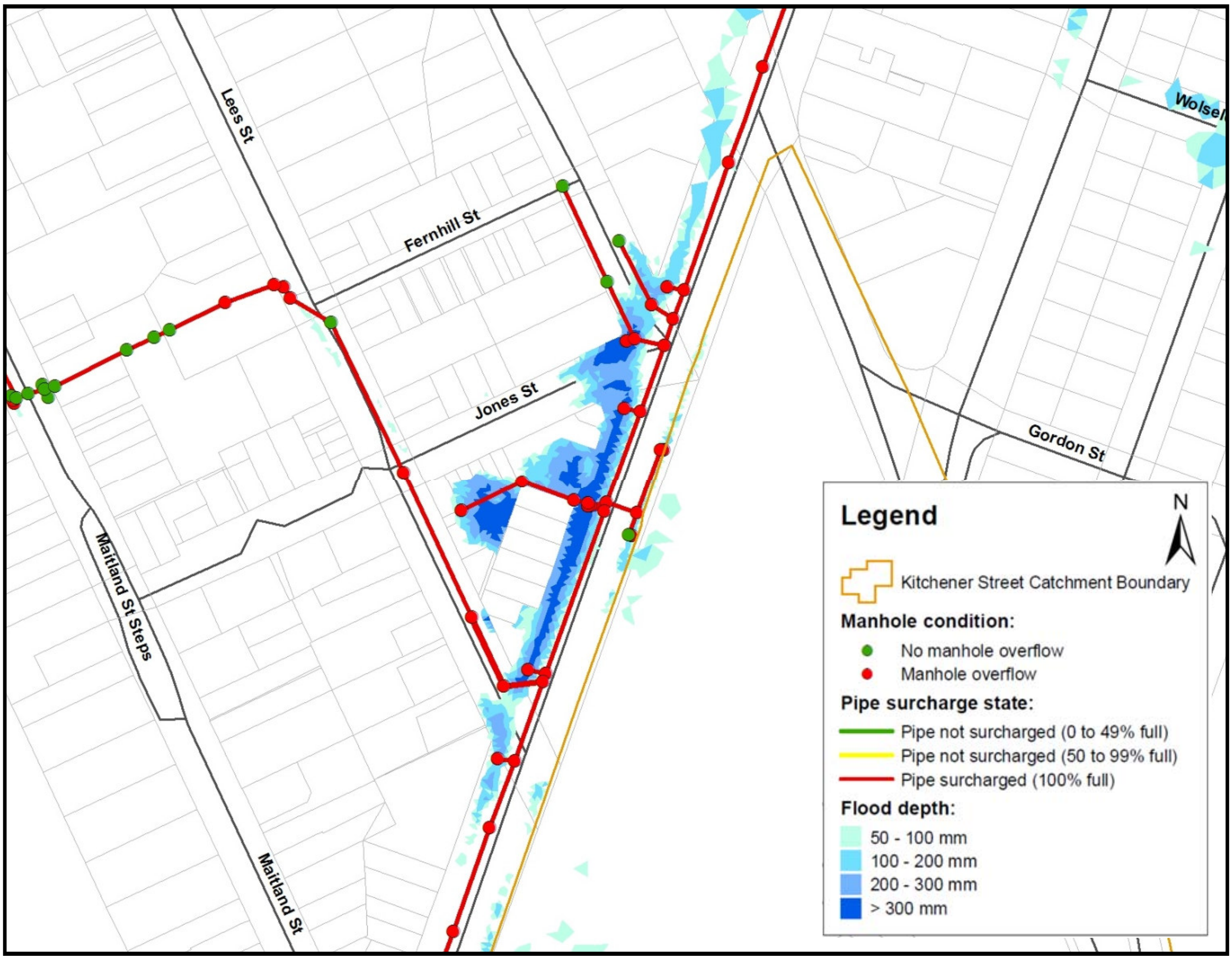


Figure 8-5: Surcharging Pipes and Manholes Causing Deep Flooding in the Kitchener Street Catchment Predicted During a 1 in 50 yr ARI Rainfall Event

8.1.4.3 Flood Hazard

The hydraulic model has been used to predict flooding during two 'emergency planning' events: a 1 in 100 yr ARI rainfall event with current land use, and during a future worst case (extreme) climate change scenario. The results from the extreme planning scenario will allow DCC to put emergency planning measures in place to avoid future catastrophic effects within the catchment, and to identify where overland flow paths lie.

A predicted flood hazard rating has been calculated for the current and future (extreme) planning scenario during a 1 in 100 yr ARI event. A flood hazard rating is a factor of velocity and depth calculated from the hydraulic model results. It indicates the likely degree of flood hazard for a given area and the associated risk to the public. A definition of each rating can be found in Table 8-3 below.

Table 8-3: Flood Hazard Rating

Flood Hazard Rating	Degree of Flood Hazard	Flood Hazard Description
< 0.75	Low	Caution – flood zone with shallow flowing water or deep standing water.
0.75 – 1.25	Moderate	Dangerous for some – (i.e. children). Flood zone with > 250 mm deep, or fast flowing water.
1.25 – 2.0	Significant	Dangerous for most – flood zone with 250 mm - 400 mm deep, fast flowing water.
> 2.0	Extreme	Dangerous for all – flood zone with 400+ mm deep, fast flowing water.

As with the majority of flooding scenarios, the emergency planning modelling identifies the industrial block on Princes Street, near The Oval, as being the most at risk of deep and / or fast surface flooding from extreme rainfall events, commanding hazard ratings of 'moderate' to 'significant' during the 2060 and 2010, 1 in 100 yr ARI rainfall event extreme scenarios.

The 2060, 1 in 20 yr ARI storm surge tide also inundates an area of approximately four hectares surrounding the wharf (particularly Kitchener Street and Birch Street) to a depth sufficient to deem these roads and properties regions of 'significant' flood hazard. Small areas at the edge of the harbour are classified as 'extreme' during this event. It is beyond the scope of this management plan to detail the effects of sea level change, however it is of importance that the stormwater network will not be functioning as designed at these extreme sea levels.

Other 'moderate' hazard areas include small regions of road and carpark / hardstand areas in the industrial, commercial and port zones. Figure 8-6 shows the 2060 (with extreme climate change) predicted flood hazard due to a 1 in 100 yr ARI rainfall event with a 1 in 20 yr ARI tide level.

During a future (2060, extreme climate change) 1 in 100 yr ARI rainfall event, the flood extents and depths predicted may render part of Jones Street, Bond Street, Buller Street and the Cumberland Street access way (to the industrial block, in front of CRT Farm Centre) impassable to traffic. However, these streets all appear to be minor roads and not strategic routes, therefore this predicted flood hazard is unlikely to cause significant traffic disruptions.

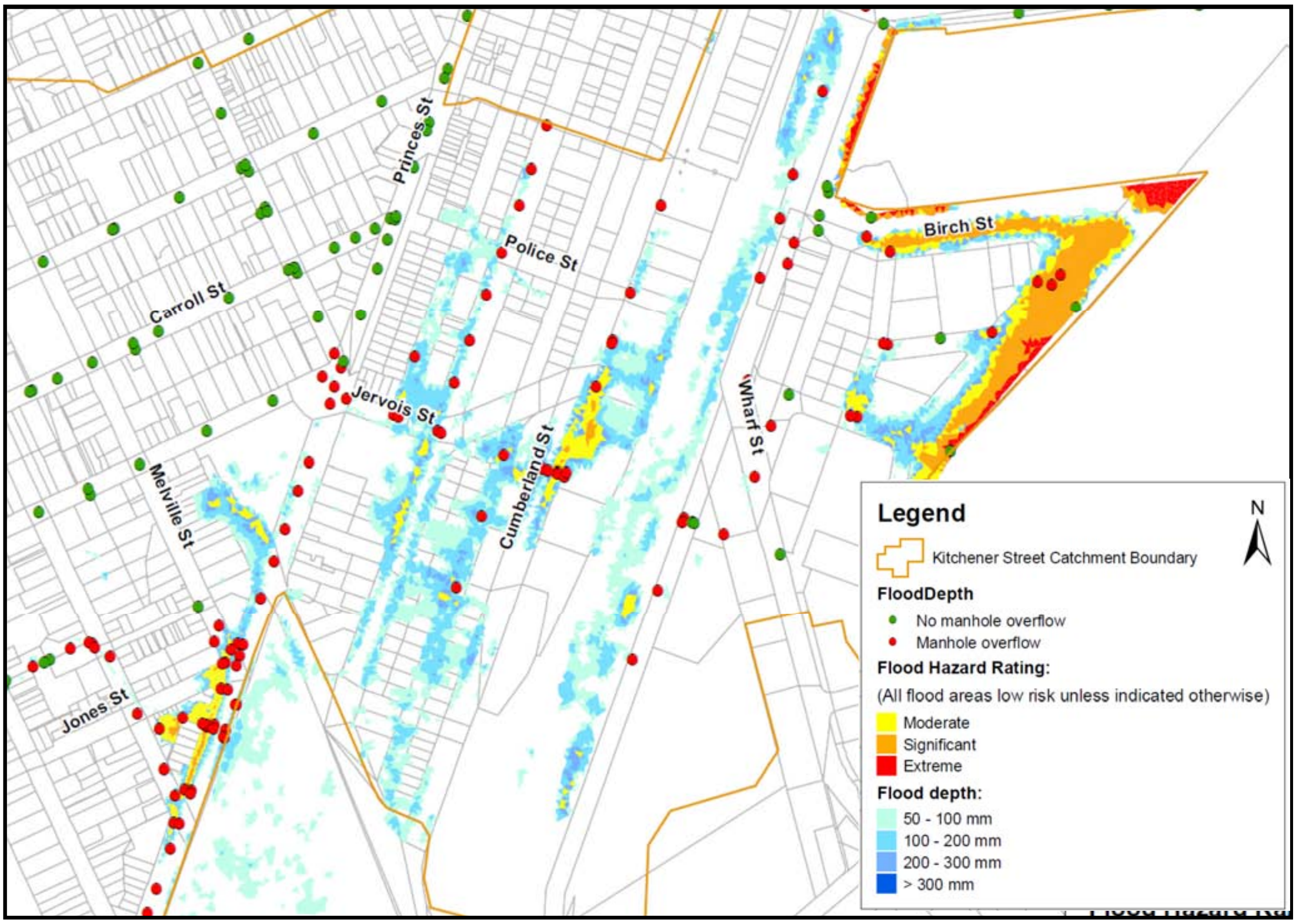


Figure 8-6: Predicted Flood Hazard, 1 in 100 yr ARI Rainfall and 1 in 20 yr ARI Tide Level – Extreme Climate Change Event

8.1.5 Network Age, Operation and Maintenance

The model predictions highlight that the branches of the main network in the flatter half of the Kitchener Street catchment struggle to contain flows up to a 1 in 10 yr ARI event. The majority of the pipes in the catchment were laid before 1940, and the DCC pipe renewals programme provides an opportunity to inspect and potentially renew these pipes in the near future; new pipes would be designed to convey the 1 in 10 yr ARI rainfall event. However, the main issue in this part of the network is the low pipe gradient and a tidal influence, hence while direct replacement with larger pipes would provide some additional subsurface capacity, the reduction in flooding may not be significant.

As outlined in Section 4.7.6, depending on the location, catchpit and inlet maintenance is undertaken by a number of different teams with variations in inspection specification / standards. The different asset management authorities / bodies (DCC, NZTA) appear not to have a coordinated approach on regular asset maintenance, e.g. trash screen clearance, until an extreme rainfall event and / or surface water flooding is occurring and in most cases reported by the general public.

During autumn months in particular, heavy rainfall can result in debris blocking the catchpits and inlet screens. A reduction in catchpit capacity due to silt build up can lead to extension of ponding durations and extents during a rainfall event. Similarly, blocking of inlet screens (of culverts or catchpits) prevents flow entering the network, also resulting in extended ponding, as well as increasing overland flow to other locations. This was verified by Network Maintenance and Management staff as a potential issue during walkovers and workshops. In particular, catchpits at the intersection of Maitland Street and South Road, and on Lees Street and Jones Street in the vicinity of The Oval have been identified as critical.

Stormwater monitoring indicated a base flow leaving the catchment during dry weather. The presence of a cross connection with the water supply network may contribute to base flows identified at the flow monitor location; further investigation may be required to confirm this, however, as these cross connections have valves, and would only discharge for flushing purposes. There may also be natural springs in the catchment; water supply investigations undertaken as part of the 3 Waters Strategy Project identified that infiltration into the stormwater system in this catchment may be likely. It is unlikely, however, to have a significant effect on stormwater network capacity, as volumes are expected to be low. DCC are inspecting the cross connections to confirm any scour valves remain closed.

8.1.6 Culture and Amenity

There are no significant cultural or recreation sites predicted to be adversely affected by stormwater quantity within the catchment.

The discharge of stormwater and associated contaminants has the potential, however, to significantly impact Käi Tahu values and beliefs. These adverse impacts are associated with effects on the spiritual value of water, mahika kai, aquatic biota and water quality.

8.1.7 Summary of Effects of Stormwater Quantity

- The current level of service for the network in this catchment varies across the catchment but is generally between a 1 in 5 and 1 in 10 yr ARI rainfall event. An area of low level of service is present in the south west and lower parts of the catchment.

- Nuisance flooding is predicted and confirmed in an industrial block bounded by Jones Street, Lees Street and Princes Street. Flooding in this vicinity becomes progressively worse during larger rain events, with overflows from Princes Street predicted to enter the South Dunedin catchment at The Oval during large events.

- Potential blockage of catchpits within the catchment is likely to contribute to flood duration and extent.

- The main stormwater system is tidally influenced to just upstream of the Princes Street – Jervois Street intersection in a 1 in 10 yr ARI rainfall event with current MHWS tide level.

- Flood depths exceeding 300 mm are predicted on one property during a 1 in 5 yr ARI rainfall event and two properties in a 1 in 10 yr ARI rainfall event.

- During the 1 in 50 yr ARI rainfall events modelled, up to 16 properties are predicted to experience flooding on part of their parcel to depths greater than 300 mm for the current land use. Mean climate change and the 2060 land use during a 1 in 50 yr ARI event could result in 21 properties experiencing deep flooding.

- During a current (2010) 1 in 100 yr ARI rainfall event, predicted maximum flood hazard rating for the catchment is ‘moderate’ – ‘significant’.

- During a future (2060, extreme climate change) 1 in 100 yr ARI rainfall event, the flood extents and depths predicted may render part of Jones Street, Bond Street, Buller Street and the Cumberland Street access way impassable to traffic.

- Leakage from the water supply system at cross connection points may be discharging potable water into the stormwater system.

8.2 Stormwater Quality

Stormwater quality is discussed in detail in Section 6. Annual monitoring of the quality of the stormwater discharged from the Kitchener Street catchment, conducted using a grab-sample technique, has been undertaken (2007 to 2010).

The following is a summary of the annual stormwater monitoring results. The observations must be viewed in the context of a very small dataset and the limitations of the grab-sampling method (discussed below).

- The levels of the majority of contaminants in the stormwater from the outfalls in this catchment are typical of stormwater quality from urban catchments, with several contaminants below detectable limits during some or all monitoring years.
- Microbial contamination (E.coli and faecal coliforms), has fluctuated over the monitoring years but generally remained within the typical range for urban stormwater except in 2010 when the monitoring results showed a significant increase in levels of microbial contamination.
- FWA fluctuations do not correspond with fluctuations in the levels of microbial contamination.
- The results show variability between years and to date, due to both the sampling method, and an insufficient number of samples to establish trends.

The potential source of microbial contamination in the stormwater from this catchment is difficult to distinguish and with just one year's data indicating high levels within the stormwater; this indicates that it may be an isolated incident. Measured peaks in levels of FWAs, an indicator of human wastewater contamination, do not correspond with peaks in the microbial contamination of the stormwater. Therefore contamination by human wastewater cannot be concluded with any certainty.

There are a number of wastewater complaint records for this catchment. The location and number of complaints varies throughout the monitoring years and it is difficult to draw parallels between the number of complaints in a given year and the high microbial contamination levels in 2010.

The variability in the stormwater quality results (from the annual monitoring) is likely to be due not only to the relatively small data set, but also due to other factors, such as the time since the previous rainfall event within the catchment, and the intensity and distribution of rainfall. A long period between rainfall events allows contaminants to build up within the catchment and as such the contaminant concentrations in the stormwater following the first rainfall event for a significant period of time may be higher.

However, the key contributing factor to the data variability is likely to be the use of grab samples to monitor the stormwater. Grab sample results give a 'snapshot' of the stormwater quality at one point in time only. Throughout a storm event, the concentration of contaminants within the stormwater varies depending on the time since the start of the event. This is indicated in Figure 8-7 below.

The time, during the storm event, that grab samples are taken can significantly affect the results. While stormwater samples taken were targeted at sampling the 'first flush', and consent conditions detailed required storm size and antecedent conditions, it is not known when, during a rainfall event, the stormwater monitoring grab samples were taken for each monitoring year. It is possible that they were taken at differing times during rainfall events, hence the data variability and lack of clear trends. Time proportional monitoring of stormwater quality would yield results that provide a more accurate profile of contaminant concentrations within the stormwater from the catchment.

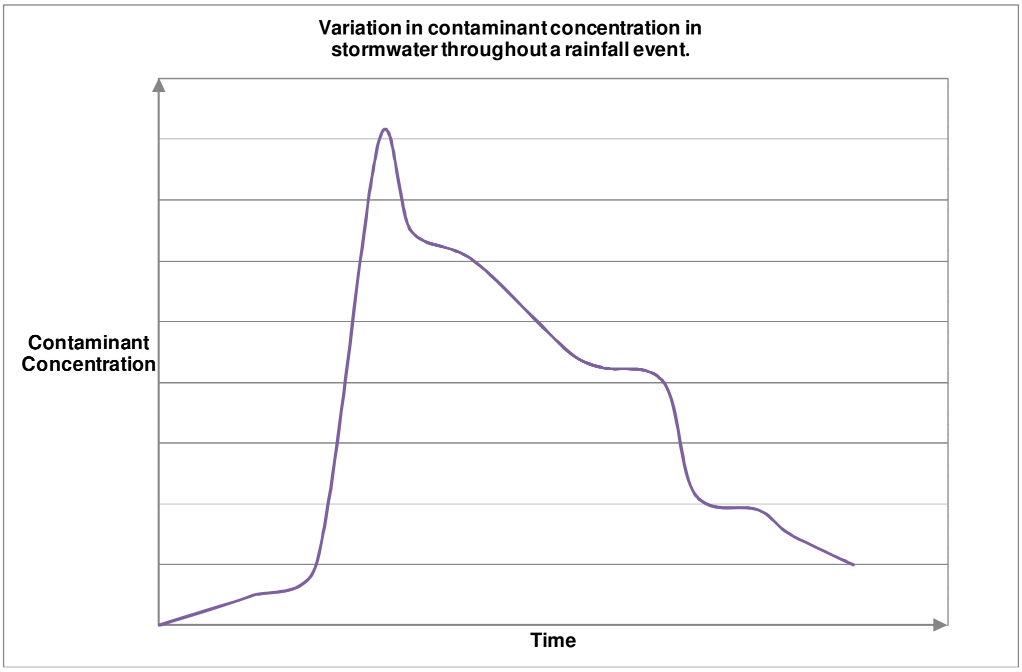


Figure 8-7: Concentration of Contaminants in Stormwater for Duration of a Rainfall Event
(Based on time-proportional sampling carried out in Dunedin)

8.2.1 Harbour Water Quality

The quality of the harbour water will be affected by numerous contaminant sources including, but not limited to: stormwater discharges from the entire harbour catchment; marine vessels; and other marine users. Currently, harbour water quality is not monitored by DCC and as such there is no clear link between the quality of stormwater leaving the outfall and the quality of the water in the harbour.

While no national or international guidelines are available for stormwater discharge quality, ANZECC (2000) guidelines are available for harbour water quality (as well as harbour sediment quality), which identify concentrations of contaminants within the marine environment under which 80 % or 99 % of species are protected.

Because of the different contaminant sources identified above, and the dilution that occurs when stormwater enters the marine environment, in order to fully utilise these guidelines, marine water quality monitoring would need to be undertaken alongside stormwater quality monitoring, and links established between stormwater discharge points and marine water quality within the harbour. Further clarity with respect to longer term environmental effects could then be established using sediment quality information.

Marine water quality is also highly variable both spatially and temporally, and sampling results would also only provide a ‘snapshot’ of water quality. Many factors influence the water quality, including dilution and dispersion; freshwater inputs (such as the Water of Leith); rainfall events; and tidal currents.

8.2.2 Harbour Sediment Quality

Contaminants in urban stormwater entering the marine environment potentially pose a risk to the health of marine organisms, primarily through the accumulation of the contaminants in marine sediments. Contaminants in the stormwater adhere to suspended particles and sediments in the marine environment and accumulate in the marine bed. High levels of contaminants within the sediments may result in adverse impact on marine flora and fauna which come into contact with those sediments.

To assess the potential effects of contaminated sediments on marine ecology, the contaminant concentrations within the sediments can be compared to sediment quality guidelines. It should be noted however, that guidelines provide indicative rather than conclusive evidence of adverse effects; any exceedence of the guidelines therefore indicates only a potential for adverse effects.

ANZECC (2000) sediment quality guidelines provide low and high trigger values. The low values are indicative of contaminant concentrations where the onset of adverse biological effects may occur, thus providing early warning and the potential for adverse environmental effects to be prevented or minimised. The high values are indicative of contaminant concentrations where significant adverse biological effects may be observed. Exceedence of these values could therefore indicate that adverse environmental effects may already be occurring.

8.2.2.1 Kitchener Street Catchment

The contaminant levels within the sediments adjacent to the Kitchener Street catchment are discussed in detail in Section 5. To summarise, the levels of contaminants in the marine sediments sampled have been variable across the monitoring years. In general lead, zinc and PAHs (and occasionally copper) have exceeded the ANZECC (2000) low trigger values for the near outfall sampling sites (< 20 m), with one instance of PAHs exceeding the high trigger value in 2008. Zinc and PAHs have exceeded the ANZECC (2000) high trigger values at the sampling site further away from the outfall (> 20 m) in 2010.

The results of the annual stormwater monitoring do not correspond with the levels of contaminants in the marines sediments, with no significantly elevated levels of copper, lead or zinc, and oil and grease being below detectable limits in most cases. In 2010, a number of contaminants measured higher concentrations in the site further from the outfall, indicating that contaminants could potentially be due to another source. However, there is also evidence that sediment may be regularly re-suspended and redistributed by wave action in this environment.

It is possible that the stormwater discharges are contributing to the contaminant levels in the sediments. It remains unclear however, in the absence of baseline data, a control site for comparison or samples from a more distant location from the outfall, the extent to which sediment contamination is as a result of historic land uses and activities within the catchment and what proportion can be attributed to current stormwater discharges. Further study is required to ascertain any temporal trends in marine sediment quality.

8.2.2.2 Harbour-Wide

Harbour-wide, trends in the levels of contaminants in the sediment remain unclear with just four years worth of monitoring data revealing high variability among contaminant levels and sites. Many contaminants are present in the sediments at various sites within the harbour at levels exceeding the ANZECC sediment guideline low trigger values.

However, levels of chromium, copper, nickel, lead, zinc and PAHs were generally found to be lower in 2010 than in previous years It may be that contamination measured in the sediment is historic and sediment quality may be improving over time due to the deposition of 'cleaner' sediments. Deposition rates in the harbour are thought to be reasonably slow, however, and any trend may take some time to observe due to this slow deposition rate.

Further monitoring of the sediments harbour wide is required to better understand the levels of contamination and establish whether any long term trends exist. It should be noted that the

Kitchener Street catchment is adjacent to the head of the harbour, which is a high energy environment, with sediments likely to be regularly re-suspended by wave action.

8.2.3 Marine Ecology

The resource consents for the stormwater discharges from the Kitchener Street catchment require that benthic and infaunal communities are monitored as well as the sampling and analysis of cockle flesh.

The biological monitoring results to date indicate that the marine benthic and infaunal communities in the vicinity of the outfalls in the catchment are of low to moderate abundance and variable diversity. However, abundance and diversity was found to generally be higher closer to the outfalls than further away.

The results of cockle flesh analysis do not indicate significantly high levels of contaminants within the samples and where applicable (for lead and cadmium), concentrations have been consistently below the maximum levels (MLs) as outlined in Australia New Zealand Food Standards Code (2004). PAHs were found to be considerably lower than other sites within the harbour. However, elevated levels of faecal coliforms were measured in the cockle flesh samples in 2010.

The results indicate that, in general, the cockle communities at this location are not being exposed to significantly high levels of contaminants. This corresponds with the stormwater quality monitoring results which indicated that in general contaminant levels were low and typical of a catchment of this nature. However, the increase in faecal coliforms measured in cockle flesh in 2010 corresponds with a spike in faecal coliform / E.coli levels in the stormwater in the same monitoring year. This may be an isolated incident and further monitoring rounds will enable confirmation of this.

Historical data and the results of biological monitoring carried out harbour - wide for DCC stormwater consent compliance indicate that, in general, a reasonably low diversity amongst the benthic and infaunal communities is likely to be symptomatic of a large proportion of the upper harbour basin. The general lack of diversity may be attributable to anthropogenic influences, including stormwater quality, but other factors such as freshwater inputs and exposure at low tide may also be contributing to the ecological health observed. It is not therefore possible to clearly link ecological health with stormwater quality.

Determining the ecological effects of contamination in the harbour environment is difficult. Unless contamination levels are very high within the sediments it is difficult to distinguish between the potential adverse effects of contamination from stormwater, contamination from other sources, and the effects of other environmental variables.

The biological monitoring results to date, harbour-wide, show that, whilst not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to the major stormwater outfalls (including the Kitchener Street outfalls) appear not to be undergoing any significant further degradation as a result of the stormwater inputs during the monitoring period (2007-2010).

8.2.4 Culture and Amenity

The harbour is an important area for recreation with a number of boat clubs and tourism operators in the area. A decline in the quality of the harbour environment could adversely impact on recreational activities.

The harbour has been used historically by Käi Tahu and their descendents and the discharge of stormwater and associated contaminants has the potential to significantly impact Käi Tahu values and beliefs. The historic decline of harbour quality has been noted by Käi Tahu. These adverse impacts are associated with effects on the spiritual value of water, mahika kai, aquatic biota and water quality. Stormwater quality in the Kitchener Street catchment does not appear to be particularly poor.

To date there is no evidence to suggest that the quality of the harbour continues to deteriorate significantly or that the quality of stormwater from the Kitchener Street catchment is significantly contributing to any deterioration of the harbour. However, the high levels of faecal coliforms observed in the stormwater from the catchment in 2010 could indicate some contribution to contamination and should be explored further.

8.2.5 Summary of Effects of Stormwater Quality

A summary of the effects of stormwater quality is as follows:

- The stormwater quality from the Kitchener Street catchment outfalls was found to be variable but the majority of contaminant levels measured were within or below the ranges considered to be typical for a catchment of this type. The exception was the 2010 sample which indicated elevated levels of faecal coliforms and E.coli. The elevated microbial levels in the stormwater may be related to isolated wastewater flooding incidents but the evidence for this remains inconclusive.

- The levels of contaminants in the marine sediments sampled have been variable across the monitoring years. In general, lead, zinc and PAHs (and occasionally copper) have exceeded the ANZECC sediment guideline low trigger values for the sampling sites <20 m from the outfalls, with one instance of PAHs exceeding the high trigger value in 2008. Zinc and PAHs exceeded the ANZECC high trigger values at the sampling site further away from the outfall (>20 m) in 2010.

- The biological sampling results suggest that the stormwater discharge from this catchment, in general, is not having an adverse effect on ecological health. However, a spike in microbial levels in the stormwater in 2010 corresponds with elevated microbial levels in cockle flesh in the same year.

- The stormwater discharge may be contributing to the contaminant levels in the sediments. However, the current contaminant levels in the stormwater do not correspond with the slightly elevated contaminant levels in the marine sediments. Further study may be able to identify whether any sediment contamination is historic or from other sources.

- Harbour-wide, levels of key contaminants in the sediments were found to be slightly lower in 2010 than previous monitoring years. Further monitoring is required to better understand the contamination levels and establish any long term trends.

- The harbour has important cultural values and is an important area for recreation. The results of investigations do not indicate that harbour quality is continuing to deteriorate as a result of the quality of stormwater from this catchment.

9 Catchment Problems and Issues Summary

Following the Assessment of Environmental Effects (AEE), and identification of catchment specific targets for stormwater management, a number of key problems and issues can be identified in the Kitchener Street catchment, and prioritised for action. These are discussed below. Section 10 following prioritises these issues, and the remainder of this ICMP involves target setting and development of options to manage the stormwater from this catchment. Figure 9-1 presents the key issues for the Kitchener Street catchment.

9.1 Stormwater Quantity Issues

9.1.1 Low Level of Service in Lower Catchment

Most of the network in the lower catchment can only convey small rain events, e.g. a 1 in 2 yr ARI rainfall event. This is due to both tidal influence and network grade and size. This results in manhole surcharging and nuisance flooding in low lying areas.

9.1.2 Nuisance Flooding

Nuisance flooding (between 50 mm and 300 mm deep) is predicted and confirmed in two main areas; South Road / Princes Street at the intersections of Maitland Street, Lees Street and Jones Street, and in the central area near Crawford Street at the intersections with Jervois Street and Police Street. In all instances, this nuisance flooding becomes progressively worse during larger rain events.

9.1.3 Deep Flooding – Current and Future Scenarios

Deep Flooding (> 300 mm deep) is predicted on one property during a 1 in 5 yr ARI rainfall event and two properties in a 1 in 10 yr ARI rainfall event.

During the current 1 in 50 yr ARI rainfall event modelled, up to 16 land parcels are predicted to experience flooding on part of their parcel to depths greater than 300 mm, however the number of properties at risk of habitable floor flooding is believed to be significantly less. Mean climate change and the 2060 land use during a 1 in 50 yr ARI event could result in 21 parcels experiencing deep flooding.

9.1.4 Flood Hazard – Current and Future 1 in 100 yr ARI

'Significant / extreme' flood hazard during large (1 in 100 yr ARI) rainfall events is predicted in a number of areas throughout the catchment, but particularly on Princes Street near The Oval, and in the Cumberland Street area. Flood hazard due to tidal inundation is predicted in areas adjacent to the harbour, however it is beyond the scope of this management plan to detail this issue.

9.1.5 Network Maintenance

City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service. This has the potential to exacerbate or transfer flooding.

Maintenance of number of catchpits in the Kitchener Street catchment, notably at the South Road / Maitland Street intersection, and along Princes Street adjacent to The Oval, is critical to the optimal operation of the hydraulic network.

9.2 Stormwater Quality Issues

It is clear that within the harbour there is historical sediment contamination likely to be from a combination of the stormwater outfall and other sources. Harbour-wide, there is potential for ongoing contamination of the sediment from stormwater, however the results are ambiguous and it has not been possible to establish a causal link from available data.

Sediments adjacent to the Kitchener Street outfall show elevated levels of some contaminants, however stormwater quality measured at the outfall site does not show correspondingly high levels of contaminants.

9.2.1 High Variability of Stormwater Quality Results

Inconsistencies in stormwater quality results mean that we are unable to see clear trends in stormwater quality, or confidently identify key contaminants to aid stormwater management.

Monitoring indicates, however, that there are no major contaminants of concern in the Kitchener Street catchment stormwater, with the exception of a single elevated measurement of E.coli and Faecal coliforms in 2010.

9.2.2 Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment

The current monitoring regime undertaken to meet consent conditions provides limited confidence in the following:

- The extent of historic versus current/ongoing harbour sediment contamination; and
- Links between stormwater quality, sediment quality, and the health of the harbour environment.

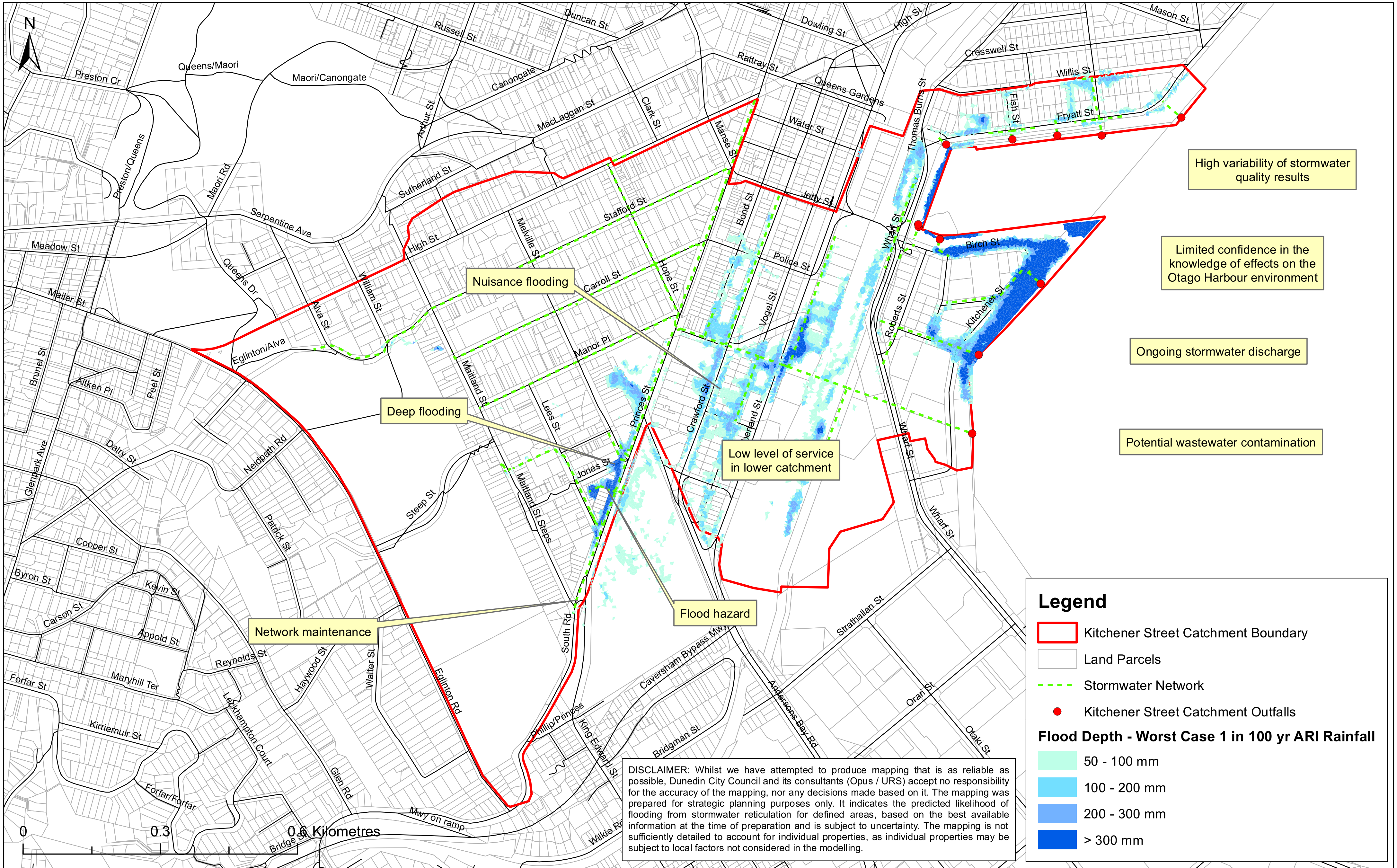
9.2.3 Ongoing Stormwater Discharge

Stormwater quality monitoring indicates that the stormwater quality discharged from the Kitchener Street catchment appears to be typical (or even low) for a mixed use catchment, and contaminant sources are likely to be this land use, combined with heavily trafficked roads. Indications from recent monitoring do not show that current stormwater discharges are having an obvious adverse effect on the receiving environment, however as discussed above, there is limited confidence in some of this information, and further data is required to validate this data.

Mechanisms already in place (e.g. the Dunedin Code of Subdivision and Development and the Trade Waste Bylaw) are designed to encourage source control in order to ensure that contaminant levels in the stormwater discharge do not increase, and that new development and existing land uses are managing stormwater quality in an appropriate manner into the future.

9.2.4 Potential Wastewater Contamination

A single stormwater sample with elevated microbiological contaminants was taken in 2010. This may indicate a wastewater discharge within the catchment, however there is no evidence to suggest that this is an ongoing discharge.



DISCLAIMER: Whilst we have attempted to produce mapping that is as reliable as possible, Dunedin City Council and its consultants (Opus / URS) accept no responsibility for the accuracy of the mapping, nor any decisions made based on it. The mapping was prepared for strategic planning purposes only. It indicates the predicted likelihood of flooding from stormwater reticulation for defined areas, based on the best available information at the time of preparation and is subject to uncertainty. The mapping is not sufficiently detailed to account for individual properties, as individual properties may be subject to local factors not considered in the modelling.

Dunedin 3 Waters Strategy

KITCHENER STREET INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 9-1

Kitchener Street Catchment Issues

DISCIPLINE	Drawn: JMH	Status: Final	
Stormwater	Checked: HES	Scale: 1:7,500	Plot Date: Sep 2011
	Approved: HES	Job. No: 42173227	Map No: Figure 9-1 / Revision: -
	Date: Sep 2011		

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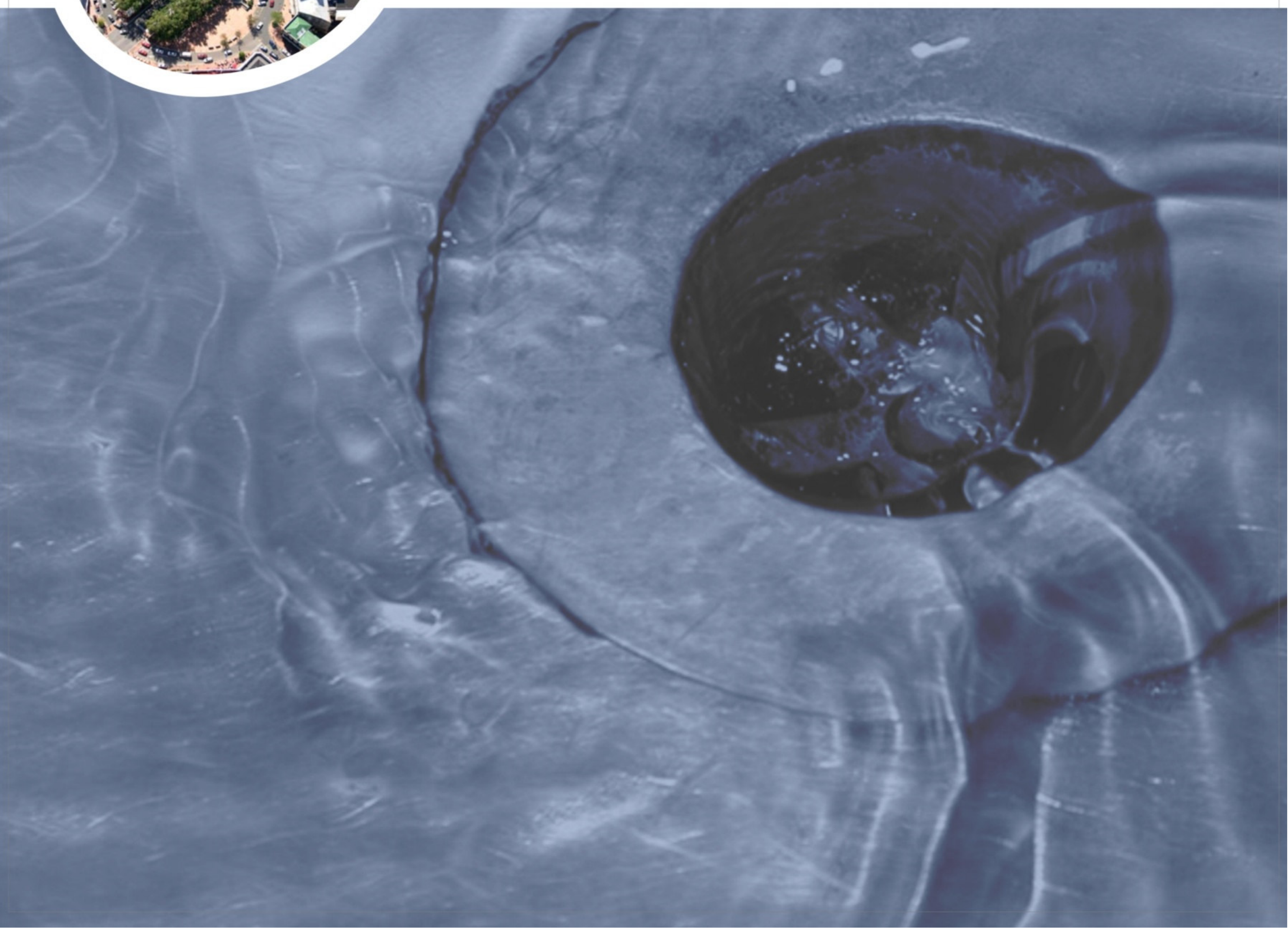
Original Size: A3

Part 4
Targets



10 Issues Prioritisation

DCC have developed a decision making framework (refer Appendix E) in line with the New Zealand and Australian risk management framework AS/NZS 4360 to enable the comparison of issues and options. A Consequence and Likelihood rating has been applied to each of the issues identified to provide a risk matrix score, leading to a definition of problem management. Figure 10-1 below shows the risk matrix used in this scoring. Other information relating to definitions for Consequence and Likelihood are provided in the analysis of each issue, and the guidelines on this are provided in Appendix E.

Table 10-1 below provides a list of the main issues identified for the Kitchener Street catchment, and a risk and consequence score for each, resulting in a 'manage passively' or 'manage actively' categorisation. The passive or active management categorisation then drives the catchment specific management approach for each issue, and later the options considered. Active management indicates that DCC will seek to implement changes to stormwater management in the catchment, whereas passive management would tend more towards monitoring and review of existing management practices to ensure that the targets set can be met.

RISK	CONSEQUENCE				
LIKELIHOOD	Negligible (1)	Minor (10)	Moderate (40)	Major (70)	Catastrophic (100)
Almost Certain (5)	Low (5) Manage Passively	Moderate (50) Manage Passively	Very High (200) Manage Actively	Extreme (350) Manage Actively	Extreme (500) Manage Actively
Likely (4)	Low (4) Manage Passively	Moderate (40) Manage Passively	Very High (160) Manage Actively	Very High (280) Manage Actively	Extreme (400) Manage Actively
Possible (3)	Negligible (3) Manage Passively	Moderate (30) Manage Passively	High (120) Manage Actively	Very High (210) Manage Actively	Very High (300) Manage Actively
Unlikely (2)	Negligible (2) Accept	Low (20) Manage Passively	High (80) Manage Actively	High (140) Manage Actively	Very High (200) Manage Actively
Rare (1)	Negligible (1) Accept	Low (10) Accept	Moderate (40) Manage Passively	High (70) Manage Actively	High (100) Manage Actively

Note
The Risk Matrix includes an indication of the minimum acceptable treatment strategy. In all cases the option of avoiding the risk should be considered first.

Figure 10-1: Risk / Consequence Matrix for Issues Prioritisation

Table 10-1: Issues Prioritisation

Issue	Consequence Rating	Likelihood Rating	Discussion	Risk Matrix Score	Management Approach
Limited Confidence in Knowledge of Effects on the Otago Harbour Environment	40	4	Past sampling programmes provide inconclusive data which means that the ongoing effects of stormwater discharges are unclear. Without better knowledge, DCC will be unable to meet its strategic objectives and ensure ongoing sustainable stormwater management. Failure to establish clear links between stormwater quality and receiving environment quality may weaken DCC's position both legally and in terms of public perception.	160	Manage Actively
Potential Wastewater Contamination	40	4	There is an indication that wastewater may occasionally discharge into the stormwater system, however without better knowledge it is difficult to establish a source and significance of the threat. Major Stakeholder Issue.	160	Manage Actively
High Variability of Stormwater Quality Results	40	3	Stormwater quality monitoring could be made more robust. Relatively low / moderate confidence in data. Without better knowledge, underpinned by good quality data, DCC cannot reliably meet its strategic objectives. Discharges from the Kitchener Street stormwater catchment, however, have contained moderately low levels of contaminants over the four year sampling period.	120	Manage Actively
Deep Flooding	40	2	Occurs in only 2 parcels in the 1 in 10 yr ARI rainfall event, and 16 in the current 1 in 50 yr ARI event. Suspected to be mostly exterior to buildings, and a number of parcels make up a small number of properties. Significant disruption would be likely to one or two businesses on Princes Street.	80	Manage Actively

Issue	Consequence Rating	Likelihood Rating	Discussion	Risk Matrix Score	Management Approach
Low Level of Service in Lower Catchment	10	5	The current level of service of the network in the lower catchment is below DCC's target for new infrastructure, as a result of both tidal influence and inadequate network capacity. Effects will be exacerbated by climate change therefore adaptation is required in order to meet future long term objectives of no increase in properties at risk of flooding due to climate change. Flooding due to low level of service occurs in limited areas, and can be managed via other issues identified. Improvements to overall network will occur progressively with pipe renewals programme.	50	Manage Passively
Network Maintenance	10	5	Inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures. Potential to exacerbate or transfer flooding effects.	50	Manage Passively
Nuisance Flooding	10	4	Nuisance flooding occurring on western side of Princes Street and adjoining streets in the vicinity of The Oval. Occurs during high frequency events, however is entirely in road corridor. Flooding predicted in both areas predicted to be mostly confined to roads and carparks in 1 in 10 yr ARI rainfall event.	40	Manage Passively
Flood Hazard – Current and Future 1 in 100 yr ARI	40	1	Flood hazard in a small number of locations, in areas already subject to deep flooding. Not predicted in vulnerable locations. Issue will be addressed as part of Deep Flooding issue. Direct tidal inundation possible in small part of catchment.	40	Manage Passively
Ongoing Stormwater Discharge	10	4	Ongoing discharge of stormwater (and associated contaminants) to the harbour. The extent of contamination is unconfirmed, but available data indicates that contaminants discharged are typical of land use.	40	Manage Passively

11 Catchment Specific Targets and Approaches for Stormwater Management

Figure 11-1 below provides a breakdown of the link between stormwater management issues identification, objectives development and the setting of targets.

The information presented in the AEE section of this report has been used to identify the key stormwater management issues for the Kitchener Street catchment. These issues have been prioritised and ranked, according to DCC's risk matrix, which looks at the consequence and likelihood of each issue.

For each issue, DCC's commitment (in terms of strategic stormwater objectives) will be examined, and a catchment specific approach outlined depending on both the strategic objectives, and the issue's priority. SMART targets are then set to guide the design of options, and also to measure the success of the catchment management approach.

Following this section, stormwater management options are developed to ensure targets are met.

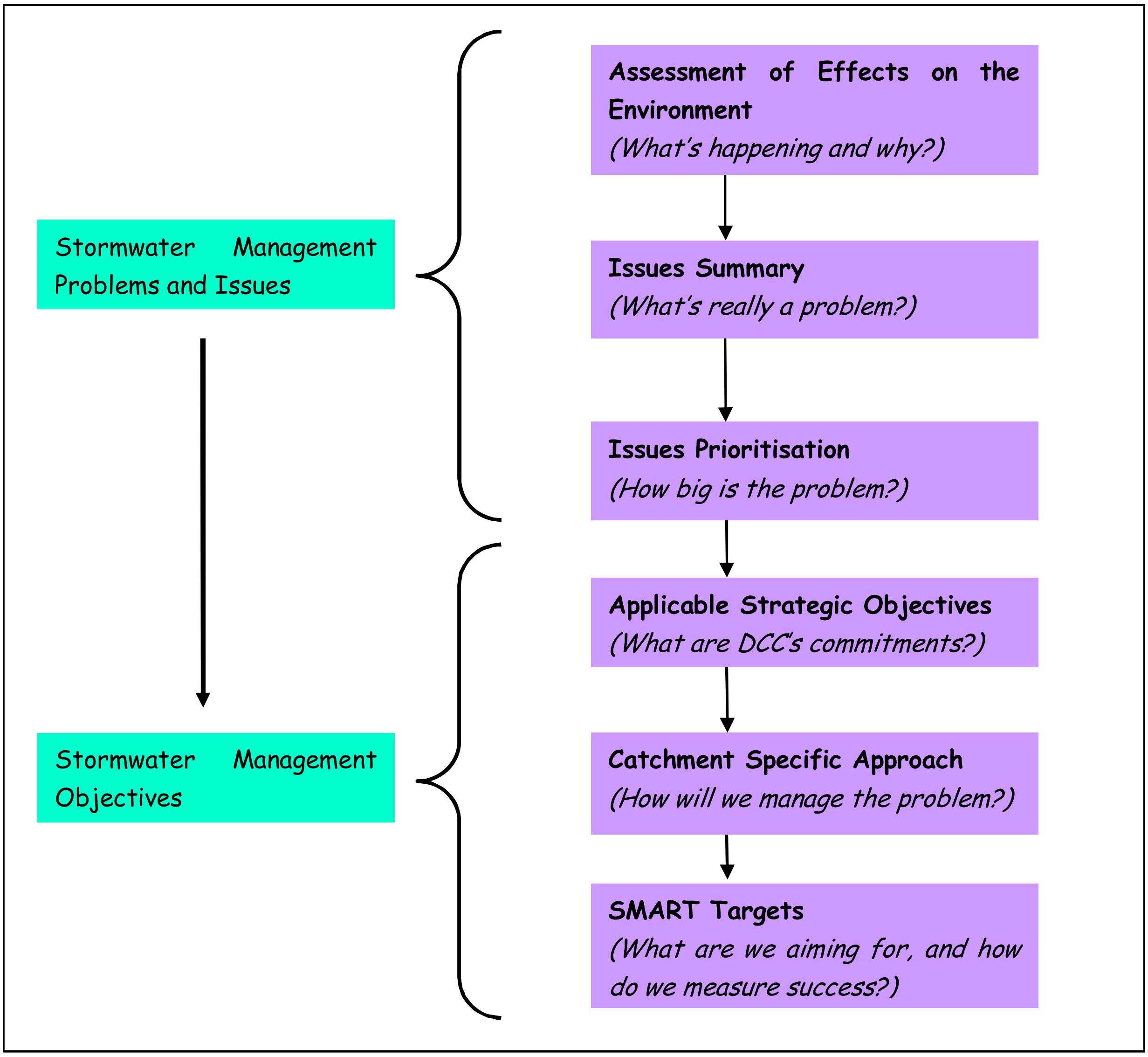


Figure 11-1: Target Development Process

Management approaches and targets are essential for providing information to ensure appropriate funding is made available for stormwater management, and that the management options implemented provide the best value for money to the community. A number of other ICMPs are being prepared by DCC for other outfalls discharging to the harbour. Similar targets will be developed for these ICMPs, and ultimately, issues prioritisation will be used to compare and prioritise recommendations across the catchments.

The catchment specific stormwater management approach is driven by the issues prioritisation, and provides guidance for options development in terms of a broad management approach for each issue, specific to each catchment. Management approaches are driven strongly by the applicable long term (50 year) strategic objectives, outlined in Section 2.

Stormwater management 'SMART' targets are an important tool for DCC; these follow a set of guidelines to ensure that they are well-defined and attainable, as outlined below:

- **S**pecific – well defined and clear targets, able to be understood;
- **M**easurable – to provide feedback to continually improve performance;
- **A**chievable – to ensure success;
- **R**ealistic – within available resources, knowledge and time; and
- **T**ime-Bound – to monitor progress on a number of timescales, and ensure time is available to achieve the goals.

Targets relate both to long and short term objectives outlined in Section 2, depending on the issue. For example, they may refer to maintenance of a certain level of service for the stormwater network, or commitments to minimise adverse effects on the receiving environment where appropriate. The AEE also guides the setting of targets. As some targets may be linked to monitoring information, it is essential that these targets are open to review and adjustment over time. Ongoing monitoring results may indicate a greater or lesser environmental impact than currently understood.

Tables 11-1 and 11-2 below outline catchment specific approaches and SMART targets for each of the key stormwater issues identified in the Kitchener Street catchment.

11.1 Stormwater Quantity Targets and Approaches

Table 11-1 presents a summary of stormwater management key effects relating to stormwater quantity, and catchment specific targets set for Kitchener Street. Approaches and targets developed for 'active' and 'passive' management of stormwater quantity issues in the Kitchener Street catchment are discussed in more detail below.

11.1.1 Deep Flooding

The Building Act requires that habitable floors (or 'useful floor space' in relation to non-residential properties) should not be at risk of flooding during a 1 in 50 year rainfall event.

Targets for this issue seek to avoid habitable floor flooding under both current and future land use and climate change scenarios. It is also desirable to avoid any increases in surface flooding of private properties during this event.

Because the modelled flood extents indicate that flooding may not actually enter a large number of buildings, parcels identified as potentially being subject to deep flooding during storm events with 1 in

50 yr ARI rainfall and smaller should be surveyed or a damage assessment undertaken to gauge the effects of deep flooding in the catchment.

Planned pipe renewals are expected to reduce the deep flooding predictions due to increased capacity in the pipe network.

11.1.2 Low Level of Service in Lower Catchment

The network in the upper part of the catchment is predicted to be able to convey a 1 in 10 yr ARI rainfall event. In the lower part of the catchment, the majority of the piped network surcharges during a 1 in 2 yr ARI rainfall event. Flooding as a consequence of the low level of service in this area is not considered to have a large effect in terms of catchment flooding, however.

The recommended targets and approaches with respect to the stormwater network performance focus on maintaining or improving the existing level of service under reasonable future development and climate change scenarios. The strategic direction provided by the 3 Waters Strategic Direction Statement indicates that the main objective with respect to flooding is to ensure that the risk of flooding does not increase in the future as development occurs, or climate change alters weather patterns and sea levels.

However, the residents' opinion survey (ROS) has been running in its current format since 2003, and gauges Dunedin city residents' overall satisfaction with the stormwater collection service, amongst other council services. The Kitchener Street catchment lies within the Dunedin City group of this survey.

In general, the council will adopt a long term approach to improving network performance and adapting to climate change by ensuring that all new network components (for example, planned pipe renewals, or upgrades in specific locations) are designed to a 1 in 10 yr ARI level of service, using conservative design storms that incorporate projected changes in rainfall intensity, coupled with conservative tidal boundary conditions. This is consistent with the Dunedin Code of Subdivision and Development, and also with the Building Act.

Currently, 66.8 % of the pipes modelled in the catchment can convey a 1 in 10 yr ARI rainfall without causing manhole overflow. Based on the age of the network, the pipes in the Kitchener Street catchment will be prioritised for assessment under the DCC pipe renewals programme. By 2060, 68 % of the pipes in the network (including those already at the desired level of service) will have been assessed and potentially replaced (with new pipes designed to convey the 1 in 10 yr ARI rainfall event). It should be noted, however, that the pipes due for renewal are those in the lower part of the catchment (part of the 43 % of pipes that cannot currently convey a 1 in 10 yr ARI rainfall event), and in reality by 2060, the number of pipes able to convey this event following renewals will be considerably closer to 100 %.

11.1.3 Network Maintenance

The maintenance and cleaning of catchpits and other stormwater structures is an essential part of maximising the efficiency and level of service of the stormwater network. As the owners of the network, DCC need to be certain that the asset is being maintained appropriately. Currently, the task of maintaining stormwater inlet assets is split between three DCC departments and one national authority. Contracts for maintenance of catchpits and inlet structures have some differences in terms of performance criteria. Additionally, there would be benefit in identifying key assets as part of the catchment management process in order to focus maintenance and cleaning efforts further.

The target set for this issue is to first develop an understanding of the current level of maintenance and cleaning, and then, if required, recommend changes in order to focus efforts and optimise inlet efficiency of the stormwater network.

In the Kitchener Street catchment, a further target will be to prioritise catchpits at the South Road and Maitland Street intersection, and along South Road and Princes Street opposite The Oval for cleaning.

11.1.4 Nuisance Flooding

Nuisance flooding is predicted and confirmed in a small number of areas in the catchment. This flooding is predicted to be predominantly along the edges of road corridors, but is not expected to inundate entire roads. There may be issues on private properties situated in low-lying areas near the surcharging stormwater system. The resolution of the ground model, however, means that the exact location of the flooding is not confirmed.

Investigations pursued to examine deep flooding in these areas, along with network renewals over time are expected to resolve or clarify the majority of the nuisance flooding issues in the catchment, however further investigation of the effects of predicted deep flooding in these areas may result in the investigation of flood management options.

11.1.5 Flood Hazard – Current and Future 1 in 100 yr ARI

Flood hazard issues in the Kitchener Street catchment are considered to be fairly minor, with hazard being mainly restricted to the small number of areas already predicted to have deep flooding during a number of events.

As such, the approach to this issue is one of passive management; ensuring that there is no increase in flooding due to development.

There is a relatively small difference between predicted hazard in the current and future scenarios. Based on the modelling undertaken (which was not a detailed model of climate change effects on sea levels), this is primarily due to sea level rise and climate change effects on rainstorm depths, rather than development.

Additionally, the area of direct inundation due to sea level rise is relatively small and confined to the area close to the harbour. Because of the significant tidal influence on system performance, changes in sea level will have an impact on flooding extents in the catchment.

Table 11-1: Kitchener Street Catchment Management Targets: Stormwater Quantity

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Deep Flooding	Model results indicate 2 parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 16 during 1 in 50 yr ARI rainfall event in current, and 21 land parcels in future planning scenarios. The only significant location of deep flooding predicted during the 2010 1 in 50 yr ARI event is surrounding the industrial block next to The Oval, in particular the western side of Princes Street from Lees Street to Jones Street, and in car parks within the associated industrial block. Based on the modelling results, it is possible that floodwaters will enter a small number of buildings during large events, due to breaks in the kerb and doorsteps flush with the pavement.	Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event. Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.	***Manage Actively*** Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event. Enhance understanding of effects of deep flooding, particularly on private property. Undertake pipe renewals programme as scheduled (with older pipes prioritised).	< 16 properties at risk of deep flooding (> 300 mm) during a 1 in 50 yr ARI rainfall event by 2060. Undertake habitable floor survey and / or damage assessment of potentially flooded properties. > 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Low Level of Service in Lower Catchment	Significant proportion of the lower network is predicted to surcharges during a modelled 1 in 2 yr ARI rainfall event, with 11.2 % of catchment manholes overflowing, however most are in the wharf area near to a harbour outfall. 43 % of catchment manholes overflow during a 1 in 10 yr ARI rainfall event.	Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives. Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event. 95 % of customer emergency response times met. > 60 % residents' satisfaction with the stormwater collection service.	***Manage Passively*** Maintain or improve existing level of service in network. Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). Undertake pipe renewals programme as scheduled (with older pipes prioritised). Use customer complaints and ROS to gauge satisfaction with the stormwater system performance.	> 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060. > 60 % residents’ satisfaction with the stormwater collection service (ongoing).
Network Maintenance	Flooding extents and durations in the Kitchener Street catchment are potentially exacerbated by variations in the frequency and standards of catchpit and inlet screen cleaning and maintenance. City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.	Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives. > 60 % residents' satisfaction with the stormwater collection service.	***Manage Passively*** Ensure consistency city-wide of stormwater structure cleaning and maintenance. Ensure cleaning and maintenance schedules and contracts are sufficiently robust. Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk.	Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012. Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide) by 2013. Develop list of key stormwater assets in Kitchener Street catchment requiring additional cleaning and maintenance checks by 2013.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Nuisance Flooding	Nuisance flooding is predicted and confirmed during small events in two main areas; South Road at the intersections of Maitland Street, Lees Street and Jones Street, and in the central area near Crawford Street at the intersections with Jervois Street and Police Street. Not expected to inundate roads or be experienced for long periods of time.	Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network. > 60 % residents' satisfaction with the stormwater collection service.	***Manage Passively*** Maintain or improve existing level of service in network. Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances). Undertake pipe renewals programme as scheduled (with older pipes prioritised). Monitor customer complaints and / or undertake site visits to confirm locations of flooding.	> 68 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.
Flood Hazard – Current and Future 1 in 100 yr ARI	Flood hazard issues in this catchment are considered to be fairly minor, with hazard being identified in areas predicted to have deep flooding during a number of events. Transport routes are not predicted to be severely affected – inundation across roads is predicted to be shallow or confined to the sides of the road. Small parts of lower catchment at risk of direct tidal inundation.	Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.	***Manage Passively*** Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event. Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas. Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances).	Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan.

11.2 Stormwater Quality Targets and Approaches

A summary of key stormwater quality effects, and catchment specific approaches and targets set for the Kitchener Street catchment are presented in Table 11-2 below. The catchment specific approaches and targets are discussed in further detail below.

Whilst the monitoring information to date does not suggest that the stormwater quality from the Kitchener Street catchment is adversely affecting the marine environment, targets and approaches set out below describe a city-wide approach to stormwater quality as the Otago Harbour is a common receiving environment for all DCC coastal stormwater discharges.

It should be noted that the Regional Plan: Coast for Otago (ORC, 2001) sets out objectives and policies relating to discharges to the CMA. Objective 10.3.1 seeks *"to maintain existing water quality within Otago's coastal marine area and to seek to achieve water quality within the coastal marine area that is, at a minimum, suitable for contact recreation and the eating of shellfish within 10 years of the date of approval of this plan."* Further, Policy 10.4.3 states that where water quality already exceeds these standards, water quality should not be degraded beyond the limits of a mixing zone associated with each discharge.

11.2.1 Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment and Variability of Stormwater Quality Results

There is high variability in stormwater quality monitoring results from each catchment. Whilst stormwater quality is influenced by many variables and it is not unusual to see a wide range of contaminant levels in monitoring results, it is considered that this issue is compounded by the current monitoring technique of obtaining single annual grab samples of stormwater for analysis.

Stormwater discharge from the Kitchener Street catchment appears to be typical of a mixed use urban land use.

Sediment monitoring has been carried out to date (2007 to 2010) to determine the quality of the marine sediments. Sampling across the catchments has indicated that there are some contaminants of concern within the harbour, measured at relatively high levels, (although only minor issues were observed in sediments adjacent to the Kitchener Street catchment). However, it remains unclear whether the contaminant levels observed are as a result of historic contamination or current discharges (from either stormwater or other sources). For this reason, the sources of contamination are difficult to identify, as are any links with the quality of DCC stormwater discharges.

The biological monitoring undertaken to date does not show any particular trends in diversity or abundance of fauna. The biological monitoring protocol is also highly variable between the catchments and not all catchments are monitored. With only 4 years of biological monitoring data that does not appear to be showing any trends, the variation in sampling protocols throughout the harbour and an absence of ecological baseline or control data for the harbour, it is difficult to draw conclusions from the biological monitoring results.

The monitoring regime to date has been insufficiently robust to enable the identification of any effects or otherwise, with any level of confidence, between stormwater quality and harbour environment health. In order to clearly identify discharges/catchments of concern and select appropriate stormwater management on a catchment by catchment basis to enable DCC to maintain or improve stormwater quality, a suitable monitoring framework, and improved confidence in monitoring data is required.

DCC have a commitment to improve the quality of stormwater discharges to the harbour and, in order to identify necessary and appropriate stormwater management actions within the catchment and city-wide, a sound understanding of the nature and effects of the stormwater discharge is required.

The approach and targets set for this issue include a staged approach that seeks to adjust the current monitoring programme in order to develop and implement an optimised monitoring framework that will provide more comprehensive and defendable information on current stormwater discharge quality and the effects thereof. Following this, it is expected that stormwater management approaches will be reviewed and adjusted to reflect DCC's strategic objectives. The recommended targets are as follows:

- Redesign the monitoring programme to develop a robust framework that will yield good quality, useful data at appropriate sites to enable a sound understanding of both catchment stormwater quality and health of the harbour environment and allow any linkages between the two to be identified.
- Using the monitoring results and other available information (such as land use), identify with confidence, discharges/catchments of concern and potential sources of unacceptable contaminant levels.
- Enable specific city-wide, targeted annual monitoring protocol to be established where necessary, including quality indicators, which can be used to provide feedback on stormwater management practices, and trigger further action as required.
- Use data to contribute to the stormwater management programme for Dunedin. This will include the identification of stormwater management actions to improve stormwater quality where required.

In the interim, while catchment specific stormwater actions and targets are still being established, DCC are committed to looking for quick-win opportunities where point source contamination has been identified, and at a minimum, to ensuring that stormwater quality does not deteriorate as a result of new development or changes in land use in the catchment. Examples of this include:

- Considering the cost and benefit of incorporating stormwater treatment into flood mitigation works where practicable.
- Requiring source control or management of stormwater contaminants in high contaminant generating land uses by enforcing the Trade Waste Bylaw, and working to educate occupiers of high-risk sites with respect to stormwater discharge quality.
- The Dunedin Code of Subdivision and Development indicates that at-source management of stormwater quantity is desirable and Low Impact Design methods are preferred.

11.2.2 Potential Wastewater Contamination

A single stormwater sample with elevated wastewater contaminants was taken in 2010. This may indicate a wastewater discharge within the catchment, however there is no evidence to suggest that this is an ongoing discharge.

The improved stormwater monitoring programme can be used to confirm (or otherwise) the existence of a wastewater source in the catchment.

11.2.3 Ongoing Stormwater Discharge

The monitoring data at present does not indicate that the levels of contaminants in stormwater from the Kitchener Street catchment stormwater are significantly high, however they appear to be typical of an urban land use. Therefore based on the best available information at this time, the prioritisation of this issue has resulted in a ‘passive management’ approach.

However, it is acknowledged that there is low confidence in the current monitoring data; therefore, this issue is related to the above issue regarding limited confidence in the knowledge of effects on the harbour environment.

The approach and targets for this issue are related to the outcomes of the targets set for confidently identifying the levels of contaminants in the stormwater and any resulting effects on the harbour environment. Following the outcomes of the proposed monitoring and stormwater management prioritisation targets, the approach to stormwater management in this catchment will be revised and catchment specific targets, where appropriate will be applied.

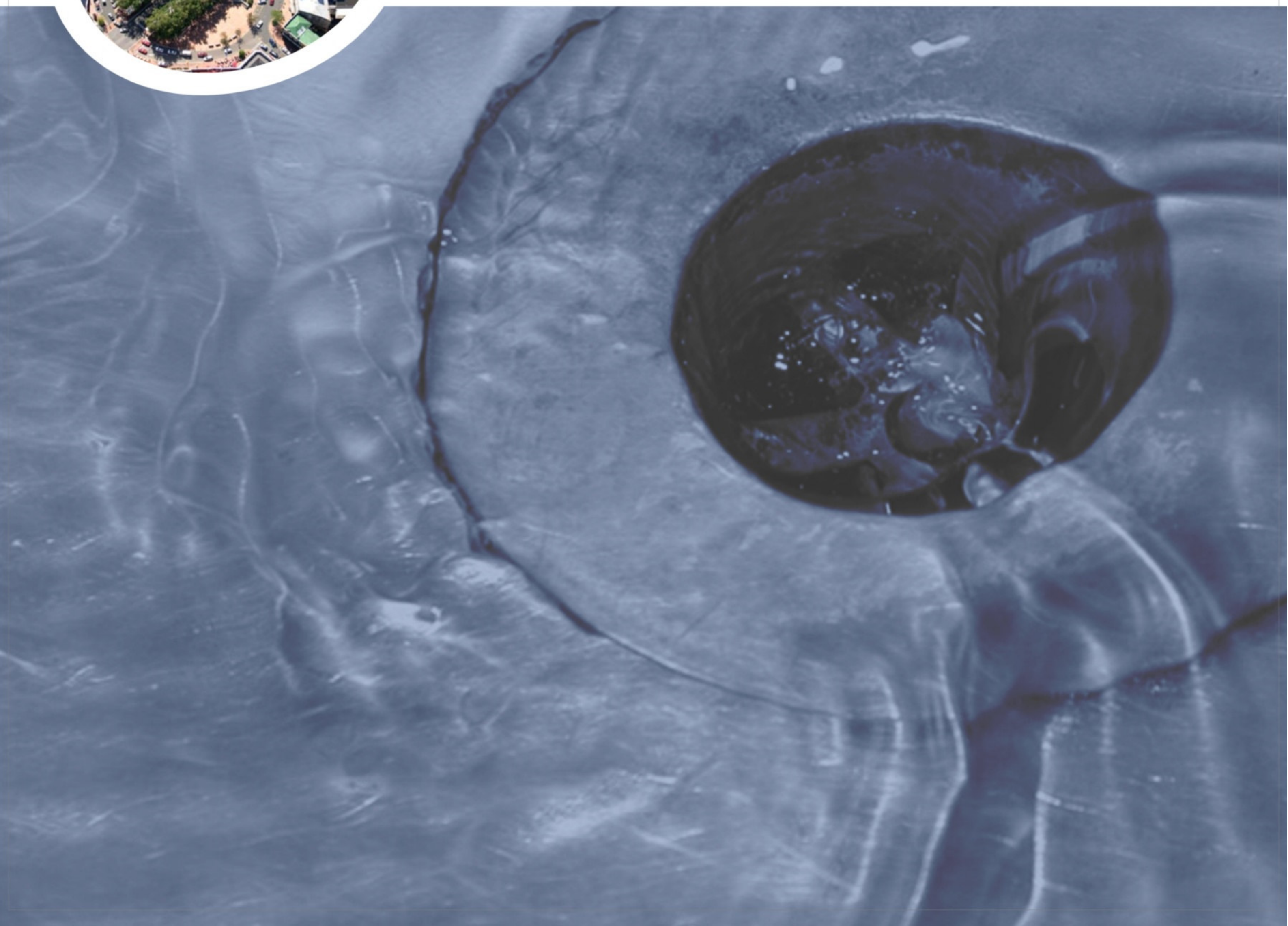
In the mean time, DCC is committed to ensuring that there is no deterioration in current stormwater discharges and reducing the contaminant levels within stormwater discharges over time through development controls, as described above.

Table 11-2: Kitchener Street Catchment Management Targets: Stormwater Quality

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results	High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear, however results to date indicate typical contaminant concentrations in stormwater discharge. Poor information on actual effects of stormwater on harbour environment. Lack of data to assess linkages between pipe discharge and harbour environment quality.	Improve the quality of stormwater discharges to minimise the impact on the environment. Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges. No recorded breaches of the RMA. Ensure stormwater discharge quality does not deteriorate.	***Manage Actively*** Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework. Develop method for determining linkages between stormwater management and harbour environment. Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. Require source control of stormwater contaminants in new development of high- contaminant generating land uses. Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality. Undertake monitoring to ensure stormwater quality does not deteriorate over time. Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges.	Robust city-wide monitoring framework developed and implemented by 2012. Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013. Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.

Issue (Problem Description)	Effects Summary	Strategic Objectives and Targets	Catchment Specific Approach	SMART Targets
Potential Wastewater Contamination	Single stormwater measurement in 2010 indicating potential wastewater contamination. No ongoing effects or discharge recorded.	Improve the quality of stormwater discharges to minimise the impact on the environment. Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges. > 75 % compliance with stormwater discharge consents. Ensure stormwater discharge quality does not deteriorate.	***Manage Actively*** Use improved monitoring programme to enable better understanding of potential catchment contamination.	Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012. Implement management options to remediate problem where necessary.
Ongoing Stormwater Discharge	Could exacerbate historical contaminant issues in the harbour. Extent to which this is likely to occur is unconfirmed. Key stakeholder issue. Based on available data, consequence currently believed to be minor.	Improve the quality of stormwater discharges to minimise the impact on the environment. Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges. > 75 % compliance with stormwater discharge consents. Ensure stormwater discharge quality does not deteriorate.	***Manage Passively*** Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable. Require source control of stormwater contaminants in new development of high- contaminant generating land uses. Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality.	No deterioration of stormwater quality due to land use change or development in the catchment. Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.

Part 5
Solutions



12 Stormwater Management Options

12.1 Introduction

Options are presented below to manage the stormwater issues identified in the Kitchener Street catchment. Options are generally capital work options, planning options, or operation and maintenance tasks. These have been developed in line with issues prioritisation and catchment specific targets and approaches set in Section 11.

When considering the options available for each issue, options considered to be 'deal breakers' are eliminated from the options to be evaluated. Example definitions of deal breakers are as follows:

- Option must be technically feasible;
- Option must meet relevant legislative requirements;
- Option must be consistent with the principles of the Treaty of Waitangi;
- Option must be aligned with the catchment specific objectives developed in Section 9 of this document;
- Option must not have greater negative environmental, social or cultural consequences than the 'do nothing' option;
- Option should not contravene any explicitly stated political objective;
- Option should not result in an increase in the risk category; and
- Option should not increase health and safety risks compared with the 'do nothing' option.

'Active management' indicates that DCC will seek to implement changes to stormwater management in the catchment, whereas 'passive management' would tend more towards monitoring and review of existing management practices to ensure that the targets set can be met. This section puts forward a number of options (where more than one exists) for each issue identified in the catchment.

Following the elimination of deal breakers, information on options for stormwater management is collated. The options identified for 'manage actively' issues are then evaluated against the QBL evaluation criteria outlined in Section 14, with the most favourable stormwater management option selected.

Following the identification of options for each stormwater management issue, and options evaluation using QBL methodology, a prioritised programme of capital works and additional investigations recommended in the Kitchener Street catchment is then developed.

The implementation of the programme is expected to progressively improve stormwater management in the catchment as part of the wider 3 Waters Strategic Plan, which incorporates programming of the outcomes recommended in all ICMPs developed across the city.

12.2 Potential Options

Outlined below are preliminary options identified for the key stormwater management issues present in the catchment. Option 'deal breakers' are eliminated and feasible options are described in further detail. Where an issue has been prioritised as 'manage passively', management options are discussed in more general terms, although planning based options may be presented where applicable. Where an issue is prioritised as 'manage actively', where available, a number of alternative options will be considered for further evaluation in Section 14.

12.2.1 Deep Flooding – Manage Actively

For future developments, there is a strategic objective to prevent this potential floor flooding during a 1 in 50 year event. DCC's target with respect to this flooding is to ensure that the risk is not increased in the future, as development occurs and climate change is taken into account. Additionally, planned pipe renewals will increase system capacity and potentially reduce potential floor flooding.

In order to fully understand the risk of habitable / useful space floor flooding, properties identified as being at risk will require building footprint confirmation and floor level survey to determine whether flood depths of 300 mm or greater would in fact enter the building. A damage assessment of affected properties which are commercial or industrial premises is often also useful in terms of identifying particularly vulnerable businesses. This is particularly important in the Kitchener Street catchment, as the number of parcels identified as potentially affected by deep flooding is significantly more than the number of properties thought to be at risk. It is estimated that approximately six properties (comprising 16 land parcels) will need to be assessed.

Whilst this issue is currently classified as 'Manage Actively', uncertainty surrounding actual floor levels and the number of properties affected prevents an accurate assessment of the likely damages and costs incurred during such rainfall events. Therefore, the exploration of other flood management options is recommended only once the threat to habitable floors is confirmed (or otherwise). Following this stage, capital works for flood alleviation will be explored if the issue is still considered to be significant, when re-assessed using the risk assessment framework.

12.2.2 Low Level of Service in Lower Catchment – Manage Passively

The 'Dunedin Code of Subdivision and Development' is used by DCC to set requirements for land development and subdivision, but is also used by DCC to guide design of network upgrades undertaken by DCC. Table 12-1 below outlines the design criteria required by DCC for new stormwater work. Compliance with this document ensures that the approach to design new pipes to convey a 1 in 10 yr ARI rainfall event is met, and that secondary protection is provided up to a 1 in 100 yr ARI rainfall event.

Low level of service in the lower catchment will be addressed over time via pipe renewals; 68 % of the stormwater pipes in the Kitchener Street catchment are due for renewal within the timeframe of this document. The renewals process includes inspection and condition assessment, and potentially extends the useful life of a stormwater asset beyond 100 years, if it is in good condition. However where capacity is an issue, and level of service is compromised, renewals will be necessary.

The ROS can also be used to gauge satisfaction with the stormwater system performance. The suburbs of Central, City Rise, Dunedin and Fern Hill, have been considered by the survey as part of the Dunedin City group; in 2010, 45 % of the respondents in this area were either satisfied or very satisfied with the stormwater collection service, with 22 % being either dissatisfied or very dissatisfied. This is lower than the DCC target for satisfaction. However, since the survey in this format began in 2003, city-wide satisfaction with the stormwater collection service has been above 60 % in every year except 2004/2005 (Research First, 2010).

Table 12-1: Stormwater Design Criteria

Function	AEP %	Return Period (ARI, years)
Primary protection	10	10
Primary protection in areas where secondary flow paths are not available or are through private property	1	100
Secondary protection	1	100

12.2.3 Network Maintenance – Manage Passively

Flooding extents and durations in the Kitchener Street catchment could potentially be exacerbated should critical catchpits not be adequately cleaned.

Regular cleaning and maintenance of catchpits and stormwater structures is essential across the city, and city-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service. The following catchment approaches have been developed for these issues:

- Ensure consistency city-wide of stormwater structure cleaning and maintenance.
- Ensure cleaning and maintenance schedules and contracts are sufficiently robust.

A review of schedules and methods used across the city could be undertaken to ensure that all possible contaminant sources (e.g. catchpits) are cleaned regularly, and the flood risk is reduced as much as possible. Alignment of contracts for this maintenance (currently with a number of agencies) would provide confidence that catchpit and stormwater structures were operating optimally.

As part of the contracts, key structures identified in each catchment management plan could be incorporated as requiring additional or more frequent attention. In the Kitchener Street catchment, the following structures would be included:

- South Road / Maitland Street intersection;
- Along South Road and Princes Street, adjacent to the Oval;
- Jones Street; and
- Lower Lees Street.

12.2.4 Nuisance Flooding – Manage Passively

The strategic direction provided by the 3 Waters Strategic Direction Statement indicates that the main objective with respect to flooding is to ensure that the risk of flooding from the stormwater system does not increase in the future as development occurs, or climate change alters weather patterns and sea levels.

Rules set for future development in DCC's Code of Subdivision and Development will ensure that into the future, new or re-development of sites will include the provision of stormwater detention and conveyance up to a 1 in 10 yr ARI rainfall event (as outlined in Table 12-1). It is likely that this, along with planned pipe renewals, will somewhat relieve the frequent nuisance flooding in the catchment over time. Additionally, the main areas experiencing nuisance flooding are being investigated under 'deep flooding' issues – nuisance flooding will therefore also abate if capital works or flood management options are implemented in these locations.

12.2.5 Flood Hazard (Current and Future) – Manage Passively

As the flood hazard in this catchment is predominantly related to deep flooding, reduction in the flood hazard is likely to occur during current and future events due to options employed to reduce deep flooding in the catchment. The catchment specific approaches identified for this issue are as follows:

- Ensure new development does not increase the number of properties predicted to flood due to the 1 in 100 yr ARI rainfall event.
- Avoid development of vulnerable sites / critical infrastructure in flood prone areas.
- Design new pipes with capacity to convey a 1 in 10 yr storm event (including climate change allowances).
- Develop a better understanding of the likely effects and magnitude of climate change.

In terms of ensuring that development does not further exacerbate flooding, management of the effects of new development would be as per the requirements of DCC's Code of Subdivision and Development (refer above to a discussion on this regarding nuisance flooding).

The approach with respect to enhancing the understanding of climate change leads to the provision of information to DCC's climate change adaptation group, so that the information about the Kitchener Street catchment can be considered as part of the city-wide climate change adaptation plan.

12.2.6 Potential Wastewater Discharge – Manage Actively

The suspected presence of a wastewater discharge has only been identified based on a single stormwater quality sample, and may have been a one-off event. This issue has been prioritised as manage actively due to the high level of uncertainty regarding the wastewater overflow, along with the fact that wastewater discharge to the environment is a key stakeholder issue, and DCC are committed to avoiding such discharges.

It is proposed that the monitoring programme be used to confirm (or otherwise) the presence of a wastewater discharge from other parts of the catchment.

12.2.7 Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment and Variability of Stormwater Quality Results – Manage Actively

While the stormwater quality data collected to date indicates that stormwater from the Kitchener Street catchment is as would be expected from an urban catchment of mixed land use, information collected to date indicates that the stormwater and harbour environment monitoring regime to date has been insufficiently robust to enable the identification of any relationship between stormwater quality and harbour environment health.

In order to clearly identify discharges/catchments of concern and select appropriate stormwater management on a catchment by catchment basis to enable DCC to meet their objectives regarding stormwater quality, a suitable monitoring framework, and a high confidence in monitoring data is required. The catchment specific approaches recommended for this issue in the Kitchener Street catchment (and city-wide) are:

- Redesign the monitoring programme to develop a robust framework that will yield good quality, useful data at appropriate sites to enable a sound understanding of both catchment stormwater quality and health of the harbour environment and allow any linkages between the two to be identified.

- Using the monitoring results and other available information (such as land use), identify with confidence, discharges/catchments of concern and potential sources of unacceptable contaminant levels.

- Enable specific city-wide, targeted annual monitoring protocol to be established where necessary, including quality indicators, which can be used to provide feedback on stormwater management practices, and trigger further action as required.

- Use data to contribute to the stormwater management programme for Dunedin. This will include the identification of stormwater management actions to improve stormwater quality where required.

- Considering the cost and benefit of incorporating stormwater treatment into flood mitigation works where practicable.

- Requiring source control or management of stormwater contaminants in high contaminant generating land uses by enforcing the Trade Waste Bylaw, and working to educate occupiers of high-risk sites with respect to stormwater discharge quality.

Due to the importance of this information in developing stormwater management options for stormwater quality (where required), the SMART targets identified for this issue seek to obtain and analyse information as quickly as possible. The primary target is as follows:

- Develop and implement a robust monitoring framework by 2012.

The approach and targets recommended include a staged approach that seeks to redesign the current monitoring framework to ensure that it will provide more comprehensive and defendable information on current stormwater discharge quality and the effects thereof. Following this, it is expected that stormwater management approaches will be reviewed and adjusted where necessary to reflect DCC's strategic objectives.

The issue of undefined effects of stormwater on the harbour environment has led to the approach of resolving the issue via the development of a suitable monitoring framework. Consequently, only one option alternative is presented:

Design a Framework for Stormwater Quality and Harbour Environment Monitoring

The augmentation of the current monitoring framework to result in the implementation of a more robust monitoring framework would allow the identification, with an improved level of confidence, any effects or otherwise of stormwater quality on the sediment quality and harbour environment health.

The monitoring framework should be re-designed to focus on the following outcomes:

- Improved confidence in stormwater quality data;

- Sound understanding of marine sediment quality, including the extent of historic contamination and rate of any ongoing contamination and potential sources;

- Identification of harbour biological health, using suitable indicators to attempt to 'single out' effects of stormwater discharges on the harbour environment;
- Identification of any links between pipe discharge and sediment quality, marine water quality, marine biology; and
- Identification of catchments/discharges of concern and associated stormwater contaminants of concern.

The results of the monitoring undertaken according to the revised framework will allow the following targets to be met:

- Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013.

Use of data following the outcomes of the monitoring framework will be via the monitoring and continuous improvement of the ICMPs, as described in Section 17. The improved data confidence will allow the prioritisation of stormwater management recommendations based on the significance of stormwater quality issues. This would occur city-wide and form part of the 3 Waters Strategic Plan.

12.2.8 Ongoing Stormwater Discharge – Manage Passively

The monitoring data at present indicates that the levels of contaminants in stormwater from the Kitchener Street stormwater are not significantly high. Therefore based on the best available information at this time, the prioritisation of this issue has resulted in a 'passive management' approach. Options for management, detailed below, take into account the industrial nature of this catchment. It is recommended that all options are applied.

The approach to stormwater quality management in this catchment will be revised following the outcomes of the proposed new monitoring framework. This will be implemented by updating the ICMP and the continuous monitoring and improving of SMART targets.

The management of stormwater discharges as new development occurs could be undertaken using several mechanisms:

- Development Controls: DCC have a preference for at-source management and low impact stormwater design as outlined in the draft Code of Subdivision and Development. This document also requires a minimisation of damage to the environment from adverse effects of stormwater runoff; that habitat requirements are taken into account; that stormwater treatment is put into place where practical and that road drainage applies appropriate stormwater treatment.
- An amendment to the business processes used to manage subdivision and development. This would be aimed at ensuring that the developer/DCC representative review the appropriate ICMP for the area of development, in order to direct stormwater treatment based on catchment specific requirements.
- Trade Waste Bylaw: The Trade Waste Bylaw currently includes standards for stormwater discharge quality. Enforcement of this Bylaw would result in an improved quality of stormwater discharge leaving industrial or commercial sites. The Bylaw currently includes standards for stormwater discharge relating to the ANZECC (2000) guidelines for Fresh and Marine quality. Following improved understanding of stormwater discharge quality and its effects, this Bylaw may require review.

- Education and Assistance: Also under the Trade Waste Bylaw, inspections of industrial premises could be undertaken to ensure that adequate on site management practices are being applied. Assistance could be provided by DCC to help achieve higher stormwater quality. It is anticipated that ORC would be involved in this type of scheme for consented discharges, and potentially have resources available to assist in city-wide education.

13 Three Waters Integration

13.1 General

A key driver for the 3 Waters Strategy Project and indeed for the re-organisation of the DCC Water and Waste Business Unit, was to break down the "silo" based approach to the three waters and to encourage integration and efficiencies that can be gained by developing a holistic approach and understanding the inter-relationships and interactions between the three waters. Key advances in this respect relate to business systems integration; simultaneous and complementary modelling; use of identical growth and planning assumptions; and the consideration of integrated solutions.

Provided below is a summary of integration opportunities explored as part of this project, between stormwater and raw water/water supply and wastewater respectively. Reports relating to raw water, water supply, and wastewater studies undertaken as part of the 3 Waters Strategy Project are available from DCC upon request.

13.1.1 Raw Water and Water Supply

The key opportunity for integration between the water supply and stormwater systems is perhaps the need/potential for stormwater harvesting. Analysis of the water supply now and to the 2060 planning horizon indicates that generally the existing water sources will be adequate to meet future demand needs. The strategic water network and the reticulation is well placed to meet future demand and daily demand patterns. However, climate change predictions indicate that Dunedin will become drier for extended periods.

Population growth in Dunedin is relatively small and there is certainly potential to reduce leakage to counter the increased demand. Consequently, there is no need to encourage wide scale stormwater harvesting to meet system demand.

The suggested use of rain tanks is a frequent feature during public consultation. Whilst there are potential water quantity and quality benefits to the use of rain tanks, their widespread use has potential economic implications. Dunedin has adequate raw water sources to supply the city. Furthermore, the variable costs of treating water and wastewater are small when compared with fixed costs (including loans and depreciation). Consequently, any widespread initiatives to reduce water demand are likely to simply increase the unit cost for water and deliver little if any economic benefit to ratepayers. The environmental benefits of rain tanks, or any other demand management initiative need to be carefully balanced against the social and economic aspects of sustainability.

Leakage from the water supply can enter storm drains as infiltration. Whilst the amount of water entering the stormwater system is likely to be relatively small, any reduction in leakage will provide some limited benefit to the stormwater system through increasing the "headroom" by reducing the base flow in the pipes. This is a minor benefit however, and should not be considered as a main driver for leakage reduction or as a possible solution to stormwater system under-capacity. One such issue has been identified for investigation in this ICMP.

13.1.2 Wastewater

There are many ways in which stormwater can enter into the wastewater system and vice versa. Upgrade / capital works of the wastewater systems can lead to changes in the quantity and quality of stormwater discharge.

In Dunedin, the following issues influencing both wastewater and stormwater have been identified:

- I&I has been identified as a problem in number of wastewater catchments city-wide. I&I may be occurring from any location in the network, for example, from mains right up to private laterals. Stormwater can enter through manhole joints and covers, broken pipes or dislodged joints. A portion of the I&I may be due to cross connections between the stormwater and wastewater, a result of illegal connections, or old combined connections which are a legacy of the once combined system.

- There are known constructed wastewater overflows which discharge wastewater to the stormwater system during wet weather, however none are known to exist in the Kitchener Street catchment. DCC state in the 3 Waters Strategic Direction Statement that they want to limit the use of these overflows in the short term with the long term target being total removal. As the overflows only occur in wet weather, if I&I can be limited in the first instance, the use of these overflows would reduce.

The success of any wastewater system rehabilitation and disconnection of cross connections will be dependent on the stormwater system having adequate capacity to take the additional flow.

The 3 Waters Strategy Project wastewater study did not identify any significant issues with the wastewater system within the Kitchener Street catchment, however stormwater sampling indicated that there may be a wastewater discharge in the catchment (although microbial contamination has only been measured on one occasion). The investigation of this is a recommendation in this ICMP.

A further opportunity for integrated solutions in this catchment between the wastewater and stormwater networks is likely to be in the co-ordination of the capital programme. This co-ordinated approach will be developed within the 3 Waters Strategic Plan

14 Options Evaluation

14.1 Options Evaluation Criteria and Methodology

Options evaluation criteria have been developed based on objectives and decision making criteria set in the following:

- The 3 Waters Strategic Direction statement;
- DCC's Optimised Decision Making Matrix; and
- DCC's LTP.

Stormwater specific criteria have been developed for the QBL (economic, social, cultural and environmental) analysis, with an additional two risk categories, Implementation Risk and Effectiveness (risk reduction) separated from the core QBL by DCC and given significant weighting; the first to ensure that operationally, capital works installed will work, and the second to highlight the benefits of each option in terms of reduction of current risk and levels of service. The scoring framework is presented in Table 14-1 below. Weighting for each of the criteria has been assigned by DCC.

14.2 Options Comparison

For the Kitchener Street catchment, the predominant 'passive management' of issues, and identification of single options for higher priority issues dictates that options comparison has not been necessary at the ICMP level. Comparison of recommendations for this catchment alongside other catchments will be undertaken as part of the 3 Waters Strategic Plan.

Table 14-1: Option Assessment Criteria and Scoring System

QBL	Option Assessment Criteria	-10	-5	0	5	10
Environmental (10)	Removal of known wastewater cross connections	Does not remove cross connection.	Reduces likelihood of cross connection occurring.	Assists in finding unknown cross connections.	Removes cross connection for design events (emergency overflow still exists).	Removes cross connection under all events.
	Contaminant reduction	None.	5 - 25 %	25 - 40 %	50 - 75 %	75 - 100 %
	Use of source control / LID	No treatment or control.	End of pipe treatment (catchment or sub-catchment based).	Site based in-line treatment / collection of contaminant.	LID with water reuse up to design event.	Source control - avoid generation of contaminant of concern.
	I&I reduction	No I&I reduction possible.	-	-	Minor I&I reduction possible without exacerbating stormwater flooding.	Major I&I reduction possible without exacerbating stormwater flooding.
	Construction effects	Major discharge of contaminants into environment during construction.	Minor discharge of contaminants into environment during construction.	-	All contaminants generated contained on site and disposed of appropriately.	No effects on environment - no contaminants generated during construction.
	Replication of current flow patterns	No volumetric control.	Minimal attenuation.	Replicates or reduces current flow patterns up to 1 in 2 yr ARI event.	Replicates or reduces current flow patterns up to 1 in 10 yr ARI event.	Replicates or reduces current flow patterns up to a 1 in 100 yr ARI event.
	Option flexibility	Constrained.	Flexible for short term scenarios but cannot be staged.	Will accommodate all scenarios but minimal staging.	Flexible for all but extreme scenarios and can be staged.	Flexible for all scenarios and can be staged.

QBL	Option Assessment Criteria	-10	-5	0	5	10
Social (10)	Interest / support of community / social interest groups	Major opposition from community / special interests groups.	Some opposition from community / special interests groups.	-	Some support from community / special interests groups.	Major support from community / special interests groups.
Cultural (10)	Fit with Māori cultural values	Contradicts key cultural values.	Unlikely to fit with values and preferred approaches.	Not specifically identified as preferred approach, but likely to fit.	Fits with preferred approach recommended by local iwi.	Involves iwi in development and design of option.
Implementation Risk (20)	Risk of operational failure	Likely operational failure. Unproven technology.	New technology. Extensive training required.	Moderately complicated new technology.	Minor modifications to technology already used. Simple new technology.	Proven technology, already utilised throughout city.
Economic (10)	Estimated Capital Cost - order of magnitude (note does not allow for internal costs)	$ 10m+	$ 1 - $ 10m	$ 500k - $ 1m	< $ 500k	Free
	Risk of cost escalation due to construction unknowns	High - escalation likely as no alternatives and insufficient information.	Moderate risk. Low number of alternatives available.	-	Can be managed via alternatives.	Low risk. Well known issue and design criteria.
	Risk of land availability	Unlikely to secure land.	Long process for negotiation, or high cost of land expected.	Moderate process / costs anticipated.	Unutilised land likely easy to secure.	Land already owned by DCC.
	Risk of protracted consent process with authorities	Consent unlikely.	High risk of long process.	Medium consent process anticipated.	Short consent process anticipated.	No consent necessary.

QBL	Option Assessment Criteria	-10	-5	0	5	10
Effectiveness (Risk Reduction) (30)	Risk reduction	Extreme risk reduced to very high; Very High reduced to high.	Extreme risk reduced to High.	Extreme or Very High risk reduced to Moderate; High risk reduced to Moderate or low.	Extreme or Very High risk reduced to Moderate; High risk reduced to Low or negligible.	Extreme or Very High risk reduced to Low or negligible.
	Deep flooding 1 in 50 yr ARI future - current	Increase in number of properties flooding in current scenario.	No change in number of properties predicted to flood, current or future.	No change in properties flooding currently, reduction in future flooding.	Number of properties predicted to flood in future scenario same as predicted for current scenario.	Number of properties predicted to flood in future scenario less than predicted for current scenario.
	Manholes overflowing 1 in 10 yr ARI future-current	Increase in number of manholes overflowing in current scenario.	No change in number of manholes overflowing, current or future.	No change in number of manholes overflowing currently, reduction in future number of manholes overflowing.	Number of manholes overflowing in future scenario same as predicted for current scenario.	Number of manholes overflowing in future scenario less than predicted for current scenario.
	Improvement in level of service	Significant reduction in perceived level of service, increase in % customer complaints.	Perceived level of service likely to decrease, some increase in % customer complaints.	No change to perceived level of service or % customer complaints.	Minimal improvement to perceived level of service, some reduction in % customer complaints.	Significant improvement to perceived level of service, large reduction in % customer complaints.

15 Option Selection

As comparison of alternative options was not undertaken for the Kitchener Street catchment, all options presented in this ICMP have been recommended.

15.1 Approaches for Active Management

The issues that have been prioritised as requiring 'active management' are: Deep Flooding, Potential Wastewater Discharge, Variability of Stormwater Quality Results, and Limited Confidence in Knowledge or Effects on the Otago Harbour Environment. The following options are recommended in order to manage those issues:

- Identify and undertake floor level survey and damage assessment of all properties potentially affected by deep flooding (up to a 1 in 50 yr ARI) – this will involve approximately six properties (comprised of 21 land parcels).
- Redesign and implement the city-wide framework for stormwater quality and harbour environment monitoring.

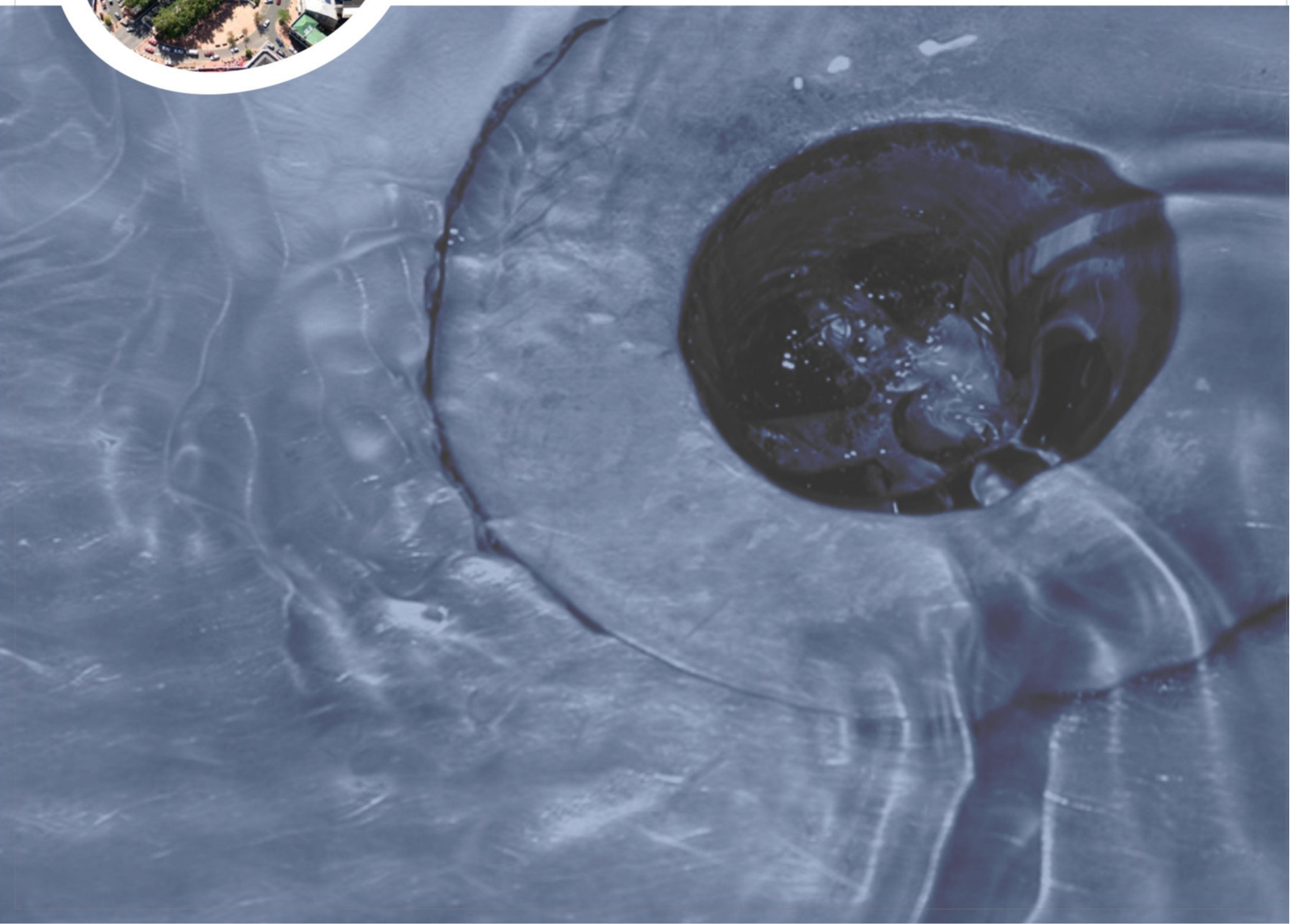
Improved data confidence will allow the prioritisation of stormwater management recommendations based on the significance of stormwater quality issues. This would occur city-wide and form part of the 3 Waters Strategic Plan.

15.2 Approaches for Passive Management

A number of other issues that have been prioritised as requiring 'passive' management will have targets achieved through measures already in place. The following options have also been identified to aid management of some of these issues:

- Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.
- Develop list of key stormwater structures for more regular cleaning as part of existing and/or future maintenance contracts, incorporating catchpits in the vicinity of South Road / Maitland Street, Princes Street, Lees Street and Jones Street.
- Utilise ROS information to continuously gauge customer satisfaction with the stormwater service.
- Provide information regarding predicted future flooding to the climate change adaptation team.
- Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.
- Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.

Part 6
Way Forward



16 Recommendations

The following tables provide a list of recommendations relating to stormwater management in the Kitchener Street catchment, and provide an indicative cost and work period for each recommendation. The recommendations are listed in order of priority, relating to the risk matrix score assigned to each issue during prioritisation. The intention is that as each task is carried out, the influence on catchment management targets is assessed, and further tasks are undertaken as necessary to achieve targets. Where a cost of $0 has been applied, it is intended that DCC staff undertake the work. Recommendations will have their delivery dates set by the 3 Waters Strategic Plan, yet to be developed. Refer to the following Section regarding implementation of the Plan.

Recommendations are split into further studies, planning and education, and operation and maintenance tasks. No capital works tasks have been recommended. Further studies recommended will assist in improving certainty around catchment management targets, or where further information is required in order to develop options.

Table 16-1: Further Study Recommendations

Risk Matrix Score	Task	Budget Cost	Work Period
160	Redesign the city-wide framework for stormwater quality and harbour environment monitoring.	$ 20 k	3 - 6 months
50	Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.	$ 0	Ongoing
20	Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI).	$ 20 k	3 - 6 months

Table 16-2: Planning and Education Recommendations

Risk Matrix Score	Task	Budget Cost	Work Period
40	Contribute information to a city-wide climate change adaptation plan.	$ 0	6 - 12 months
40	Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.	$ 0	2 months
40	Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.	$ 20 k	6 months

Table 16-3: Operation and Maintenance Recommendations

Risk Matrix Score	Task	Budget Cost	Work Period
160	Implement the revised city-wide monitoring framework.	$ 25 k	Annual
50	Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance.	$ 5 k	2 months
50	Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.	$ 20 k	2 months

17 Implementation, monitoring and Continuous Improvement of the ICMP

17.1 Implementation

As detailed in Section 1 of this report, a number of DCC documents are linked to the outcomes of this ICMP. These include the Code of Subdivision and Development, the District Plan, and the 3 Waters Strategic Plan. A number of other documents are subsequently also influenced by this document.

The DCC 3 Waters Strategic Plan pulls together the recommendations from all ICMPs, as well as other 3 Waters work prepared by DCC. Currently, 10 ICMPs are under development, and the recommended options presented by each ICMP will need to be managed in a coordinated manner. Targets set within each ICMP, and issue prioritisation will be used to determine the programme for commitment of staff resources, and both operational and capital funds for recommended works across the city over the coming years.

17.2 Monitoring and Continuous improvement

The continuous monitoring and reporting with respect to the SMART targets developed for each of the critical stormwater issues ensures that the success of this ICMP will be measurable.

Recommendations presented in Section 16 above have been prioritised, and provide the opportunity for DCC to progressively work towards these targets. It also ensures that when targets have been reached, DCC can re-evaluate recommended works appropriately.

The revision of the ICMP will be required at a number of milestones, and may either be minor updates or major changes as follows:

1. When the revised stormwater and harbour environment monitoring programme has been implemented and information collated and assessed to confirm any key stormwater quality issues requiring management;

2. Due to changes in climate change predictions; and

3. As monitoring data is collected and reviewed for trends. The monitoring framework developed for assessing the effects of stormwater discharges on the harbour environment will need to be refined as more information is learnt about the effects on the harbour, and key areas of concern.

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