Stage 1 ICMP Development

March 2014

Wellington City 1884: View from Mt Victoria

Wellington City 2014: View from Mt Victoria

Absolutely Positively Wellington
Me Heke Ki Pōneke
Wellington City Council

capacity infrastructure services

Quality Assurance Statement

This report has been prepared on behalf of Wellington City Council (WCC) by Capacity Infrastructure Services Ltd (Capacity) for submission to Greater Wellington Regional Council (GWRC) in accordance with Condition 7 of Consent WGN090219. [27418] [27419] [30500] & [30501] ("the consent").

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Approvals

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Final Review	Dr Shane Kelly, Coast and Catchment Ltd	24 March 2014	
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Cover Photos

Wellington City 1884: View from Mt Victoria - WCC
Wellington City 2014: View from Mt Victoria - Ishaq Idris

Contents

Appendices

Table of Figures

Table of Tables

Abbreviations

ADWF	Average dry weather flow
Capacity	Capacity Infrastructure Services Ltd
CMP	For the purposes of this report, a CMP is a catchment management plan prepared for one or more of Wellington City's 17 stormwater catchments within the eight receiving environment catchments. See also ICMP, below
Consent WGN090219	Refers to Consent Numbers WGN090219 [27418] [27419] [30500] & [30501] issued by Greater Wellington Regional Council to Wellington City Council
Council	Wellington City Council
Cu	Copper
DDT	Dichloro- Diphenyl-Trichloroethane
GWRC	Greater Wellington Regional Council
ITO	Industry Training Organisation
ICM	Integrated catchment management
ICMP	For the purposes of this report, an ICMP is an integrated catchment management plan prepared for one of Wellington City's eight receiving environment catchments, including its constituent stormwater catchments. See also CMP, above
PAH	Polynuclear Aromatic Hydrocarbons
Pb	Lead
PDWF	Peak dry weather flow
LGA	Local Government Act
MCA	Multi-criteria analysis
QEII Trust	QEII was established under the Queen Elizabeth the Second National Trust Act 1977 to aid conservation on private land
Receiving environment catchment	A group of stormwater catchments grouped together on the basis of a shared coastal receiving environment that is readily distinguishable from other parts of Wellington City's coastal receiving environments (here are eight of these, as shown in Figure 9)
RMA	Resource Management Act
SFRG	Suitability for Recreational Grade
Stormwater sub-catchment	One of the 17 stormwater catchments that comprise the eight receiving environment catchments, as shown in Figure 08
TPH	Total Petroleum Hydrocarbons
WCC	Wellington City Council
WWTP	Wastewater Treatment Plant
Zn	Zinc

Checklist: Report Content and Consent Conditions

The table below is provided for the convenience of the auditors.

Condition	Requirement	Report section
Integrated Catchment Management Plan (ICMP)		
6.	The consent holder shall prepare and implement an Integrated Catchment Management Plan (ICMP) to cover all of the catchments authorised by consent WGN090219. The ICMP shall be prepared in two stages as outlined in condition 7 and 8 of this consent. The ICMP shall identify and address the management of existing and future water quality and sediment contamination issues related to the stormwater discharges covered by this consent and be in accordance with the environmental objectives approved under condition 5 of this consent. The assessments and development of the ICMP shall be undertaken by a suitably qualified and experienced person(s). Note: It is acknowledged that these consents relate only to stormwater discharges into the coastal marine area, and thus the ICMP prepared under this condition cannot be expected to address all surface water issues (such as flooding, on-site management of stormwater flows and water quality in streams). The ICMP required by this consent is expected to be prepared in a way that enables other aspects of catchment management to be added over time, and is the first stage of an ongoing water management partnership between the Wellington City Council (as consent holder), Wellington Regional Council (as consent authority) and the community. Note: The ICMP required by this condition, condition 6 of WGN090219 [27419], condition 6 of WGN090219 [30500] and condition 6 of WGN090219 [30501] can be combined into a single ICMP report.	Section 2.1, 2.3 Scope of the ICMPs Figure 2
Stage 1 of the ICMP development		
7.	The consent holder shall submit to the Manager, Environmental Regulation, Wellington Regional Council, Stage 1 of the ICMP as required by condition 6 of this consent. Stage 1 of the ICMP shall apply to the whole of the catchments covered by this consent and shall include, but not be limited to, the following:	Whole report
Stormwater catchment characteristics and descriptions		
7. a)	Plans and descriptions of the stormwater network, catchments, and receiving environments covered by this consent. As a minimum, the plans and descriptions shall include information on:	Section 4 and Appendix B
7. a) i)	Catchment areas and their boundaries and the location of major stormwater outfalls (including streams and the coast) and the network within that catchment.	Section 4 and Appendix B
7. a) ii)	Existing and potential land uses that are permitted under the Wellington City District Plan. Land uses shall be categorised and described in relation to their potential to generate increased runoff and stormwater contaminants to the stormwater network, and an estimate of the rate and extent of the likely changes in land use shall be included. This information shall be updated, if appropriate, following any proposed or operative changes to the Wellington City District Plan which may result in the changes to the description.	Section 4 and Appendix B
7. a) iii)	The location and description of industries and other high risk facilities	Section 4

Condition	Requirement	Report section
	(for example, landfills and/or factories) that may potentially make a disproportionate contribution to stormwater contamination.	and Appendix B
7. a) iv)	The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices.	Section 4 and Appendix B, Appendix K
7. a) v)	The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, and;	Section 4 and Appendix B, Appendix J
7. a) vi)	A description of the ecological, recreational, amenity and cultural values, and environmental quality of the receiving environments potentially affected by stormwater discharges authorised by this consent. The descriptions shall also include an assessment of recreational use (including food gathering) in the receiving environments. These descriptions shall be undertaken by a suitably qualified and experienced person(s).	Section 4 and Appendix B
Environmental objectives		
7. b)	The approved environmental objectives developed under condition 5 of this consent.	Appendix G Section 2.2, 5.2 Figure 56 & 57 Tables 14, 15, 17
Identification and assessment of stormwater network issues and contaminants		
7. c)	The identification of flooding and overland flow in relation to stormwater discharges, an assessment of the associated issues and an outline of the options to address these issues, and the development of options for their management.	Sections 3.1, 3.2, 3.3 and Section 4
7. d)	The identification and assessment of wastewater overflow and infiltration issues within the stormwater network, and the development of options for their management to prevent or minimise them.	Sections 3.4 and 4 and Appendix J
7. e)	The identification of types, sources and loads of sediment and key physical and chemical contaminants in stormwater, and predictions of future trends in key chemical contaminant loads. Key chemical contaminants include, but are not limited to, copper, zinc and polycyclic aromatic hydrocarbons.	Section 3.5, Section 4 and Appendix C
7. f)	An assessment of the effects of chemical stormwater contaminants on the coastal receiving environment and expected trends in chemical contamination in the coastal receiving environment.	Section 4 and Appendix C
7. g)	Methods and a timetable (including, as relevant, annual commitments) to manage issues which are to be addressed on the basis of the whole area covered by these consents, (for example, public education about stormwater and contaminants; any changes to policies, plans, bylaws or standards; ongoing network maintenance and management programmes, strategic upgrades and/or additions to the stormwater network; memoranda of understanding with parties with city-wide interests); and	Section 5 Table 15
7. h)	Identification and prioritisation of areas, and a timetable for the	Prioritisation

Condition	Requirement	Report section
	development of catchment-specific plans to be prepared in Stage 2 of the ICMP. The consent holder shall submit Stage 1 of the ICMP for approval to the Manager, Environmental Regulation, Wellington Regional Council, within 3 years of the consent being granted. Any amendments to the content of the ICMP, shall be to the approval of the Manager, Environmental Regulation, and Wellington Regional Council.	areas: Section 6 Tables 16, 17 and 18. Time Table: Section 7, Table 19
Stage 2 ICMP statement		
Condition 8 b), c) and d), and 9	8b) A statement of appropriate specific targets, standards or other performance benchmarks to be met on a specified timetable for each catchment (or group of catchments) 8c) The identification of preferred methods, including works, management solutions and any other actions, and the development of a programme to meet the stated targets and standards for each catchment (or group of catchments),	Section 08

1 Executive Summary

Capacity on behalf of WCC is preparing Integrated Catchment Management Plans (ICMPs) for the City of Wellington. This is required in order for WCC to discharge stormwater to the harbour and coast. This document describes the first part of this process ('Stage 1 ICMP'), a process underpinned by the following Vision and Mission.

ICMP Vision

Wellington enjoys healthy fresh and coastal waters and ecosystems, healthy swimming waters and attractive waterways and coastlines. Its people are secure from flood risk at home and work.

ICMP Mission

To address legacy issues, current problems and future challenges through proactive planning and the provision of water services in an integrated, sustainable, and environmentally and economically sound manner.

To achieve the vision and mission effectively and efficiently requires an ***integrated*** approach to catchment management. Here ***integration*** means that all relevant information is synthesized to provide an overall picture of the stormwater system and its operation, and the benefits and effects on social, cultural, economic and environmental values.

Stage 1 of the ICMP process provides the groundwork for the actual ICMPs, which will be prepared in Stage 2. The objective of Stage 1 is to gain a better insight into the levels of service required of the city's stormwater activity, as the basis for assessing issues, priorities and methods. ICMPs will be prepared for eight Catchments. Five coastal receiving environment catchments have been identified for the development of the first set of Stage 2 ICMPs (**Figure 1**). These five catchments were selected on the basis of the effects of flooding and contamination in coastal receiving environments from these catchment areas.

ICMPs for three stream catchments (Owhiro Bay, Kaiwharawhara and Ngauranga) will be prepared later, because the consent envisages fresh water issues being addressed in the future, which will be aligned with timeframes for Regional Plans.

This document summarises the results of the work undertaken in Stage 1 and includes:

- Descriptions of the stormwater catchment characteristics
- Assessment of any stormwater network issues (including wastewater inputs to the stormwater network) and contaminants
- Assessment of the types, sources and loads of sediment and key physical and chemical contaminants in stormwater, and predictions of future trends in key chemical contaminant loads
- Methods and a timetable to manage the issues which are to be addressed
- Priority rating of catchments for issue management

- A timetable for the development of the Integrated Catchment Management Plans during Stage 2 of the ICMP.

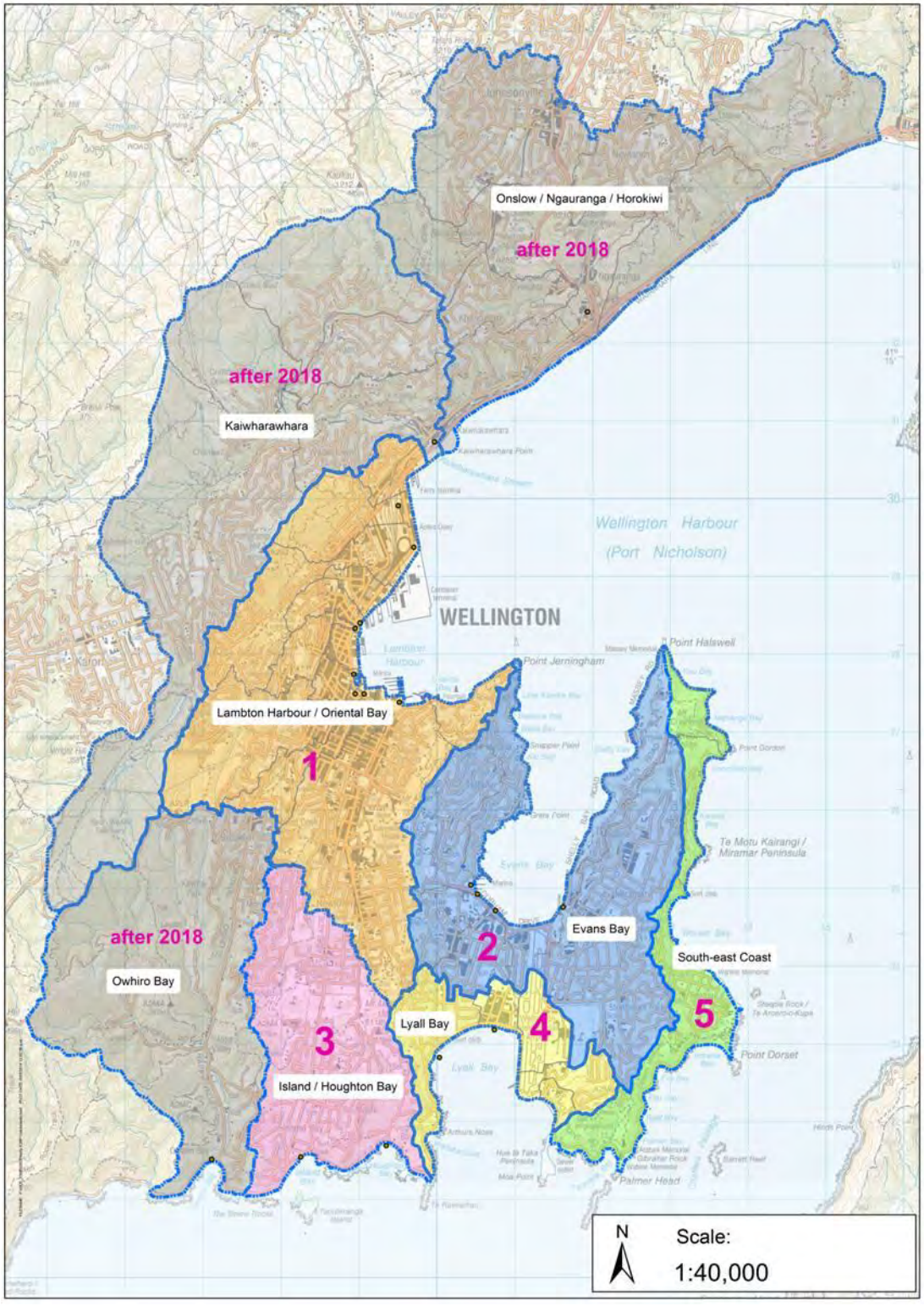


Figure 1: Wellington's Eight Receiving Environment Catchments (ICMP Catchments)

NOTE: Order of Stage 2 ICMP preparation is marked in numbers 1 to 5

1 Introduction and Purpose

1.1 Resource Consent WGN090219

On the 18th of February 2011 GWRC granted Consent Number WGN090219 [27418] [27419] [30500] & [30501] to WCC to "*continue to discharge stormwater and occasionally contaminated stormwater….directly into the coastal marine area*….".

Condition 6 of the consent requires that:

- "The consent holder shall prepare and implement an ICMP to cover all of the catchments authorised by consent WGN090219."

Conditions 6, 7 and 8 of the consent require the preparation of that ICMP in two stages:

- Stage 1 ICMP Development: due to be lodged with GWRC by 14 March 2014[1]
- Stage 2 ICMP Development: due to be lodged with GWRC by 14 March 2018.

1.2 Purpose

The purpose of this report is to outline what has been achieved and learned in Stage 1 of the ICMP process and to comply with the requirements of condition 7 of the consent.

The full consent conditions relating to ICMPs are listed in Appendix A and the relevant parts of those conditions will be referred to throughout this report.

1.3 Structure and Layout

The report falls into nine main sections:

- Section 1: Introduction and purpose of this report
- Section 2: High-level background to the global resource consents and the growth of Wellington City, followed by an introduction to Wellington's receiving environment catchments
- Sections 3 - 8: Description of Wellington's stormwater and wastewater networks, city-wide aspects of flooding and sediment runoff, and the Stage 1 ICMP, provided as a high level summary demonstrating how the information gathered to date will be used to achieve compliance with the resource consent conditions
- Appendices: Details of the technical analysis conducted and information supporting Sections 3 – 6.

[1] *A two week extension of time to submit the Stage 1 report has been granted by GWRC, to complete the external peer review process. The new submission date is 28 March 2014. See Appendix I*

2 Introduction

This section covers the ICMP's purpose and scope.
Then, as indicated by condition 7 a) of the consent, it gives a brief historical description of Wellington's stormwater and wastewater networks and introduces the City's catchments and coastal receiving environments.

2.1 Purpose of the Stage 1 ICMP

The purpose of the Stage 1 ICMP is to provide the information required by condition 7 of the resource consent (see Appendix A), which requires the Stage 1 ICMP to:

- describe the stormwater catchment characteristics
- refer to the environmental objectives already submitted for approval by GWRC
- identify and assess stormwater network issues (including wastewater inputs to the stormwater network) and contaminants
- assess the types, sources and loads of sediment and key physical and chemical contaminants in stormwater, and predictions of future trends in key chemical contaminant loads
- set out methods and a timetable to manage the issues which are to be addressed
- identify and prioritise areas for issue management
- set out a timetable for the development of the catchment-specific plans to be prepared in Stage 2 of the ICMP

These matters, together with further detailed information specified in the consent conditions, are addressed in this report.

Figure 2 shows the relationship between the Stage 1 and 2 ICMPs. The ICMP covers a period of eight years to March 2018. This includes the investigation, development and implementation phases.

As stated under consent condition 6 (see Appendix A), the ICMP cannot be expected to address all surface water issues, but rather, it "is expected to be prepared in a way that enables other aspects of catchment management to be added over time, and is the first stage of an ongoing water management partnership between the Wellington City Council (as consent holder), Wellington Regional Council (as consent authority) and the community."

The ICMP vision and mission have therefore been proposed in order to ensure that Stage 1 and 2 ICMPs lay a robust foundation for the ongoing development of integrated catchment management planning in Wellington, with other aspects of catchment management being added over time as necessary or desired.

Capacity has consulted with a number of territorial authorities as well as engineering and environmental consultants regarding how best to prepare the Stage 1 and 2 ICMPs. It found that there is no single standard, benchmark or accepted process for developing an ICMP, or for what should be included in it. It is, however, clear that an ICMP must:

- reflect the unique requirements of the location
- reflect the expectations of the community

- be a continually improving process, informed by data and the inputs of a wide range of stakeholders

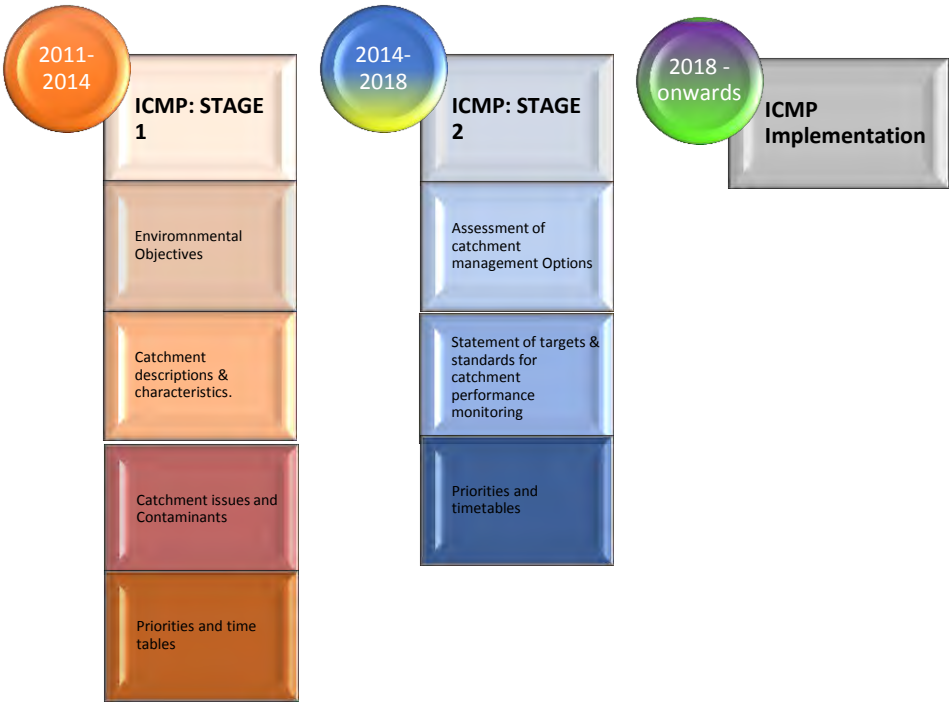


Figure 2: Wellington City's ICMP process

2.2 Process for Achieving Environmental Objectives

The Environmental Objectives agreed with and approved by GWRC in 2012 should be considered a starting point in the development of the ICMP process. The objectives underpin Stage 1 (as outlined in this report), but will be refined in progressive stages as more information becomes available and our understanding improves. The broad environmental objectives will be closely scrutinised, and from these, 'SMART' (specific, measurable, achievable, realistic and time-based) objectives will be developed during Stage 2 to ensure their implementation and outcomes can be measured. The proposed process to follow when developing Stage 2 ICMPs is discussed in Section 8.

The development of an ICMP is a continually evolving process involving a cycle of 'understanding', 'planning', 'doing' and 'reviewing' which will facilitate a range of quick wins, while guiding successive ICMP stages. This approach will enable the environmental objectives to be continually refined and redefined until such a time as they can be used to underpin the establishment of 'Levels of Service' (LoS) targets in each catchment.

2.3 Scope of the Stage 1 ICMP

- Stage 1 only outlines the effects of stormwater discharges that are contaminated with diffuse sources[2] and wastewater inputs, and not with wet-weather discharges from the Moa Pt wastewater treatment plant.

[2] *Diffuse pollution occurs when potentially-polluting substances leach into surface waters and groundwater as a result of rainfall, soil infiltration and surface runoff. The source of this pollution, usually due to a recent or past activity on land, is the widespread inputs of contaminants of many types. Typical examples includes: pesticides from a wide range of land uses, contaminants from roads and paved areas, and atmospheric deposition of contaminants arising from industry and the use of fertiliser in agriculture and forestry.*

- As stated in consent condition 6 (see Appendix A), these global consents "relate only to stormwater discharges into the coastal marine area, and thus the ICMP prepared under this condition cannot be expected to address all surface water issues (such as flooding, on-site management of stormwater flows and water quality in streams) at this stage. That said, addressing issues in the coastal marine area will inevitably have positive benefits for freshwater bodies that feed them, and this can support future work in due course.

2.4 Brief History of Wellington's Stormwater and Wastewater Networks

2.4.1 The Development of Wellington City

The rugged South Coast, the bays and harbour, the rural hinterland, and the green belts, ridgelines and hilltops – all these define Wellington. An important part of Wellington's identity is the marine environment that surrounds the city. Wellington is a city where the natural environment permeates the urban environment, enabling a high quality of life for its inhabitants. Our environment carries significant ecological, economic, social and cultural values, and creates economic opportunities for the city. Like other cities and towns in New Zealand, Wellington was originally covered in native vegetation which was modified by Maori and again more extensively by early European settlers. The city was once cloaked by about 20,000 hectares of low-land broad- leaved podocarp forest. Today, less than 5% of this forest remains, mostly in gullies and remote areas out of the reaches of development. These relics of ancient forest are now accompanied by regenerating forest. The wind-buffeted and salt-laden coastal escarpments facing the Cook Strait (Wellington's South Coast) and the harbour escarpments were once covered with a mosaic of coastal forest and scrub. Today, less than 1% of coastal forest remains. The land has also been more modified than most other New Zealand cities by the combined effects of earthquakes that uplifted land and reclamation that further extended the shoreline.

The Wellington urban area is the major population centre of the southern North Island, and also holds the distinction of being the world's southernmost capital city. The urban areas include residential, commercial and industrial land use. Rural land is used largely for farming, particularly sheep and cattle grazing. The study area within Wellington City encompasses a total land area of about 7710 Ha, including substantial areas of coastline, parkland and bush land.

The original inhabitants of the Wellington area were the Taranaki Whanui and Ngati Toa Maori people. European settlement dates from 1840, when a township was established in the Lambton Harbour area. In 1855 an earthquake struck the area, raising the coastline and creating flat land for settlement in and around the harbour. Land was also reclaimed to form what is now the central city. Rapid residential development took place from the 1880s into the 1920s, spurred by commercial and industrial growth and improved access. Growth slowed from the 1930s, and then further expansion took place from the post-war years onwards. Development spread to the northern areas from the 1970s. Gentrification and renovation of the inner city took place from the late 1970s, including transformation of the waterfront.

The estimated resident population of the City increased from the mid-1990s, rising from 163,400 in 1996 to 187,700 in 2006, due largely to an increase in the number of dwellings, particularly medium density housing. By 2006, the City contained 40% of the Wellington Region's population. Population growth is expected to continue, particularly in the central and northern suburbs. In 2031, the population of Wellington City is forecast to be 230,600, an increase of 42,900 persons (23%) from 2006. This represents an average annual growth rate of 0.83%.

Figure 3: Wellington harbour view from Mt Victoria in 2014

Source: Courtesy of Jackol by http://flickr.com/photos/44124329962@N01/516092798

2.4.2 Land Use Changes

Wellington's shoreline today is very different from the one occupied by Maori and on which the first European settlers landed in 1840. In those days, it was simply a beach, until wharves and jetties were built. Since those early days, reclamation has added more than 155 hectares of land to the inner-city area. Earthquakes have raised land and led to the removal and replacement of hundreds of buildings.

It was in the 1850s that the first sizeable reclamations took place, and by the end of the 1870s some 28 hectares of land had been reclaimed using spoil from the hills behind Lambton Quay and from Wadestown Hill, and the new seawalls ran almost in a straight line from the bottom of Willis Street to Pipitea Point. The first deep water wharves were constructed in the area, which became Queens Wharf, the first pile being driven in 1862, but most of the Te Aro foreshore and its wharves remained privately owned. The period from 1880, saw some major developments, including a reclamation north of Pipitea Point for railways land, while south of Queens Wharf the Te Aro area was extended seaward, removing the last vestiges of private ownership of the foreshore. By the end of the 19th century, the 1840 shoreline had disappeared.

The following 30 years saw further reclamations for railways and Harbour Board purposes, and the construction of additional wharves, the seawall at Oriental Bay and a boat harbour at Clyde Quay.

The next and final phase of reclamation in Lambton Harbour took place in the 1960s and 1970s, when new methods of cargo handling - containerisation and roll-on/roll-off cargoes - required more land adjacent to ship berths. Reclamation was carried out on both sides of Queens Wharf and, most significantly, the container terminal was created by a large reclamation at Thorndon, where the first container ship berthed on 19 June 1971. Today the terminal has 24.3 hectares of back-up space capable of holding some 6,284 containers.

Figure 4 compares the 1840 shoreline with that of today.

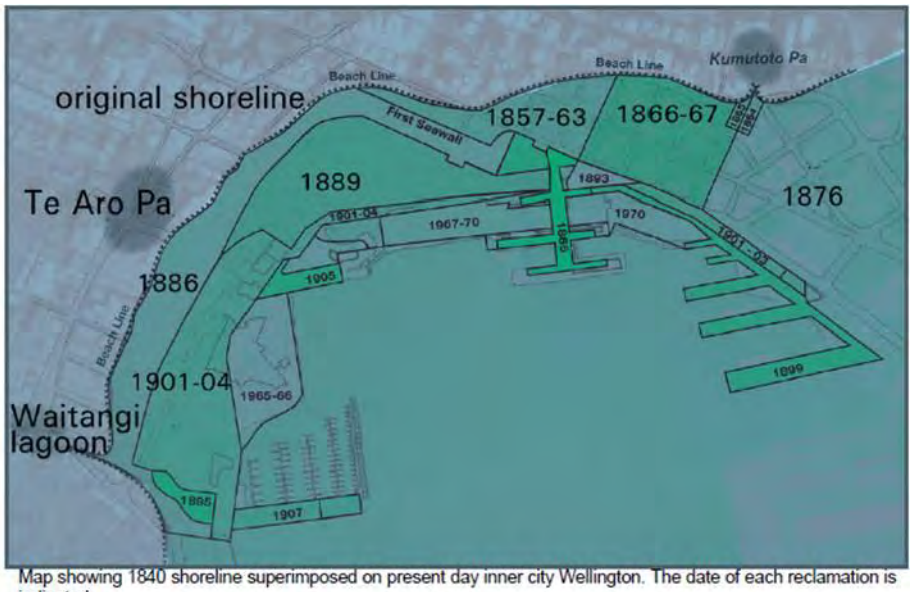


Figure 4: Wellington's Inner City Shoreline in 1840 and 2014

The Hutt Road was initially a narrow formed track that ran from the edge of Thorndon and wound its way around the western side of Wellington harbour to Petone and the Hutt. At high tide and in bad weather the road was impassable. The 1855 earthquake raised the road, along with the rest of the shoreline, by up to one metre, and suddenly the Hutt Road was a much more viable route. The road was steadily improved throughout the 19th century, largely paid for by a toll. This easier access and improved public and private transport modes opened up the Hutt Valley and other areas further from the city to more rapid urban development.

2.4.3 Impacts of Land Use Change

Wellingtonians have relied on the oceans for food, as a waste dump, for recreation, for transport, for economic opportunities and much more, over the years. However, it is not only our activities in the marine environment that affect life in the sea, it is also the things we do on land. Wellington city contains 40% of the regional population living within 10 - 20 kilometres of the coast, so it is not surprising that land activities have impacted the marine environment. Human impacts have increased along with rapid population growth, substantial developments in technology and significant changes in land use. Contaminants from roads, buildings, stormwater and wastewater systems have affected sediment and water quality in the coastal environments, particularly Lambton harbour. Sediment runoff has increased during urban development and associated earthworks.

Human and urban activities generate contaminants, which have increased in step with rapid population growth. Traditional piped stormwater networks very efficiently move these contaminants to aquatic receiving environments. Contamination of stormwater can result in public health risks and the closing of beaches, and can negatively affect water-based recreation and shellfish gathering. These effects in turn cab have adverse effects on cultural and tourism values.

Wellington's outdoor areas are also regarded as having significant recreation and tourism value, which in part relies on the state of the natural ecosystems (**Figure 5**). Activities include sailing, snorkelling, diving, ocean swimming, kayaking, fishing, wildlife watching, and walking along the coast (**Figure 6**).

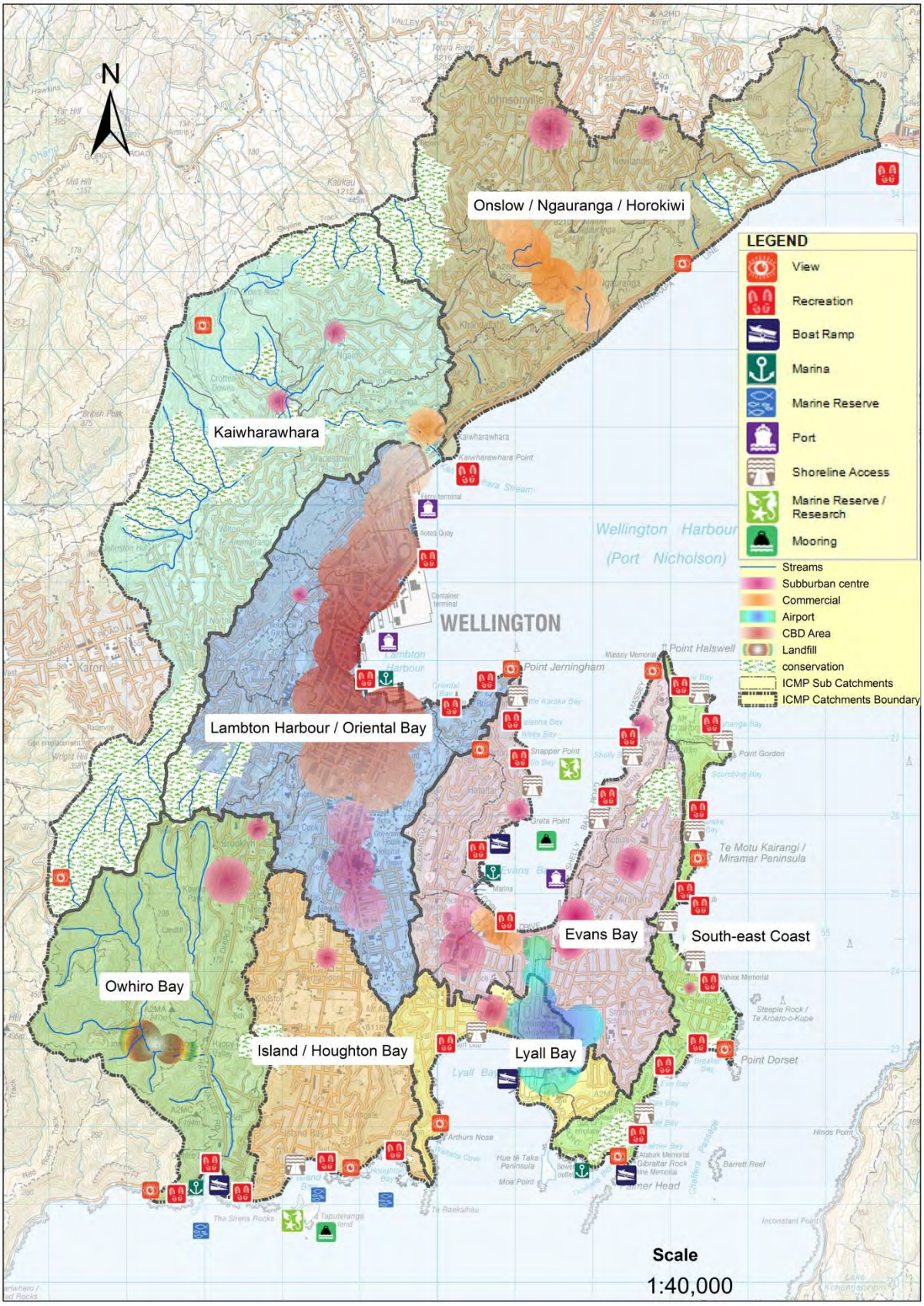


Figure 5: Amenity Values

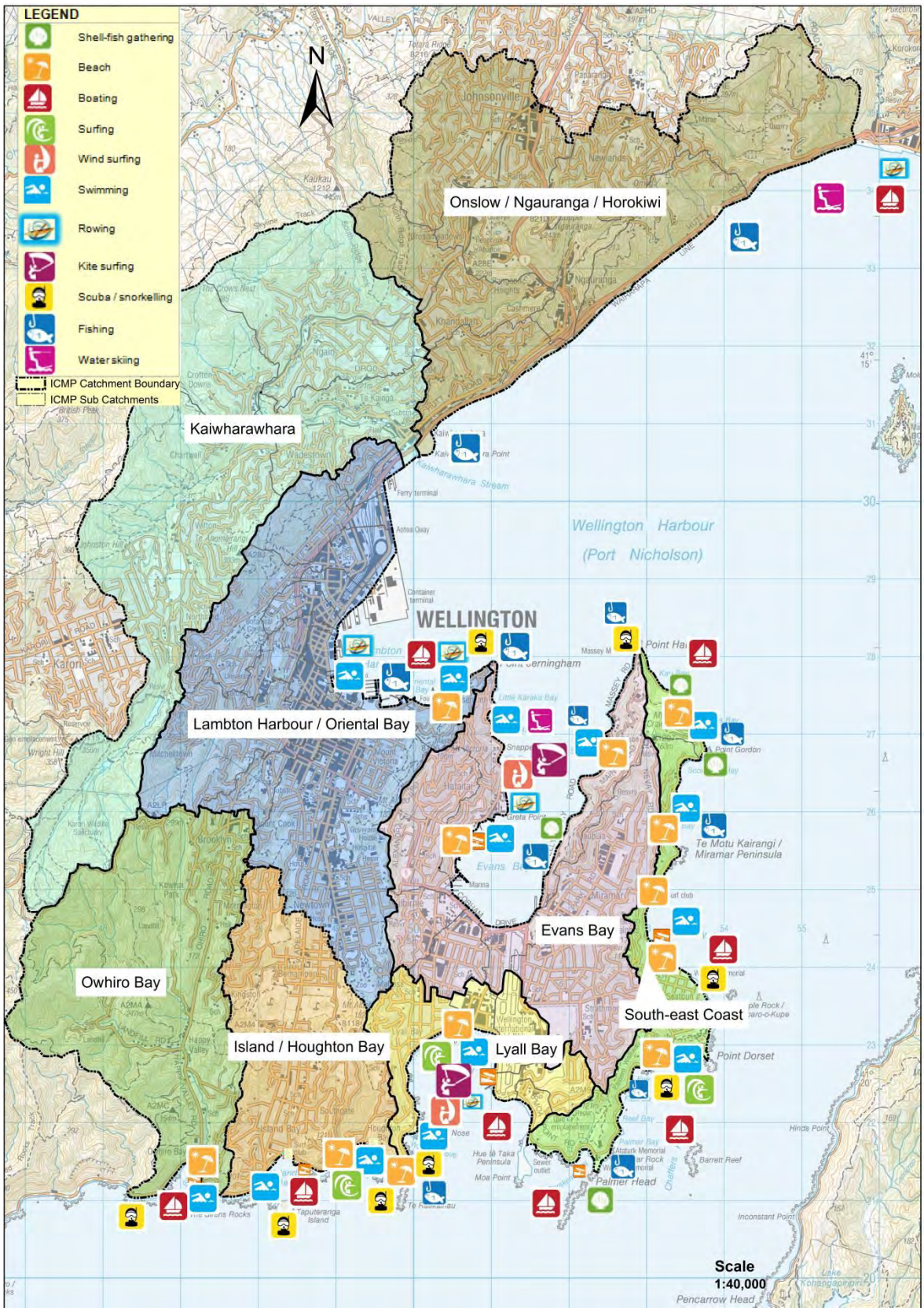


Figure 6: Recreational Features

Figure 5 and **Figure 6** show Wellington's stormwater catchments and their respective receiving environments, highlighting the key land uses and receiving environment values. The icons in the freshwater and coastal receiving environments relate to the following values:

- natural streams
- shellfish gathering and bathing areas
- boating and fishing areas
- the Centre Port commercial port area

These values also help to inform the identification of the priority areas discussed in section 6.

2.5 Introducing Wellington's Receiving Environment Catchments

The issues identified in GWRC's Proposed Regional Policy Statement, the objectives in Capacity's 2012 discussion document and the ICMP-related conditions of consent all focus on outcomes for the coastal marine receiving environments. Those issues are:

- adverse effects on the natural character of the coastal environment
- coastal water quality and ecosystems
- human activities [that] interfere with natural coastal processes

These issues are aligned with those set out in the consent, which have informed the issues identified and discussed in the catchment summaries in the Section 4.

The focus of the resource consents is on the coastal receiving environments into which the Wellington City's rivers and stormwater runoff flow. This made it desirable to aggregate the City's 34 stormwater sub-catchments around a series of eight readily distinguishable receiving environments. The 34 stormwater sub-catchments were clustered into these eight catchments based on:

- the characteristics of their shared coastal receiving environments and recreational uses, which delineate a group of five catchments adjoining distinctive coastal receiving environments for which Stage 2 ICMPs will be prepared. These are Lambton Harbour, Evans Bay, Island/Houghton Bay, Lyall Bay and East Coast
- the large size of the three remaining stream catchments which discharge into the coastal receiving environment (Owhiro Bay, Kaiwharawhara and Ngauranga). These catchments require further research before Stage 2 ICMPs can be produced to gain better understanding of the effects of stormwater and the subsequent impact on the ecosystem health, amenities and riparian zones.

Figure 7 and **Figure 8** show these five coastal receiving environment catchments with their respective receiving environments, and the three stream catchments. Within these eight catchments are 17 stormwater catchments made up of 34 smaller "stormwater sub-catchments".

In compliance with consent conditions for Stage 1 ICMP development, research into the individual catchment characteristics was assessed for 17 stormwater catchments (**Figure 8**). The findings are summarised for eight coastal and stream catchments (**Figure 7**).

The summaries in section 4 relate to the eight receiving environment catchments. Appendices B1-B17 provides more detailed information for each of the 17 stormwater catchments.

Figure 7: Wellington's Eight Receiving Environment Catchments

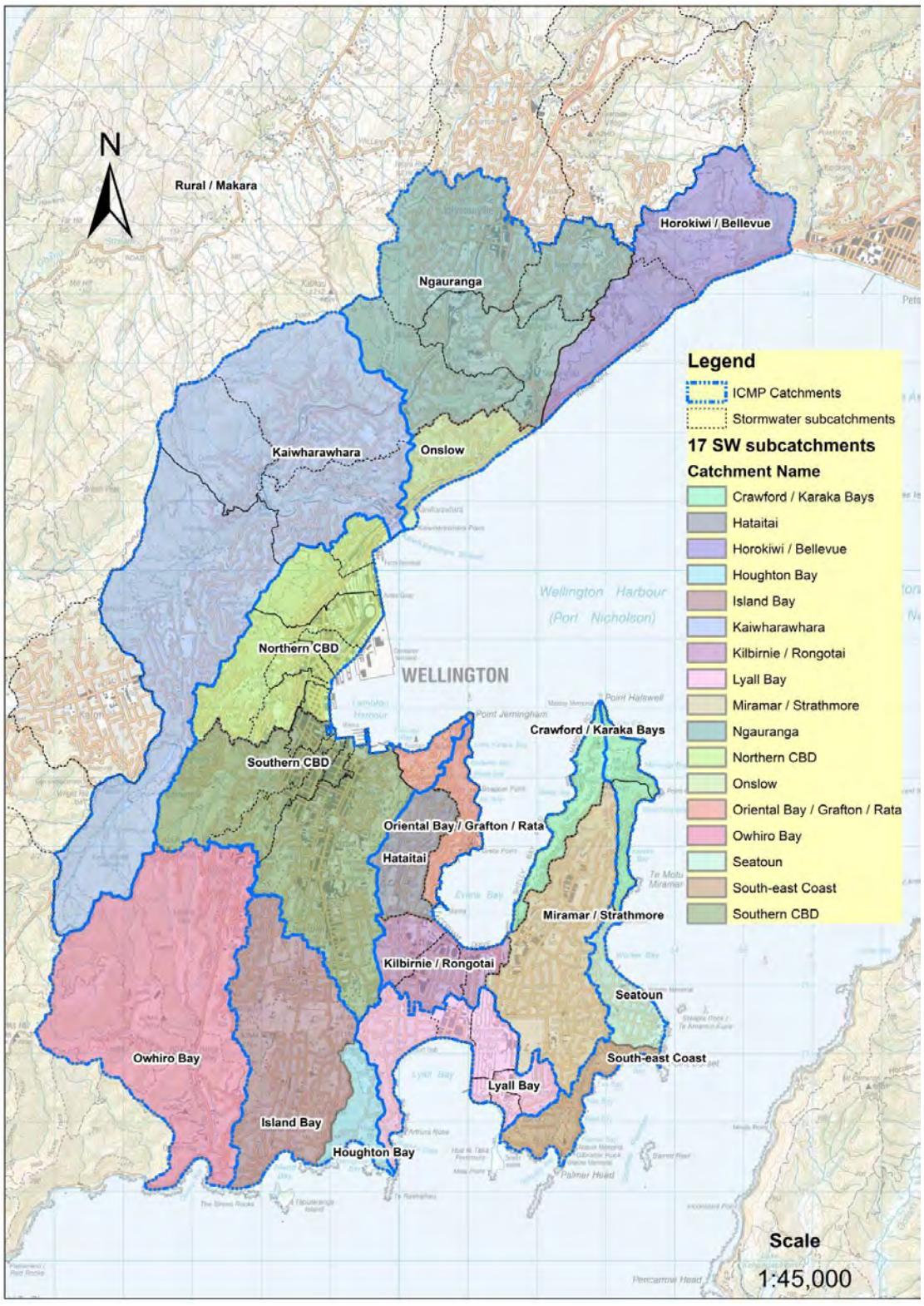


Figure 8: Wellington's 17 Stormwater Sub-catchments (made up of 34 sub-catchments)

3 Flooding, Wastewater, Sediment Runoff and Climate Change Effects

This section addresses the following requirements of condition 7:
7 c) The identification of flooding and overland flow in relation to stormwater discharges, an assessment of the associated issues and an outline of the options to address these issues, and the development of options for their management on:
7 d) The identification and assessment of wastewater overflow and infiltration issues within the stormwater network, and the development of options for their management to prevent or minimise them.
7 e) The identification of loads of sediment

Wellington City's successful functioning depends on a complex network of infrastructure - water supply, wastewater, stormwater, solid waste disposal and transport systems - to support the platform for economic development and community wellbeing. These assets represent a major historic investment.

However the wastewater, solid waste and stormwater utility operations can cause contamination of freshwater and coastal receiving environment to varying degrees, depending on contaminant type, concentration and loading, together with the sensitivity of the receiving environment. The effects can adversely affect public health and recreational and economic activities and degrade amenity values.

In managing its networks, Council recognises the need not only to maintain and, if necessary, improve the levels of service that contribute to the successful functioning of the City in the usual social, cultural and economic terms, but also to manage any environmental effects of network discharges to freshwater and coastal receiving environments. District Plan rules facilitate the efficient functioning of such networks and also ensure that their adverse environmental effects are avoided, remedied or mitigated. These matters are discussed later in the report.

This section discusses the following issues:

- stormwater systems
- climate change impacts
- flooding, overland flow paths and depressions
- wastewater system and wastewater overflow and infiltration issues
- sediment loads

3.1 Stormwater System

3.1.1 Piped System

Wellington's public stormwater system has grown over the last 130 years or more, along with the city's growth in population and corresponding urban footprint. Initially there were uncontrolled natural watercourses and streams leading from the hills to the sea nearby. Increasingly these watercourses became confined by development, filled in and piped to allow for more intensive use of land. While

some remnants of the open watercourses and streams still exist in many less accessible places in the city such as public reserves and outlying land, most of the city is serviced by piped stormwater drains.

There are some 550 km of piped systems and approximately 25km of open semi-urban watercourses in Wellington, excluding those in rural areas. Wellington's current stormwater network comprises a complex gravity system of reticulated pipes, culverts, catch-pits, grit traps, secondary overland flow paths and streams, that together convey almost 80 million cubic metres of stormwater every year from buildings, roads, land use and open spaces into the city's coastal receiving waters.

Until the 1980s, piped stormwater systems (the primary system) within the city were designed and built to carry a five-year return storm. Since the 1980s, most stormwater pipes have been designed and built to carry a 50-year return storm. Excess stormwater flows that result from larger storms or from blockage are carried by overland flow paths along streets and hollows on both public and private property. These areas are referred to as the secondary stormwater system, and the downhill routes taken by these excess flows are known as secondary flow paths. In Wellington, no direct effective controls are exercised over secondary flow paths, even though there are substantial flood damage risks to the community, buildings and property.

The city's stormwater pipes are old with some associated deterioration in pipe condition and performance necessitating some essential renewal programmes. Over 80% of the stormwater pipes are 40-60 years old, and only about 10% meet Council's current 50-year return storm capacity standard. The remaining 90% of pipes have around 2-5 year return storm capacities.

3.1.2 Streams

Most of Wellington is serviced by the piped stormwater system, but a number of significant permanent watercourses and streams remain within the urban area. Some of the larger and more important are the Owhiro, Kaiwharawhara and Ngauranga streams. These open streams have some culvert sections and numerous bridges, most of which are private. Some of these streams pass through private properties.

In recent years these stream remnants have been recognised for their environmental value and as worthy of enhancement, rather than being deemed semi-wasteland or back yards only good for carrying flood flows. Where they exist, streams and open channels are also usually much more efficient at transporting flood flow than pipes, but they suffer from several disadvantages: they are often subject to private encroachment for the purposes of gaining valuable land, they need regular maintenance and vegetation removal, and the smaller streams are difficult to manage effectively in the urban environment.

3.1.3 Stormwater System Management

Council has full control over all public drains whether these are on private or public land and has considerable control over the management of stormwater on private property and private drains. Under the RMA, the Building Act and District Plans, Council has particular control over practically all land use and development in relation to matters affecting stormwater management. The current prescribed levels of service are set down in the Stormwater Service Plan (Stormwater Asset Management Plan). Detailed design standards for new stormwater works are set down in the WCC Code of Practice for Land Development. Various other policy documents including the District Plan are also relevant.

The constructed and natural stormwater networks together provide a number of valuable services to the community and city in general, including:

- The removal of excess stormwater in order to reduce flooding and flood damage to buildings, roads and property, risk to human safety, and nuisance factors; these drivers generally set the size, extent, and cost of the network
- The drainage of groundwater away from areas that would otherwise be soft and wet, providing more stable hillsides and drier basements and foundations all over the city

They also inadvertently transport sediment, debris, litter and traces of other contaminants such as hydrocarbons, heavy metals including zinc, and biological matter including animal faecal residues. Thus, at the input end, these services clean the catchment environment, but do so by depositing the pollutants at the expense of the local watercourses and coastal waters at the output end of the stormwater pipes. Water quality and amenities in these receiving environments are controlled by Regional Plans and resource consents.

Historically, priorities for renewing stormwater and wastewater pipes have been driven by ongoing improvements to customer levels of service. For example, priority has been given to 'known' or 'predictable' problem areas where the risks are greatest, including critical drains (deep drains and drains under buildings or major roads and railways) and drains with ongoing faults or which are obviously at risk for collapse.

As will be explained in section 5, in Stage 2 ICMP, the information on the state of the piped stormwater and wastewater assets will be combined with information on risks posed to coastal receiving environments by these assets. This will enable prioritisation of areas for renewal in order to reduce adverse environmental effects addressed by the resource consent in the most cost-effective manner.

3.2 Climate Change Impacts

Climate change could pose a risk to the supporting infrastructure, and this in tune presents significant challenges in terms of the future planning of infrastructure needs. There is still a high degree of uncertainty about the timing and exact nature of climate change impacts. Nevertheless effective forward planning is vital for there to be a cost-effective management response.

Wellington City has worked with the GWRC and NIWA on a coastal study to identify sea level rise, storm surge and wave set-up scenarios and the areas of the region most at risk. This study shows that Wellington has the highest rates of sea level rise in New Zealand. In addition the City has been studying the social, cultural, environmental and economic risks of future sea level rise. This work will identify potential response options for different areas of the city in a consistent and coordinated way.

Climate models predict that Wellington is likely to experience more extreme storms with sea temperatures rising, stronger winds, more intense and possibly more frequent rainfall events and a rise in sea level. This has significant implications for preventing flood damage and managing stormwater. Wellington City mapped sea level rise effects for different planning horizons. Figure 9 shows potentially affected areas of the CBD for 1.1m sea level rise coinciding with storm surge.

Data presented by Ministry for the Environment suggest that Wellington will experience wetter winters, and an increase the frequency of large storms and rainfall intensities (to the order of 10%). In addition, Wellington will experience warmer all year round temperatures, including increased temperatures in the warmer months. Such climate change may create risks to the environment, infrastructure, the economy and public health. The key potential effects are:

- coastal flooding and coastal erosion

- surface flooding: rises in sea level also have serious flooding and inundation risks for low-lying coastal areas, and will increase river flooding
- landslips and increased risk to infrastructure in hilly areas
- wastewater capacity issues due to increases in inflow and infiltration (predicted wetter winters and higher intensity rainfall events are likely to result in greater flooding and inflow and infiltration)
- higher predicted mean sea levels could affect the groundwater levels in coastal areas potentially increasing levels of infiltration. These increases have the potential to increase hydraulic loads which would result in increased overflows in some parts of the network, increased levels of inflow and infiltration (I/I) increase pumping costs and energy use
- stormwater network capacity issues due to increased rain intensity

Stormwater flooding in low lying areas, with associated coastal erosion and inundation, is of major concern because some of these areas are already compromised at high tide level. Sea level is predicted to rise progressively and significantly within the strategic planning horizon. The actual order of rise predicted is 200 mm by 2050, and 500 mm above the present by 2100; however the Ministry for the Environment requires an allowance of 400mm by 2050 and 900mm by 2100, for planning purposes. Therefore, there is a need to integrate the impacts of climate change on services and infrastructure into future planning. This will be addressed in the Stage 2 ICMPs.

Figure 9: Potentially Affected Areas of the CBD by Sea Level Rise

3.3 Overview of Flooding, Overland Flow Paths and Depressions

The note to condition 7c of the resource consent states that the Stage 1 ICMP should be "prepared in a way that enables stormwater flows, among other aspects of catchment management to be added over time".

In acknowledgement of this, Wellington City has collated city-wide data on flooding, overland flow paths and depressions.

This section gives a city-wide overview of this information, which is not repeated in the catchment summaries that follow in section 4 of this report. Later sections of this report include priorities, options, methods and a timetable for addressing flooding, overland flow paths and depressions in the more detailed Stage 2 ICMPs. This will inform the more detailed analysis needed to improve levels of service in identified catchments.

3.3.1.1 Levels of Service

Wellington City has two levels for addressing flood protection for intervention. This approach recognises that the consequences of secondary overland flow vary depending on the location and nature of the adjacent land use. These levels are:

- base level, defined as an unacceptable level of flood protection that should be corrected in the short-term
- intermediate level, defined as flooding problems that can be tolerated in the short-term but should be targeted for longer-term upgrading

Flooding incidents that fall outside of those two categories will be addressed or prioritised as effects dictate and resources allow. The flood intervention levels are outlined in **Table 1**.

Table 1: Flood Intervention Levels

Land use	Intervention trigger		
	Unacceptable situation Trigger for upgrading	**The minimum acceptable (no upgrade considered)**	**Standard for new design**
Arterial roads, major community facilities related to essential services	>1 in 20 years	1 in 50 years	1 in 100 years
Houses, commercial and industrial buildings, internal flooding	>1 in 10 years	1 in 20 years	1 in 50 years
Garages, sheds and unoccupied basements – internal flooding	>1 in 2 years	1 in 5 years	1 in 10 years
Roads, active recreational area, access to property – safe use denied, damage	>2 in each year	1 in 2 years	1 in 5 years
Gardens, yards, passive recreation areas, flooding >150mm deep over more than 20 square meters	>5 in each year	1 in 2 years	1 in 2 years

3.3.2 Flooding

Since around 1980, all new stormwater works in Wellington City where habitable buildings and streets are at risk of flooding have been designed and constructed to convey run-off from storms up to a 1 in 50 year recurrence interval. Areas where this has occurred include areas upstream of the Johnsonville stormwater tunnel, Ballance St, Waring Taylor St, Harris St, Palmer St, Tacy St, much of the Island Bay trunk system, and also where recent renewals have been undertaken in the suburbs.

More recently, many buildings have ground slab construction, there is significant infill and street furniture is common. As a result, street flood flow is now the major source of building flooding, serious complaints, and damages, and the stormwater system capacity is often the perceived cause of the flooding, according to the public.

Around 70% of the city is still served by the older stormwater system designed to convey storms up to a 5 year recurrence interval. As a result of development, much of this system is only capable of conveying run-off from storms of a 1 in 2-year annual recurrence interval, i.e. a 50% annual exceedance probability. Major areas where this occurs are:

- Parts of Wellington CBD
- Parts of Island Bay
- Karori
- Kilbirine
- Lyall Bay
- Miramar
- Newtown
- Ngauranga
- Seatoun

Historically, flood investigations have been triggered as a result of a specific flood event. Stormwater Catchment Management Plans (SW-CMPs) have been completed for 11 of the 34 stormwater sub-catchments. These plans identify known flooding issues, and this information is given in catchment-specific summary reports in **Appendix B**.

Up until 2012/13, there were very few reported flood events. In 2012/13 however, 49 buildings were flooded and many flood-related incidents were reported (**Figure 10**). Some were identified as nuisance flooding due to blockages. Breakdowns of the reported incidents are presented in **Table 2**.

Wellington City has prepared Flood Hazard Maps as part of its Catchment Management Planning process. To date 10 flood hazard assessments have been produced, covering 7,419ha. These maps are based on the 1 in 50-year return period storm event. A freeboard of 300mm is added to the estimated peak flood water level which informs the minimum floor level in each flood risk area and the hazard map information is continually improved (please see the Catchment Characteristics and Issues report in Appendix B for more detail). These Flood Hazard Maps show the more significant flood paths and identify general low areas subject to flooding risk. In most cases, they also provide guidelines for minimum safe levels for house floor construction.

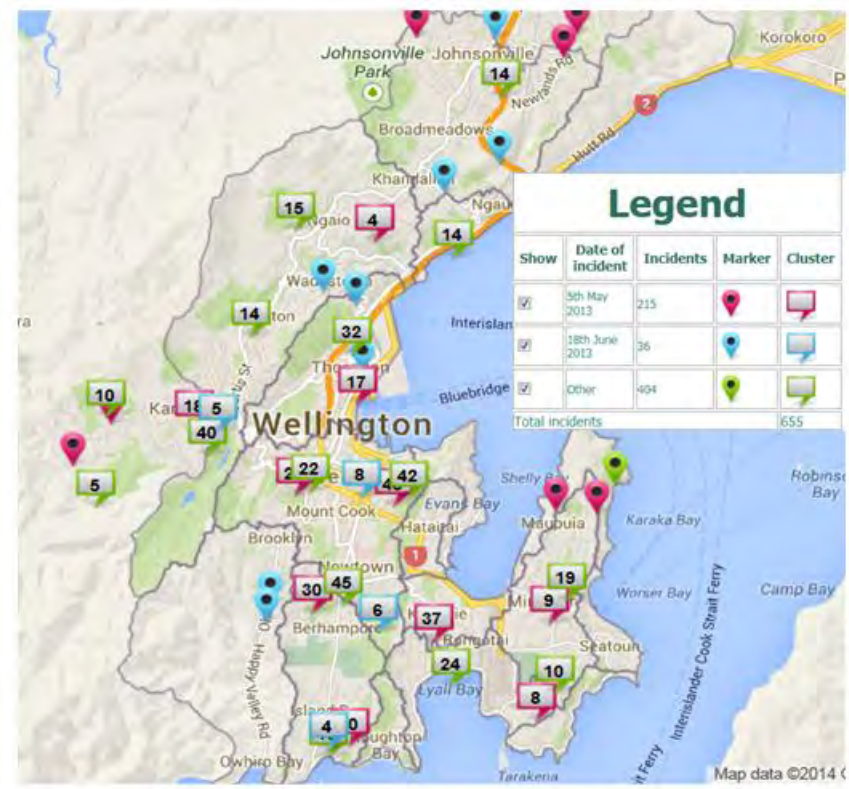


Figure 10: Flood Incidence Records for 2011-2013 for ICMP Catchments

Table 2: Reported Flood Related Incidents

Catchment	5th May 2013 1 in 50 year return period	18th June 2013 1 in 20 year return period	Other incidents Jan 2012 – May 2013
Ngauranga	2	3	16
Kaiwharawhara	15	4	50
Northern CBD	14	4	53
Southern CBD	83	10	64
Oriental Bay	1	0	3
Evans Bay (Hataitai, Kilbirnie and Miramar)	42	1	37
South-east Coast	0	0	12
Lyall Bay west (mainly)	18	2	12
Island Bay	17	5	20
Owhiro Bay	5	2	13
TOTAL	197	31	280

NOTE: Most incidents were identified as nuisance flooding due to blockages.

3.3.3 Overland Flow Paths

Wellington City is geographically confined by hills and the harbour and is regarded as built-up, with nearly all stormwater being carried directly or indirectly to the sea via the piped network.

Any excess above the 1 in 5 year annual recurrence interval (i.e. a 20% annual exceedance probability), is carried via street channels and secondary flow paths. This has been considered acceptable historically

because buildings, shops and houses were generally much higher above ground level than has been the trend in the last 30-40 years.

Overland flow paths have been delineated using the Wellington City 2006 LiDAR dataset (LiDAR) (**Figure 11**). This information (and any updates) will be used in Stage 2 ICMP to investigate flood risks and any environmental risks from secondary flow paths passing through low-lying high hazard areas.

The data presented in this report have been obtained from a high level analysis and as such, results should be considered indicative only. More details are provided in Appendix G.

3.3.4 Depressions

For the high-level identification of potential flood risk areas in this Stage 1 ICMP, depression areas were mapped as areas that would be inundated if no pipe network was present(Appendix G) . The most significant depression areas and secondary flow paths are shown in **Figure 11**. The threshold for defining these depression areas is a flood maximum depth exceeding 150 mm, flood volume exceeding 50 m^3 and the flood area exceeding 500 m^2. There are a number of significant depression areas in all ICMP catchments. Fortunately, these areas are generally drained by large culverts or tunnels.

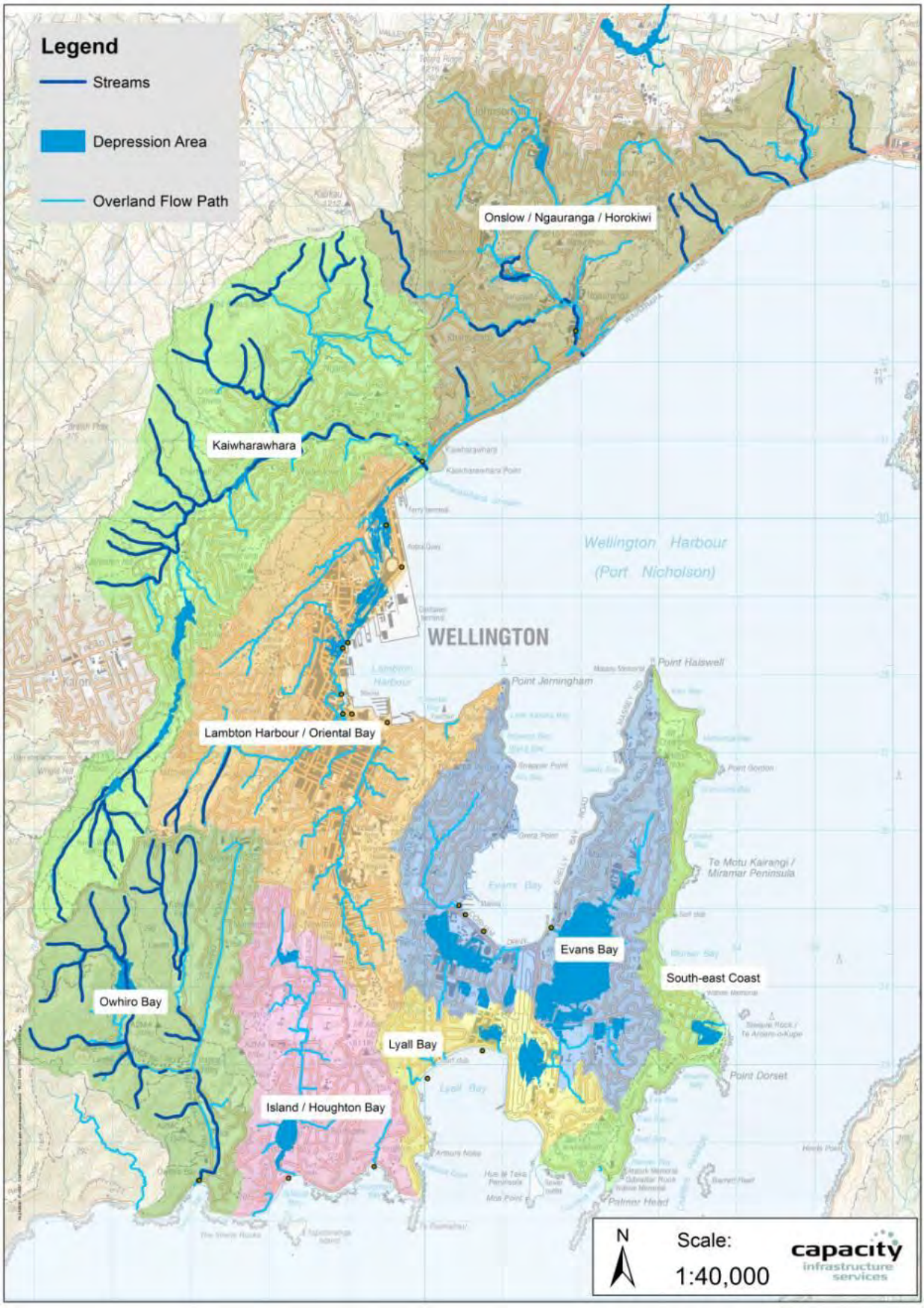


Figure 11: Map of overland flow paths and depression areas

3.4 Wastewater Overflow and Infiltration Issues

3.4.1 Description of the Wastewater System

3.4.1.1 Network

Wellington City has separate wastewater networks. Wastewater problems have beset Wellington since its settlement in 1840, and the wastewater network has grown since the 1880s when the installation of wastewater pipes was first recorded. Prior to this, wastewater, or night-soil as it was referred to then, was buried in convenient places, piped into streams and stormwater pipes, or collected by night carts. Since then requirements and attitudes to wastewater collection and treatment have evolved and developed to a high standard.

In 1899 a proper wastewater scheme was established, which included:

- a wastewater network in the areas around the harbour
- a sea outfall at Moa Point
- a wastewater tunnel through Mount Victoria
- overflows to stormwater systems

Introduction of the new scheme resulted in a substantial decrease in wastewater-related diseases in the city.

The current wastewater reticulation system is conveyed to the Interceptor Wastewater Network, which begins in Ngauranga Gorge, traverses the Kaiwharawhara and Ngaio foothills, passes through Thorndon and the western edge of the central business district, through Newtown and under Mount Victoria before passing through Kilbirnie and the Airport. Most of the wastewater comes from domestic and commercial sources (approximately 70%). Industrial flows comprise less than 15% of the total wastewater flow. Approximately 10 to 15% of the dry weather flow comes from groundwater infiltration into the system.

Much of the Wellington wastewater pipeline system is aged and approximately 32% of it is in poor condition. Inflow and infiltration (I/I) is estimated to account for about 12% of the dry weather flows reaching to the Moa Point Wastewater treatment Plant. The proportion of I/I increases significantly during or immediately after rainfall events and in some wastewater catchments in the City, the ratio of peak wet weather flows (PWWF) to average dry weather flow (ADWF) is as high as 10:1.

The wastewater network also affects the quality of stormwater run-off, because wastewater networks have relief features such as designed overflow structures to enable them to cope with intense weather events or with faults resulting in flows that exceed network capacity.

Stormwater can enter to the wastewater system by:

- surface water running into wastewater manholes or gully traps
- illegal cross-connections between the stormwater and wastewater systems
- infiltration (groundwater seeping into the wastewater pipes via imperfections or cracks in the pipes and fittings)

Conversely, wastewater can gain access to the stormwater system by way of direct inflows from:

- leakage from broken pipes

- wastewater pipes illegally connected to stormwater drains
- wet weather overflows from wet wells in wastewater pump stations and from the constructed overflow weir structures built in strategic locations along the wastewater network

One of the consequences of wet weather I/I is that the mixed wastewater/stormwater flows can exceed the capacity of pump stations and/or the main interceptor or the reticulation network, particularly in the lower parts of catchments, resulting in overflows to stormwater network and hence to the sea. More generally, wet weather I/I increases the rate of leakage of wastewater from wastewater pipes to stormwater pipes throughout the City.

3.4.1.2 Moa Point Wastewater Treatment Plant

Approximately 80% of Wellington's wastewater is collected by the main Interceptor Wastewater network and is conveyed to the Moa Point Wastewater Treatment Plant (WWTP) on Wellington's south coast near Wellington Airport. The Moa Point scheme consists of the WWTP and the associated inlet pump station; the dewatering plant at the Southern Landfill; the sludge transfer pipeline from the Moa Point WWTP to the dewatering plant; a short outfall and a long outfall. The wastewater catchment is approximately 5,500 hectares in area and its collection system includes 48 pump stations and over 820 km of wastewater pipes of varying age and condition.

The Moa Point WWTP became fully operational in January 1998. It receives wastewater from a residential population of approximately 157,000 (2013 projected population). The average daily inflow (ADF) into the plant is 175,000 m^3/day (2030 L/s); while the average daily dry weather flows (ADWF) is 65,200 m^3/day or around 760 L/s. The peak wet weather flow (PWWF) is 3000 L/s. The PWWF: ADWF ratio at Moa Point is approximately 4:1.

The maximum capacity of the treatment plant is 3000 L/s. If the WWTP inflow exceeds 3000 L/s, raw wastewater discharges via the long outfall, approximately 1.8km from shore. If the incoming flow exceeds 4500 l/s, raw wastewater discharges via the short outfall.

Figure 12 shows the number of overflow incidents recorded at the long outfall since 1999. Overflows only happen during heavy rainfall.

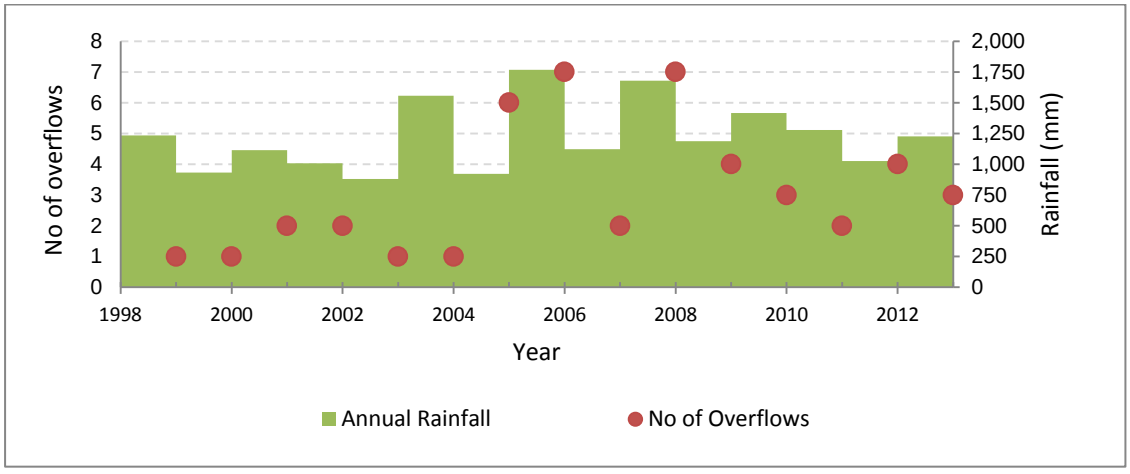


Figure 12: Overflow Incidents recorded at the Moa Point Long Outfall Since 1998

NOTE: Average annual rainfall in Wellington is approximately 1200 mm. The highest overflow incidences were recorded in 2006 and 2008; both years are reported as wet years with annual rainfall of more than1600 mm.

Under normal operating conditions, treated effluent was discharged via the short outfall until 2004, then by the long outfall after 2004. Since then, the short outfall has operated only on one occasion, due WWTP malfunction, but not due to excessive incoming wet weather flow.

WCC projections (2008) suggest that the population served by the Moa Point WWTP may increase to around 175,000 by 2043 (30 years from now, low growth projection), a 29% increase, giving a projected ADWF of approximately 84,000 m^3/day or 980 L/s.

3.4.1.3 Details of Overflow Locations and Assessment

More details are provided in Appendix J

3.4.1.4 Wastewater Inputs to the Stormwater System

As described above, wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. In 1993, a major program of works, the "Sewage Elimination Program", was commenced to reduce wastewater contamination.

Since 1993, Wellington City has been implementing a programme of works aimed at progressively reducing wastewater contamination of stormwater. The key work programmes are a Sewage Pollution Elimination project - a 15 year, $70 million project; the Drainage Rehabilitation Strategy (1998); and an Inflow and Infiltration Reduction Plan (Wellington Overflow Mitigation Plan or WOMP, 2011). The Sewage Pollution Elimination project was successful in meeting its goals of reducing wastewater pollution across the city: persistent dry weather wastewater pollution has been eliminated to an acceptable standard. However, wet weather pollution remains a challenge. The first work programme was scheduled for 15 years (1993-2008). The second work programme was implemented in 2008 and is currently on-going.

The rehabilitation works undertaken since 1993 include cross-connection studies and repairs, removal of constructed wastewater overflows, rehabilitation of known wastewater pipe faults, and pump station upgrades including backup facilities to prevent overflows.

WCC has undertaken works on various wastewater catchments to reduce the occurrence of both dry weather and wet weather pollution of stormwater. Much of this work has been driven by the conditions specified in the stormwater discharge consents to meet water quality standards.

A six-year staged overflow monitoring programme was implemented to record the duration of overflows, when they occur and what conditions cause them to occur. This information was used to design mitigation measures to minimise overflows. The current monitoring programme consists of a selected number of overflow points per year and is summarised in **Table 3**.

Table 3: Current Overflow Monitoring Programme

Monitoring year	Total number of sites monitored	Constructed overflows	Pump stations
Year 1 (2008/09)	14	10	4
Year 2 (2009/10)	33	24	9
Year 3 (2010/11)	28	18	10

Monitoring year	Total number of sites monitored	Constructed overflows	Pump stations
Year 4 (2011/12)	23	15	8
Year 5 (2012/13)	30	17	13
Year 6 (2013/14)	33	20	13

Altogether 59 overflow weir structures (constructed and pump station wet wells) have been included in the monitoring programme since 2008/09.

Data obtained from this monitoring activity has been used to:

- report overflow incidents (i.e. send alerts) to Regional Public Health organisations and interested parties. Data reported on the standard overflow notification form include the flow rate, duration and total volume
- report overflow incidents to Wellington City Council as required by a monthly Service Level Agreement Report
- determine monitoring sites for the succeeding year (sites are dropped after system upgrades result in no further overflow incidents)
- initiate investigations aimed at reducing the frequency of overflows
- provide supporting information for the overflow mitigation plan (a capital works programme)

Monitoring data have recently been augmented by predictions of catchment overflows using the Trunk Wastewater network computer model of the main Interceptor Wastewater. Wastewater overflow from the catchment upstream of the constructed overflow structure at Murphy Street was estimated using a hydraulic network model. This wastewater catchment covers a total area of 1700 ha above the Murphy Street overflow structure. The model was calibrated with monitored overflow data described above, and it calculated frequency and volumes of overflow (**Figure 13**).

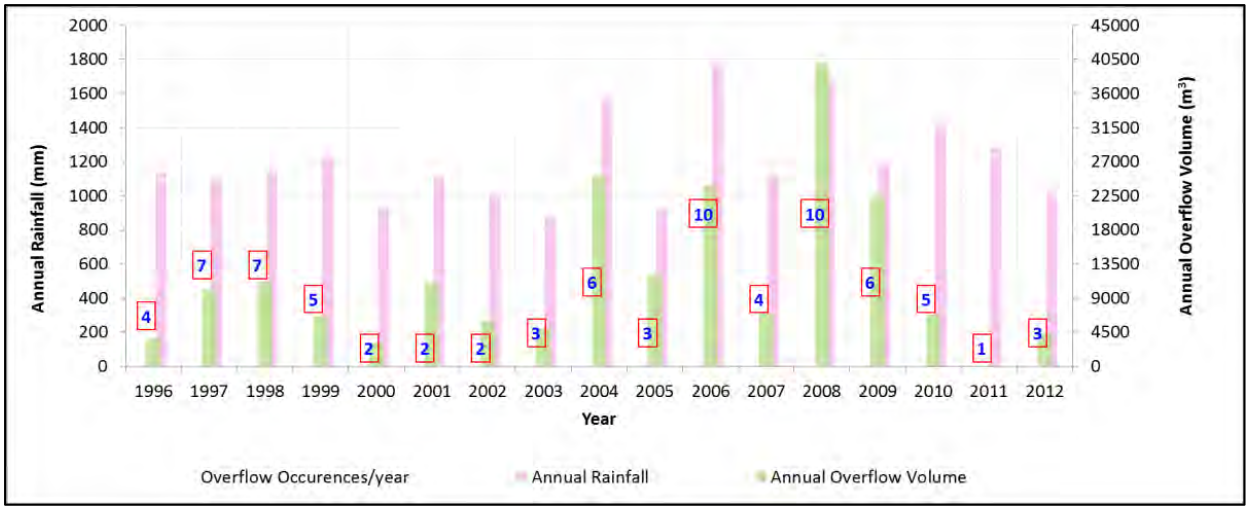


Figure 13: Overflow Volumes and Frequency Comparison - Murphy Street Overflow Structure

NOTE: Average annual rainfall in Wellington is approximately 1200 mm. The highest overflow incidences were recorded in 2006 and 2008; both years are reported as wet years with annual rainfall of more than1600 mm.

Computer modelling and monitoring data indicate that the most significant wastewater overflow point in the City's wastewater network is at Murphy Street (within the main wastewater interceptor), where a constructed overflow provides significant system relief for the downstream network. However, more monitoring and reticulation network modelling is needed to identify overall levels of rainfall-dependent infiltration and inflow around the City.

The average annual over flow volumes for all monitored locations are shown in **Figure 14**. Monitored values for reported incidents since 2008/09 are provided in individual sub catchment "Catchment Characteristics and Issues" reports in Appendix B.

3.4.1.5 Inflow and Infiltration Assessment

Capacity recently commenced a program to assess inflow and infiltration. The wastewater network's performance and potential impacts on the stormwater system were evaluated through two different procedures for the catchments across Wellington. This program is being used to:

- prioritise hydraulic modelling programmes to gain a broad understanding of network issues
- ensure that the wastewater network system performance is being adequately monitored so as to provide accurate asset management information
- determine the extent of inflow infiltration levels in sub-catchments and develop a strategic plan for further investigation and development of mitigation solutions

Catchments were categorised into four different groups for leakiness:

- low: < 5% rainfall-dependent infiltration and inflow (RDII)
- medium: 5% -10% RDII
- high: 10-15% RDII
- significant: >15% RDII

'Low leakiness' indicates that works are not needed. Works are needed for Significant, High and Medium leakiness, in order of priority.

Modelled Inflow and Infiltration

A dynamic wastewater network model was used to determine the network performance of catchments upstream of the Murphy Street overflow. This is a major overflow on the main trunk wastewater system. The model was built, calibrated and verified as part of the Davis Street overflow investigation (Capacity, 2012) in compliance with condition 10 of the consent WGN090219 [27419]. Data from 11 flow gauge locations and four pump stations were used to calibrate and verify the model.

This calibrated model was used to estimate catchment average leakiness and the potential for wastewater contamination of stormwater in "hot spot" areas. Network performance was assessed under different wet weather conditions. From this, Catchment Rainfall-Dependent Infiltration and Inflow (RDII) were calculated. This is mapped in **Figure 14**.

Monitored Inflow and Infiltration

Elsewhere in Wellington, and downstream from the Murphy street overflow, RDII was determined from monitoring data. Since June 2011, six flow monitors have been installed in the wastewater network at strategic locations, which are all located downstream of the Murphy street overflow weir structure. Flow and overflow monitoring has been conducted according to the monitoring guidelines specified in the Regional Flow Monitoring Specification (Capacity, 2012). The data show trends in flows (seasonality,

antecedent conditions, holiday flow periods, population changes and the like) for the flow monitoring period.

Flow data were analysed in terms of the following performance indicators:

- I/I ingress: estimates the volume of rainfall per contributing area to the wastewater system in the form of inflow and infiltration as a percentage [I/I Volume] / [Catchment Area x Rainfall Total]
- I/I leakage: estimates the volume of rainfall per metre of pipe that enters in the wastewater system in the form of inflow or infiltration (Litres/per metre pipe/per mm rain)
- Peaking Factor: the ratio of Peak Wet Weather Flow (PWWF) to Average Dry weather Flow (ADWF). Wastewater reticulation systems are normally designed with a peaking factor of 4-5:1 (Wastewater Network Design Code of Practice). Peaking factors over 5 are an indication of direct inflow problems in the upstream reticulation catchment
- overflow volumes: monitoring data are used to estimate annual average inflows to the stormwater network

The above indicators were calculated for at least five different rain events to generate different wastewater overflow scenarios in order to comprehensively assess the catchment response. These indicators were then used to determine the catchment leakiness (RDII in **Figure 14**), possible wastewater contamination issues and “hot spot” areas where overflows are more likely.

Catchment leakiness calculated for the CBD was assessed to be in the range of 5-10% RDII, which is in the medium category. However, this value was based on limited historical monitoring data from one flow gauge site, which is not sufficient to provide the necessary assessment of network performance at the sub catchment level .Therefore, catchment leakiness for the CBD catchment is not presented in **Figure 14** (the CBD catchment is marked in white). A more detailed assessment will be carried out for this catchment once detailed flow data for sub catchments have been gathered in Stage 2 ICMP.

These findings will be considered when developing work programmes as required by consent conditions 7 h) and 7 g).

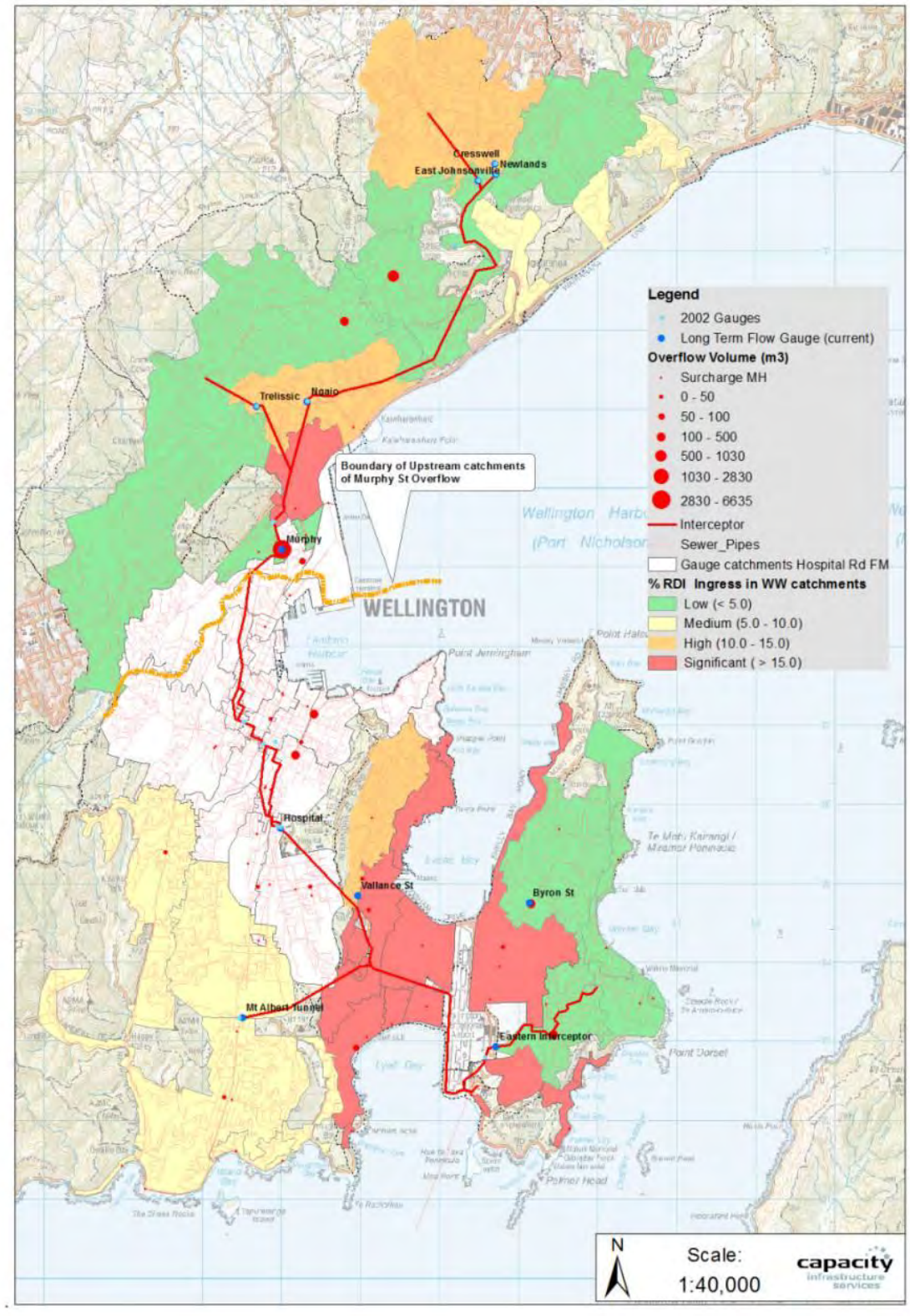


Figure 14: Inflow Ingress and Wastewater Overflows

3.5 Sediment Loads in Stormwater

Fine sediment can be a significant contaminant in urban stormwater and its receiving waters. This is probably not the case in Wellington for several reasons. There is relatively little ongoing urban development and hence bare soil, which is the major source of fine sediment in urban areas. Limited sampling of Wellington's stormwater drains showed fine sediment concentrations were not particularly high (MWH 2008) and were more typical of mature urban areas (Williamson 1993). Coarse sediment (sand, gravel and cobbles) on the other hand, probably forms a significant portion of the total erosion load in Wellington streams, so the proportion of fine sediment will be low compared with that in other areas of New Zealand where fine sediment is an issue (e.g. in Auckland). More importantly, there are no reports or strong indications that urban-derived sediment deposition or discolouration is a major issue in Wellington's harbour or coastline. This is a contrast to Porirua/Pauatahanui Harbours where sediment loads are high and sediment deposition is an issue owing to larger rural catchments and significant areas of urban development.

Before European colonisation, sedimentation rates in the harbour were estimated to be very low (0.3 mm/yr). From the late 19th century to the middle of the 20th century, rates became much higher, due to land clearance (19th century), uplift and redistribution of sediment as a result of the 1855 earthquake, dredge spoil dumping from the Port of Wellington and gravel extraction near the mouth of the Hutt River from the 1930s to around1970. Recent sedimentation rates measured at one site in the middle harbour, about 1 km west of Somes Island, were found to be 2-5 mm/yr. The Hutt River provides the largest sediment load to the harbour, which has been estimated in tonne per annum.

Estimates of annual sediment loads entering the Wellington harbour from different catchments are shown in **Table 4**. No measurements have been taken for the catchments, but limited sampling in some stormwater drains shows that concentrations are relatively low compared with stormwater quality in other parts of New Zealand.

The largest urban inputs of sediment are the stormwater discharges to Lambton Harbour, under Aotea Quay, and the Kaiwharawhara and Ngauranga Streams.

Table 4: Estimated Sediment Loads Entering Wellington Harbour

Catchment	Area (km^2)	Annual sediment load (tonnes/yr)
Hutt River	615	132000
Kaiwharawhara stream (including urban areas)	16.8	1300
Ngauranga stream (including urban areas)	9.2	600
Wellington Harbour urban area (Lambton Harbour, Kaiwharawhara, North Coast, Evans Bay)	56.5	2200

Note: This is an approximate estimation only. Open space and rural estimations are based on NIWA's Water Resources Explore Model and urban yields are based on a global average. Detailed monitoring is recommended to develop Wellington-specific yields.

The Hutt River provides the largest sediment load to be deposited into the harbour (**Table 4**). If these load to be equally distributed and settled over the whole harbour, it would give a deposition rate of about 1 mm/year (for 85 km^2 harbour). If this load were to be distributed over the eastern harbour (about 28 km^2), it would be about 3 mm/year. However, it is likely that a high proportion of the Hutt River load leaves the harbour during northerly winds. Overall, the differences between measured and calculated rates are inconclusive, which renders the development of a useful receiving water model which takes into account the effect of dilution by uncontaminated sediment, more difficult.

Ship movement and propeller disturbance is a major sediment transport factor near wharves. The effect is clearly noticeable within 50m of wharves but visible turbidity can be observed in ships' wakes approaching and leaving the port, so propeller effects could be a factor in sediment and contaminant distribution beyond 50m from wharves.

Winds have a strong effect on the turbidity of Wellington harbour waters, and it is likely that fine sediment and associated contaminants are re-suspended and dispersed from the northern shore and throughout Evans Bay. The sediment transport process within the harbour is shown in **Figure 15**. The dispersion of contaminants from different urban catchments will probably overlap due to the complex nature of the transport process.

Overall, while a qualitative picture emerges of where discharged sediment may be deposited; quantitative estimates of deposition rates near Wellington City (Evans Bay, Lambton Harbour and the Northern Coast) have not yet been developed.

Urban-derived sediments beyond the mixing zone will dilute contaminant concentrations accumulating in the harbour, but because sediment loads are estimated to be relatively low, the effect will be relatively minor.

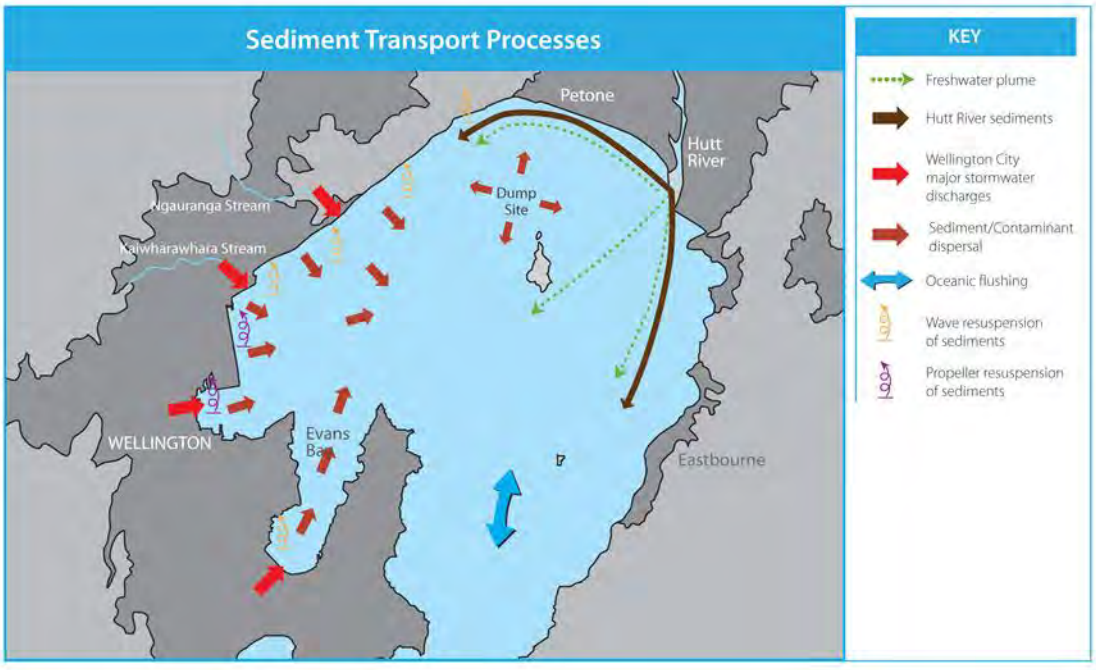


Figure 15: Expected Sediment Transport Processes in Wellington Harbour

Note: The dredge spoil dump site is marked as "dump site"

4 Stormwater Catchment Characteristics and Descriptions

This section of the report addresses the requirements of condition 7 by summarising the available technical information for the Wellington City stormwater catchments under the following broad headings:

1. stormwater catchment characteristics and description, discussed under the subheadings of the items listed in condition 7 a) i to vi
2. identification and description of stormwater network issues and contaminants, discussed under the subheadings of the items listed in condition 7 d) - 7 e)
3. assessment of effects on the coastal receiving environment, discussed under the subheadings of the items listed in condition 7 f)
4. management options for 2 and 3 above

Detailed technical information for each of the 17 stormwater catchments is provided in Appendices B1-B17.

Further detailed information relating to values, environmental quality, physical and chemical contaminant loads and trends, and an assessments of effects as required by conditions 7 a), 7 a) vi, 7 e) and 7 f) are provided in Appendices C1, C2, D, E, G, J and K.

Maps of the eight stormwater catchments and their sub-catchments and respective receiving environments characteristics, features, descriptions and assessments are summarised in sections below.

4.1 Evans Bay

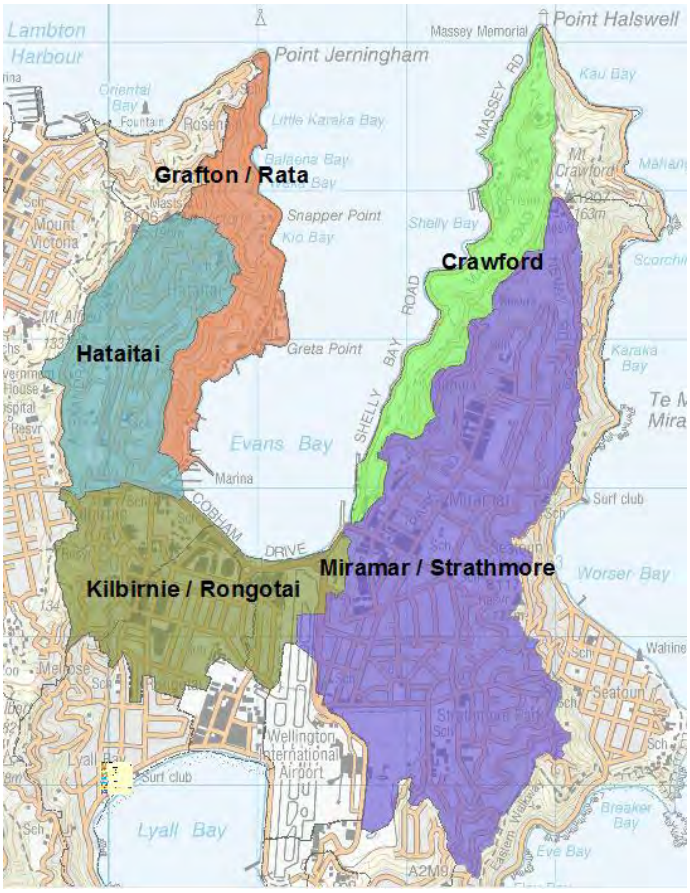


Figure 16: Evans Bay catchments

4.1.1 Overview

Evans Bay is a large, semi-exposed bay on Wellington Harbour. It stretches from Pt Jerningham east of Oriental Bay, to Pt Halswell below Mt Crawford and has an area of 4.5 km^2. It is a major amenity for Wellington for port and boating activities and for recreation. It receives stormwater from the suburbs of Rata, Grafton, Hataitai, Kilbirnie, Rongotai, Miramar and Mt Crawford (**Figure 16** and **Table 5**). Most stormwater is discharged at the head of the bay.

Table 5: Evans Bay Catchment Characteristics

Sub catchment	Area (ha)	Land Use	No. of Outfalls	WW pumps stations and constructed overflow locations
Crawford	100	Parks and reserves	Minor outfalls to Shelly Bay	--
Grafton / Rata	84	Older residential	2 moderate and many minor outfalls	PS14, PS15 and PS16
Hataitai	126	Older residential & town belt	1 major culvert	2 CSOs and PS42
Kilbirnie	130	Older residential, shopping and commercial	1 major culvert	PS17 and PS18

Rongotai	18	Older residential suburban, Airport	1 major culvert	
Miramar	394	Old & new residential, shopping, commercial and light industrial	1 major culvert	PS23, PS24 and PS30

4.1.2 Stormwater Catchment Characteristics and Descriptions

4.1.2.1 General

The Evans Bay Catchment is formed by the natural ridgelines leading to Mt Victoria in the west, Mt Crawford in the east, (**Figure 16** and **Figure 17**). The catchment is predominantly residential with some large green spaces, e.g. the town belts in Hataitai, Mt Crawford. This catchment is serviced by major shopping centres at Kilbirnie, Rongotai and Miramar. Employment areas are concentrated in the south of the catchment at commercial and light industrial premises and at the airport.

The Miramar basin is surrounded by ridges on all sides. The catchment historically would have drained naturally to the south-east corner of Lyall Bay. However, uplift and the ground reclamation and raising of the ground level for the airport now form a topographical obstruction. The lowest point of the basin is 2m below the ground surface at the Miramar cutting (the lowest 'exit point' of the catchment), which is at approximately 4m RL.

The cliff-top area of Crawford is well covered with bush and native vegetation, with impressive views over Wellington Harbour.

Detailed information regarding the catchment characteristics is provided in Appendices B1, B8, B9 and B10.

4.1.2.2 Land use

The Evans Bay catchments are predominantly urban-residential areas. About 50% of the catchment area is covered with impervious. The major sources of stormwater contamination are vehicle emissions, run-off from roads, general run-off from residential and commercial properties, and occasional illegal discharges of contaminants into the stormwater system.

Grafton/Rata and Hataitai have very little commercial or light industrial land use (business centres etc.). The Kilbirnie/Rongotai catchment is characterised by moderate commercial and light industrial land use, including part of the airport runway and the bus depot. The Miramar catchment also includes significant areas of commercial and light industrial land.

4.1.2.3 Other Facilities

Descriptions of other types of facilities are provided in the Catchment Characteristics summary reports in Appendices B1, B8, B9 and B10. These include:

- 7 a)iii. The location and description of industries and other high risk facilities (e.g., landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices , (locations, maintenance regime and descriptions are provided in Appendix K)

- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, (constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

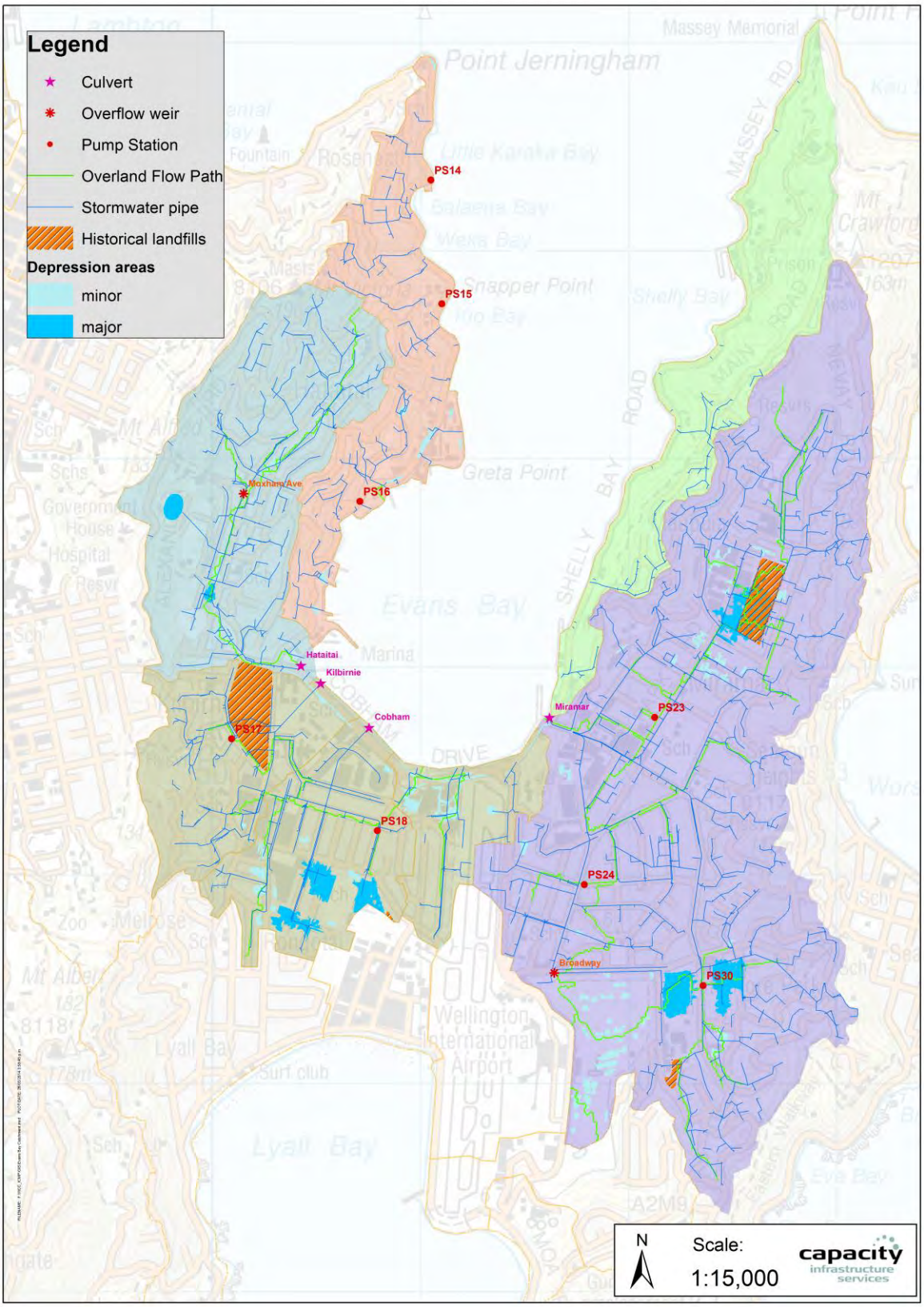


Figure 17: Evans Bay Catchment Features

4.1.3 Description of Values and Receiving Environment

Detailed descriptions of the ecological quality of the receiving environment are provided in Appendix C1. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi during Stage 2.

4.1.3.1 Receiving (Discharge) Environment

Four major outfalls discharge into the head of Evans Bay: one outfall discharges near Miramar wharf (from the Miramar stormwater catchment), two outfalls discharges near Cobham Drive and Evans Bay marina (from the Kilbirnie stormwater catchment) and one outfall discharges into Evans Bay marina (from the Hataitai stormwater catchment).

Several minor outfalls drain the slopes of the Miramar Peninsula in the east and the slopes rising steeply above Hataitai Beach, Greta Point, Kio Bay and Balaena Bay, on the western side of Evans Bay. The Grafton/Rata stormwater system is a series of minor stormwater catchments which drain directly to the coast through small outfalls. This area includes parts of Hataitai and Roseneath. The Crawford stormwater drainage system discharges through a series of small outfalls along the coast.

Evans Bay is a sheltered bay which is protected from deep ocean swells and is subject only to waves produced by local winds. Wave energies will be low in the middle of the bay but are probably high at the head of the bay where the largest stormwater discharges occur. Ship and boat movements may cause re-suspension and dispersal of sediment near the wharves and marina.

4.1.3.2 Amenity and Recreational Uses

Amenity and recreational uses are depicted in **Figure 18** for Evans Bay. Cultural values have not been mapped, because consultation with Iwi is still in progress.

Activities at the head of the bay are predominantly related to boating and shipping, e.g. port and marina activities, boat launching and kayaking. Some secondary contact recreation occurs as a result of these activities and via wading in the shallow waters near the marina. Passive recreation in the form of walking and sight-seeing also occurs. In contrast, the outer half of the bay is used predominantly for recreational activities involving primary contact – swimming, kite and wind surfing, scuba diving and snorkelling, as well as boating and fishing.

Balaena Bay and Hataitai Beach are inner-harbour pebble beaches on the western side of Evans Bay, adjacent to Evans Bay Parade. Hataitai Beach is small but picturesque - it lies between rustic boat sheds and the re-developed Cog Park, and there are often yachts moored not far off shore. Both Balaena Bay and Hataitai Beach are mostly used for swimming and launching small boats and kayaks.

Shelly Bay and Shark Bay have secluded rocky coves nearby and are popular picnic and swimming spots, with access to walkways on Mt Crawford. Shelly Bay is the site of a former air force base. Its military history began with the construction of the Submarine Mining Depot Barracks in 1887. It then became a naval base from 1907 to 1946, when it was transferred to the Royal New Zealand Air Force. The facility was finally closed in 1995. In 2009 the land was handed over to Taranaki Whanui ki Te Upoko o Te Ika as part of a Treaty of Waitangi settlement.

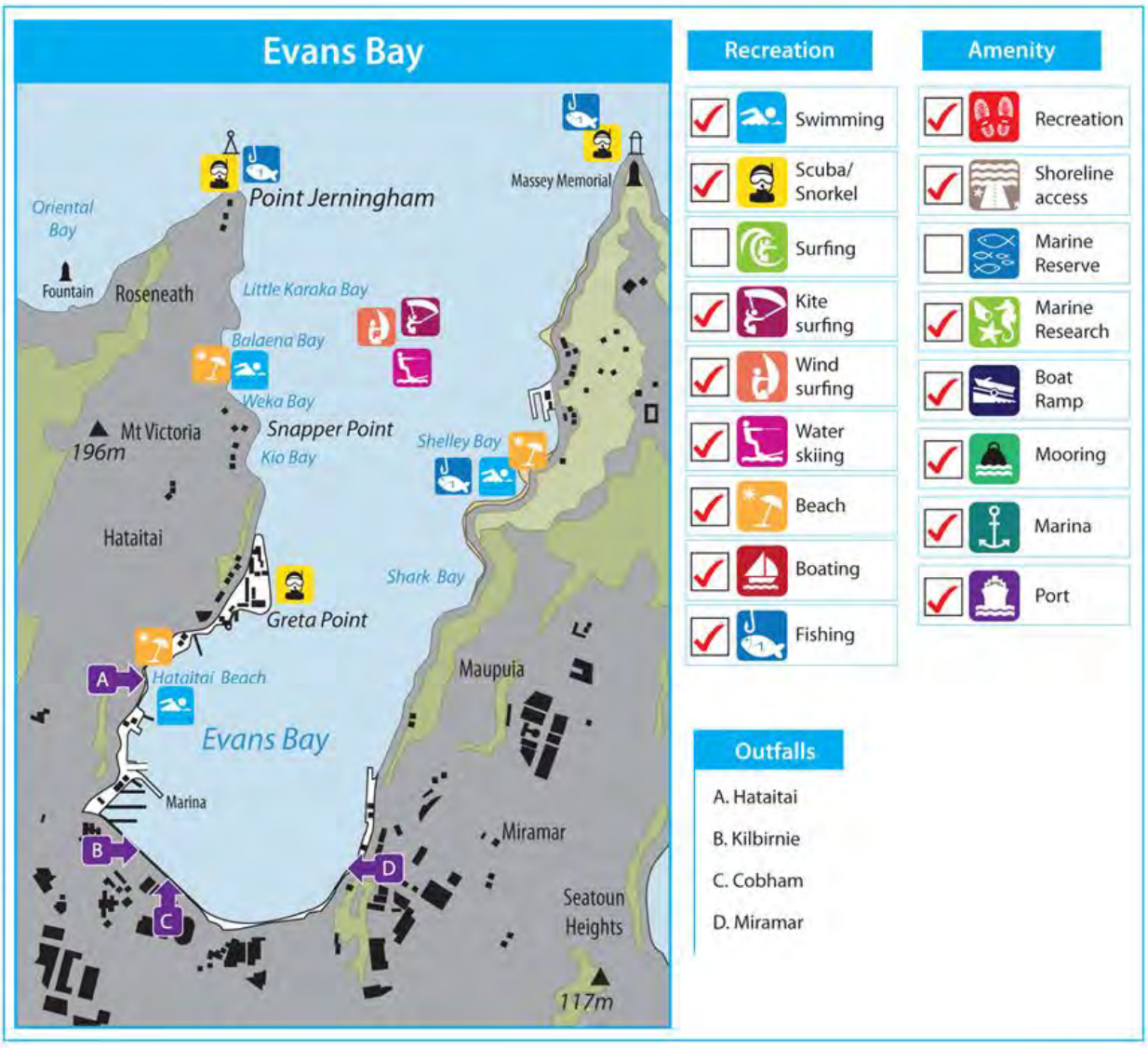


Figure 18: Amenities and Recreational Values at Evans Bay.

NOTE: Amenities are shown on the key only. Recreation activities are shown on the key and their locations are also shown on the map. .

4.1.4 Stormwater Network Issues and Contaminants

4.1.4.1 Flooding

Currently there are no known significant flooding issues in the Hataitai catchment. However the topography of the catchment means that the main secondary flow path is through the suburban centre and a number of residential properties. The trunk stormwater network is generally between 75 and 110 years old, and therefore the older parts are approaching or have reached the end of their expected life.

Regarding the Kilbirnie / Rongotai catchment, surface flooding was reported throughout the catchment during the 6 May 2013 storm event, with a number of buildings along Kilbirnie Crescent and Bay Road being flooded.

Flooding was a frequent problem in Miramar catchment until the existing stormwater network system and outfall was constructed. There has been a long history of flooding in Miramar, with a number of

significant events during the last 20 years. The number of flooding complaints recorded by Council during and after the February 2004 storm far exceeded those received for previous storms. Surcharging of the main trunk stormwater pipelines contributed to all ponding experienced in the flat part of Miramar during the 2004 storm. It should be noted that in many cases, secondary overland flow paths running off the hillsides also contributed to these ponds, but surcharging of the main trunk pipelines is considered the more fundamental issue.

There are currently no known significant flooding issues in the Crawford, Grafton and Rata catchments. Flood risk in the low lying areas along the coast road is however likely to be exacerbated by a future sea level rise as this will affect the operation and maintenance of stormwater outfalls.

4.1.4.2 Contaminant Types, Sources and Loads in Stormwater

4.1.4.2.1 Sediment Loads

City-wide sediment loads are discussed in Section 3.5

4.1.4.2.2 Diffuse Sources

Catchment-wide contaminant sources include roofs and other building materials found in older and new urban areas, traffic (largely residential), road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, and wild and domestic animals. Vehicles (tires, brake linings, oil leakage, and exhaust) are a significant generic source. The significant extent of commercial and light industrial areas, including the airport, suggests traffic densities are moderate to heavy in parts of the catchment. The Crawford area, being mostly open land with through roads and small pockets of residential land use, would be a minor source of contaminants.

4.1.4.2.3 Wastewater Inputs

More details are provided in the sub catchment summary reports in Appendices B1, B8, B9 and B10.

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. Wastewater rehabilitation works undertaken since 1993 include cross connection studies and repairs, removal of constructed wastewater overflow, rehabilitation of known wastewater pipe faults, and pump station upgrades, including backup facilities to prevent overflows.

4.1.4.2.4 High Risk Facilities (Potential 'hot spots')

No landfills are currently operating in the catchment (Hataitai, Grafton and Rata). However closed landfills are located beneath Miramar and Kilbirnie Parks. A former Wellington Gas Company gasworks site in Miramar, which operated from 1915 to 1972, caused significant levels of shallow groundwater contamination in that vicinity. Oils have also been detected in sediments near Miramar wharf in the southern bay, and are likely to be sourced from seepage or spillage.

4.1.4.2.5 Loads of Chemical Contaminants

The chemical quality of stormwater has not been measured in these catchments, but it is likely to be in the middle of the urban stormwater contamination range, based on extensive information collected in Wellington and other parts of New Zealand which reveals high concentrations of stormwater related heavy metals, especially Cu, Pb and Zn in drains and catch pits.

The chemical quality of stormwater has not been measured. Stormwater loads of Zn, Cu, Pb and PAH from the catchment are moderate. The catchment area is about 12% (of total Wellington area) and predicted loads in Lyall Bay are about 14% of the total stormwater load from Wellington. The annual loads (the mass of contaminant) are moderate for Wellington, a reflection of a well-developed, predominantly residential area.

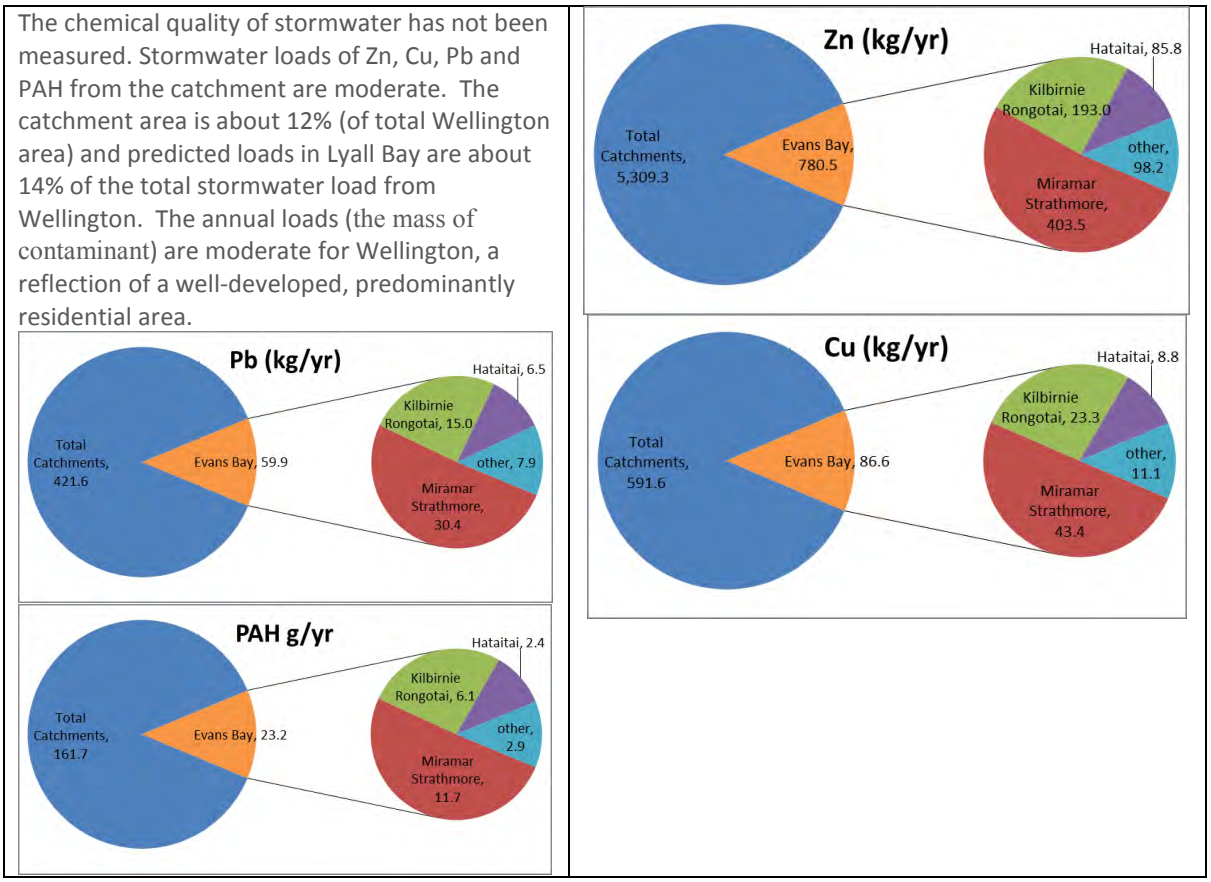


Figure 19: Estimated Chemical Loads in the Evans Bay catchment

4.1.4.2.6 Wastewater Contamination

Bacteriological monitoring at four outfalls shows significant improvements in quality since 1992 (Detailed information is provided in Appendix D and E). Recent monitoring indicates low contamination from wastewater during dry weather and wet weather at the Cobham and Kilbirnie outfalls, but there can be high dry weather and wet weather contamination at Hataitai and Miramar.

4.1.4.3 Prediction of Future Trends in Key Chemical Contaminant Loads

Present day discharges are expected to lead to a gradual increase in the concentrations of Zn, and to a lesser extent Cu, in bay sediments. It is unlikely that the present day concentration levels in stormwater are sufficient to increase concentrations of these contaminants in the bay sediment. Much of the current contamination is due to past discharges and activities. It is possible that transport and dispersal processes will gradually reduce the concentrations of these contaminants.

4.1.5 Assessment of the Effects of Contaminants

Urban stormwater has the potential to affect:

- the aesthetic quality of the water in the southern parts of the bay;
- human health mostly through secondary recreation activities such as swimming, kite and wind surfing, scuba diving and snorkelling;
- marine organisms in the bay

4.1.5.1 Aesthetics and Gross Pollutants

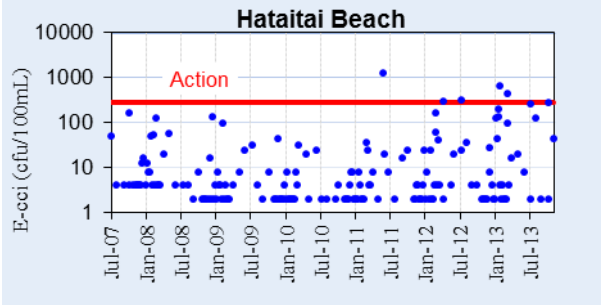
A persistent hydrocarbon odour, reported oil surface films and minor scum and froth compromise aesthetics at the Miramar outfall, (**Figure 21**). A number of investigations of the source have been conducted by Capacity but the source has not yet been identified.

Some scum & foam, floating and suspended matter, oil and grease, biological growth and die-off, as well as discoloration have been observed at the Hataitai and Kilbirnie SW outfalls. These outfalls are located in sheltered waters of the marina, which itself may be contributing to these problems. At the Cobham culvert further along the southern shores of Evans Bay, aesthetics factors are generally observed to be good.

Along the northern shores of the bay, aesthetics are affected by debris, including plastic litter, from time to time. Local stormwater runoff may be one source, along with street littering.

4.1.5.2 Human Health

Suitability for recreation, in compliance with the Suitability for Recreation Grades protocol, is monitored at four beaches in Evans Bay (detailed information is provided in Appendix E). Suitability for full body immersion is measured, i.e. for the primary contact that occurs in swimming, surfing, scuba diving, and snorkelling, and water-skiing. The grades are currently "Good" at the four monitored sites (**Figure 20**). Occasionally the action level is breached, but this is short-lived and has not necessitated the erection of warning signs (see **Figure 20**). No monitoring of microbiological quality in the receiving water takes place near any of the major outfalls in the head of the bay, but there is little recreational activity here.



Bathing beach quality (as measured by enterococci – E-cci) at Hataitai Beach, the closest beach to the major stormwater outfalls. Similar results are found at Shark Bay, Balaena Beach and Koi Bay. The action levels are occasionally exceeded mostly during rain events, but these events are short lived.

Figure 20: Measured Enterococci values at Hataitai beach

The test carried out on blue mussels in 2006 at Shark Bay and Point Jerningham showed the water was clear of any contaminants and at Shark Bay; it was fully compliant for shellfish gathering and consumption.

The beach and shellfish monitoring suggests that bacteriological pollution of the bay is low, and that it should not affect recreational uses over most of the bay, most of the time.

4.1.5.3 Chemical Contaminants

A number of studies have measured chemical contamination in the bay. Very high levels of heavy metals (Zn, Pb and Cu) have been found within 50m of Miramar and Kilbirnie outfalls. These high concentrations and their rapid decrease with distance from the stormwater outfalls are not surprising.

High concentrations of polynuclear aromatic hydrocarbons (PAH) and total petroleum hydrocarbons (TPH) were also found close to the Miramar outfall, and as mentioned above, this may be partly attributed to the former gasworks. They may also be due to the historical use of coal tar (a by-product

of the gasworks) for roading adhesive or are perhaps the result of spillage of petroleum products during port activities.

Over the wider bay area, Pb, Hg, DDT, Cu and Zn exceed sediment quality guidelines. These guidelines are used to signal the possibility of harmful effects on benthic animals that live in and on the sediment of the bay.

PAH, Pb, DDT and Hg are not currently being discharged in sufficient quantities in urban stormwater to have led to such high levels of contamination, but stormwater may have carried high loads of these substances in the past (termed “legacy contamination”). However, there may have been other sources, such as industrial discharges, spillage during port operations, and leaching and cleaning of antifouling paints from ships and boats.

Chemical contamination is summarised at three monitoring sites in **Figure 21** which shows the current degree of contamination (legacy contamination), the degree of contamination by Zn and Cu (present day stormwater contamination), and an indication of the concern for build-up of toxic contaminants from further stormwater discharges (future stormwater contamination).

Figure 21 also shows a strong gradient from the head of the bay to the mouth of the bay. Legacy contamination is found throughout the bay, while present day stormwater heavy metals are of concern now and for the future in the southern bay.

Despite the level of contamination in the bay, a survey of blue mussels in 2006 found that they were not especially contaminated nor were concentrations much greater that levels found in mussels at more remote locations on the east coast.

4.1.5.4 Ecological Effects

The high levels of heavy metal contamination found close to outfalls have a strong effect on the ecology near the outlets, with large decreases in the types and numbers of animals. However, this biological effect could also be partly due to frequent high flows, coarse sediments, and enrichment with organic matter, salinity changes and other contaminants.

These strong biological effects diminish rapidly with distances of 30 -50m from the outfall. Further offshore, where samples are more indicative of the overall ecological health of the bay, and in the southern part of the bay, ecological monitoring has distinguished “moderate” biological effects. In the northern part of the bay, effects are slight (classified as low-medium on **Figure 21**). Minor or no effects are only found towards the middle of Wellington Harbour at considerable distances (4-6 km) from the bay.

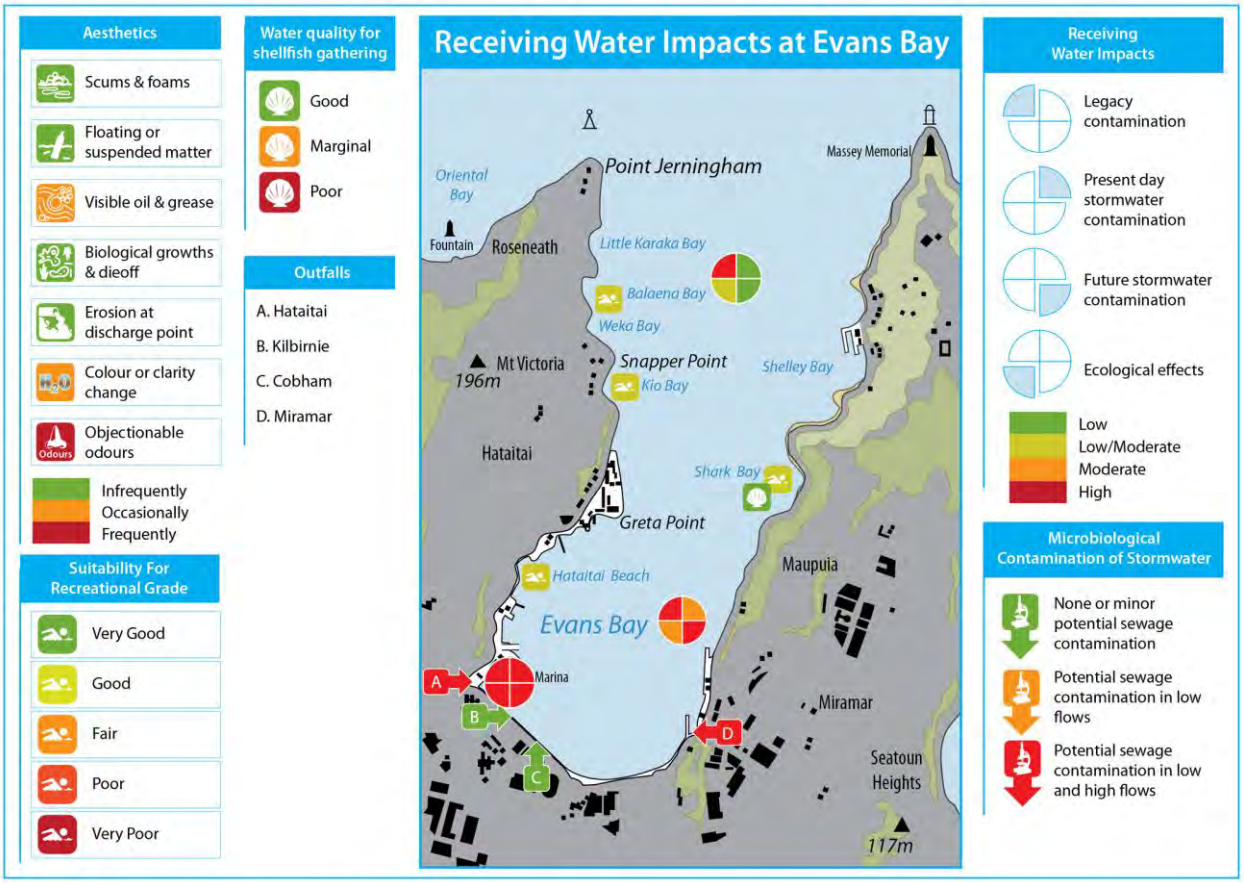


Figure 21: Stormwater Impacts in Evans Bay

4.1.6 Stormwater Management Options

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

4.1.6.1 Quality

- Monitoring will continue for faecal coliforms and enterococci in the outfalls and beaches, and investigations also will continue into the source of apparent wastewater contamination in the outfalls.
- Managing stormwater discharges in terms of the chemical contamination of the bay and the accompanying ecological effects requires an understanding of the relationship between historical, current and future contaminant inputs and fate, and is more complex (and hence more uncertain) than managing stormwater discharges in terms of microbiological contamination.
- Continue to monitor harbour sediments (in 5 years time)
- Continue to apply source controls and other best management practices to any urban development as prescribed in the WCC Codes of practice.
- Address other preventable sources of these contaminants such as spillage and illegal disposal or discharge of contaminants and antifouling paint residues from boat cleaning.
- The Stage 2 ICMP should also recommend any other necessary rules to minimise the cumulative negative impact of development on stormwater runoff.

4.1.6.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

4.1.6.2.1 Hataitai

- NZTA is planning to widen SH1 along Wellington Road and Ruahine Street, with detailed design currently forecast for 2016 and construction expected to begin in 2018. It is envisaged that the trunk stormwater network from near Goa Street downstream to the outfall could be upgraded as part of this project. Hydraulic analysis and condition assessment of the trunk stormwater system should be carried out prior to commencement of the NZTA project, so that any upgrade requirements can be programmed accordingly. In this regard it is proposed that a detailed catchment model be completed as part of the Stage 2 ICMP.

4.1.6.2.2 Kilbirnie

- A range of water quantity management options has been investigated (Capacity, Kilbirnie CMP, 2010) to manage flood risks within the catchment. Several options were investigated:
    - Soak-pits
    - Supplementary or bypass drains
    - Upgrading of existing drains
    - Pump stations
- Further investigations including hydraulic modelling are currently being carried out to mitigate flooding in the Kilbirnie West catchment. A detail investigation will be outlined in the Stage 2 ICMP.

4.1.6.2.3 Miramar:

- The following flood mitigation options were identified after 2004 flooding incidents:
    - Trunk stormwater upgrading
    - Upgrading of stormwater drains in the Weka street catchment
    - Upgrading of hill side-line catchments
    - Localised upgrading around individual properties in Stage 2
- The stormwater management plan for Miramar catchment recommended that:
    - Low and medium cost works should be programmed for construction
    - Longer-term practices, investigations and works should be carried out or put into place as appropriate.
- In 2005 and 2006, the works were implemented which mitigated flood risk through localised drain upgrades, improved secondary flow paths and sump upgrading. This included a localised stormwater upgrade in the Weka Street / Darlington Road area which improved flood protection up to a 2% AEP event for one of the five properties that had been flooded more than once in ten years.
- Between 2007 and 2009, floor levels were raised for a further four properties that did not meet the minimum flood protection level of service outlined in the Stormwater Asset Management Plan.

- Model upgrade: the existing detailed catchment model (which is now 16 years old and requires a number of improvements) may be updated as part of the Stage 2 ICMP. The model will be used to update flood hazard maps and minimum floor level requirements.

4.1.6.2.4 Crawford and Karaka Bays:

- No significant flood mitigation investigations have been carried out to date. Detailed investigation will be carried out in Stage 2

Figure 22: Stormwater outfall Kilbirnie

4.2 Lambton Quay-Oriental Bay

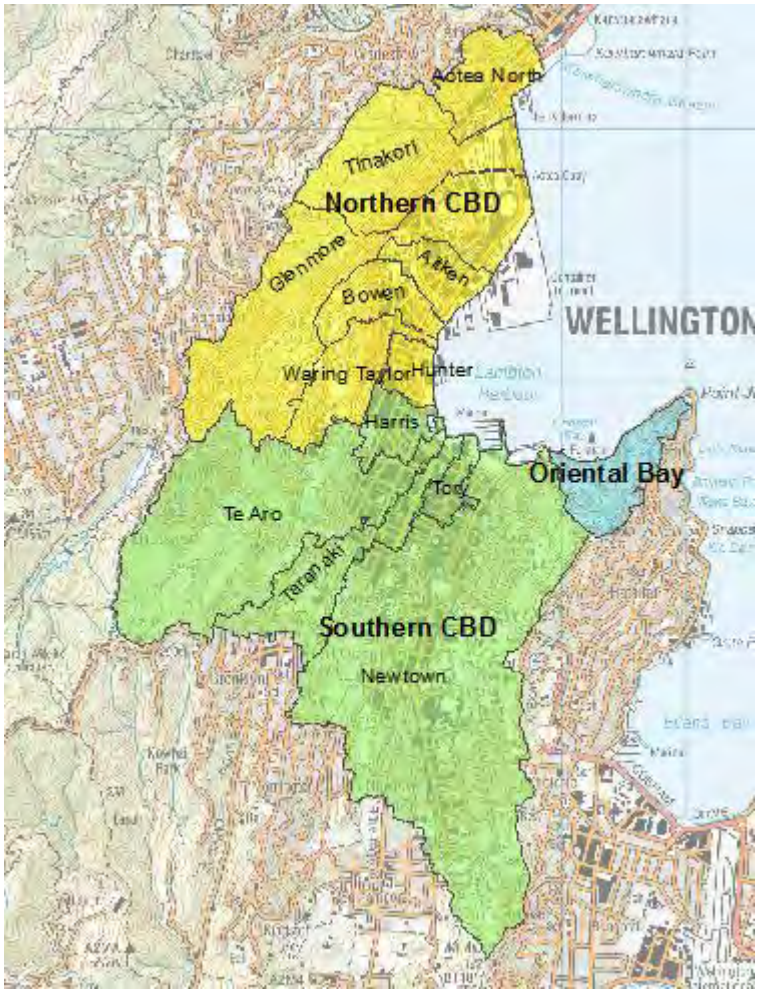


Figure 23: Catchments Adjoining Lambton Harbour

4.2.1 Overview

Lambton Harbour covers the north-eastern corner of Wellington Harbour. It stretches from the northern coast along Aotea Quay to Lambton Basin, and the beach front of Oriental Bay. Its commercial amenities include the Port of Wellington, Inter-island ferry terminals, and a large marina. Recreational amenities include the waterfront of the CBD, Oriental Bay beaches and boat launching and mooring facilities.

The catchment of Lambton Harbour (including Aotea Quay and Oriental Bay) drains the northern and western slopes of Mt Victoria and the large basin comprising the CBD and Newtown. It includes parts of the CBD, Newtown, Vogeltown, Mount Cook, Mount Victoria, Tinakori, Highbury, Northland, Kelburn, Thorndon, Oriental Bay and Roseneath.

Table 6: Lambton Harbour Catchment Characteristics

Sub catchment	Area (ha)	Land Use	No of Outfalls	WW pumps and constructed overflow weirs
Aotea North	47.7	Residential/ commercial and industrial. Railway yards and wharves. Heavy traffic (motorway). Part of Town belt. Port workings	2 at Inter-Islander terminal	--
Tinakori	112.4	Residential/ commercial and industrial.	2 at Aotea Quay Originally Wai-Paekaka Stream	PS12, PS13
Glenmore St	197.4	Predominantly residential and business. Port workings. Part of Botanic Gardens and Town belt.	1 near Stadium the Pipitea Stream	Murphy St CSO, PS10, PS111, PS21
Aitken	28.7	Predominantly residential and business.	2 at Bunny and Pipitea quay	--
Bowen	37	Inner city, Residential and commercial. Port workings	1 at Whitmore Street, originally the Waipiro Stream	PS09
Waring Taylor	51.2	Predominantly residential, 28% central city, 12% open space. High traffic density	1 at Waring Taylor originally the Kumutoto Stream	--
Hunter	18.6	All within CBD. Commercial. High traffic density	4 (minor)	--
Harris	26.6	All within CBD.	1	PS06
Te Aro	241	Residential, commercial and industrial. Heavy traffic.	1 near Taranaki Originally Waimapihi Stream (also called the Aro Stream or the Polhill Stream)	--
Taranaki	71.7	Residential, commercial and industrial. Heavy traffic.	1 near Taranaki St	PS05
Tory	15.4	Residential, commercial, some industrial. Heavy traffic	1 at Tory St	--
Newtown	468.4	Residential and significant commercial, light industry.	1 at OPT originally by the Waitangi Stream	Drummond St CSO, PS02, PS03 and PS04
Oriental Bay	49.2	Urban residential with Town Belt reserves and scrub	--	PS01

4.2.2 Stormwater Catchment Characteristics and Descriptions

4.2.2.1 General

There are three major stormwater catchments discharging into Lambton Harbour (**Figure 23**). The Southern CBD catchment consists of seven stormwater sub-catchments. The largest is the Newtown catchment which encompasses 448 ha of Newtown, Vogeltown, Mount Cook, Mount Victoria and part of Courtney Place. The Northern CBD discharging under Aotea Quay consists of two stormwater sub catchments, Glenmore St and Tinakori. These catchments include Highbury, Northland, Kelburn and Thorndon. Oriental Bay/Roseneath is a residential area on the northern side of Mt Victoria, and is drained by a series of minor stormwater collection areas. **Table 6** summarises key features of each catchment and **Figure 24** shows catchment characteristics.

Detailed information on catchment characteristics is provided in Appendices B6, B7 and B8.

4.2.2.2 Land use

The Southern CBD catchments are predominantly inner city commercial and high density residential, with significant port and railway areas, motorways, and light industrial and green spaces. Traffic densities are very heavy and include many truck and rail movements.

The northern CBD catchments have large areas of open space (Botanic Gardens and Tinakori Hill) and low-medium density residential in the upper parts, but significant port and railway areas, motorways, commercial and light industrial in the lower regions. Traffic densities are very heavy and include many truck and rail movements.

Land use in the Oriental Bay catchment is predominantly residential, but also includes a number of cafés, restaurants, the Freyberg Swimming pool, and the Port Nicolson Marina. Traffic densities are likely to be moderate. Diffuse urban-sourced pollution is probably in the low-middle end of the urban contamination range.

4.2.2.3 Other Facilities

Descriptions of other facilities are provided in Appendices B6, B7 and B8. These include:

- 7 a) iii. The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, (constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

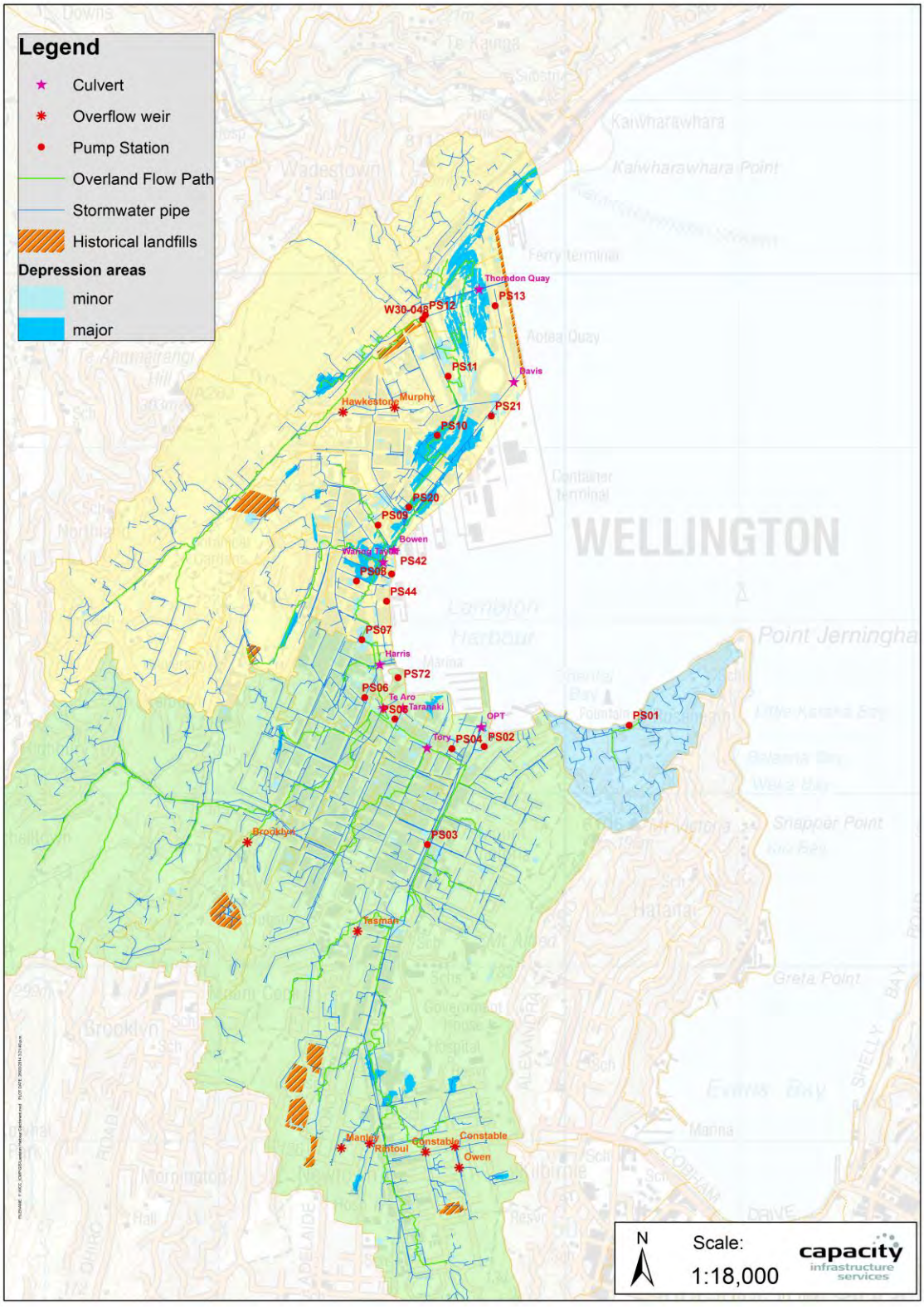


Figure 24: Lambton Harbour Catchment Characteristics

4.2.3 Description of Values and Receiving Environment

Detailed descriptions of the ecological quality of water in the receiving environment are provided in Appendix C1. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2 of the ICMP process.

4.2.3.1 Receiving (Discharge) environment

The Southern CBD stormwater drainage system discharges into Lambton basin via nine major outfalls located under wharves and harbour walls, stretching from the Overseas Passenger Terminal to the Bluebridge Ferry terminal. The Northern CBD stormwater drainage system discharges into Wellington Harbour through two major culverts under Aotea Quay. Stormwater from Oriental Bay discharges via approximately 21 minor outfalls (mostly road sump leads) to the coastal waters fringing these catchments.

The receiving environment is a sheltered harbour, which is protected from deep ocean swells, with most waves being produced by local winds. Sediment in the harbour is mostly mud and silt. Near the wharves, the seabed is disturbed by propeller backwash of large or powerful ships manoeuvring near the wharf edge.

4.2.3.2 Amenity and Recreation

Amenity and recreational uses are shown in **Figure 25**. Cultural values have not been mapped, as consultation with Iwi is still in progress.

The major amenity in the vicinity of these outfalls is the port, including local and Cook Straight ferry terminals, and non-commercial port activities, such as the Chaffers marina. Most of the Lambton Basin shore is accessible to the public and is a major recreational asset for Wellington. Walking and sight-seeing are popular recreational activities over much of the southern area. Swimming at Frank Kitt Park, small boat activities, and fishing also occur in these areas.

Wellington's most popular beaches (Freyberg and Oriental) are used extensively for swimming and picnicking, along with small boat activities in the water. A Council project to enlarge and enhance both Freyberg and Oriental Bay beaches was completed in 2004, using sand from Golden Bay, Nelson. The beach's sand area is now four times larger than previously.

Figure 25: Amenity and Recreational Values in Lambton Harbour and Oriental Bay

Note: Amenities are shown in the key only. Recreation activities are shown on the key with the main locations for these activities on the map

4.2.4 Stormwater Network Issues and Contaminants

4.2.4.1 Flooding

Historical evidence indicates that flooding has been a frequent problem in the Northern and Southern CBD catchments. A number of areas were badly affected by flooding in May 2013, particularly in Newtown.

The capacity of the stormwater network is restricted in the lower reaches due to flat gradients across the reclaimed land. Outfalls are submerged or partly submerged by sea levels, and due to the insertion of other services (e.g. other pipe networks) into the network, also may reduce pipe capacity. The sea level rise impacts around the CBD catchments are shown in **Figure 26**.

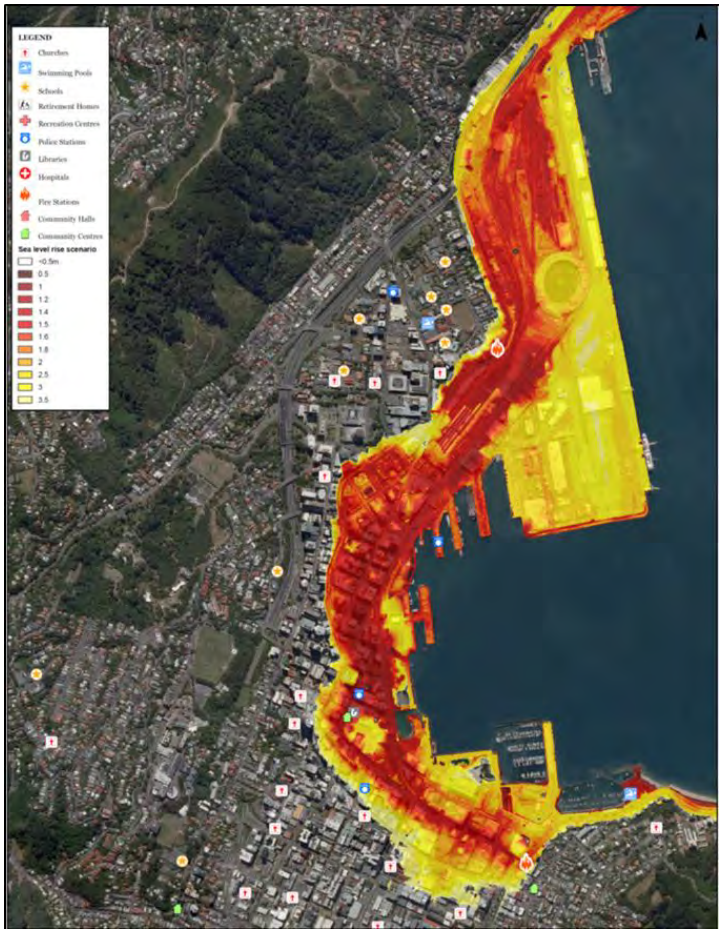


Figure 26: Potentially Affected Areas of the CBD by sea level rise

4.2.4.2 Contaminant Types, Sources and Loads in Stormwater

4.2.4.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5

4.2.4.2.2 Diffuse Sources

Catchment-wide sources include roofs and other building materials found in older urban areas, road surfaces and other impermeable surfaces. These are a major stormwater contaminant source, as much of the land is built on impervious, and many buildings are tall, with large surface areas. Vehicles (tires, brake linings, oil leakage, exhaust) are another major generic source, as the catchment has a dense network of motorways, major city streets, parking lots and buildings, and transport hubs (including Wellington's main train and bus stations and product distribution yards).

4.2.4.2.3 Wastewater Inputs

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. Wastewater network rehabilitation works undertaken since 1993 include cross connection studies and repairs, removal of constructed wastewater overflows, rehabilitation of known wastewater network

faults, and pump station upgrades including backup facilities to prevent overflows. The most significant constructed overflow in the wastewater network is discharge via the Davis Street culvert. The recorded average annual overflow volume is about 6000 m^3 with an average frequency of 1 in 4 months, (more details are given in the Davis St Report, Capacity, 2012 and Appendix J).

Southern CBD catchments also have few wastewater overflow locations. These are marked in **Figure 14** (further details are provided in the stormwater catchment reports in Appendices B6, B7 and B8). The reported average annual overflow volume from pump station 2 is about 450 m^3 discharged to the Overseas Passenger Terminal outfall during significant wet weather conditions.

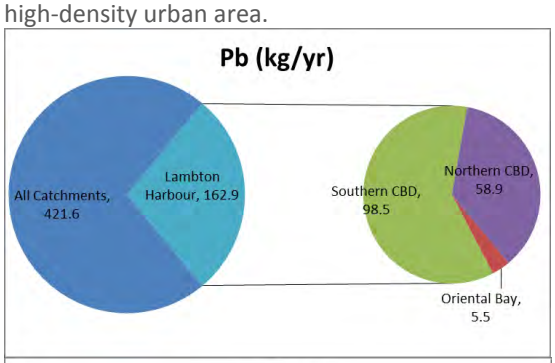
4.2.4.2.4 High Risk Facilities (Potential 'hot spots')

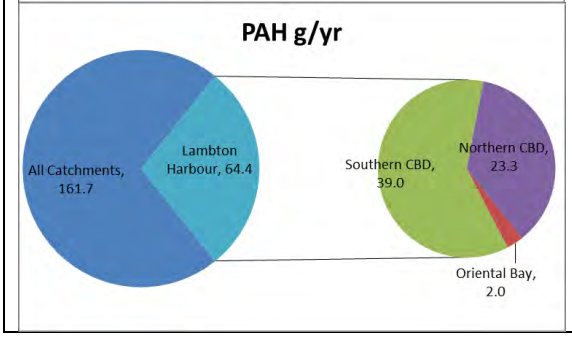
Potential hot spots include the railway shunting yards and workshops, port marshalling yards, and the Wellington to Hutt/Porirua motorway, which has an average daily traffic count in excess of 50,000 vehicles.

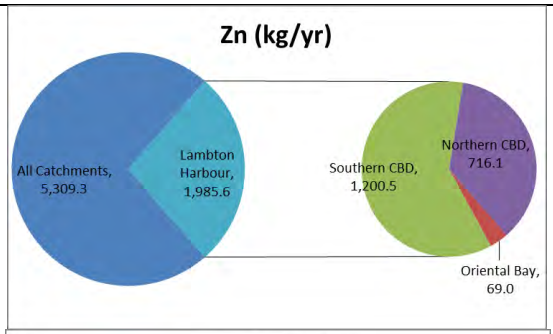
4.2.4.2.5 Loads of Chemical Contaminants

The chemical quality of stormwater has been measured at the Waring Taylor and Newtown (OPT) outfalls since 1993. Suspended sediment concentrations are low, but organic matter concentrations can be high. Zn and Cu concentrations are elevated, both in water and sediments deposited in the drains, as would be expected for urban stormwater. PAH concentrations are also high in drain sediments and are characteristic of motor vehicle sources. DDT and PCBs are found in low-moderate concentration in drain sediment.

Stormwater loads of Zn, Cu, Pb and PAH from the catchment are predicted to be high. The catchment area is about 18% of Wellington City and loads are about 37% of the total stormwater load from Wellington (The proportion of loads are shown in the adjacent chart). The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of a well-developed, high-density urban area.







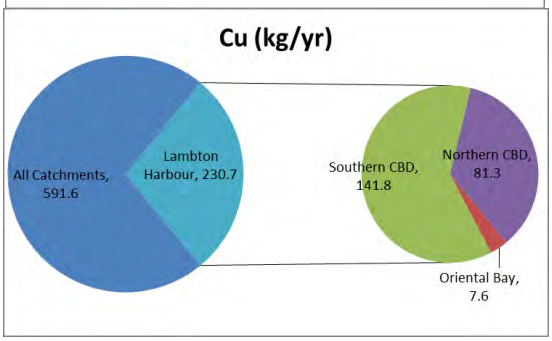


Figure 27: Estimated Chemical Loads from Lambton Harbour Catchments

4.2.4.2.6 Wastewater Contamination

The inner harbour sites at the Thorndon Container Terminal, Frank Kitts Park (near Harris St SW culvert and Aotea Lagoon), and Ferry Terminal (near the Kaiwharawhara Stream mouth) would be expected to be markedly impacted by stormwater run-off. Six of the nine major outfalls show indications of wastewater contamination and are under investigation and remediation (see **Figure 29**).

There have been large improvements in bacterial quality in the discharges at nine monitored outfalls since 1992. Recent monitoring indicates little dry weather and wet weather contamination from wastewater at the Davis and Thorndon – Tinakori outfalls, but significant dry weather and wet weather contamination at the remainder. These issues are currently being investigated and remediated. Recent monitoring has also shown that faecal coliform concentrations are increasing again slightly, and this is thought to be due to connection of wastewater systems to stormwater drainage during the current construction and reconstruction of commercial and apartment buildings in some of the catchments.

A survey of blue mussel quality in 2006 found low faecal coliform concentrations in these shellfish at the Thorndon Container Terminal, Ferry Terminal, Frank Kitts Park and Point Jerningham (GWRC 2006). The beach monitoring, together with the shellfish results, suggests that the stormwater discharges do not lead to widespread, persistent bacteriological pollution in this receiving water, despite having the largest input of stormwater in Wellington City.

4.2.4.2.7 Prediction of Future Trends in Key Chemical Contaminant Loads

Present day contamination from heavy metals in stormwater is relatively high. Zn is predicted to go from Amber status to Red status within 30 years in the middle of the basin. Closer to shore, and outside the basin, it is predicted to go from green to amber status within 30 years, but not along Aotea Quay.

It is unlikely that the present-day levels of Pb, Hg, DDT and PAH in stormwater is sufficient to increase concentrations of these contaminants in the sediment. Much of the current contamination is due to past discharges and activities. It is possible that transport and dispersal processes will gradually reduce the concentrations of these contaminants. In other words, the discharge of these contaminants will not keep pace with natural recovery processes. Detailed information is provided in Appendix C2.

4.2.5 Assessment of the Effects of Contaminants

Urban stormwater has the potential to:

- affect the aesthetic quality of water in the harbour (as viewed from cruise ships and ferries, and their passenger terminals) and Lambton Basin
- affect human health during swimming at Francis Kitt Park and Oriental Bay beaches
- affect human health during scuba diving and snorkelling around Pt. Jerningham
- affect marine organisms in Wellington Harbour

4.2.5.1 Aesthetics and Gross Pollutants

Occasional scum, oil slicks and murky water are seen in the Lambton basin - Thorndon Quay discharge (see **Figure 29**), on the popular Oriental Bay beaches. Aesthetics are occasionally compromised with debris, which may include litter and sea lettuce (see **Figure 29**). It is possible that the debris may originate from the beach and surrounding facilities such as cafes and streets rather than from local stormwater run-off, since the beaches and streets attract many people who might contribute to litter

problems. Another factor might be spillages at the port or marina. The debris issue is probably consistent with the location of the beach in a major harbour.

4.2.5.2 Human Health

The rating on the Suitability for Recreational Grades (SFRG) assessment is "Good" at Aotea Lagoon and Freyberg and Oriental beaches (see **Figure 29**). The SFRG measures the suitability for full body immersion (primary contact) that might occur in swimming, scuba diving and snorkelling. If it is suitable for primary contact, then it is also suitable for secondary contact activities such as boating and fishing. Indicator bacteria levels are exceeded from time to time and this has been attributed to rainfall-runoff events (see **Figure 28**). Detailed information is provided in Appendix E.

Bathing beach quality at Oriental Bay and Aotea Lagoon (Francis Kitts Park) is shown in **Figure 28**. The action levels are occasionally exceeded (mostly during wet weather), but these events are short lived.

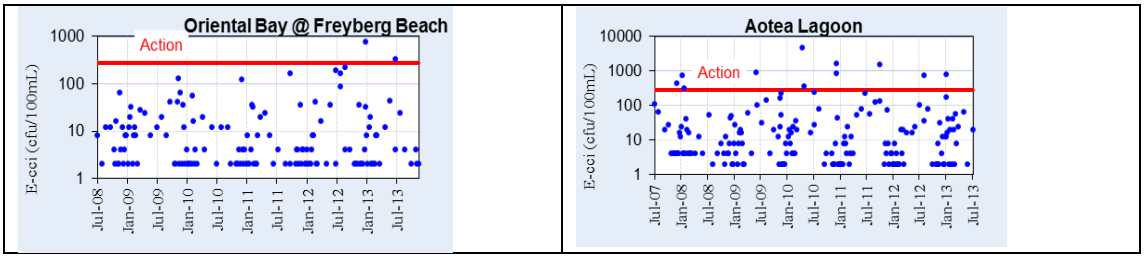


Figure 28: Bathing Beach Quality at Oriental Bay and Aotea Lagoon (Frank Kitts Park)

A survey of blue mussel quality in 2006 found low faecal coliform concentrations in these shellfish at the Thorndon Container Terminal, Ferry Terminal, Frank Kitts Park and Point Jerningham (GWRC 2006). The beach monitoring, together with the shellfish results, suggests that the stormwater discharges do not lead to widespread, persistent bacteriological pollution in this receiving water, despite having the largest input of stormwater in Wellington City.

Five of nine major outfalls show indications of wastewater contamination and are under investigation and remediation (**Figure 29**).

4.2.5.3 Chemical Contaminants

A number of studies have measured chemical contamination in the bay. Very high levels of heavy metals Zn, Pb and Cu have been found within 50m of the stormwater outfalls. These high concentrations close to outfalls decrease rapidly with increased distance from the stormwater outfall.

Over the wider harbour, DDT, high molecular weight PAH, Pb, Hg, Cu and Zn exceed sediment quality guidelines. PAH, Pb, DDT and Hg are not currently being discharged in sufficient quantities in urban stormwater to have led to these levels of contamination. In the past, stormwater may have brought in high loads of these substances, especially Pb (from use in petrol), PAH (from coal tar used in roads), and maybe DDT and Hg from excessive use and spillage, wash off and disposal in the catchment area. Furthermore, there may have been other sources such as industrial discharges (before connection to the sanitary system), spillage during port loading or off-loading, and leaching of heavy metals from antifouling paints and treated timber. Modern-day urban stormwater has much lower concentrations of Pb and PAH. Cu and Zn are the contaminants of on-going concern in terms of toxic effects in receiving waters.

Chemical contamination has been summarized in **Figure 29**. Chemical contamination summarized at nine sites shows the current degree of contamination from historical pollution (legacy contamination), the degree of contamination by Zn and Cu (present-day stormwater contamination), and an indication of the concern for build-up of Zn and Cu concentrations from further stormwater discharges (future stormwater contamination).

Figure 29 shows strong chemical gradients from the Lambton basin out into the harbour. Legacy contamination is experienced at all nine sites, while present day contamination from stormwater heavy metals is of concern now and for the future in the Lambton basin.

4.2.5.4 Ecological Effects

Ecology near the wharves and the larger outfalls can be strongly disturbed, with very low numbers of benthic species and individuals. Biota (flora and fauna) becomes rapidly more varied and numerous with increasing distance (10 -50 m) from the wharf, with species richness, species diversity and total abundance increasing markedly.

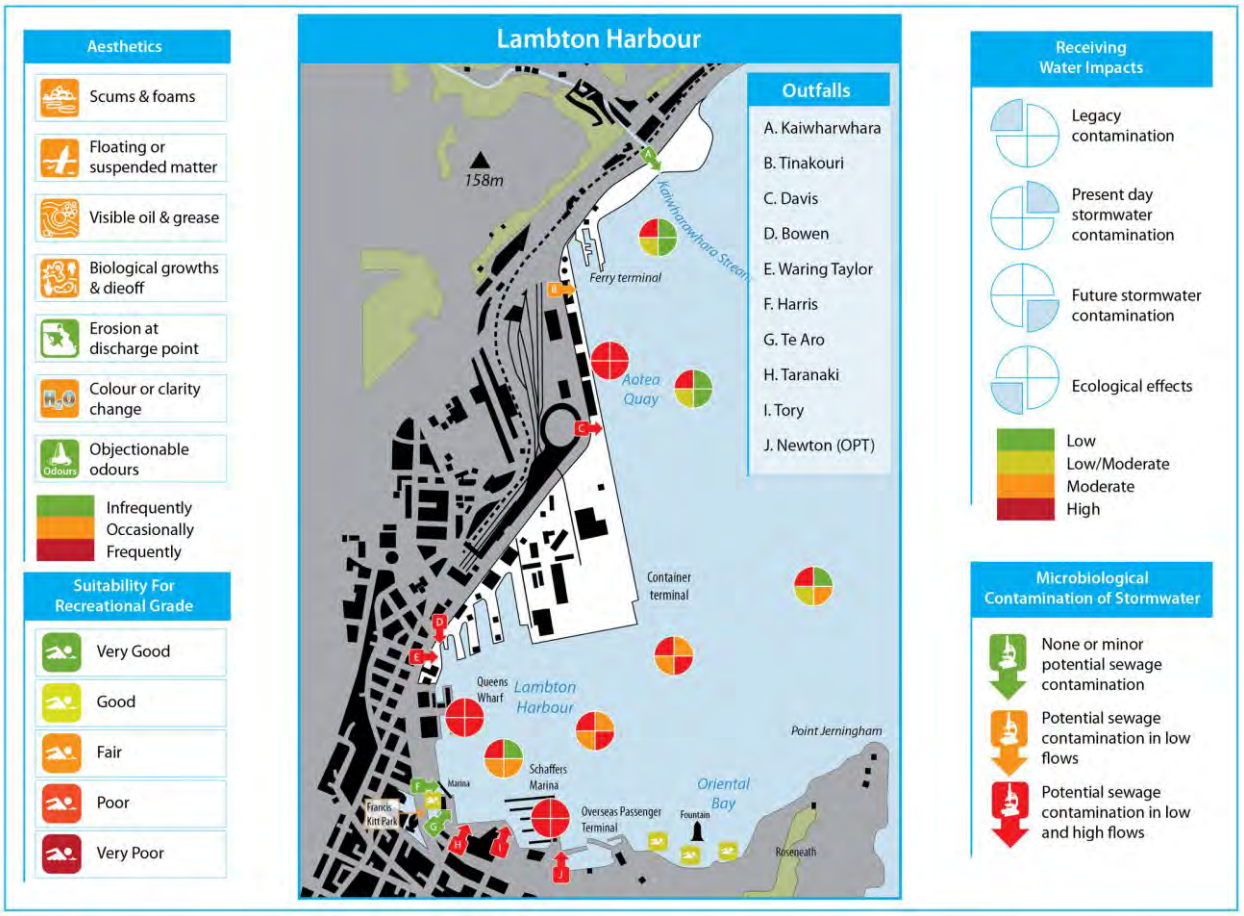


Figure 29: Stormwater Impacts in Lambton Harbour

The strong biological effects diminish rapidly with distances of 30 - 50m from major outfalls. Further offshore, where samples are more indicative of the overall ecological health of the harbour, ecological monitoring has distinguished “intermediate” biological effects. Within 4 km of the wharves and quay, current studies are still showing effects, which we have classified as slight. Small or no effects are only found out towards the middle of Wellington Harbour at considerable distances (4-6 km) from the bay.

4.2.6 Stormwater Management Options

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

4.2.6.1 Quality

Some potential outcomes for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Coastal debris can be found in the harbour environment from time to time. Further investigation is underway to determine suitable litter dispersal facilities and mechanisms to improve these issues.
- Review of current sediment traps and sump cleaning programme is identified
- Monitoring will continue for faecal coliforms and enterococci in the outfalls, and investigations will continue into the source of apparent wastewater contamination in the outfalls.
- Monitoring of harbour sediments will continue for another 5 years.
- It is identified that a detailed wastewater network model needs to be prepared to gain further insights into the wastewater network capacity, potential overflow issues, and for identifying solutions.
- Source controls and other best management practices will continue to be applied to any urban development as prescribed by WCC Codes of practice.
- Other preventable sources of these contaminants should be addressed, e.g. spillage and illegal disposal or discharge of contaminants, and antifouling paint residues from boat cleaning.
- Contaminant impact awareness programmes within the public will be implemented. NOTE: a pilot project within the Taranaki Street sub-catchment is currently being implemented

4.2.6.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Following the 6th May 2013 flooding in the Wellington CBD, options to mitigate flooding are currently being investigated.
- Pipe sections known to be in poor condition need to be rehabilitated.
- Consider a long term, phased replacement (and upgrade) strategy
- Potential construction of the Basin Reserve Fly-over in 2014 may require pipe upgrade of the network through this area and this will be investigated under Stage 2.

4.3 East Coast

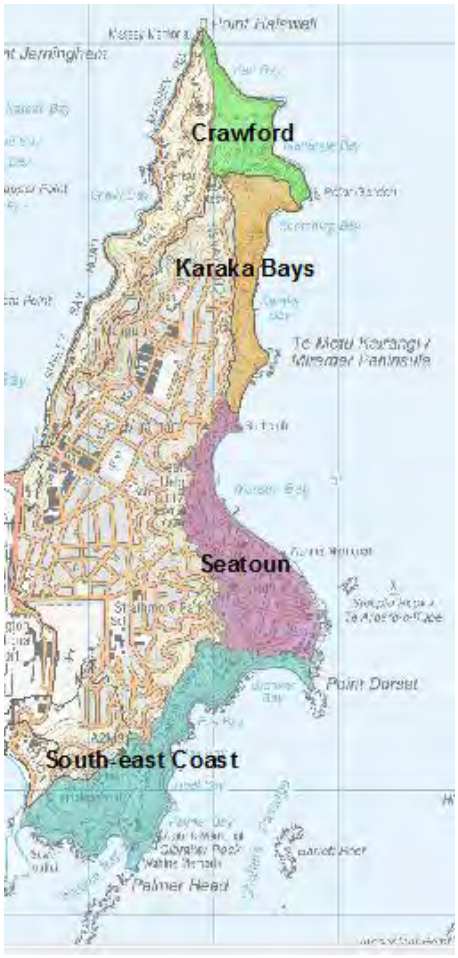


Figure 30: East Coast catchments

4.3.1.1 Overview

The East Coast lies on the eastern side of the Miramar Peninsula, to the east of the city. It forms the western side of the channel leading into Wellington Harbour and is very exposed in the south but more sheltered in the north. Its rocky coastline is interspersed with popular beaches such as Breaker, Worser, and Karaka Bays. The East Coast receives stormwater from four stormwater catchments: Crawford, Karaka Bays, Seatoun and South-east Coast (see **Figure 30**, **Figure 31** and Table 7.

Table 7: East Coast Catchment Characteristics

Sub catchment	Area (ha)	Land Use	No of Outfalls	WW pumps stations and constructed overflow locations
Crawford	43.0	Regenerating forest with relatively high diversity. Sheltered by pines macro-carpas and gum trees	Minor outfalls	--
Karaka Bays	46	Regenerating forest with relatively high diversity. Sheltered by pines, macro-carpas and gum trees.	18+ minor outfalls	PS27 and PS29
Seatoun	96.2	Suburban area with reserves	20+ minor outfalls	PS25, PS26 on one CSO
South-east Coast	108.7	Suburban area with reserves	12+ minor outfalls	PS32, PS33 and Moa Point Short Outfall

4.3.2 Stormwater Catchment Characteristics and Descriptions

4.3.2.1 General

The catchment includes the residential suburb of Seatoun. To the north and south of Seatoun, most of the coast comprises parks and reserves of re-generating bush, with through-roads and small pockets of residential land use. The stormwater system was constructed from c.1910 onwards. It is separate from the wastewater system, although wastewater overflows have occurred in the past. Detailed information on catchment characteristics are presented in Appendices B11, B12 and B13.

4.3.2.2 Land use

The East Coast catchment is predominantly residential and open space. Most urban land use is concentrated in Seatoun. Crawford, Karaka and the South-east Coast are mostly Open Space with small pockets of residential land, institutions and through-roads. The Open Space is mostly re-generating forest with relatively high diversity, sheltered by old stands of pines, macro-carpas and gum trees.

4.3.2.3 Other Facilities

The descriptions of other facilities are presented in Appendices B11, B12 and B13. These include:

- 7 a) iii.The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities(constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

4.3.3 Description of Values and Receiving Environment

The detailed descriptions of the ecological quality of the receiving environment are provided in Appendix C. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2 of the ICMP process.

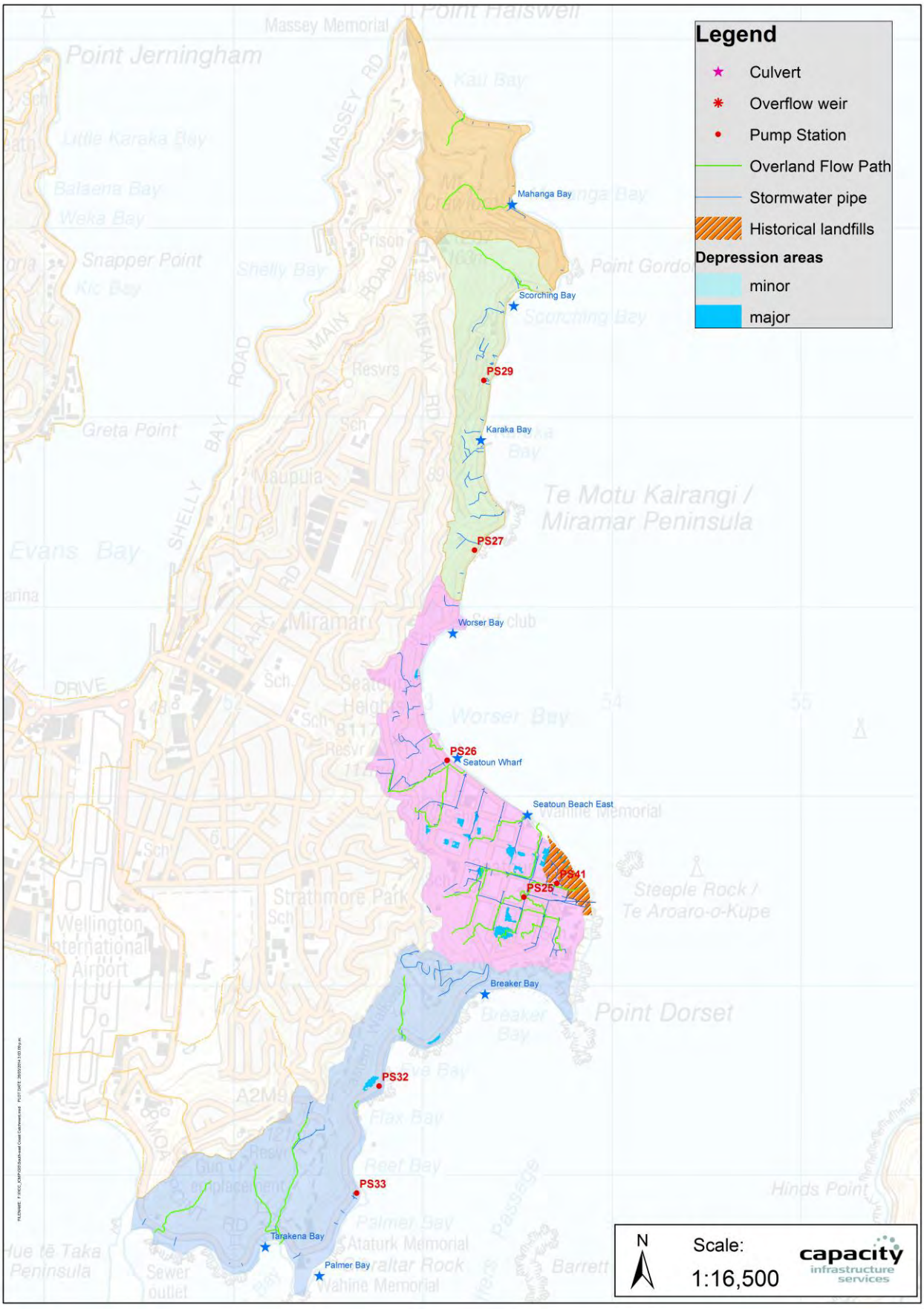


Figure 31: South-east Coast Catchment Features

4.3.3.1 Receiving (Discharge) Environment

To the north and south, stormwater discharges through a series of small outfalls along the coast or in overland flow. The discharge environment is spread along a semi-exposed coast of beaches separated by rocky headlands. Being on the semi-open coast, it is subject to relatively high energy from waves and currents.

The Seatoun stormwater catchment does not form a single drainage area but rather a series of minor catchments, which have a limited stormwater collection system or none at all.

4.3.3.2 Amenity and Recreation

Amenity and recreational uses are shown in **Figure 32** for the East Coast. Cultural values were not mapped, because consultation with Iwi is still in progress.

The southern end of the Miramar Peninsula, from Huetetaka Point to Point Dorset, consists of very exposed rocky reef which is subject to extreme wave action and is characterised by dramatic geomorphology with many deep clefts and guts in the rock (**Figure 32**). The South East Coast is suitable for walking; picnicking, watching ships enter and leave the harbour, and admiring the ocean views. Breaker Bay is a picturesque sandy cove and part of the Oruaiti Reserve. Tracks lead from the beach to the escarpment, cliffs and ridgeline. The Eastern Walkway begins nearby and has excellent views of the harbour entrance and Pencarrow Head.

North of Point Dorset, from Seatoun to Scorching Bay, the coastline varies from rocky shore to sandy beaches. Worser Bay Beach is a large, sandy inner-harbour beach with views of the Orongorongo Range across the harbour, Steeple Rock and Seatoun Beach. In summer, its calm waters make it a popular destination for families, and it is also well-used by the local yacht club. The Seatoun Coast is also suitable for walking, watching ships enter and leave the harbour, and admiring the ocean views. A large area of sand dunes at the southern end of the beach planted with marram and pingao is an attractive feature of the beach. Dunes once covered the entire seaward side of the road, but by the 1950s they had been levelled and grassed.

The northern end of the beach is the site of the Worser Bay Lifesaving Club (established in 1910) and the Worser Bay Boating Club (established in 1926).

Scorching Bay Beach is a popular sandy inner-harbour bathing beach with a large grassed area. It is sheltered from the northerly wind. It is a popular place to soak up the sun and watch ships entering and leaving the harbour. Other smaller cobble and pebble beaches include Kau Bay, Mahanga Bay and Karaka Bay. There are many walking opportunities around the coastal road and over Mt Crawford. Point Halswell is a popular dive spot.

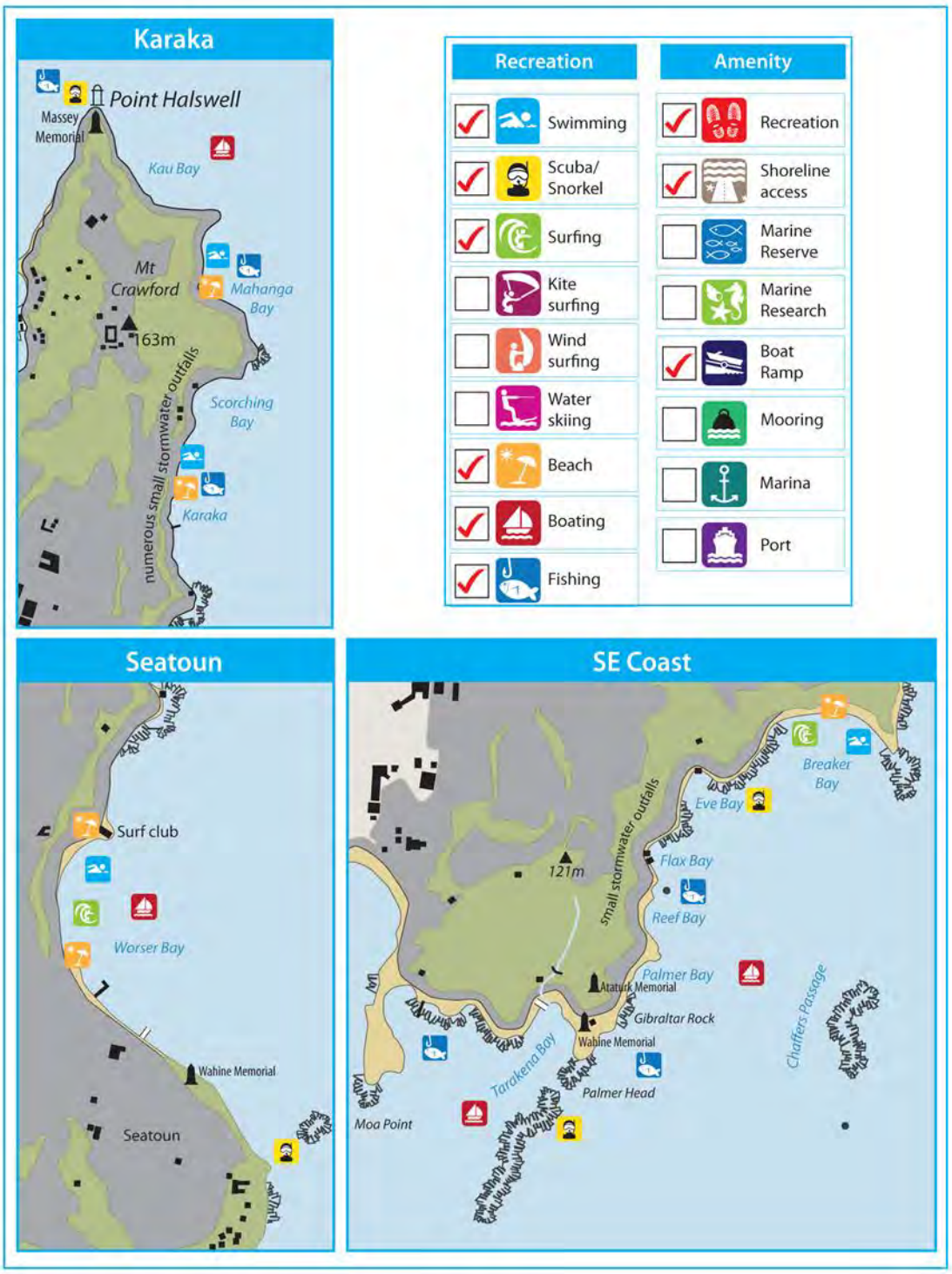


Figure 32: Amenity and Recreational Values on the East Coast.

Note: Amenity values are shown in the key only. Recreation activities are shown on the key with the main locations for these activities on the map

4.3.4 Stormwater Network Issues and Contaminants

4.3.4.1 Flooding

There are currently no known significant flooding issues in the South-east catchments. Flood risk in the low-lying areas along the coast road is however likely to be exacerbated by any future sea level rise as this will affect the operation and maintenance of stormwater outfalls.

Significant flooding has occurred on several occasions in the Seatoun catchment, in the basin behind the beachfront from Gore St though Seatoun Park to Munroe St. Most of the stormwater network in this area, including the outfall, dates from the 1930s to 1950s and is therefore likely to have a capacity of less than 50% AEP. Blockage of the outfalls with beach gravel sometimes occurs in southerly storms.

4.3.4.2 Contaminant Types, Sources and Loads in Stormwater

4.3.4.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5

4.3.4.2.2 Diffuse Sources

Catchment-wide sources are minor and include roofs and other building materials found in residential land, soil disturbance (gardening, landscaping, surface soil damage), vegetation, and wild and domestic animals. Vehicles (tires, brake linings, oil leakage, exhaust) are a significant generic source, and contaminants from roads probably dominate urban run-off quality. Relatively little stormwater contamination is expected from the areas outside Seatoun. Diffuse urban-sourced pollution is expected to be at the low end of the urban contamination range.

4.3.4.2.3 Wastewater Inputs

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. Pump stations at Seatoun have been fully rehabilitated, including automatic monitoring and the provision of control equipment and flow storage (4 times ADF,) to minimise the risk of overflows. Cross connections were surveyed and repaired where required. Further details are provided in Appendices B11, B12, B13 and J.

4.3.4.2.4 High Risk Facilities (Potential Hot Spots)

The Fort Dorset Defence Force facility is now fully decommissioned and the area is being developed as residential properties. No landfills are currently operating in this area, but a minor landfill was operated at the Fort Dorset parade ground in the 1930's and 40's.

4.3.4.2.5 Loads of Chemical Contaminants

The chemical quality of stormwater has not been measured in these outfalls, but as described above, it will probably be in the low end of the urban stormwater contamination range (**Figure 33**).

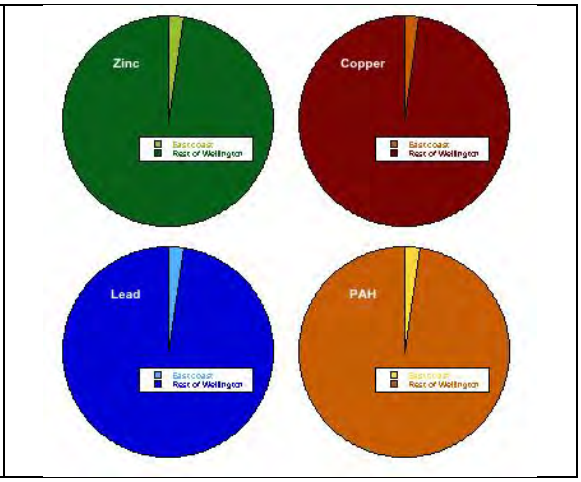
Stormwater loads of Zn, Cu, Pb and PAH from the catchment, excluding any inputs from the landfill sites, are low. The catchment is about 3.4% of the Wellington City area and loads are about 2.5% of the total stormwater load from Wellington (The proportion of loads are shown in adjacent chart). The specific loads (the mass of contaminant per area) are very low for Wellington, a reflection of the large area of Open Space.	

Figure 33: Estimated Chemical Loads in South-east Coast

4.3.4.3 Wastewater Contamination

No monitoring has occurred for these outfalls and no known wastewater overflow incidents are recorded.

4.3.4.4 Prediction of Future Trends in key Chemical Contaminant Loads

Because of the relatively small catchment dominated by open land, and because of dilution and dispersion and the resulting low concentrations, contaminants are not expected to have an effect on this coast.

4.3.5 Assessment of the Effects of Contaminants

Urban stormwater has the potential to affect

- the aesthetic quality of the beaches
- human health during swimming and scuba diving/snorkelling
- marine organisms along the coast

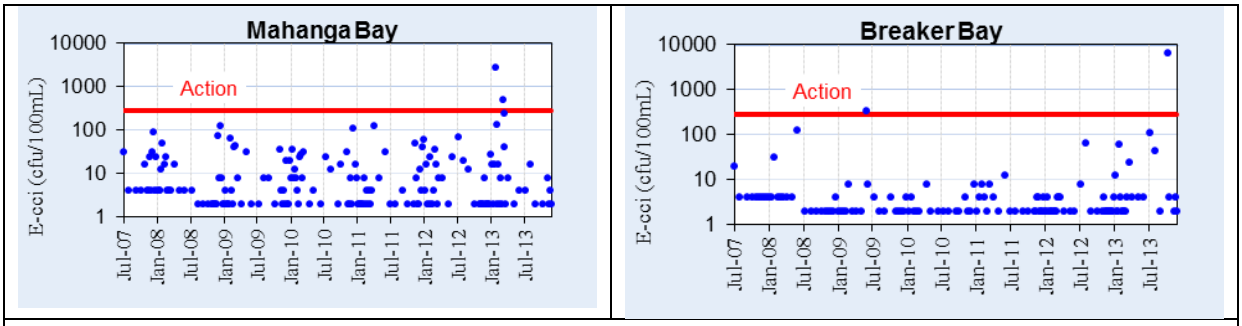
4.3.5.1 Aesthetics and Gross Pollutants

This factor has not been assessed in this receiving water, but is not expected to be a problem.

4.3.5.2 Human Health

The suitability for full body immersion (primary contact) which occurs with swimming, surfing, scuba diving, snorkelling, water-skiing, and kite and wind surfing is measured by the Suitability for Recreational Grades (SFRG). SFRG values are Good at Scorching and Mahanga, and at the three sites along Worser Bay, and Very Good at Breaker Bay (**Figure 34**). Occasionally the action level is breached in beach monitoring at one or other of these six sites on this coast, but these are short-lived and have not necessitated the erection of warning signs (see **Figure 34**). Overall, the stormwater discharges are not predicted to affect the amenity values associated with this coastline.

A survey in 2006 suggests blue mussels were not contaminated at Mahanga Bay, Scorching Bay or Pt. Dorset, and water quality has been found to be fully compliant for shellfish gathering and consumption at Mahanga Bay.



The results of beach monitoring of enterococci (E-cci)at two of the six sites monitored on this coast; Mahanga Bay (closest to Wellington Harbour) and Breaker Bay (closest to Cook Strait). The generally very low levels at Breaker Bay reflect the 'Very Good' Suitability For Recreation Grade for this beach.

Figure 34: Beach sampling results at Mahanga and Breaker Bays

4.3.5.3 Chemical Contaminants

The chemical contamination of the water and sediments in the receiving environment has not been assessed. Concentrations of heavy metals and organic contaminants have been measured at 3 - 4 sites in blue mussels in 2001 and 2006. The mussels were not contaminated. Because of the relatively small catchment dominated by open land, and the resulting low concentrations in stormwater, dilution and dispersion, contaminants are not expected to have an effect on this coast.

Legacy contamination, present-day stormwater contamination, and future stormwater contamination have all been classified as low in this environment (**Figure 35**).

4.3.5.4 Ecological Effects

There is no information on the ecological sensitivity to stormwater on this coast. The ecological sensitivity is probably high, having high water quality from Cook Strait, and diverse habitat. The eastern and northern shores of the Miramar Peninsula are home to numerous brown, red and green seaweeds, and a biologically rich and diverse community of invertebrates.

Contamination of the water and sediments along the coast is probably very low; it is a relatively large length of semi-exposed coast with multiple small outfalls along the coast. Therefore, the ecological impacts are assessed as being low (**Figure 35**). Impacts are not expected to worsen significantly in the future.

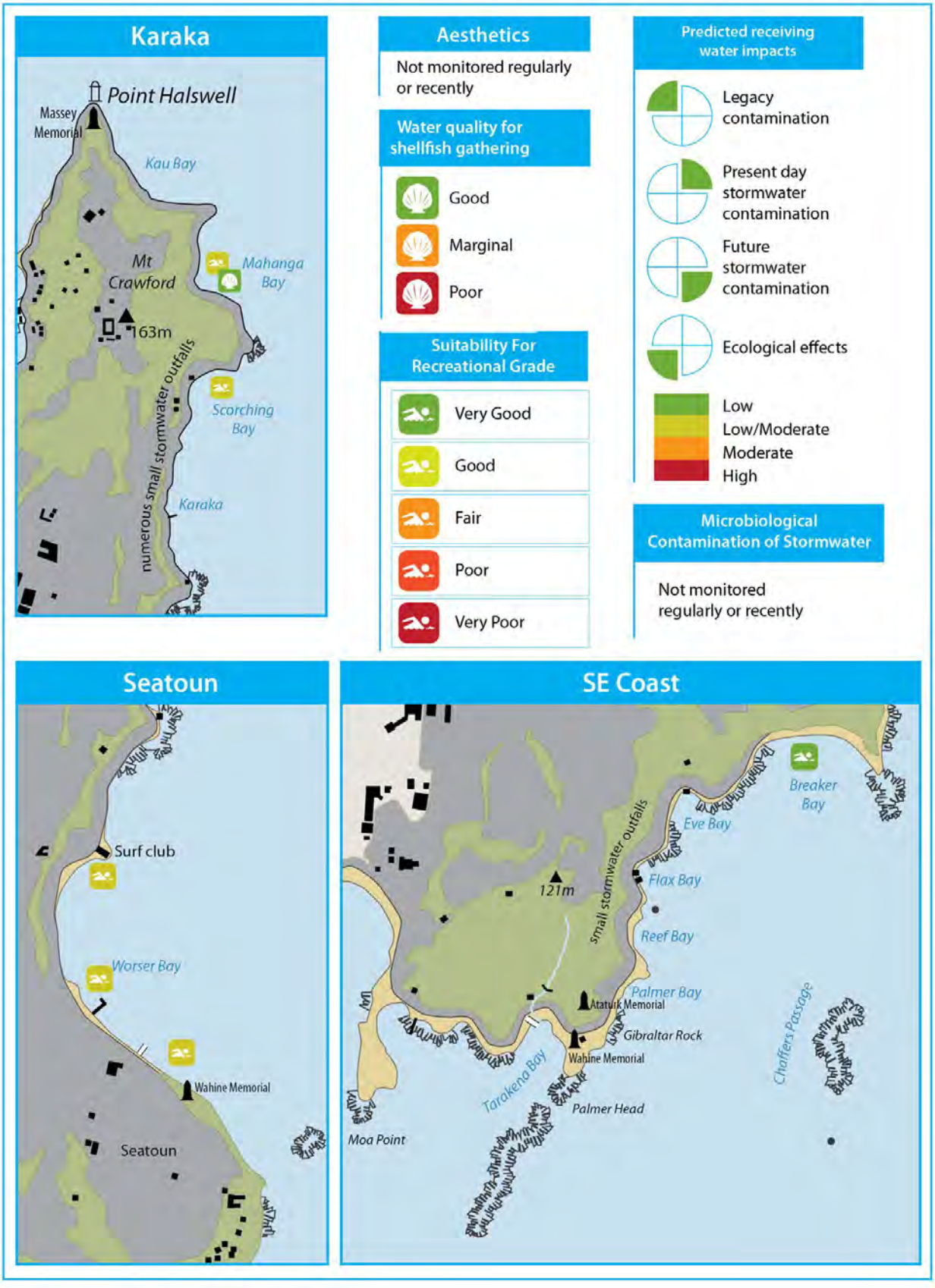


Figure 35: Stormwater Impacts - East Coast

4.3.6 Stormwater Management Options

4.3.6.1 Quality

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Source controls and other best management practices to continue to be applied to urban development by WCC.
- No known wastewater network issues have been detected, hence detailed catchment modelling is not considered necessary as part of Stage 2.
- Continue the current programme of inspections of wastewater pipes, fault detection and rehabilitation works as necessary.

4.3.6.2 Quantity

- Detailed catchment modelling is not considered necessary as part of the Stage 2 ICMP. It is identified to continue to manage flood risk on an as-required basis.
- As there are no known stormwater management or treatment devices in the catchment, best management practices will be applied to urban development as planned by WCC.

4.4 Lyall Bay

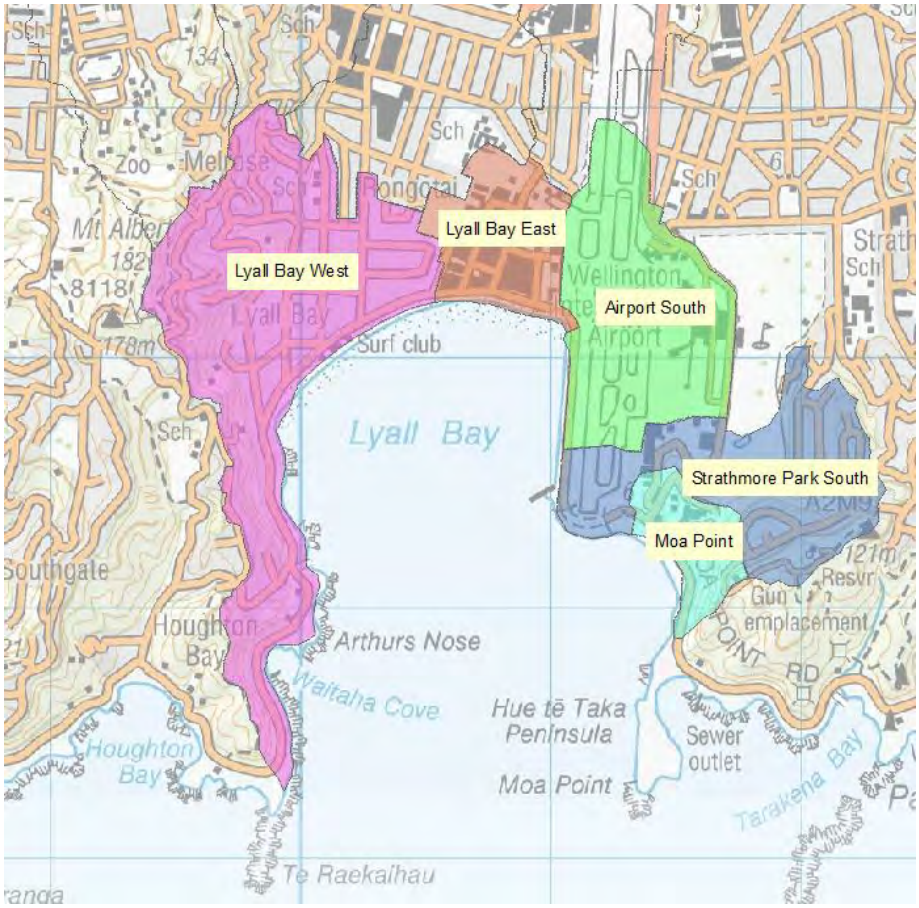


Figure 36: Lyall bay catchments

4.4.1.1 Overview

Lyall Bay is a large embayment that lies on Wellington's exposed south coast. It has a large popular beach enclosed by rocky headlands. It receives stormwater from Lyall Bay catchment, the southern parts of the Miramar Golf Course and Wellington Airport and part of Moa Point Wastewater Treatment Plant (**Figure 36**, **Figure 37** and **Table 8**).

Table 8: Lyall bay catchment characteristics

Sub catchment	Area (ha)	Land Use	No of Outfalls	WW pumps stations and constructed overflow locations
Lyall bay West	118	fully developed and outer residential	4 major outfalls and minor outfalls	PS19, PS35 and one constructed overflow
Lyall Bay East	29	fully developed and outer residential	2 major outfalls and minor outfalls	PS22, PS34
Airport South	63	Airport land.	1 major outfall	
Strathmore Park South	57	fully developed and outer residential	1 major outfall	PS31
Moa Point	16	fully developed and outer residential	1 major outfall	Long and short Moa Point outfalls

4.4.1 Stormwater Catchment Characteristics and Descriptions

4.4.1.1 General

The Lyall Bay catchment includes the steep land rising to the ridge-lines on both arms of the bay. It consists of open space and pockets of houses, and a large proportion of the gently sloping urban area to the north. The catchment is bounded to the west by the ridgeline between Lyall Bay and Houghton Bay up to Melrose and Mt Albert, to the north by Wha Street, Resolution Street and Coutts Street and to the east by Stewart Duff Drive and Ahuriri Street in Strathmore Park. Detailed information on catchment characteristics is provided in Appendix B14.

4.4.1.2 Land use

Land use in the Lyall Bay catchment is predominantly residential, light commercial, industrial and airport (**Table 8**). Traffic densities are likely to be relatively high, with roads servicing shopping centres, the airport and access to the Miramar peninsula. The major sources of stormwater contamination include vehicle emissions, run-off from roads, and general run-off from residential, commercial, light industrial and airport properties.

4.4.1.3 Other Facilities

Descriptions of other facilities are provided in Appendix B14. These include:

- 7 a) iii.The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities(constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

4.4.2 Description of Receiving Environment Values

Detailed descriptions of ecological quality in the receiving environment are provided in Appendices C1 and C2. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2 of the ICMP process.

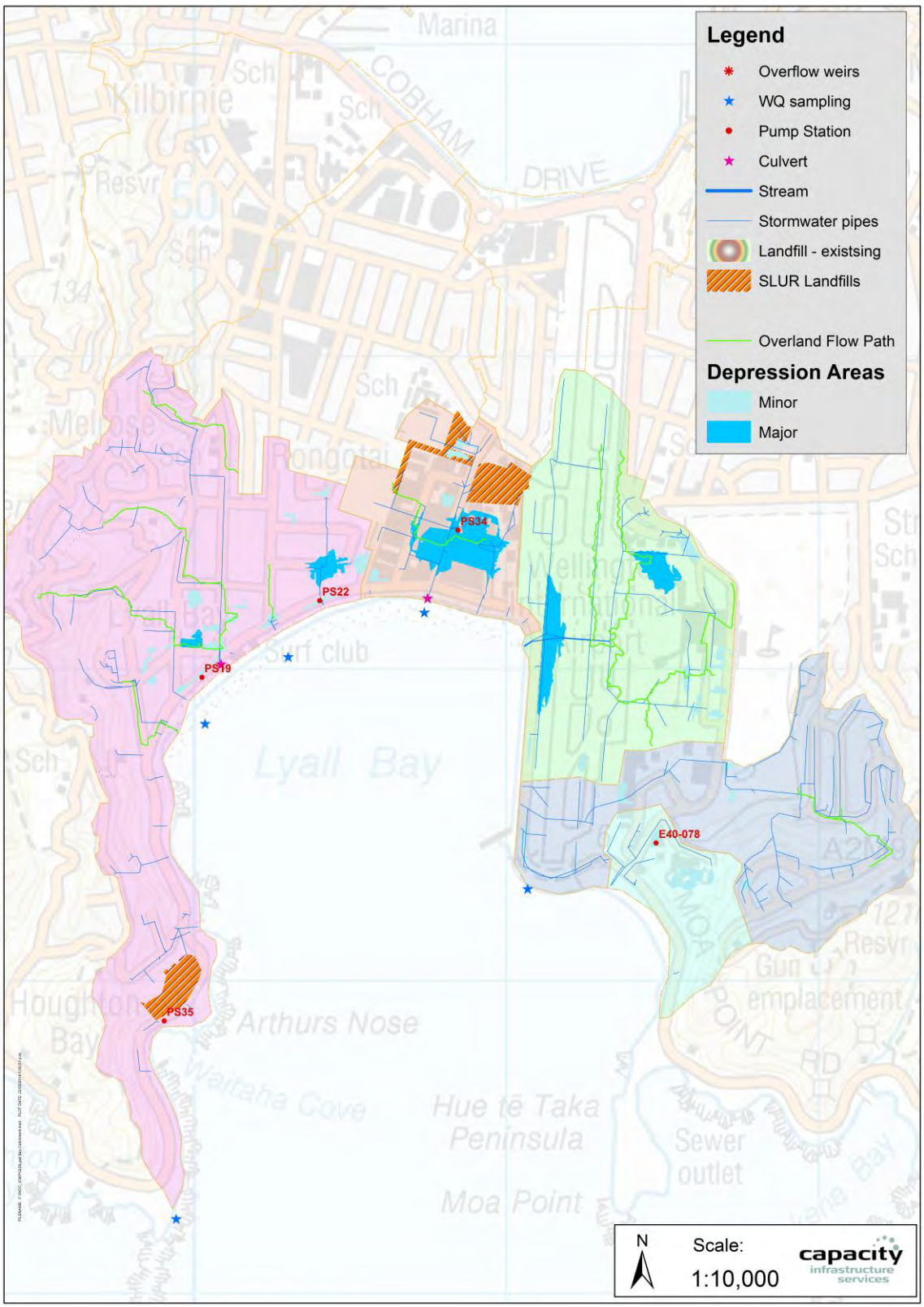


Figure 37: Lyall Bay Catchment Features

4.4.2.1 Receiving (Discharge) Environment

The catchments discharge through a series of outfalls at Lyall Bay Beach, Moa Point, and near the breakwater at the south end of the runway. The discharge zone is thus spread along a large exposed beach, breakwater and rocky coast. Being on the open south coast, it is subject to relatively high energy

from waves. Wet weather flow, especially during large storms, may remain near the shore for some time due to favourable conditions (e.g. on shore winds), but would then be dispersed within a few tidal cycles.

4.4.2.2 Amenity and Recreation

Amenity and recreational uses are shown in **Figure 38**. Cultural values were not mapped, because consultation with Iwi is still in progress.

Lyall Bay is Wellington's most popular surf beach. It is home to two surf-lifesaving clubs, and many of the activities here are surf-related. Lyall Bay also has a playground. Recreation includes walking, picnics, dog walking, swimming, surfing, windsurfing, kitesurfing and kayaking.

The remnants of once extensive sand dunes are being restored with plantings of pingao and spinifex.

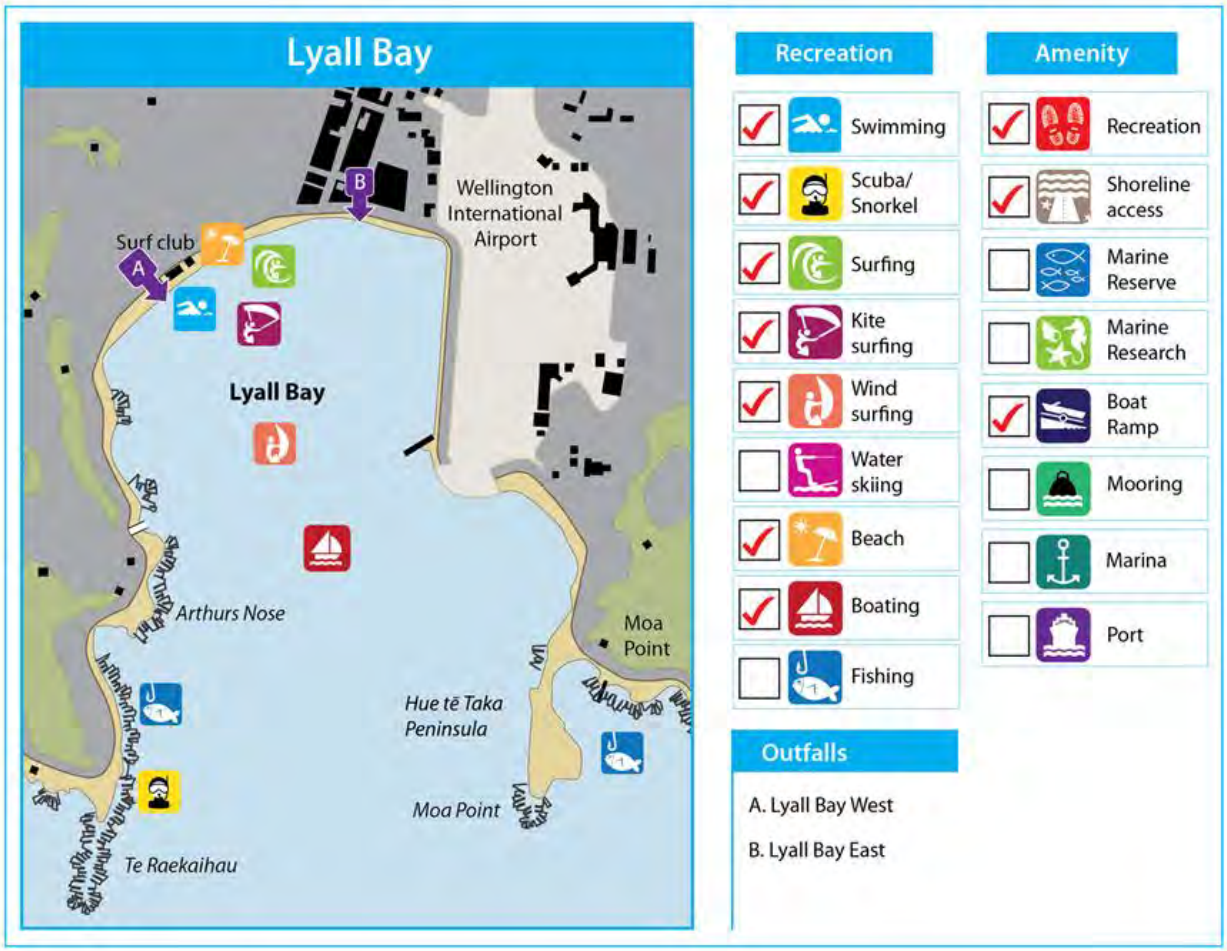


Figure 38: Amenity and Recreational Values at Lyall Bay.

NOTE: Amenity values are shown in the key only. Recreation activities are shown on the key with the main locations for these activities on the map

4.4.3 Stormwater Network Issues and Contaminants

4.4.3.1 Flooding

There are no known historic widespread flood issues in the catchment. However, a number of potential flood hazard areas are identified in the depression maps. Localised flooding occurred on Queens Drive near Rua Street and at the junction of Onepu Road and Lyall Parade during the 6th May 2013 event (estimated to have had an AEP of around 2%).

Maintenance of sumps and outfalls can be an issue, as these frequently become blocked by sand. Due to the sandy nature of the soils in the catchment, it is likely that a significant proportion of rainfall will infiltrate into the ground.

Flood risk in the low-lying areas is likely to be exacerbated by any future sea level rise as this will affect the operation and maintenance of stormwater outfalls.

4.4.3.2 Contaminant Types, Sources and Loads in Stormwater

4.4.3.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5

4.4.3.2.2 Diffuse Sources

Catchment-wide sources include roofs and other building materials found in older urban areas, traffic, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, and wild and domestic animals. Vehicles (tires, brake linings, oil leakage, and exhaust) are a significant generic source.

The highly impervious area and the high density of sources suggest that diffuse sourced pollution is probably at the medium level of the urban contamination range.

4.4.3.2.3 Wastewater Inputs

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. Wastewater pipe rehabilitation works undertaken in the Lyall Bay/Airport catchment since 1993 include cross connection studies and repairs, removal of constructed wastewater overflow, rehabilitation of known wastewater faults, pump station upgrades including backup facilities to prevent overflows, and a major trunk network upgrade. Because of the old ceramic piping system (some parts are circa 1910) maintenance repairs continue to the present day as needed.

More details are provided in Appendix B14 under sub catchment summary reports.

4.4.3.2.4 High Risk Facilities (Potential hot spots)

No landfills are currently operating within the Lyall Bay drainage area, but minor landfills were operated at Endeavour Road, the western part of the airport, and at Moa Point during the 1930s and 40s.

4.4.3.2.5 Loads of Chemical Contaminants

The chemical quality of stormwater has not been measured in these outfalls, but owing to the land uses described above, it will probably be in the medium level of the urban stormwater contamination range (**Figure 39**).

4.4.3.2.6 Wastewater Contamination

Bacteriological quality has been monitored at the Lyall Bay West outfall since 1992 (Detailed information is provided in Appendix D and E). There have been substantial improvements in quality as the result of removal of the constructed overflow structure and pump upgrades. Annual median faecal coliform values have fallen about 10-fold from the early 90s to the present day. The two outfalls show low wastewater contamination of stormwater during dry weather.

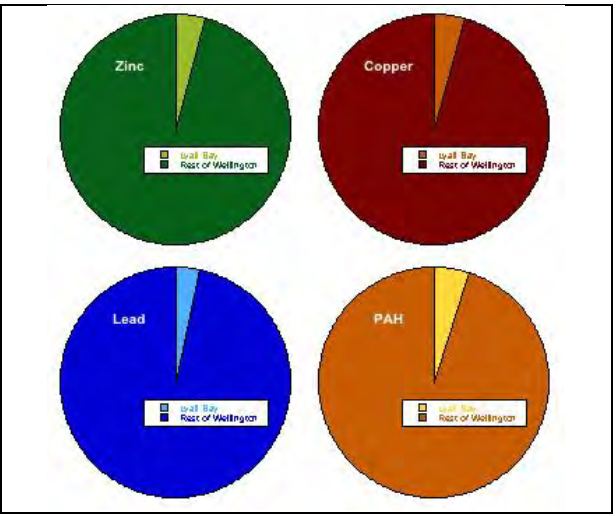
Stormwater loads of Zn, Cu, Pb and PAH from the catchment are moderate. The catchment area is about 4%, and loads are about 5%, of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington.	

Figure 39: Chemical Load estimation from Lyall Bay catchment

4.4.3.3 Prediction of Future Trends in key Chemical Contaminant Loads

It is unlikely that the present day levels of chemical concentration in stormwater will increase concentrations in the bay sediments.

4.4.4 Assessment of the Effects of the Contaminants

Urban stormwater has the potential to

- affect the aesthetic quality of the beach
- affect human health during swimming, surfing, kite surfing, wind surfing and scuba/snorkelling
- affect marine organisms in the bay

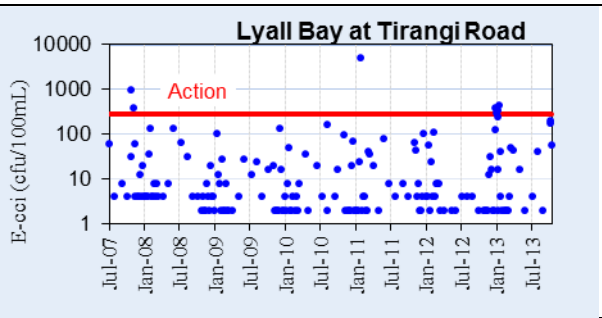
4.4.4.1 Aesthetics and Gross Pollutants

The aesthetics value is judged as good, with few or no reports of odours, solids, discoloration, surface films, scum, foam, biological growths or debris (**Figure 41**).

4.4.4.2 Human Health

The suitability of the receiving waters for full body immersion (primary contact) that might occur during swimming, surfing, scuba diving, snorkelling, water-skiing, and kite and wind surfing is assessed by the Suitability for Recreational Grade (SFRG). The SFRG rating is 'Good' at the three beach monitoring sites (GWRC 2013).

Indicator bacteria occasionally exceed guidelines for contact recreation at the beach during rainfall events (**Figure 40**) and occasionally, warning signs are erected as required by MfE Guidelines, for example, once in the 2012-13 season. Overall, the stormwater discharges have only minor effects on the amenity values associated with this surf beach during rainfall events.



Bacterial quality (measured by enterococci, E-cci) is generally good at the two sites monitored at Lyall Bay beach. Stormwater runoff during rain event occasionally results in exceedance of action levels (the red line), which very occasionally requires warning signs (e.g., in January 2013).

Figure 40: Beach monitoring at Lyall Bay

4.4.4.3 Chemical Contaminants

The chemical contamination of the receiving environment has not been assessed. Because of dilution and dispersion and the resulting low concentrations, contaminants are not expected to have a significant effect in the Bay. Legacy contamination, present day stormwater contamination, and future stormwater contamination have all been classified as low.

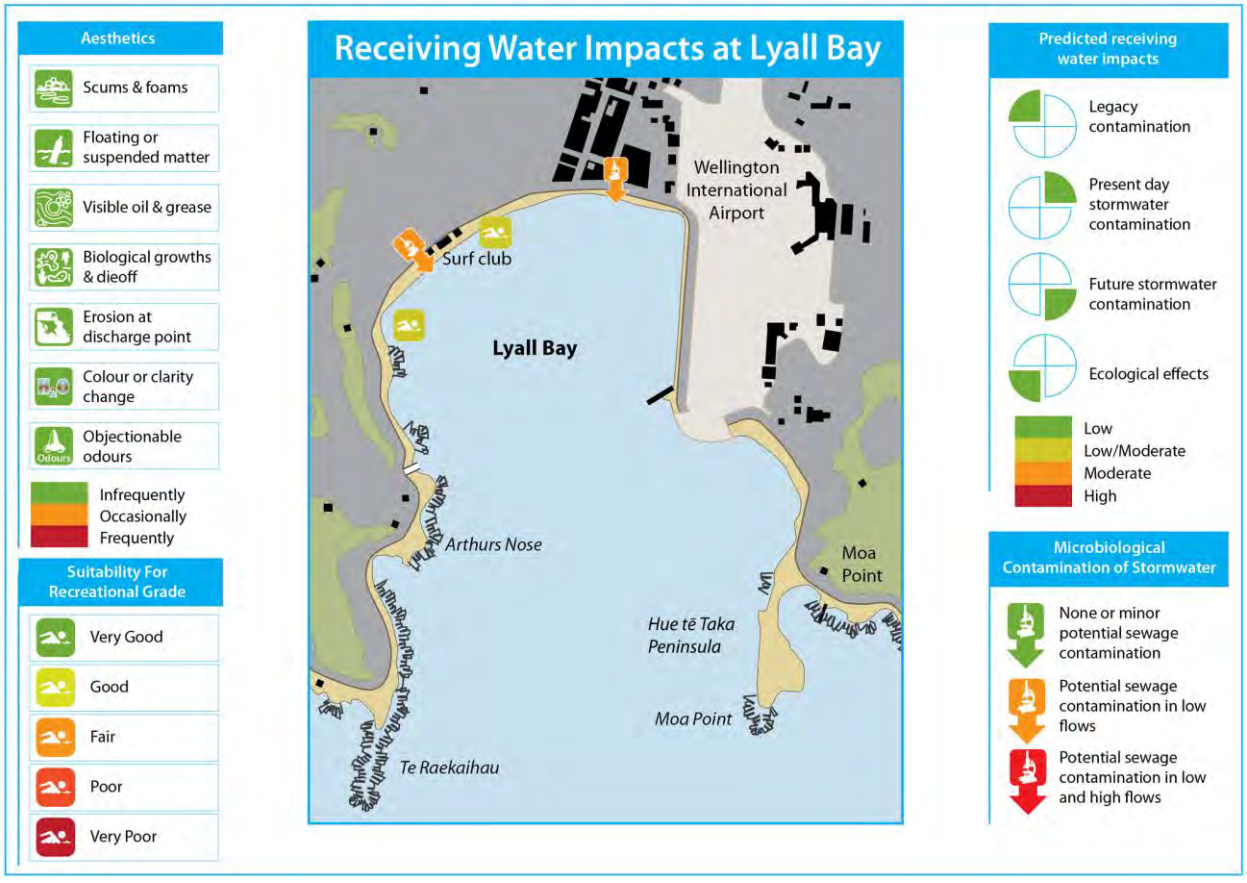


Figure 41: Stormwater Impacts in Lyall Bay

4.4.4.4 Ecological Effects

There is no information on the ecological sensitivity to stormwater in Lyall Bay. The ecological sensitivity is probably high, as this is a relatively pristine environment, having high water quality from Cook Strait and very diverse habitats. Contamination of the water in the bay during both dry weather flow and storm inputs is probably low; it is a relatively large bay on the exposed south coast with outfalls spread over a wide area (**Figure 41**). However, depending on winds and tides, stormwater may be retained near the beach for a few tidal cycles. Accumulation of contaminants in the Bay is probably very low because of the relatively high energy in this environment. Therefore, the ecological impacts are expected to be low (**Figure 41**) but may worsen significantly in the future.

4.4.5 Stormwater Management Options

4.4.5.1 Quality

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Source controls and other best management practices will be applied to urban development as planned by WCC.
- Continuing current wastewater management programmes is identified
- Further investigations into the existing wastewater network issues will be carried out as part of the Stage 2 ICMP.
- Monitoring for faecal coliforms and enterococci in the outfalls and beaches will continue.
- The source of apparent wastewater contamination in the outfalls will be investigated.

4.4.5.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- No significant flood mitigation investigations have been carried out to date, however several outfalls along Lyall Bay beach have recently been upgraded to reduce the incidence of blockage from sand and debris during southerly storms.
- A detailed model of the entire catchment is not considered necessary given the fragmented nature of the network and differing levels of flood risk across the catchment. Localised desktop analyses and / or smaller models are likely to be sufficient for the purposes of the Stage 2 ICMP.
- Best management practices will be applied to urban development as planned by WCC.

4.5 Island Bay-Houghton Bay

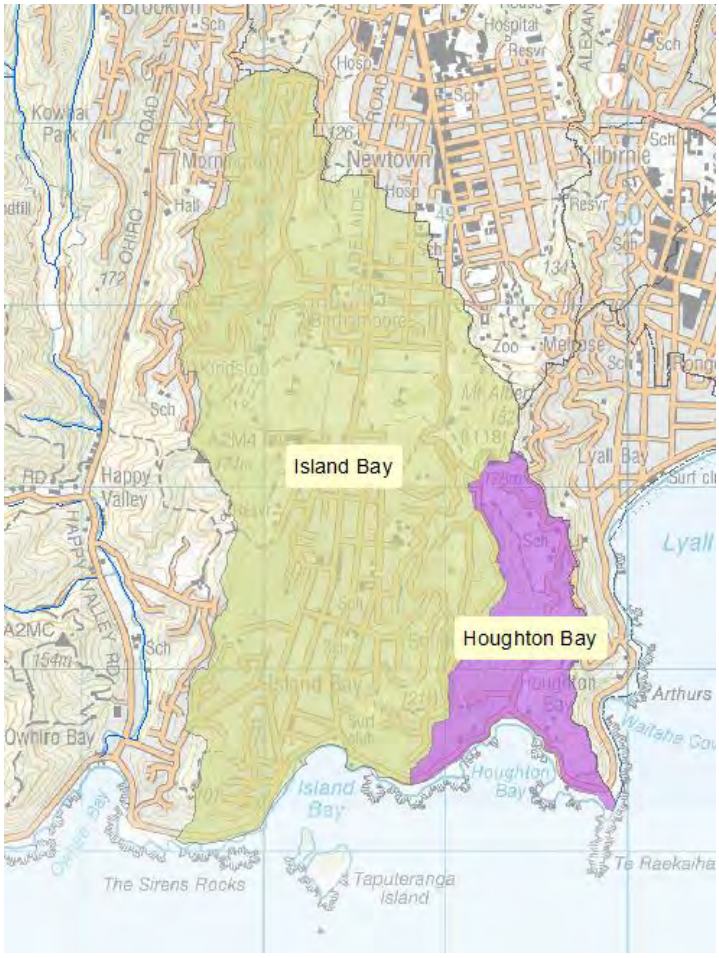


Figure 42: Island bay catchments

4.5.1 Overview

Island and Houghton Bays lie on Wellington's exposed south coast. They are part of the Taputeranga Marine Reserve and have popular beaches. They receive stormwater from the suburbs of Island Bay, Berhampore and Houghton Bay (**Figure 42**, **Figure 43** and **Table 9**).

Table 9: Island bay catchment characteristics

Sub catchment	Area (ha)	Land Use	No. of Outfalls	WW pumps stations and constructed overflow locations
Island Bay	512	Moderately developed, outer residential catchment	3 major outfalls	3 constructed overflows and 2 pumps stations (PS37 and PS40)
Houghton Bay	88	Lightly developed, outer residential catchment	1 major outfall	PS36

4.5.2 Stormwater Catchment Characteristics and Descriptions

4.5.2.1 General

The stormwater catchments lie to the south of Wellington City centre, extending from Vogeltown in the north to the Island and Houghton Bay outfalls to the south. The stormwater systems were constructed from c. 1910 onwards. They are separate from the wastewater system, but there are designed overflows for when the wastewater system fails.

The oldest branches of the stormwater network in Houghton Bay were constructed in the 1930s and 1940s during housing development on parts of the eastern hill slopes and Cave Road. These drains historically discharged into the stream running down the valley, which was subsequently piped during the filling of the landfill in the 1950s and 60s. Detailed information on catchment characteristics is provided in Appendices B15 and B16.

4.5.2.2 Land use

The catchments cover a total area of 500 ha of which an estimated 250 ha (50%) is impervious. They are predominantly residential with small pockets of commercial land use. The much smaller Houghton Bay stormwater catchment is predominantly parks and reserves (60%) with a small residential area (40%). The Houghton Bay landfill, which operated from 1950 to 1971, underlies some parks.

4.5.2.3 Other Facilities

The descriptions of other facilities are provided in Appendices B15 and B16. These include:

- 7 a) iii.The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, (constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

4.5.3 Description of Values and Receiving Environment

The detailed descriptions of the ecological quality of the receiving environment are provided in Appendix C1. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2 of the ICMP process.

4.5.3.1 Receiving (Discharge) Environment

Island Bay and Houghton Bay are on the open south coast. They are subject to relatively high energy from large swells, although Island Bay is partially sheltered by Taputeranga Island. Island Bay has a relatively large catchment, hence a relatively large storm flow volume which discharges to a relatively small, partially sheltered bay (**Figure 44**). Stormwater may be held up in the bay for a few tidal cycles,

depending on winds and tides. At Houghton Bay, both dry and wet weather flows are expected to be rapidly diluted and contaminants dispersed by wave energy and currents at this exposed beach.

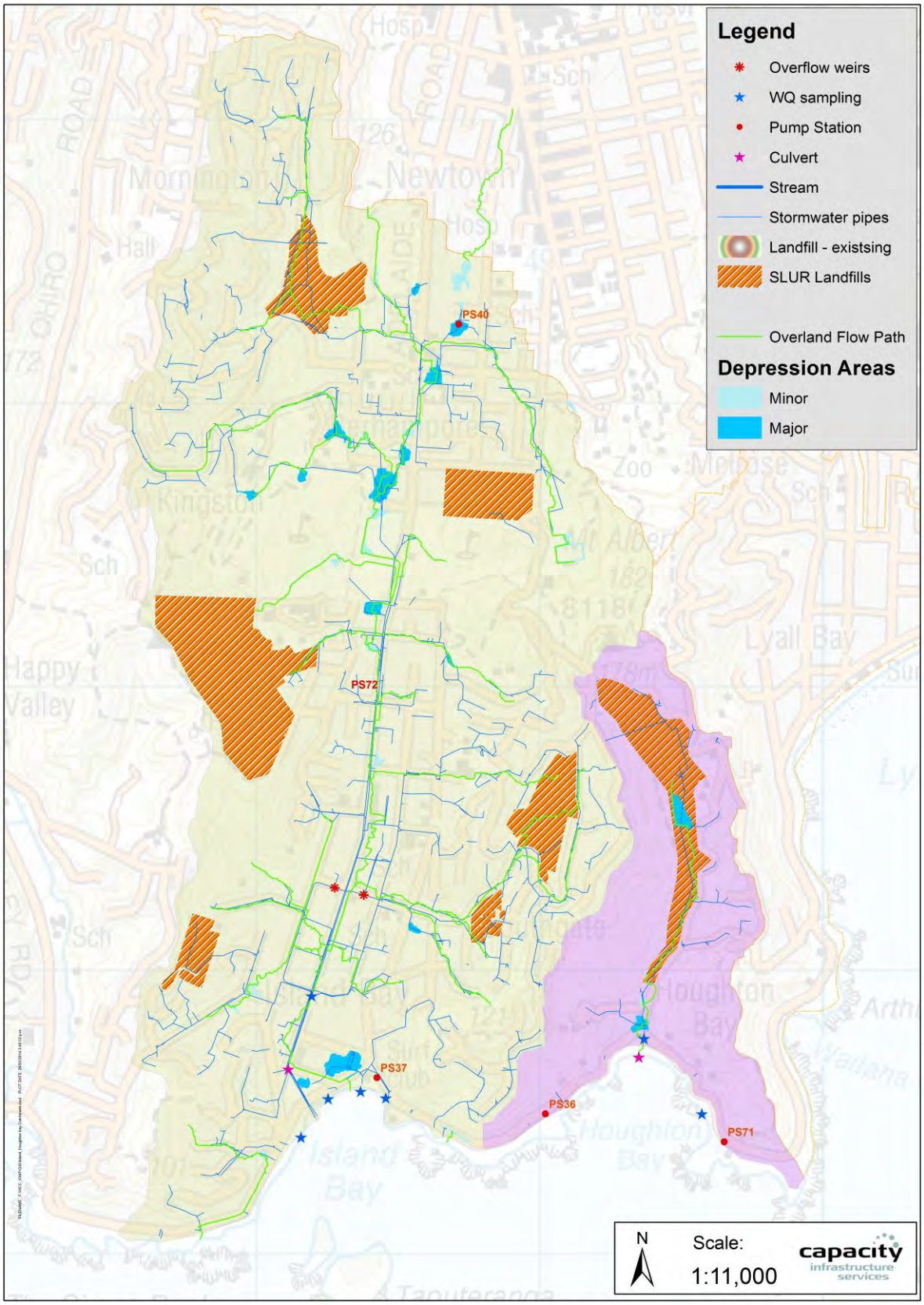


Figure 43: Island and Houghton Bay Catchment Features

4.5.3.2 Amenity and Recreation

Amenity and recreational uses are shown in **Figure 44**. Cultural values were not mapped, because consultation with Iwi is still in progress.

Island Bay is at the end of the City to Sea and Southern walkways, and near the centre of Taputeranga Marine Reserve. Just east of the Bait House, divers and snorkelers can follow offshore reefs on a marked dive trail and see a wide variety of marine life. Divers can also explore the wreck of the navy frigate HMNZS[3] Wellington, which lies east of Taputeranga Island. A swim raft is moored in this bay during summer months.

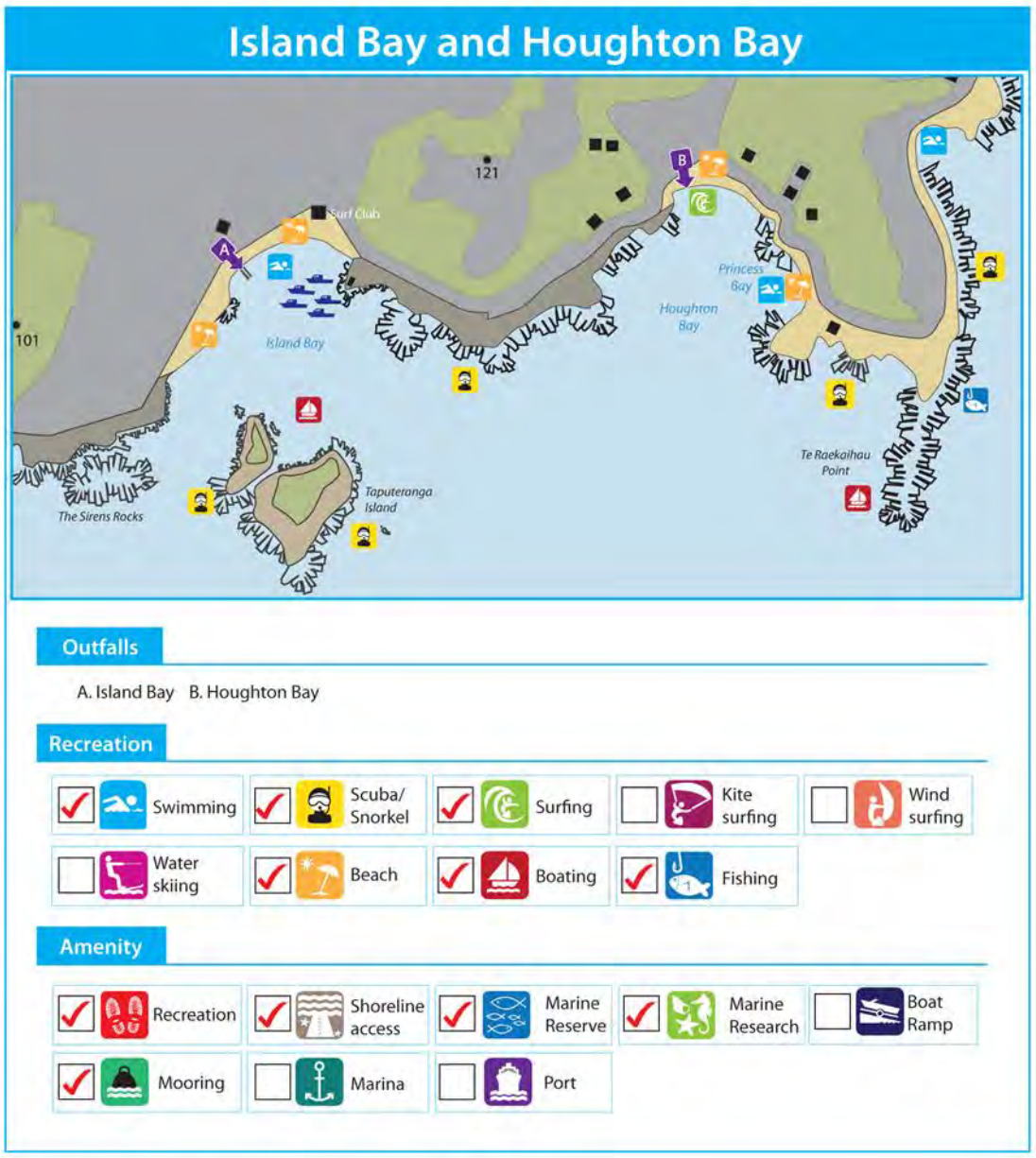


Figure 44: Amenity and recreational values at Island and Houghton Bays

NOTE: Amenities are shown in the key only. Recreation activities are shown on the key with the main locations for these activities on the map.

[3] *HMNZS Wellington was a Leander class frigate of the Royal Navy and the Royal New Zealand Navy (RNZN).*

The western end of Island Bay beach is less developed and has remnants of the original sand dunes. The Island Bay Coast Care Group has planted native sand dune vegetation such as pingao there in recent years.

Taputeranga, the island that gives the bay its name, was the site of a small pa used as a refuge by Ngati Ira following the Te Atiawa occupation of the area. The sheltered bay later became a centre for Italian, Greek and Shetland Islander fishing communities. Fishing boats still moor in the bay and land their catch near the Bait House, which now houses the Island Bay Marine Education Centre.

Houghton Bay is exposed to large southerly swells that can cause a dangerous undertow. It can be unsafe for swimming, but surfers can sometimes be seen when conditions are suitable. In the same bay is Princess Bay, a sheltered sandy beach, which is a popular place to swim in summer. It is tucked between the Houghton Bay headland and Te Raekaihau Point. On a clear day, the peaks of the Kaikoura Range in the South Island can be seen.

The bays are part of the Taputeranga Marine Reserve, which aims to return the marine habitats to a more natural state and increase the size and abundance of fish. There are short coastal tracks leading to Te Raekaihau Point and the large rocky points are good places to explore rock pools. Te Raekaihau Point, ('the headland that eats the wind') marks the boundary of the Taputeranga Marine Reserve.

Overall, the amenity values are compromised in Island Bay by stormwater discharges for swimming after major rain events, and in having only a 'fair' grade at the more sheltered beach at the head of the bay.

4.5.4 Stormwater Network Issues and Contaminants

4.5.4.1 Flooding

There have been a number of records of flooding in Island Bay since the area was developed. Historical evidence indicates that flooding has been a frequent problem in Island Bay; however over the last 10-15 years the trunk system in The Parade has been upgraded to mitigate flooding. There are a number of areas that were affected by flooding in 1995 (particularly in Berhampore); however there have been few if any trunk upgrades upstream of Dee Street.

Currently there are no known significant flooding issues in the Houghton catchment. The main secondary flow path follows the valley floor which is primarily open space, however overland flow and ponding may affect residential properties in the lower part of the valley around Cave Road in more extreme events.

The exception is the outfall at the bottom of Houghton Bay Road, which includes a secondary overland flow intake at 82 The Esplanade, and which is less than 20 years old. An initial desktop analysis of this section of the stormwater network indicates that it has a capacity of at least 2% AEP. This infrastructure serves the depression area upstream of The Esplanade.

4.5.4.2 Contaminant Types, Sources and Loads in Stormwater

4.5.4.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5.

4.5.4.2.2 Diffuse Sources

Catchment-wide sources common to all older urban areas, include metal roofs and building materials, road surfaces and other permeable surfaces, soil disturbance (gardening, landscaping, surface soil damage), vegetation, and wild and domestic animals. Vehicles (tires, brake linings, oil leakage, and exhaust) are a significant generic source. Land use is predominantly residential and traffic densities are likely to be relatively low. Run-off from the parks and reserves could be affected by park activities such as spraying and fertilising.

4.5.4.2.3 Wastewater Inputs

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. Wastewater contamination of stormwater has been a major issue in the past. Bacteriological quality was very poor in the 90s, which was addressed through pump station rehabilitation, drain condition surveys and rehabilitation, and cross connection survey and repair mostly in 1994 – 1997. This resulted in substantial reductions in faecal coliforms in water sampled at the outfall.

There are five locations in the catchments where wastewater is designed to overflow into the stormwater system during extreme conditions. These include three overflow points in the wastewater system, and two pumping stations. Inadvertent and/or illegal cross connections with wastewater pipes or wastewater pumping malfunctions have been surveyed, monitored and repaired since 1994. The old ceramic piping system, some of which dates back to circa 1910, dictates that maintenance repairs continue to the present day as needed. Further details are provided in Appendices B16 and J.

4.5.4.2.4 High Risk Facilities (Potential 'hot spots')

Potential known "hot spots for contamination" include a large closed Houghton Bay landfill in the valley floor near the outlet. This appears to be a major source of contamination of the stormwater system at Houghton Bay. Leachate enters the storm water pipes from the closed landfill. This is caused by the lack of capping or layers in the landfill to retain the leachate. This situation is exacerbated by the existence of field drains connected to the storm water system, which capture groundwater from the landfill. Low flows from the landfill have been diverted to the wastewater system, and continuing to investigate ways to manage the issue.

In the Island Bay catchment, there are a number of closed and covered landfills. Some of these contain clean fill from urban development, while some were rubbish tips. While there is no information on contamination from these sources, two common signatory contaminants of landfill leachate, iron and petroleum hydrocarbons, are not especially elevated in the stormwater. This indicates landfill contamination of stormwater is not a major issue in the Island Bay discharge.

4.5.4.2.5 Loads of Physical and Chemical Contaminants

Twice yearly sampling since 1992 shows the Island Bay stormwater discharge is of "typical" urban stormwater quality – highly variable, at times having elevated concentrations of suspended solids, organic matter, nutrients, copper, lead and zinc. Measurement of persistent organic pollutants throughout one storm showed quite high levels of banned organochlorine chemicals in the particulate matter in stormwater (Williamson, 2014, see more details in Appendices C1 and C2).

Stormwater loads of Zn, Cu, Pb and PAH from the catchment, excluding inputs from the landfill sites are moderate. The catchment covers about 6.5% of the Wellington City area and loads are about 9% of the total stormwater load from Wellington (The proportion of loads are shown in adjacent chart). The specific loads (the mass of contaminant per area) are moderate for Wellington.

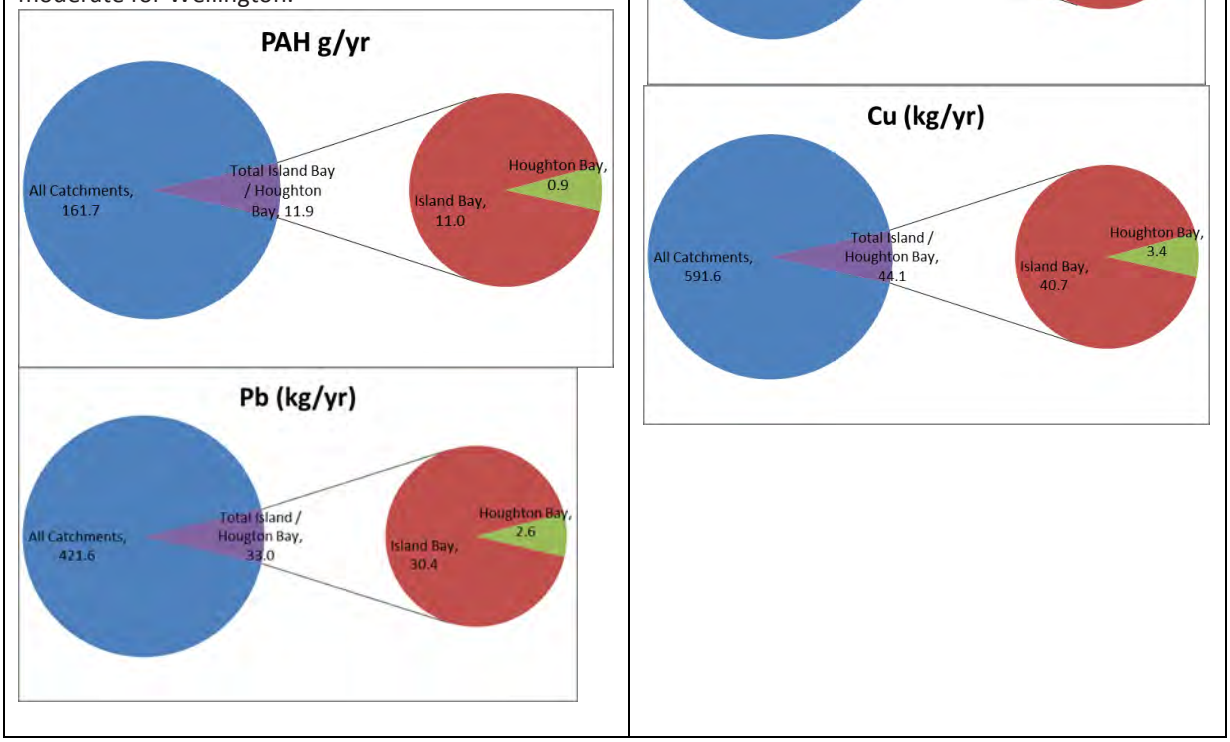


Figure 45: Chemical Load estimation from Island Bay and Houghton Bay catchments

4.5.4.2.6 Wastewater Contamination

Bacteriological quality was improved greatly from 1994 to 2011 through the repair of pipes and a pumping station, and removal of cross–connections with the wastewater system. By 2011, concentrations were "typical" of rain-runoff from urban developed land, and no evidence of significant wastewater inputs was found. However, after 2011, there has been a moderate increase in faecal coliform numbers at Island Bay but not at Houghton Bay. Detailed information is provided in Appendix D and E.

4.5.4.3 Prediction of Future trends in key Chemical Contaminant Loads

It is unlikely that the present day levels of chemical contaminants in stormwater are sufficient to increase concentrations of these contaminants in the bay sediments.

4.5.5 Assessment of the Effects of Contaminants

Urban stormwater has the potential to:

- affect the aesthetic quality of the beach,
- affect human health during swimming, scuba diving and snorkelling,
- affect marine organisms in the marine reserve

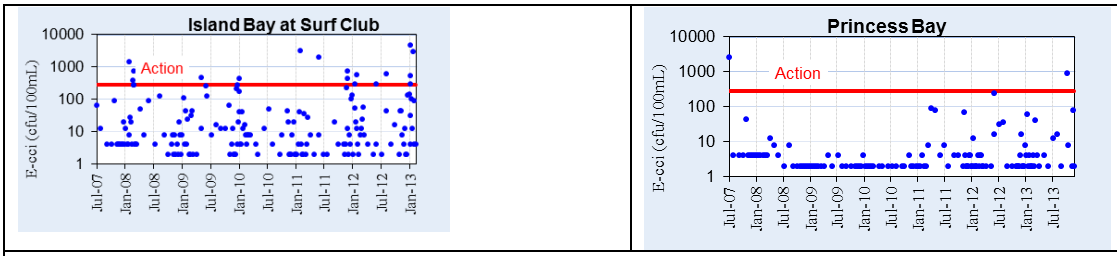
4.5.5.1 Aesthetics and Gross Pollutants

The outfalls and their surroundings are visually inspected every month. Visual "aesthetics" are generally good at Island Bay, with few or no reports of odours, solids, discoloration or surface films, scum or foam (**Figure 47**).

"Aesthetics" are poor in Houghton Bay with reports of odours, discoloration and erosion (**Figure 47**). The discoloration appears to arise from iron oxide deposits, while hydrocarbons appear to be the source of the odours (Williamson, 2014, sees more details in Appendices C1 and C2). These are likely due to landfill leachate, and various measures are in place to address this. The erosion is probably due to the stream needing to cut its path to the sea through the accumulating cobbles on the beach.

4.5.5.2 Human Health

Suitability for Recreational Grade (SFRG) is monitored at four sites. This measures the suitability for full body immersion ("primary" contact) that might occur in swimming, surfing, scuba diving and snorkelling. SFRG is Good in Island Bay at the beach near Derwent St, but only Fair in the inner part of the Bay (Surf Club and Reef St Recreational Ground) (**Figure 46**) (see more details in Appendices D and E). SFRG is Very Good at Princess Bay. Indicator bacteria often exceed MfE guidelines for contact recreation during rainfall events in Island Bay, occasionally persisting over several days, requiring warning signs to be erected (**Figure 46**).



The results of beach monitoring for enterococci (E-cci) at two of the four sites monitored in these bays, Island Bay at Surf Club and Princess Bay. The action level is exceeded reasonably frequently at two sites in Island Bay, and this is reflected their 'Fair' Suitability For Recreation Grade. The generally very low levels at Princess Bay reflect the 'Very Good' Suitability For Recreation Grade for this beach.

Figure 46: Island Bay and Princess Bay beach monitoring

The results of beach monitoring at two of the four sites monitored in these bays, Island Bay at Surf Club and Princess Bay are presented in **Figure 46**. The action level is exceeded reasonably frequently at two sites in Island Bay, and this is reflected in their 'Fair' Suitability for Recreation Grade. The generally very low levels at Princess Bay are reflected in the 'Very Good' Suitability for Recreation Grade for this beach.

4.5.5.3 Chemical Contaminants

There is no receiving water or sediment contaminant data in Island Bay. However Cd, Pb and Hg were below national standards in paua flesh collected in Island Bay, and concentrations of PAH, DDT and PCB were very low (see Appendix C for more details).

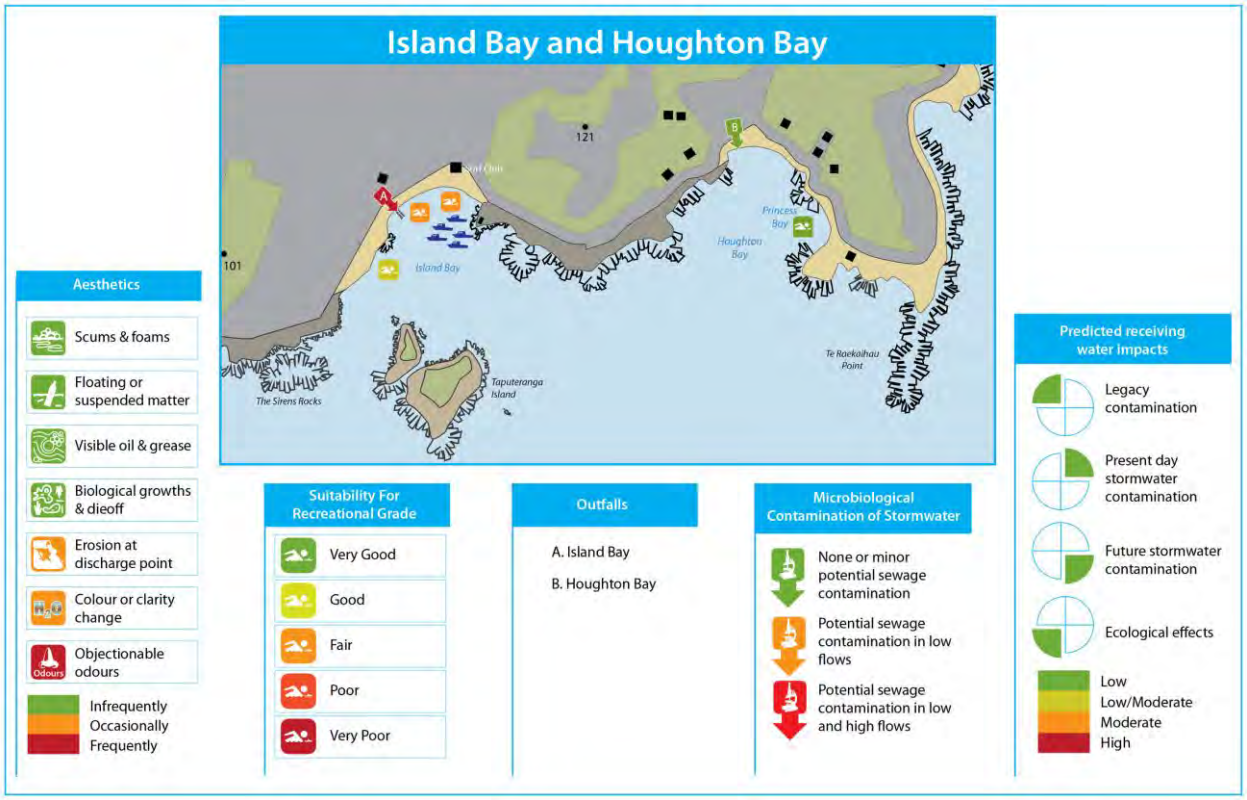


Figure 47: Stormwater Impacts in Island and Houghton Bay

At Houghton Bay, sediment samples collected in 2000 and 2012 at the point where the stream crosses the beach did not show any serious contamination for heavy metals (except iron) or PAH. As a result of dilution and dispersion, concentrations would be expected to be very low in water and sediments, and contaminants are not expected to have a significant effect in these Bays. Legacy contamination, present day stormwater contamination, and future stormwater contamination have all been classified as low (**Figure 47**).

4.5.5.4 Ecological Effects

There is no information on the ecological sensitivity to stormwater in Island Bay or Houghton Bay. However, the ecological sensitivity is probably high, being relatively pristine environments and having high water quality from Cook Strait, and a diverse range of habitats. However, the risk of significant ecological impact is probably low, as a result of flushing with clean oceanic water from the exposed south coast, which provides rapid dilution and dispersion. Therefore, the ecological impacts are expected to be low (**Figure 47**). Impacts are not expected to worsen significantly in the future.

4.5.6 Stormwater Management Options

4.5.6.1 Quality

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Continue current wastewater mitigation plan: a high priority task will be to address the ongoing issue of wastewater contamination in the outfall at Island Bay during dry and wet weather flows.
- To improve bathing water quality at the beach (the SFRG), an expanded sampling programme identifying microbiological contaminant sources and analysing discharge impacts is identified. This will include:
    - Checking small local stormwater or groundwater inputs near Surf Club;
    - Developing a better understanding of the microbiological contamination process at Island Bay by measuring salinity and turbidity during beach microbiological sampling.
    - Extent of chemical analysis of stormwater: including ammonia and BOD analysis is identified; this may provide useful information regarding landfill leachate.
- Source controls and other best management practices are continued to be applied for urban development by WCC.

4.5.6.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Completion of the final stage of The Parade upgrade to mitigate flooding issues need to be undertaken
- Consider a long term, phased replacement (and upgrade) strategy.
- It is identified that the detailed catchment model (currently in draft form) be updated and finalised as part of the Stage 2 ICMP.
- Detailed catchment modelling is not necessary as part of the Stage 2 ICMP for the Houghton Bay catchment. It is identified that management of flood risk will be continued on an as-required basis.
- Best management practices will be applied to urban development as planned by WCC.

Figure 48: Island Bay

4.6 Owhiro Bay

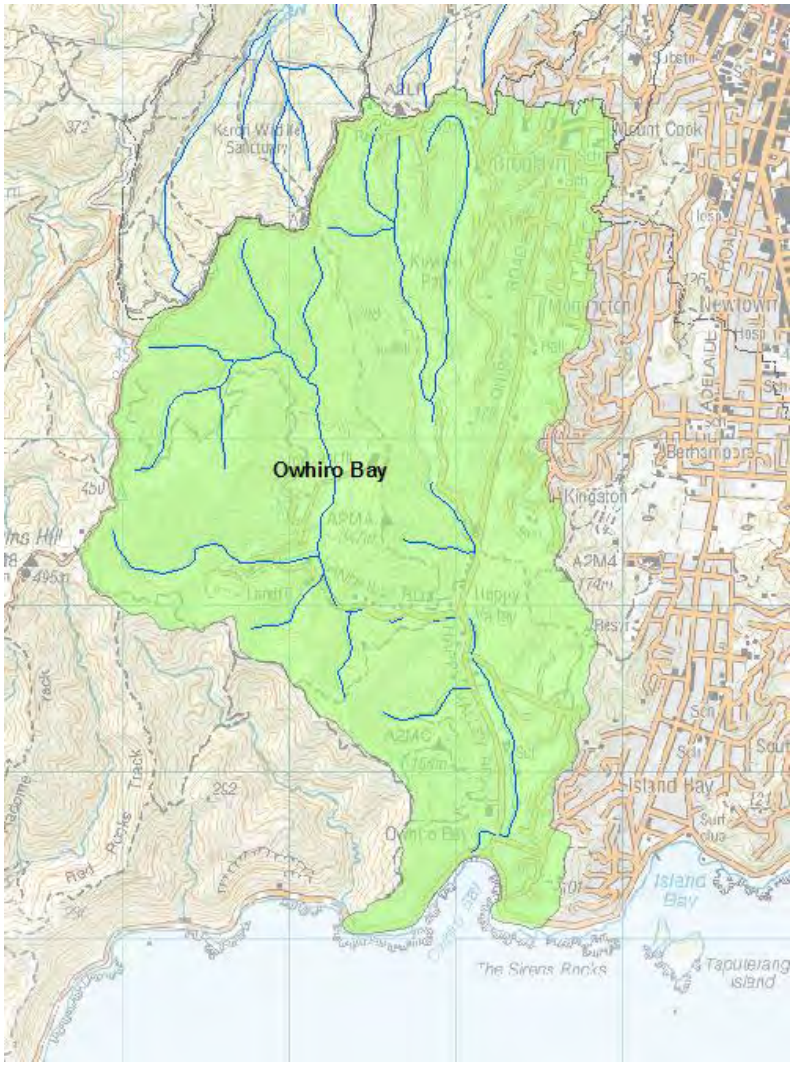


Figure 49: Owhiro Bay Catchment

4.6.1 Overview

Owhiro Bay lies on Wellington's exposed south coast. It is part of the Taputeranga Marine reserve and has a beach and boat launching facilities. Owhiro Stream discharges at the beach and drains mostly open space and rural land. It also carries stormwater from a residential area near Brooklyn and from operating landfills (**Figure 50**).

Table 10: Owhiro bay catchment characteristics

Sub catchment	Area (ha)	Land Use	No of Outfalls	WW pumps stations and constructed overflow locations
Owhiro Bay	970	Lightly developed outer residential catchment with conservation land use	1 stream outfall	1 constructed overflow and 2 pump stations (PS38 and PS39)

4.6.2 Stormwater Catchment Characteristics and Description

4.6.2.1 General

The Owhiro Stream stormwater catchment (**Figure 49** and **Table 10**) lies to the south of Wellington City centre, extending from Brooklyn in the north to the stream mouth at Owhiro Bay. It receives stormwater from parts of Brooklyn. The Owhiro catchment is relatively steep and streams are confined in relatively narrow and steeply incised valleys. Detailed information on catchment characteristics is provided in Appendix B17.

4.6.2.2 Land use

The Owhiro Bay catchment covers an area of 953 ha, of which an estimated 85 ha (9%) is impervious. The majority of the catchment (around 74%) is Open Space or rural, covered mostly in gorse scrubland, 22% is urban and 4%, bare ground and landfill.

4.6.2.3 Other Facilities

The descriptions of other facilities are provided in Appendix B17. These include:

- 7 a) iii.The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, (constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

4.6.3 Description of Values and Receiving Environment

The detailed descriptions of ecological quality of the receiving environment are provided in Appendix C. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2.

4.6.3.1 Receiving (Discharge) Environment

Owhiro Bay is on the open south coast and is subject to relatively high energy from waves. Freshwater inflows are about 100 l/s during low flow (0.1 m^3/s), and are predicted to be 14 m^3/s for the 2 year return period storm. Dry weather flows are expected to be rapidly diluted at the beach, and any contaminants dispersed by wave energy and currents. Wet weather flow, especially during large storms, may remain near the shore under some wind, wave and tide conditions for some time, but should then be dispersed within a few tidal cycles.

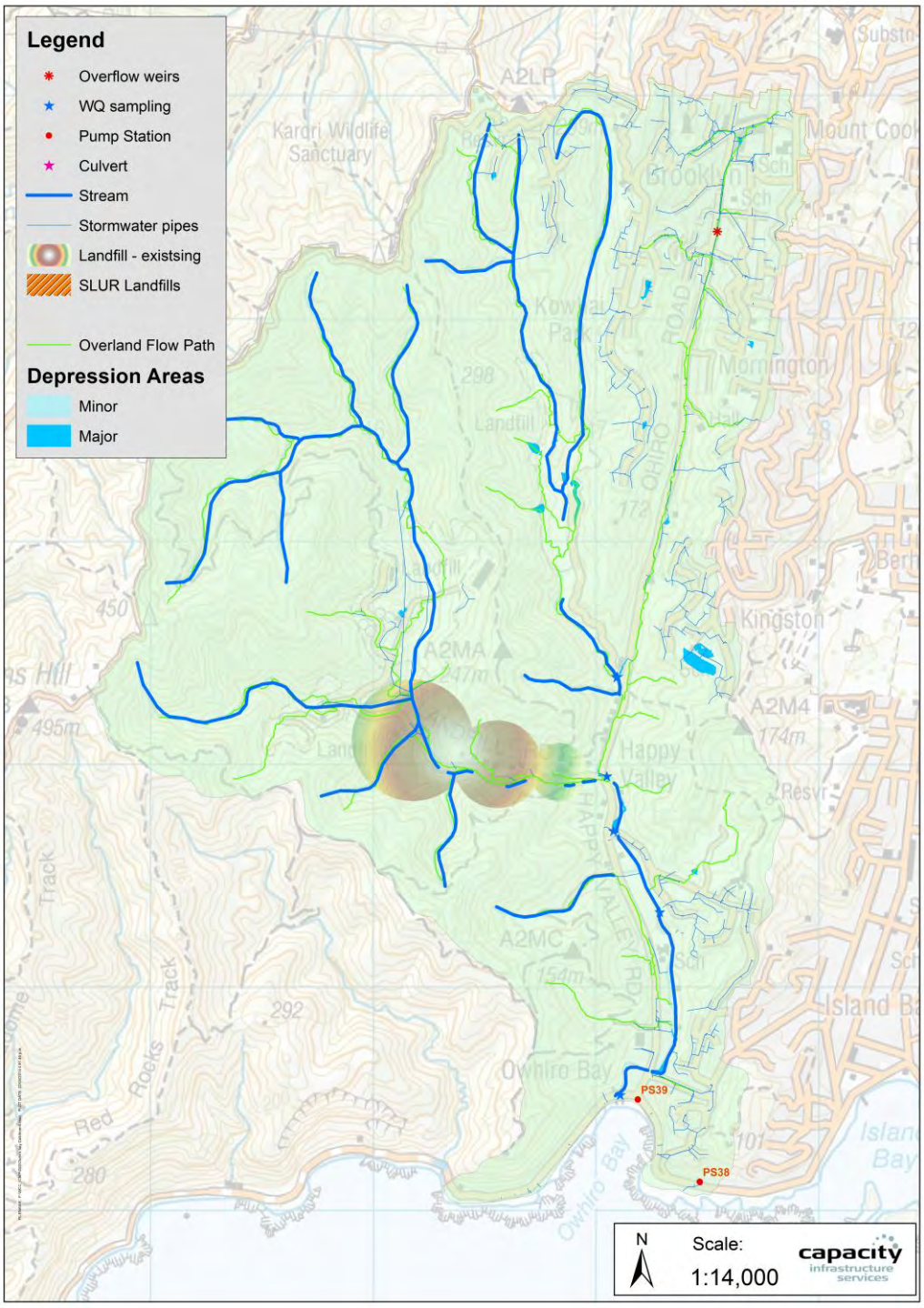


Figure 50: Owhiro bay Catchment Features

4.6.3.2 Amenity and Recreation

Amenity and recreational uses are shown on **Figure 51**. Cultural values were not mapped, because consultation with Iwi is still in progress.

Owhiro Bay is the closest south coast beach to the central city. The sheltered Owhiro Bay boat ramp and car park is on the eastern side of the bay. The Friends of Owhiro Stream group has initiated a project to restore and protect Owhiro Bay Stream, the only un-piped city stream flowing to the south coast. The community group has planted more than 8,000 native trees.

Owhiro Bay was the site of a well-developed Māori settlement when Europeans arrived - middens, implements and ovens are evidence of Māori cultivation and occupation.

Figure 51: Amenity and recreational values at Owhiro Bay

NOTE: Amenities are shown in the key only. Recreation activities are shown in the key with the main locations for these activities on the map.

4.6.4 Stormwater Network Issues and Contaminants

4.6.4.1 Flooding

There are no known historic flooding issues in the catchment. During large events depression areas get flooded. There is little development in the valley floor other than roads and flood risk in the catchment is therefore considered to be relatively low.

4.6.4.2 Contaminant Types, Sources and Loads in Stormwater

4.6.4.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5.

4.6.4.2.2 Diffuse Sources

Catchment-wide sources will be dominated by runoff from the gorse scrubland. Urban stormwater is a relatively minor input. Urban sources include metal roofs and building materials, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, and wild and domestic animals and vehicles (tires, brake linings, oil leakage, exhaust).

4.6.4.2.3 Wastewater Inputs

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. Model predictions on the main interceptor wastewater network indicate that Pumping Station 38, which

is located on Owhiro Bay Parade, is likely to overflow directly to the coastal marine area at an average recurrence interval of 5 years.

Other potential sources of faecal contamination in the Owhiro Stream include droppings from birds, dogs, cats, possums, goats, horses, cattle and sheep. More details are provided in Appendix B17 under sub catchment summary reports.

4.6.4.2.4 High Risk Facilities (Potential hot spots)

Potential known 'hot spots for contamination' include a number of operating and closed landfills - WCC's Southern Landfill and adjacent private landfills. These may have a slight to moderate impact on contaminant concentrations in the stream. Available monitoring data indicate that contaminant loads derived from these landfills are of a similar order of magnitude to those carried in runoff from urban Brooklyn. A closed landfill is located at Murchison Road.

4.6.4.2.5 Loads of Chemical Contaminants

The quality of stormwater in this catchment is relatively unknown. Contamination of the suspended sediment carried by stormwater during one storm in 2002 had unusually high levels of arsenic, copper, chromium, iron, silver and zinc (KML 2005). This finding is not consistent with this low degree of urbanisation, or the dominant land use (gorse, scrub). It suggests contamination from the landfills or other industrial activity. Measurement of persistent organic pollutants during this storm also revealed occasionally high levels of DDT and dieldrin and moderately elevated PCB levels in the particulate matter in stormwater. This requires further investigation, (Williamson 2013, Appendix C).

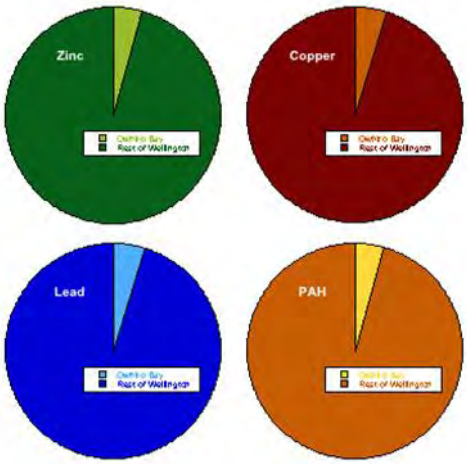
Stormwater loads of Zn, Cu, Pb and PAH from the catchment, excluding the inputs from the landfill sites, are predicted to be low. The catchment area is about 13% of Wellington City and loads are about 6% of the total stormwater load from Wellington. The proportion of loads is shown in the adjacent chart. The specific loads (the mass of contaminant per unit area) are low for Wellington, reflecting the small urban area (about 20%) and the large area of scrub land.	

Figure 52: Chemical load estimation

4.6.4.2.6 Wastewater Contamination

Concentrations of faecal coliforms in the stream near the beach are low and consistent with a partially developed catchment. Monitoring data suggest that there are no significant dry weather wastewater leaks and no significant wet weather wastewater overflows over the whole monitoring period from 1992 to 2012. Detailed information is provided in Appendix D and E.

4.6.4.3 Prediction of Future Trends in key Chemical Contaminant Loads

It is unlikely that the present-day levels of chemicals in stormwater are sufficient to increase concentrations of these contaminants in the bay sediments. Further detailed investigation will be carried-out in Stage 2.

4.6.5 Assessment of the Effects of Contaminants

Urban stormwater has the potential to affect:

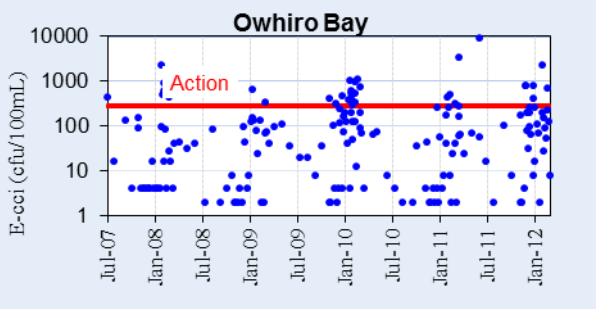
- the aesthetic quality of the beach
- human health during swimming and scuba diving/snorkelling
- marine organisms in the marine reserve

4.6.5.1 Aesthetics and Gross Pollutants

Visual 'aesthetics'are generally good, with no recent reports of odours, solids, surface films, scum or foam (**Figure 54**). The stream forms a small shallow lagoon as it crosses the beach. Some die-off of biological growth has been reported in this area. This is probably because periphyton growing (and dying) under variable conditions of light, nutrients and long periods of dry flow. Discoloration is observed in the beach water after rain.

4.6.5.2 Human Health

The Suitability for Recreational Grade (SFRG) measures the suitability for full body immersion (primary contact) that might occur in activities such as swimming, scuba diving and snorkelling. The SFRG is rated as Poor at Owhiro Beach (**Figure 53**). Indicator bacteria at the beach often exceed MfE guidelines for contact recreation, which has resulted in warning signs being erected from time to time (**Figure 53**).



The monitored enterococci (E-cci) levels at the beach show blocks of time in some years where the action level (the red line) is exceeded. These are not due to the stream quality, but are possibly due to the accumulation of decaying seaweed on the beach each summer.

Figure 53: Beach Monitoring Owhiro Bay

A more detailed investigation (termed "faecal source tracking") late in the 2012/13 bathing season suggested wildfowl as one of the main sources, although human, dog and ruminant sources could have compounded the effects. Seagulls can gather in large numbers in the bay. High concentrations of indicator bacteria were also found with no obvious warm-blooded source, which led scientists to consider the source was the decaying seaweed (the tidal wrack) on the beach, where indicator bacteria are known to occur, presumably after being 'inoculated' from elsewhere.

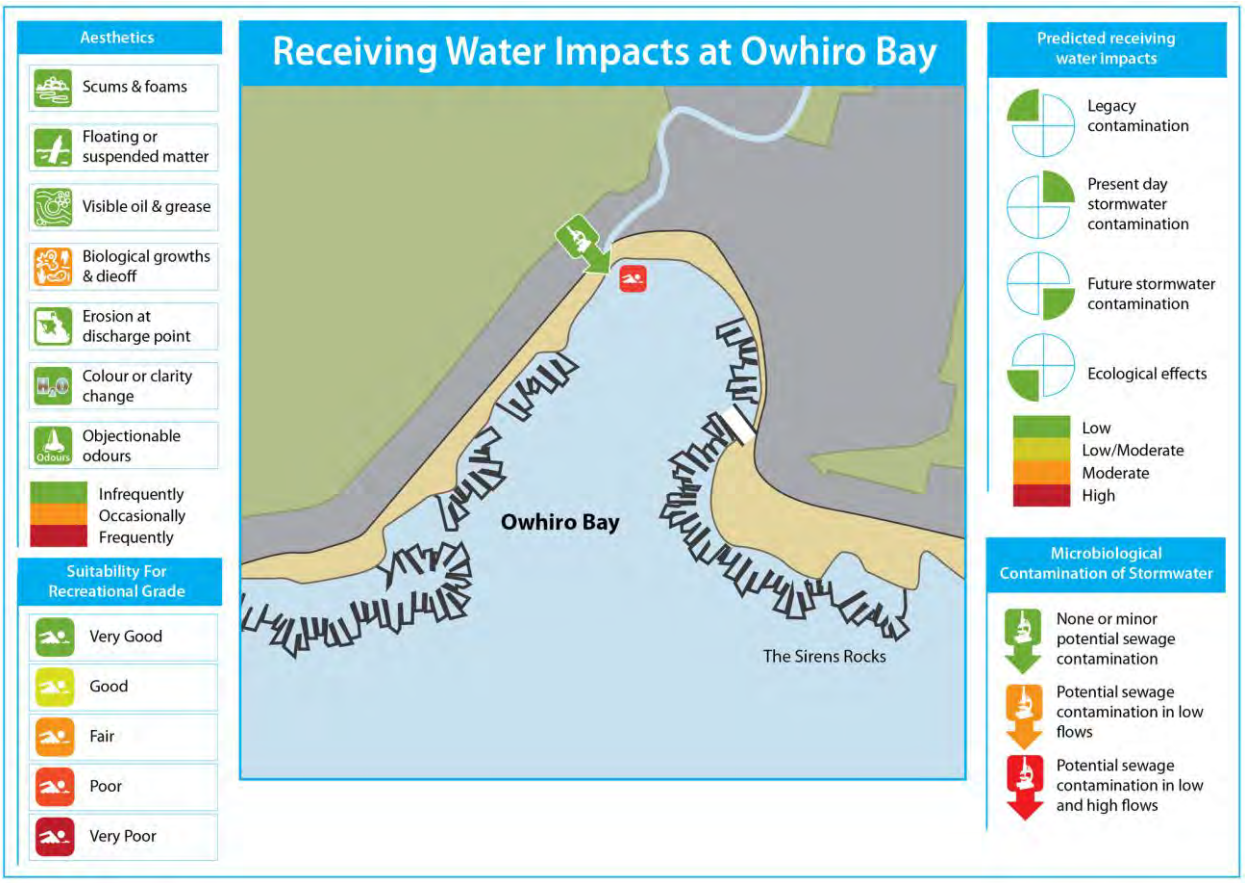


Figure 54: Stormwater impacts in Owhiro Bay

4.6.5.3 Chemical Contaminants

There is no information on receiving water contamination. Re-suspension, dilution, and dispersion processes are likely to be high, so contaminants should not occur in high concentrations within the water column of the bay, nor should they accumulate in sediments. However, the unusual chemical characteristics of the stream water, the likely influence of the landfill, and the relatively small amount of data, make this assessment uncertain. Legacy contamination, Present day stormwater contamination, and future stormwater contamination have all been classified as low (**Figure 54**).

4.6.5.4 Ecological Effects

The ecological sensitivity is probably high, being a relatively pristine environment, and having high water quality from Cook Strait, and a diverse range of habitats. As described above, any contamination is probably widely dispersed in the water column and into Cook Strait, and there is unlikely to be any accumulation of contamination. Therefore the ecological effects have been classified as low. However, the unknown contribution of landfill leachate makes the degree of confidence of these predictions uncertain.

4.6.6 Stormwater Management Recommendations

4.6.6.1 Quality

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Further sampling of stream sediments and stormwater for heavy metals, PAH and organochlorine pesticides is recommended as this is an unusual site because of the landfills.
- The above sampling should include analysis of ammonia and BOD in stormwater samples, which are useful indicators of landfill leachate.
- Source controls and other best management practices should be applied to urban development as planned by WCC.
- Monitoring should continue for faecal coliforms and enterococci in the stream and bay.
- Develop great insight into the microbiological contamination and dispersion processes at Owhiro Bay by measuring salinity and turbidity during beach microbiological sampling.

4.6.6.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- A capacity analysis will need to be completed for major culverts and tunnels.
- A a Rapid Flood Hazard Assessment be completed early in Stage 2 of the ICMP, to provide an indication of where further detailed modelling and flood hazard mapping may be required.
- Best management practices should be applied to urban development as planned by WCC

4.7 Kaiwharawhara Catchment

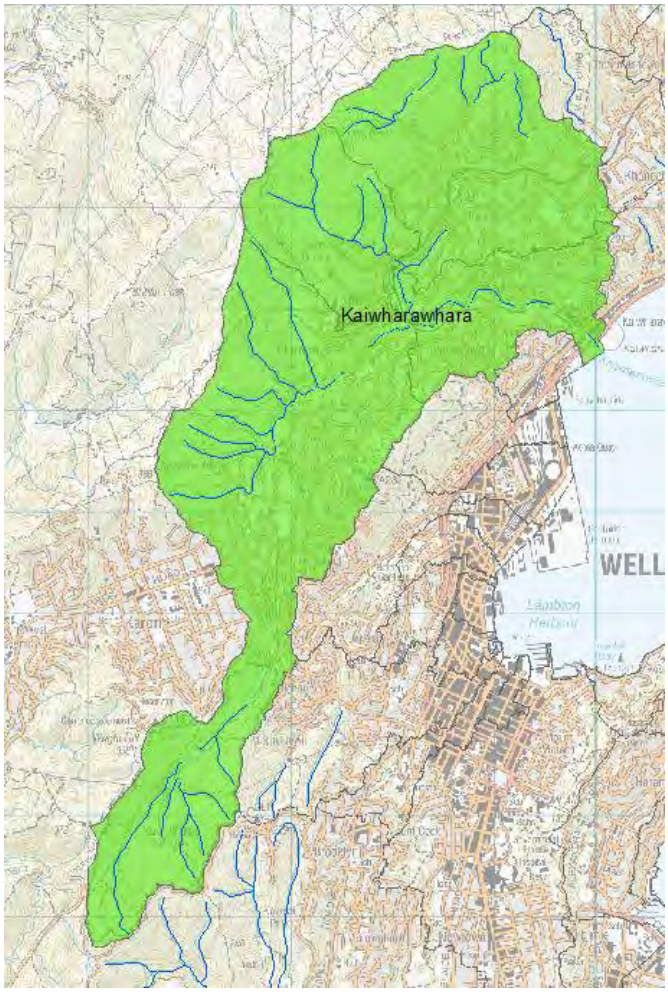


Figure 55: Kaiwharawhara Catchment

4.7.1 Overview

The Kaiwharawhara Stream catchment has multiple discharges to Kaiwharawhara Stream, which discharges to Wellington Harbour via Ngaio Gorge. The Kaiwharawhara Stream and stormwater catchment lies to the north and west of Wellington City centre, and includes parts of Karori, Wilton, Wadestown, Ngaio and Khandallah. The stormwater catchment covers an area of 16.7km^2 and encompasses the suburbs of Wilton, Wadestown, Crofton Downs and Ngaio, and parts of Karori, Northland, Kaiwharawhara and Khandallah.

The catchment is bounded to the east and south by the ridgeline extending from Te Ahumairangi Hill (Tinakori Hill) and around the Zealandia Wildlife Sanctuary, to the west by Karori, Johnston Hill and The Crow's Nest, and to the north by Mt Kaukau and a low ridge through Khandallah, (**Figure 55** and **Table 11**).

Table 11: Kaiwharawhara Catchment Characteristics

Sub catchment	Area (ha)	Land Use	No of Outfalls	WW pumps stations and constructed overflow locations
Kaiwharawhara	1670	Lightly developed outer residential catchment with conservation land and open space.	One stream outfall at Kaiwharawhara	One constructed overflow structure and PS 46

4.7.2 Stormwater Catchment Characteristics and Descriptions

4.7.2.1 General

Kaiwharawhara Stream originates in the Karori Wildlife Sanctuary, passing through two water supply reservoirs before draining a predominantly residential area. The Kaiwharawhara Stream discharges to Wellington Harbour via Ngaio Gorge, and reclaimed land near its mouth (**Figure 56**). Detailed information on catchment characteristics is provided in Appendix B5.

4.7.2.2 Land use

There are large areas of open space in the Karori Sanctuary and the western hills, and a small motorway, and an industrial and commercial zone near the stream mouth. The middle reaches of the stream drain new and old residential areas, with small suburban centres.

4.7.2.3 Other Facilities

The descriptions of other facilities are provided in Appendix B5. These include:

- 7 a) iii.The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, (constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

4.7.3 Description of Values and Receiving Environment

The detailed descriptions of the ecological quality of the receiving environment are provided in Appendix C. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2.

4.7.3.1 Receiving (Discharge) Environment

The Kaiwharawhara stream-mouth has been significantly modified by the reclamation of this coast for road and rail into central Wellington.

This northwest corner of the harbour is sheltered, being protected from deep ocean swells, but possibly subject to waves produced by local winds. In southerly storms, these waves could be quite large and sediments along this coast are likely to be dominated by coarser fractions (sand-sized or larger) down to 8 mm in size. Any fine sediments and associated contaminants that deposit in the near shore zone are likely to be dispersed offshore into the wider harbour.

This area of stream has been highly impacted through contamination and modification (e.g. through industrial land run-off, reclamation, channelisation, reduced riparian vegetation, invasive weed species, and sedimentation).

The estuary is poorly defined; it has a restricted mouth and no lagoon in the lower reaches. It offers little habitat for birdlife or fish: the regular inundation of the gravel banks by the tide render them of little use to nesting shorebirds, and the modified margins and gravel beds of the estuary offer no suitable habitat for inanga spawning.

4.7.3.2 Amenity and Recreation

The Kaiwharawhara Stream estuary has limited access due to the presence of roads and railway lines, and has little recreational value. As described above, it also has little ecological value. However, the area is being promoted as a desirable recreational destination and link within the Sanctuary to Sea Walkway and the proposed Great Harbour Way – Te Aranui o Poneke project.

4.7.4 Stormwater Network Issues and Contaminants

4.7.4.1 Flooding

Currently there are no known significant flooding issues in the catchment. A significant proportion of development is located on relatively steep and convex hill slopes which are likely to have a lower flood risk than other parts of Wellington. Parts of Ngaio and Khandallah are however relatively flat and are therefore likely to be more susceptible to flooding.

The culverts and tunnels draining many of the depression areas are considered critical from a flood risk perspective.

The commercial area at the bottom of Ngaio Gorge around Hutt Road is susceptible to flooding due to the constrained channel and low bridges, and flood risk in this area is likely to be exacerbated by any future sea level rise.

4.7.4.2 Contaminant Types, Sources and Loads in Stormwater

4.7.4.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5

4.7.4.2.2 Diffuse Sources

Catchment-wide sources include roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tires, brake linings, oil leakage, and exhaust) are probably the major generic source, associated with motorways, SH1, major feeder roads, shopping areas and industrial parking lots.

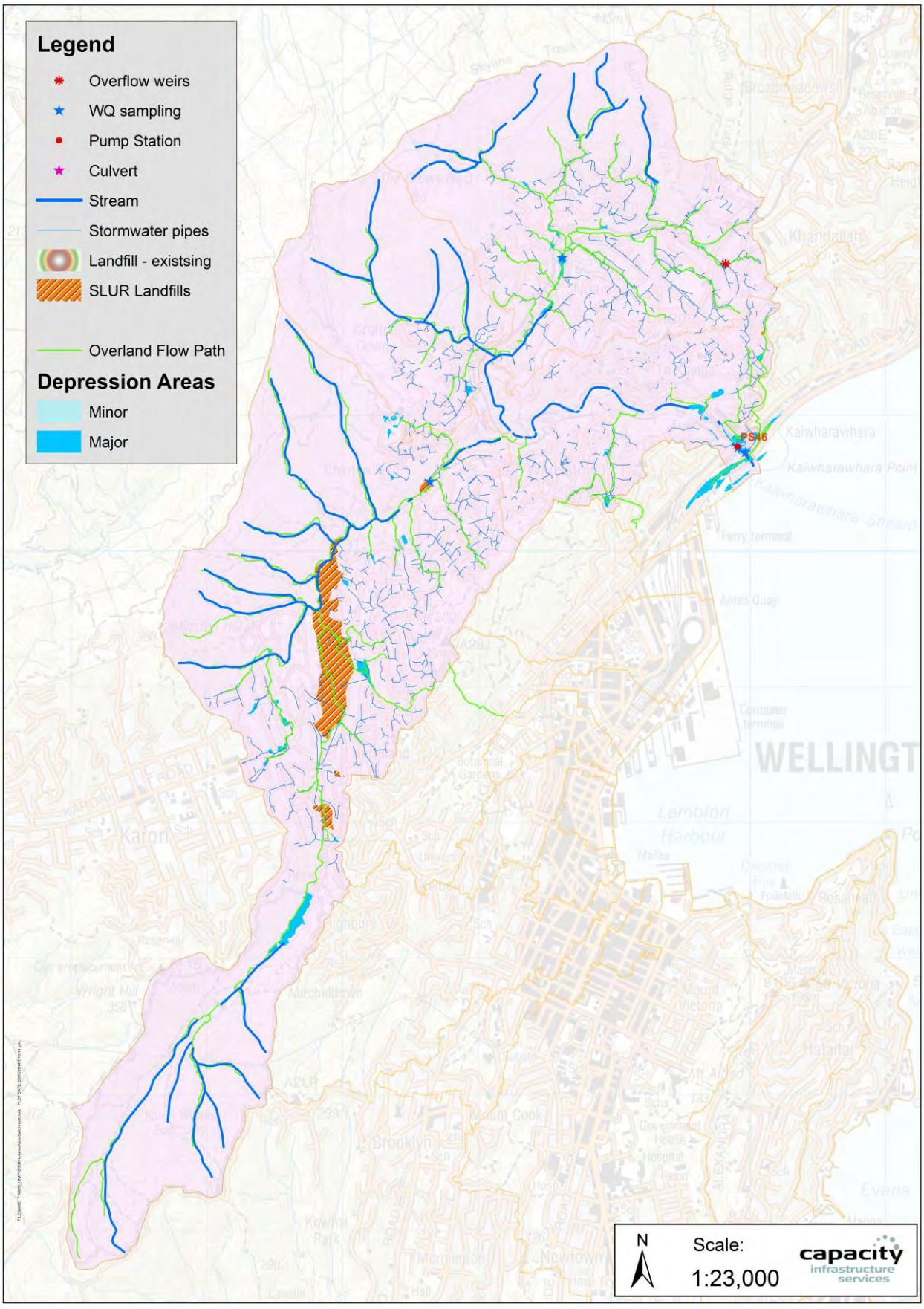


Figure 56: Kaiwharawhara Catchment Features

4.7.4.2.3 Wastewater Inputs

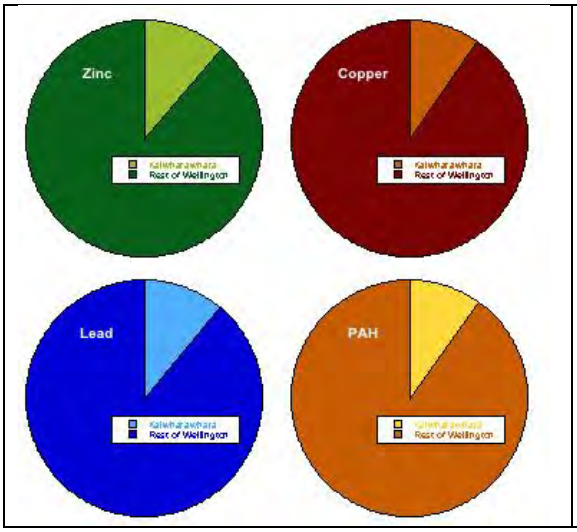
Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. In these catchments, wastewater rehabilitation works have been undertaken since 1993, including checking and repairing cross-connections, studies and fixing known wastewater pipe faults. More details are provided in Appendix B5 under sub catchment summary reports.

4.7.4.2.4 High Risk Facilities (Potential hot spots)

Potential hot spots include the Wellington to Hutt and Porirua motorways. SH 1 has an average daily traffic count in excess of 50,000 vehicles. Kaiwharawhara stream is piped under disused landfills, which were known to have contributed to elevated concentrations of arsenic, lead, zinc and other metals in stream sediments in the past. Three other additional disused landfills exist in the catchment.

4.7.4.2.5 Loads of Chemical Contaminants

Kaiwharawhara stream has been strongly impacted by diffuse source pollution from urban areas in the past (and probably landfill leachate). Water quality criteria were exceeded for Cd and Cu (see more details in Appendix C). Sediments were highly contaminated with Zn and Pb, and moderately contaminated with Cu and As. More recent surveys of sediments have found sediments strongly contaminated with Zn and PAH. Legacy contaminants DDT and Pb were still elevated in some samples of Kaiwharawhara stream sediments, (see more details in Appendix C).



Stormwater loads of Zn, Cu, Pb and PAH from these catchments are predicted to be high because the combined catchment area is about 21% of Wellington City. Loads are about 10% of the total stormwater load from Wellington. The proportion of loads for Kaiwharawhara shown in the charts. The specific loads (the mass of contaminant per area) are low - moderate for Wellington, a reflection of a predominantly residential area with large areas of Open Space.

Figure 57: Chemical Load Estimation - Kaiwharawhara Catchment

4.7.4.2.6 Wastewater Contamination

Monitoring at the stream mouth indicates that there are relatively low levels of wastewater contamination. (Detailed information is provided in Appendix D and E).

4.7.4.3 Prediction of Future Trends in Key Chemical Contaminant Loads

It is unlikely that the present day levels of chemical contaminants in stormwater are sufficient to increase concentrations of these contaminants in the estuarine sediments. More detailed investigation will be carried-out in Stage 2.

4.7.5 Assessment of the Effects of Contaminants

4.7.5.1 Aesthetics and Gross Pollutants

No aesthetic issues have been reported near these stream outfalls. However, apart from a short stretch of gravel at the stream mouth, most of the lower estuary has been constrained by concrete culverts and is devoid of vegetation and therefore of little aesthetic value.

4.7.5.2 Human Health

No monitoring has taken place near the mouth of the Kaiwharawhara stream.

4.7.5.3 Chemical Contaminants and Ecological Effects

Chemical and ecological effects at the Kaiwharawhara Stream outfall are strongly affected by the inputs from other outfalls along the North Coast, particularly from Onslow, and Aotea Quay. Studies have been conducted off Aotea Quay, which is likely to be affected by the Kaiwharawhara Stream discharge (Refer to Lambton Harbour Section 4.2.5 for a summary of chemical and ecological effects, **Figure 29** and **Figure 61**).

4.7.6 Stormwater Management Recommendations

4.7.6.1 Quality

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- Stream water quality monitoring is recommended to gain greater understanding of contaminant sources

4.7.6.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

- The capacity of all culverts and tunnels that serve significant depression areas to be assessed, and asset information in the WCC asset management system to be updated.
- A capacity analysis and/or flood risk assessment to be completed for culverts and tunnels that serve significant depression areas.
- Regular maintenance requirements for all culverts and tunnels that serve significant depression areas to be identified.
- A hydraulic model and flood hazard maps of the lower Kaiwharawhara Stream to be developed

4.8 Wellington Harbour North

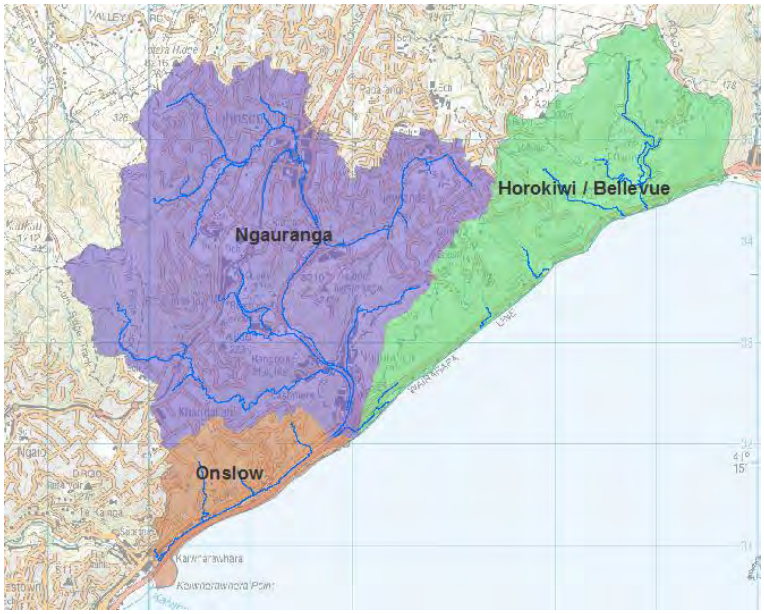


Figure 58: Ngauranga Stream Catchments

4.8.1 Overview

The north coast of Wellington Harbour stretches from Aotea Quay to Petone Beach. This straight coast is rocky and exposed and has limited accessibility due to the proximity of SH1, SH6 and the main trunk railway. It receives stormwater from Ngauranga, Onslow and Horokiwi, and Belmont (**Figure 58** and **Table 12**).

Table 12: Ngauranga Stream Catchment Characteristics

Sub catchment	Area (ha)	Land Use	No of Outfalls	WW pumps stations and constructed overflow locations
Horokiwi / Bellevue	472.9	Outer residential, conservation land	Small, multiple	--
Ngauranga	963.8	Outer residential with light industrial areas	Small multiple to Ngauranga Stream	PS59
Onslow	144.6	Outer residential	Small, multiple	PS45

4.8.2 Stormwater Catchment Characteristics and Descriptions

4.8.2.1 General

The Ngauranga stormwater catchment includes parts of Khandallah, Johnsonville and Newlands. Onslow is a small coastal catchment that lies between the Kaiwharawhara and Ngauranga stream mouths. Horokiwi/Bellevue stream lies to the west of Petone and is mostly rural and conservation land, with a small residential area. Detailed information on catchment characteristics is provided in Appendix B2, B3 and B4.

4.8.2.2 Land use

Ngauranga Stream drains a predominantly residential catchment, but includes significant commercial and light industry areas in Johnsonville, Newlands and Ngauranga. Onslow is predominantly Open Space with significant areas of motorway and light industrial/commercial premises. Horokiwi/Bellevue stream carries mostly 'rural' runoff. About 24% of the catchment area comprises impervious surfaces.

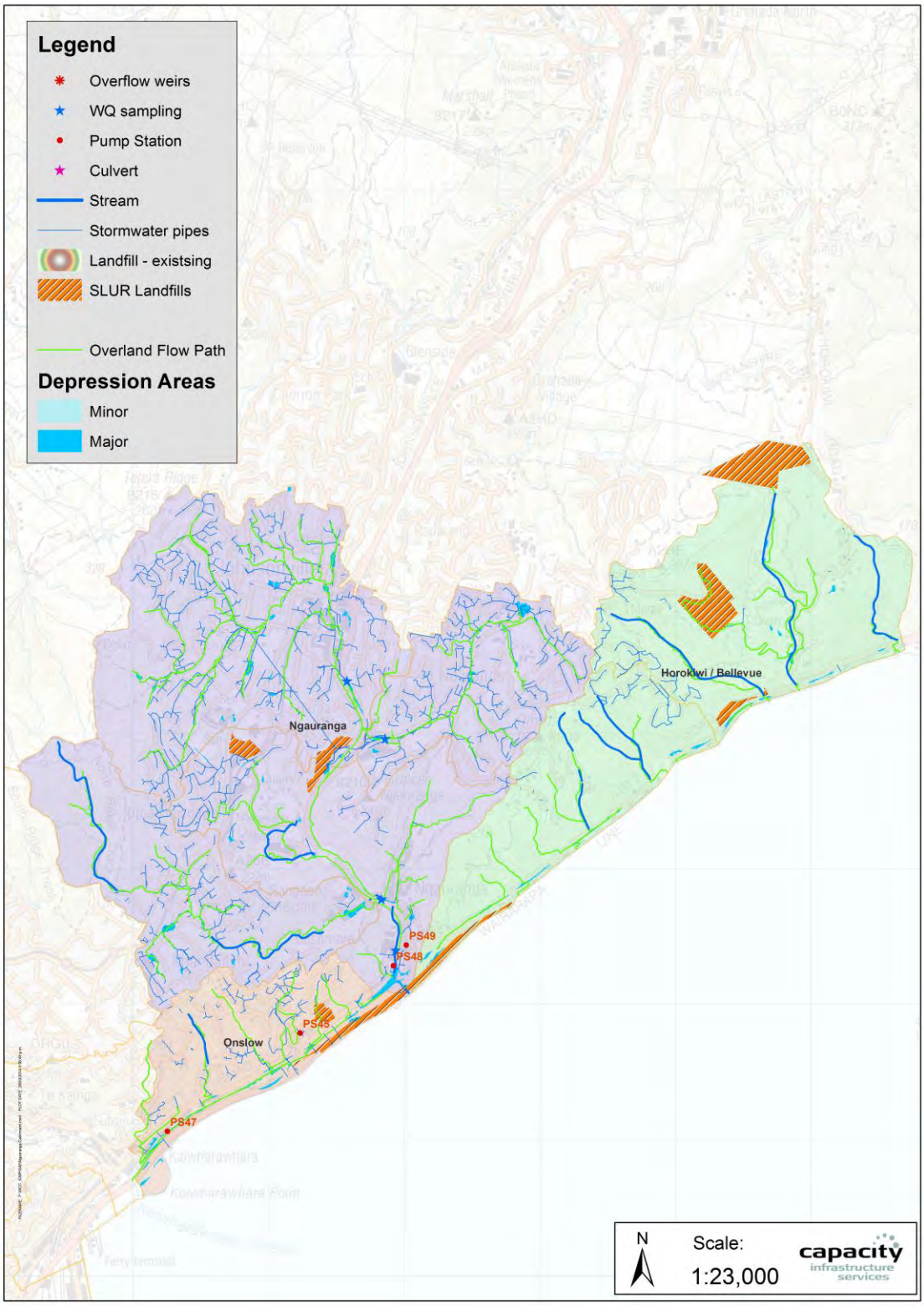


Figure 59: Ngauranga Catchment Features

4.8.2.3 Other Facilities

The descriptions of other facilities are provided in Appendix B2, B3 and B4. These include:

- 7 a) iii.The location and description of industries and other high risk facilities (for example, landfills and factories) that may potentially make a disproportionate contribution to stormwater contamination
- 7 a) iv. The location and description of current stormwater management and treatment devices, including the sub-catchment areas serviced by those devices, (locations, maintenance regime and descriptions are provided in Appendix K)
- 7 a) v. The location and description of constructed wastewater to stormwater overflows, wastewater pump stations and wastewater storage facilities, (constructed overflow weir locations, wastewater pump stations, storage facilities and descriptions are provided in Appendix J)

4.8.3 Description of Values and Receiving Environment

Detailed descriptions of the ecological quality of the receiving environment are provided in Appendix C. The effects of stormwater discharges on ecological quality are discussed below. Cultural values will be assessed in consultation with Iwi in Stage 2.

4.8.3.1 Receiving (Discharge) Environment

The Ngauranga stormwater catchment discharges to Ngauranga Stream at multiple locations, which in turn discharges to Wellington Harbour at Ngauranga after passing under the State Highway 2 motorway. Onslow has a number of small stormwater outfalls discharging directly to the coast. Horokiwi/Bellevue Stream discharges directly to the coast near Petone Beach.

The North Coast is sheltered and protected from deep ocean swells, but is subject to waves produced by local winds. In southerly storms, these waves could be quite large and sediments along this coast are likely to be dominated by coarser fractions (sand-sized or larger). Any fine sediments and associated contaminants that deposit in the near shore zone are expected to be dispersed offshore into the wider harbour.

4.8.3.2 Amenity and Recreation

Amenity and recreational uses are shown in **Figure 60** for the North Shore. Cultural values were not mapped, because consultation with Iwi is still in progress.

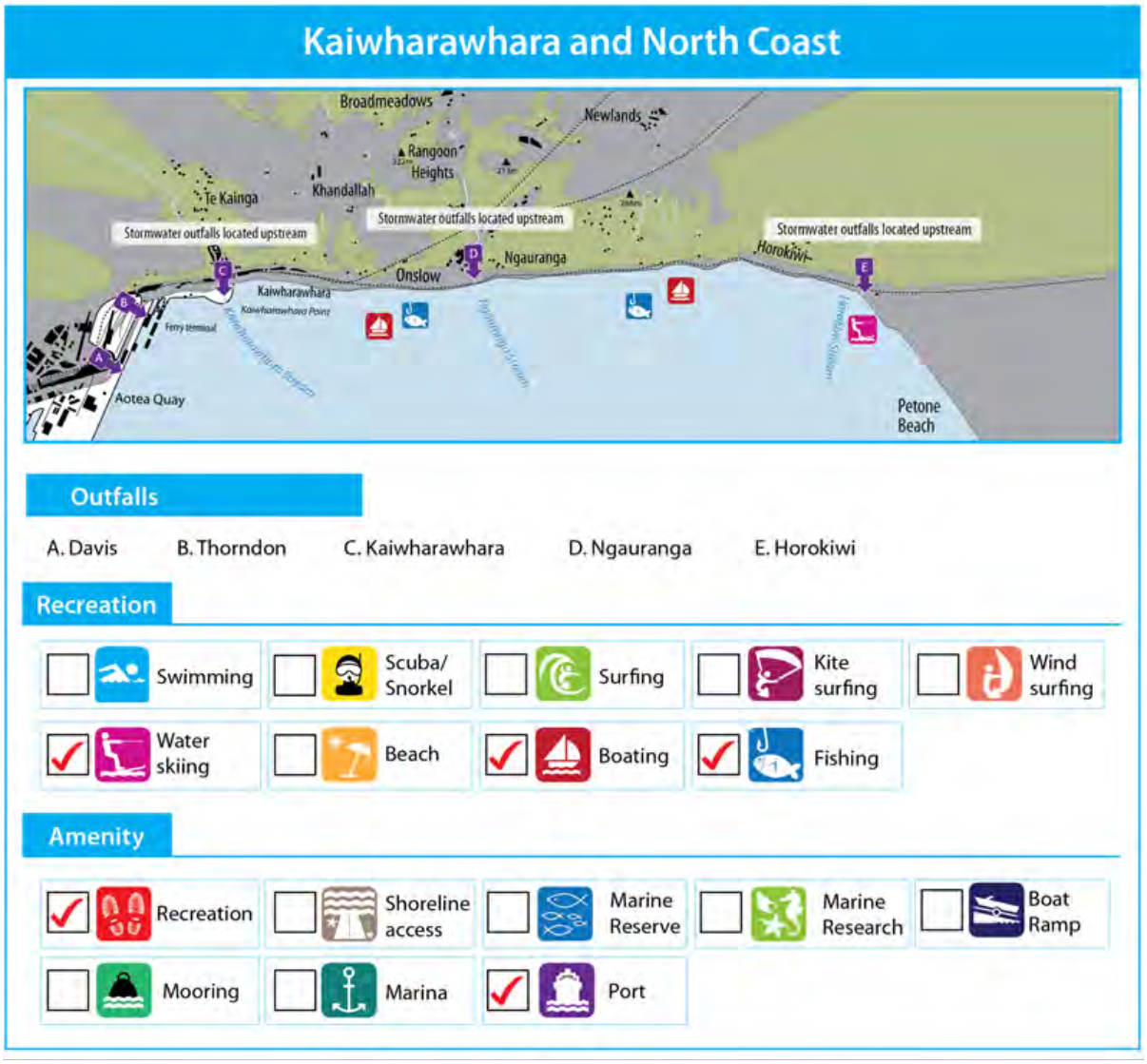


Figure 60: Amenity and recreational values along the northern shore from Kaiwharawhara Stream to Horokiwi/Bellevue Stream

NOTE: Amenities are shown in the key only. Recreation activities are shown on the key with the main locations for these activities also depicted on the map.

Along the northern shore, the main amenity values of the receiving waters are boating and fishing. Some water-skiing occurs in the east from Petone Beach. There is very little and only difficult access from the shore because of SH1 and the Wellington-Hutt railway line. The coast is also exposed and some distance from suitable launching places, and is probably only accessed by motorised recreational fishing boats.

4.8.4 Stormwater Network Issues and Contaminants

4.8.4.1 Flooding

Historically there have been significant flooding incidents in Ngauranga catchment but there are no known current flooding issues of significance in the catchment. The commercial area and state highway

at the bottom of Ngauranga Gorge is susceptible to flooding due to the narrow channel and low bridges, and flood risk in this area is likely to be exacerbated by any future sea level rise.

A number of areas in the catchment are susceptible to ponding and many parts of the catchment do not have adequate secondary flow paths. This includes the Johnsonville suburban centre and the Tyers Road commercial area.

4.8.4.2 Contaminant Types, Sources and Loads in Stormwater

4.8.4.2.1 Sediment Loads

Sediment loads are discussed City-wide in Section 3.5

4.8.4.2.2 Diffuse Sources

Catchment-wide sources include roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tires, brake linings, oil leakage, and exhaust) are probably the major generic source, being associated with the motorways, SH1, major feeder roads, shopping and industrial parking lots.

4.8.4.2.3 Wastewater Inputs

Wastewater contamination of stormwater can occur through cross-connections, from leaking wastewater pipes, and from overflows when the wastewater system becomes overloaded or fails. In these catchments, wastewater rehabilitation works have been undertaken since 1993, including checking and repairing cross-connections, studies and fixing known wastewater pipe faults. Detailed information is presented in Appendix B2, B3 and B4.

4.8.4.2.4 High Risk Facilities (Potential hot spots)

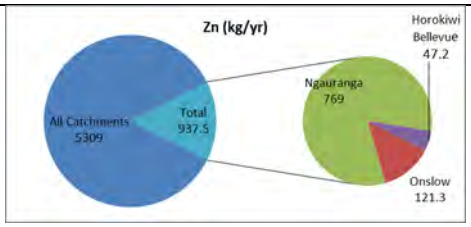
Potential hot spots include the Wellington to Hutt and Porirua motorways. State Highway 1 has an average daily traffic count in excess of 50,000 vehicles. One large landfill operated in the Ngauranga catchment from 1961 to 1971. The Kiwi Point Quarry and Taylor Preston Abattoir are currently located in this area.

4.8.4.2.5 Loads of Chemical Contaminants

The chemical quality of stormwater and stream sediments has been occasionally monitored in Ngauranga stream in the past, with Cu, Pb and Zn contamination being revealed. Legacy contaminants DDT and Pb were still elevated in Ngauranga stream sediments near the outlet in 2007. The level of contamination is expected to be moderate for Ngauranga and Onlow, but low for Horokiwi stream.

4.8.4.2.6 Wastewater Contamination

Ngauranga Stream has wastewater contamination during both dry and wet weather flows. It is under routine and responsive investigation for cross connections between wastewater and stormwater. Detailed information is provided in Appendix D and E.

Stormwater loads of Zn, Cu, Pb and PAH from these catchments are predicted to be moderate because the combined catchment area is about 21% of Wellington City. Loads are about 18% of the total stormwater load from Wellington. The proportion of Zn loads for is shown in adjacent chart. The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of higher loads from	

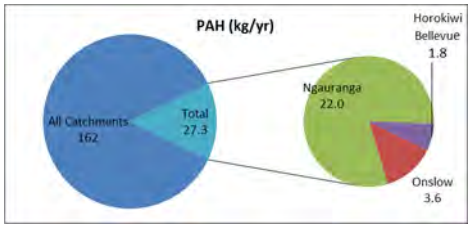
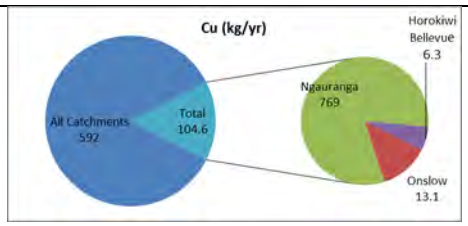
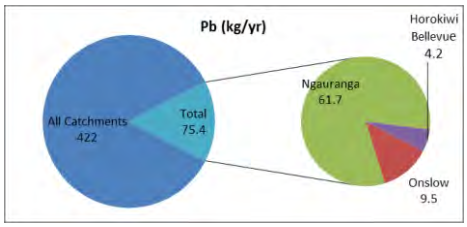
Ngauranga and low loads from large areas of Open Space. 	 

Table 13: Estimated Chemical Loads Ngauranga Catchments

4.8.4.3 Prediction of Future Trends in Key Chemical Contaminant Loads

It is unlikely that the present day levels of chemical contaminants in stormwater are sufficient to increase concentrations of these contaminants in the marine sediments. More detail investigation will be carried out in Stage 2.

4.8.5 Assessment of the Effects of Contaminants

Chemical and ecological impacts along the North Coast are strongly affected by the inputs from Kaiwharawhara Stream and, to a lesser extent, Aotea Quay. The following sections discuss impacts closer to Ngauranga Stream.

4.8.5.1 Aesthetics and Gross Pollutants

No problems have been reported near these stream outfalls.

4.8.5.2 Human Health

The receiving waters are not monitored for microbiological quality.

4.8.5.3 Chemical Contaminants

The Wellington harbour marine sediment quality investigation found that concentrations of DDT, Pb, and Hg exceeded sediment quality guidelines near the Ngauranga Stream mouth in 2006 and 2011 (**Figure 61**). Pb, DDT and Hg are not currently being discharged in sufficient quantities in urban stormwater to account for these high levels of contamination, although stormwater may have carried high loads of these substances in the past. There may also have been other sources such as industrial discharges. Modern day urban stormwater has much lower concentrations of Pb and PAH, and Cu and Zn are the main contaminants of concern in terms of toxic effects in receiving waters.

Chemical impact assessment suggests: the current degree of contamination from historical pollution (Legacy contamination), the degree of contamination by Zn and Cu (Present day stormwater

contamination), and an indication of the concern for build-up of Zn and Cu concentrations from further stormwater discharges (Future stormwater contamination), (**Figure 61**). The sites are fairly similar, which reflects the moderate gradient in contamination off shore from the Ngauranga Stream mouth. Zn concentrations are expected to reach 'amber' status within 30 years in the two sites closest to the shore.

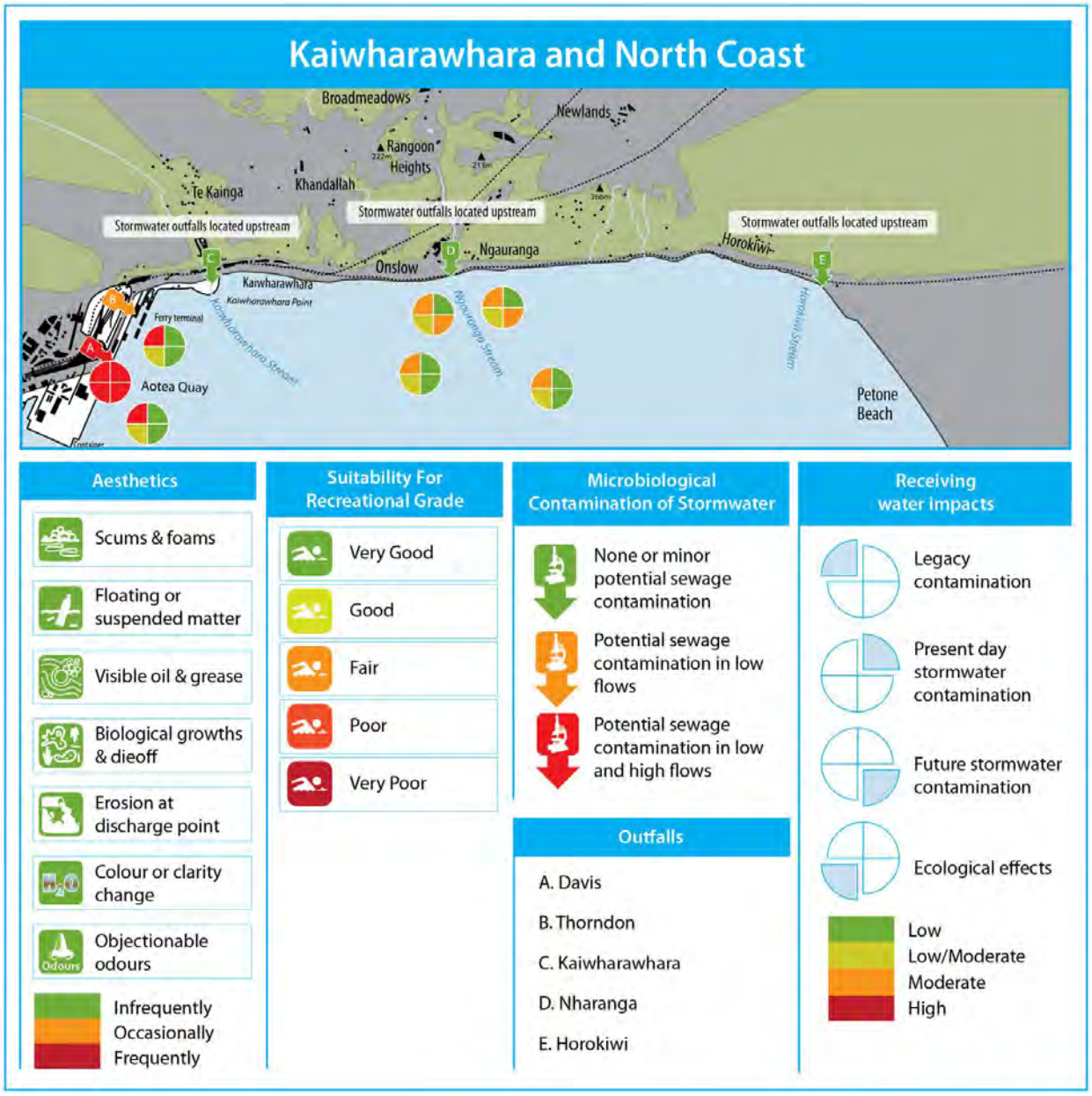


Figure 61: Receiving water impacts along the northern shore of Wellington Harbour

4.8.5.4 Ecological Effects

The Wellington harbour marine sediment quality investigation has identified moderate biological effects at distances 0.5 to 1 km off the northern shore (**Figure 61**). Low or zero effects are only found towards the middle of Wellington Harbour at considerable distances (4-6 km) from the shore.

4.8.6 Stormwater Management Recommendations

4.8.6.1 Quality

Some potential actions for stormwater quality management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

There are no high priority recommendations to address stormwater impacts in the Ngauranga catchment. Medium priority recommendations include additional analysis to help improve long-term management.

- Further sampling of stream sediments and stormwater for heavy metals, PAH and organochlorine pesticides is recommended as this catchment has historical landfills.
- The above sampling to include analysis of ammonia and BOD in stormwater samples, which are useful indicators of landfill leachate.
- Source controls and other best management practices to be applied to urban development as planned by WCC.
- Monitoring to continue for faecal coliforms and enterococci in the stream.

4.8.6.2 Quantity

Some potential actions for stormwater quantity management options are detailed below; however, there will be further assessments within Stage 2 of the ICMP process.

Ngauranga

- The capacity of all significant culverts and tunnels to be assessed, and asset information in the WCC asset management system to be updated.
- A capacity analysis and/or flood risk assessment should be completed for critical culverts and tunnels.
- Regular maintenance requirements for all critical culverts and tunnels to be identified.
- A detailed catchment hydraulic model and flood hazard maps to be developed.

Horokiwi and Bellevue

- Flood risk will continue to be managed on an as-required basis.

Figure 62: Silt trap at Ngauranga Stream besides Abattoir

5 Options, Methods and Timetables to Manage Issues

This section addresses condition 7 of Consent Number WGN090219, which requires, among other things:
7g) "Methods and a timetable (including, as relevant, annual commitments) to manage issues which are to be addressed on the basis of the whole area covered by these consents, (for example, public education about stormwater and contaminants; any changes to policies, plans, bylaws or standards; ongoing network maintenance and management programmes, strategic upgrades and/or additions to the stormwater network; memoranda of understanding with parties with city-wide interests)…"

5.1 Overview of Potential Adverse Effects of Stormwater Contaminants

Table 14 summarises the potential adverse effects on the environment produced by stormwater loading or by high concentrations of contaminants as described in Section 4.

5.2 Overview of Options and Methods

A wide variety of approaches are needed to address the many diverse adverse effects identified. The consent refers to both options and methods, so for the purposes of this report:

- options are interpreted as the various statutory powers that define the Council's mandate for action
- methods are interpreted as the more specific management interventions provided for within each of those statutory options

Management options available to the Council in its ICMPs are provided for under:

- the statutory methods under the LGA
- the statutory and non-statutory methods in the RMA
- statutory and non-statutory methods available under other legislation, such as that relating to parks, biodiversity, roads and so on

These options provide a large and ever-growing portfolio of methods for achieving the objectives of ICMPs, ranging from the traditional asset management approaches to community input via technologies such as crowd-sourcing of GIS information on asset faults or natural and other values.

The methods used in a given catchment reflect the issues, opportunities and priorities identified in the research and engagement work conducted as part of the catchment planning process. Detailed catchment specific methods will be selected as part of Stage 2 ICMP preparation, so the Stage 1 report gives a high-level overview of what is currently under way and proposed.

Table 14: Potential Adverse Effects

Contaminant	Area of Impact				
	Public Health	**Marine Eco-system**	**Aesthetics / Amenity Values**	**Recreational Values**	**Cultural Values of Iwi**
Pathogens	Contamination of bathing waters and shellfish.		Public health concerns impact on amenity values.	Public health concerns impact on recreational values.	Cultural values compromised by human waste in stormwater.
Heavy Metals	No indication that concentrations are a human health risk	Elevated concentrations in marine sediment present increased risk to benthic ecology	Possible impacts on ecology impact amenity values.	Public concerns for diminished fishery from effects on benthic ecology	Impacts on ecology impact cultural values.
PAH (Organics)	No indication that concentrations are a human health risk	Elevated concentrations in marine sediment present increased risk to benthic ecology	Possible impacts on ecology impact amenity values.	Public concerns for diminished fishery from effects on benthic ecology	Impacts on ecology impact cultural values.
Fine Sediment	Reduced visibility may increase risk of accidents to bathers during rain-runoff		Visual impacts of discharge plumes.	Visual impacts of discharge plumes.	Visual impacts of discharge plumes.
Litter	Accumulated litter increases risk to coastal area users.	Localised impacts on benthic habitat quality, fish and birds.	Visible impacts of floatables, litter and other types of detritus	Visible impacts of floatables, litter and other types of detritus. Impacts on ecology impact cultural values.	Visible impacts of floatables, litter and other types of detritus. Impacts on ecology impact cultural values.

5.3 Timetable of Methods

As required by consent condition 7 g), and pending the development of the detailed Stage 2 ICMPs, a broad overview and timetable of methods is in **Table 15**.

The timetable adopted covers a 20 year period as envisaged by consent condition 5, which states that "The objectives should set out a strategy for a 20 year period (or longer, if appropriate) for the management of stormwater in the catchments covered by this consent."

Methods will be introduced over time as follows:

- ongoing ('business as usual') work programmes and methods will be maintained, but realigned to reflect the receiving environment priorities identified in this report
- special (one-off or periodic) programmes will be introduced if the need is identified by the Stage 2 ICMPs, such as 5-yearly surveys of hazardous substances, locations and uses
- new methods will be introduced as needed, based on current proposals for new work programmes, and as indicated by the first high priority ICMPs

Condition 5 requires the preparation of objectives to "provide a framework to address any adverse effects stormwater discharges have on receiving environment values and the functions and services that stormwater management provides in relation to urban development and redevelopment. These include consideration of ecological values and processes, water and sediment quality, natural and physical resources, human health and safety, and recreational, cultural and amenity values". Condition 7 b) refers to the inclusion of these objectives in the Stage 1 ICMPs.

Compliance with condition 5 was achieved with Capacity's discussion document entitled "Environmental Objectives for the Integrated Catchment Management Plans 2012" (Appendix G). This paper was circulated across councils and the community and it was generally agreed that there are five broad categories of objectives:

1. catchment objectives associated with the underlying assets
2. water quality objectives associated with inputs and the receiving environment
3. stormwater quantity objectives associated with the management of stormwater generally
4. amenity value objectives associated with the amenity value of the city's natural areas
5. community engagement objectives associated with the interaction with the community

It can be seen that the five categories of objectives listed above encompass all the items in the second paragraph of condition 5, and also provide for community engagement (objective 5), which is essential for helping Council to identify values, issues and effects.

The timetable of methods in **Table 15** thus tracks which of the already agreed objectives, the methods will achieve. However, many of the methods listed achieve multiple objectives – for example, network improvements that reduce the frequency and magnitude of microbial concentrations that exceed the water quality benchmarks will also improve amenity values, and meet cultural outcomes when these are developed as part of Stage 2. Consequently, one or more key objective is listed for each method, although a contribution may also be made towards achieving other objectives.

Figure 63 shows how ICMPs synthesise the large amount of legal, asset, environmental, social and cultural information they collect in order to be able to follow the environmental management process, and create work plans based on objectives.

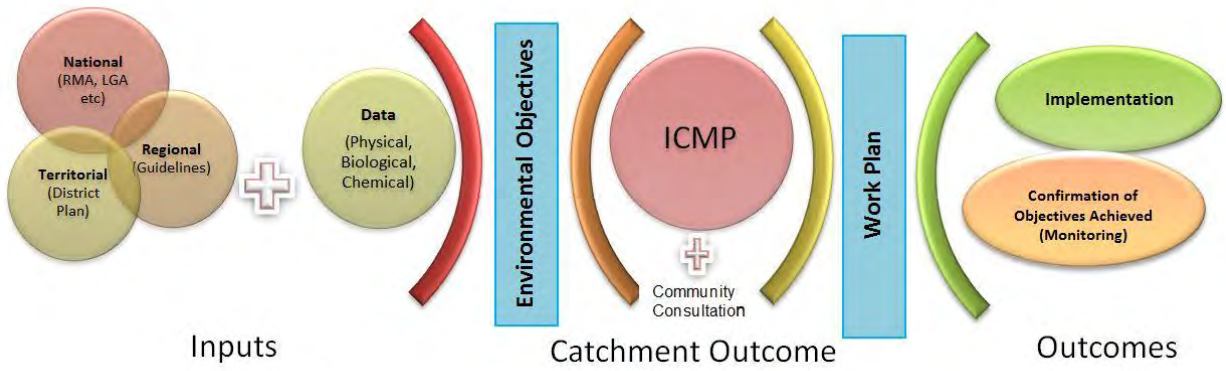


Figure 63: The Process of ICMPs

NOTE: Process synthesise legal, asset, environmental, social and cultural information for action and monitoring

The Stage 1 ICMP is a high-level overview for the city as a whole that will enable it to prepare the more detailed catchment-specific management plans envisaged for Stage 2, which in turn will enable the development of cost effective work programs.

Each of the objectives listed above has an environmental, economic, social and cultural aspect. Collectively referred to as the "four wellbeing's", these are referred to in both the RMA and LGA, and are depicted in **Figure 64**

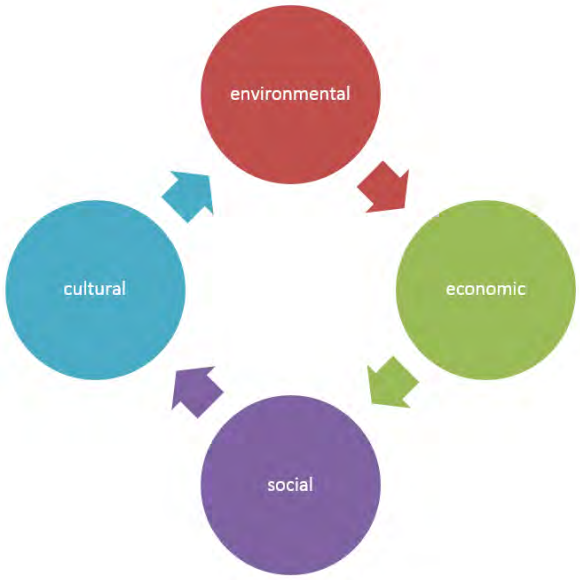


Figure 64: The Four Wellbeing's

While the community was consulted as required by Part 6 (Section 95C) of the Act during the consent application process, a considerable amount of data still needs to be gathered before the wider effects of Wellington City's stormwater activities can be fully understood.

In relation to the consent conditions, the environmental data (physical, biological and chemical) collected provide a greater understanding of the environmental effects of the City's stormwater

activities. However, the City's knowledge of the economic, social and cultural effects of the stormwater activity has not yet reached the same level of maturity.

For this reason, the Stage 2 ICMP development process will focus on developing a more in-depth understanding of all the effects of the stormwater activity, including its effects on the four wellbeings of the Wellington community. While some community engagement is already well under way and more is planned, Iwi engagement needs to be initiated.

Under conditions 11 and 12 of the resource consent, such further community engagement is proposed as part of Stage 2 ICMP development, based on the data in this Stage 1 report. The community engagement process will provide stakeholders with the opportunity to grow our collective 'shared intelligence' and will inform the identification of values, issues and methods.

Detailed methods will often be rolled out as part of a wider work programme, such as the asset (activity) management plans under the LGA, which define capital expenditure and operational programmes. This ensures cost-effective use of resources.

Table 15 provides indicative timelines for methods of addressing the adverse effects of stormwater discharges over a timeframe from 2014 to 2038.

Table 15: Indicative Timelines for Methods of Addressing the Adverse Effects

Option	Methods/work programmes	Responsible	ICMP Environmental Objectives					Time Frame		
			1. Catchments (Assets)	2. Quality	3. Quantity	4. Amenity	5. Community	Short term (June 2018)	Medium term (2018 – 2021)	Longer term (2021 – 2038)
Local Government Act methods / work programmes										
Capacity's Strategic Plan	This sits above the operational plans, and provides input into them to provide long-term direction and to ensure the 3 Waters Asset (activity) Management Plans are not developed in isolation, but are cost-effectively developed and delivered.	Capacity / WCC	✓	✓	✓	✓	✓	Align programmes with ICMP priorities	Ongoing	Ongoing
Stormwater Service Plan (Asset Development Plan – Stormwater) – **These are ongoing programmes**	• Stormwater grit cleaning • Beach and stream water quality monitoring • Baywatch recreational bathing water monitoring • Asset renewals • Routine maintenance of stormwater intake and outlets • Routine Inspection and cleaning of stormwater culverts • Condition assessment • Culvert Inspection Plan • Stormwater Intakes and Outfall Operation and Maintenance Plan • Critical Drain Inspection Plan • Repeat drainage faults • Treatment Device Operation and Maintenance Plan • Pipe renewal / Upgrade Plan - CAPEX • Stormwater pump station operation and maintenance plan • Reactive Maintenance Plan - Under Operation Team • Environmental Monitoring-Culvert outfall Monitoring Plan (20 outfalls, 21 coastal beach sites) • Three-Waters Strategy Implementation	Capacity / WCC	✓	✓	✓	✓	✓	Align programmes (as required) with ICMP priorities	Ongoing	Ongoing
Stormwater Service Plan – These are ongoing programmes	• Level of Service consultation, benchmarking and standard-setting • Liquid waste management plan		✓	✓	✓	✓	✓	Align programmes (as required) with ICMP priorities	Ongoing	Ongoing
Wastewater Action Plan (Asset Development Plan – Wastewater)	• Wastewater network and PS Operation and Maintenance plan • Sanitary Surveys • Wastewater Network Grit Chambers Operation and Maintenance Plan • Wastewater PS wet well cleaning	Capacity / WCC	✓	✓	✓	✓	✓	Align programmes (as required) with ICMP priorities	Ongoing	
	• Trunk model upgrade plan • Wastewater pump upgrade plan • Asset renewals / upgrades	Capacity / WCC	✓	✓	✓	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing

Option	Methods/work programmes	Responsible	ICMP Environmental Objectives					Time Frame		
			1. Catchments (Assets)	2. Quality	3. Quantity	4. Amenity	5. Community	Short term (June 2018)	Medium term (2018 – 2021)	Longer term (2021 – 2038)
Wastewater Action Plan (Asset Development Plan – Wastewater)	• Overflow monitoring • Wastewater flow monitoring • Condition assessment • Interceptor Management Plan (includes Trunk model management plan) • Hydrogen Sulphide Management Plan • Moa Point Treatment Plant Management Plan • Inflow / Infiltration (I/I) Reduction Plan • Overflow Mitigation Plan • Level of Service consultation, benchmarking and standard-setting	Capacity / WCC	✓	✓	✓	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Roading Activity Management	• Transport Asset Management Plan 2010/11 - 2019/20 • Road Open Space operational activities • Road sweeping • Sump cleaning • Code of Practice for Working on the Road	WCC / NZTA	✓	✓	✓	✓	x	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Parks, Sports and Recreation Activity Management	• Biodiversity Action Plan (September 2007) • Our Capital Spaces (2013) • Town Belt Management Plan • Outer Green Belt Management Plan • Northern Reserves Management Plan (2008) • Parks and Open Space Asset Management Plan • Marinas Asset Management Plan, • Play Areas, Skate parks and bike skills Asset Management Plan	WCC	✓	✓	x	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Parks, Sports and Recreation Activity Management	• Botanic Gardens, Asset Management Plan • Sports fields Asset Management Plan • Cemeteries Asset Management Plan	WCC	✓	✓	x	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Solid Waste Activity Management	• Solid Waste Management and Minimisation Plan • Closed Landfill Management Plans	WCC / Private	✓	✓	x	✓	✓	Align programmes (as required) with ICMP priorities	Ongoing	Ongoing
Strategy, Plans, Policy and Bylaws	• Long Term Plan • Wellington Towards 2040 • Environmental Strategy • Urban Development Strategy • Trade Waste Bylaw	WCC	✓	✓	✓	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
	• Consolidated Bylaw • Assessment of Water and Sanitary Services (2005) • Climate Change Action Plan (2013) • Lateral Policy (2005)	WCC	✓	✓	✓	✓	✓	Align programmes (as required) with ICMP priorities	Ongoing	Ongoing
Strategy, Plans,	• Trade Waste Charges Policy (2008)	WCC	✓	✓	✓	✓	✓	Align programmes (as	Ongoing	Ongoing

Option	Methods/work programmes	Responsible	ICMP Environmental Objectives					Time Frame		
			1. Catchments (Assets)	2. Quality	3. Quantity	4. Amenity	5. Community	Short term (June 2018)	Medium term (2018 – 2021)	Longer term (2021 – 2038)
Resource Management Act methods / work programmes										
National Policy Statements (NPS) and Environmental Statements (NES)	• New Zealand Coastal Policy Statement • NPS Freshwater	GWRC/ WCC	✓	✓	✓	✓	✓	Align ICMPs with intent of policy document		
Regional Planning	• Regional Strategy • Regional Policy Statement (2013) • Proposed Regional Rules (2014) • Whatua process ; o Porirua Harbour (2014) o Wellington Harbour (2014) • Regional Stormwater Action Plan (XXXX)	GWRC and TA's	✓	✓	✓	✓	✓	Align ICMPs with intent of policy document	Ongoing	Ongoing
District planning	• Land use controls • Development Contributions Policy (July 2009) • Code of Practice for Land Development (2012) • Water Sensitive Urban Design guide (draft 2013)	WCC	✓	✓	✓	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Structure and Spatial Panning	Some examples:: • Centres Policy (September 2008) • Johnsonville Town Centre Plan (November 2008) • Kilbirnie Town Centre Revitalisation Plan (August 2010) • Newlands Centre Plan (April 2010) • Northern Growth Management Framework • Public Space Design Policy (2010) • Waterfront Development Plan 2010/11	WCC	✓	✓	✓	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Consents and compliance	• Issuing, applying for and monitoring compliance with resource consents, including for stormwater treatment devices and other water sensitive measures	WCC / GWRC	x	✓	✓	✓	x	Align programmes (as required) with ICMP priorities	Ongoing	Ongoing
Consents and compliance	• Pollution Management (Prevention of point source inputs • Management of contaminated sites • Pollution Management (education)	GWRC	✓	✓	x	✓	✓	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Environmental monitoring	• Shellfish Sampling assessment - 5 yearly	GWRC	x	✓	x	✓	x	Ongoing	Ongoing	Ongoing
	• Harbour sediment sampling programme - 5 yearly	GWRC/WCC/HCC	x	✓	x	✓	x	Ongoing	Align programmes (as required) with ICMP priorities	Ongoing
Examples of other methods under the RMA										

Option	Methods/work programmes	Responsible	ICMP Environmental Objectives					Time Frame		
			1. Catchments (Assets)	2. Quality	3. Quantity	4. Amenity	5. Community	Short term (June 2018)	Medium term (2018 – 2021)	Longer term (2021 – 2038)
Iwi Partnerships	• Port Nicholson Block Settlement Trust, Te Rūnanga o Toa Rangatira	WCC/ Iwi	✓	✓	x	✓	✓	Ongoing	Ongoing	Ongoing
Research, monitoring and evaluation by Council, iwi and Community	• E.g. Community based monitoring such as community SHMAK (Stream Health Monitoring and Assessment Kit) and CHI (cultural health index)	WCC / Community	✓	✓	x	✓	✓	Ongoing	Ongoing	Ongoing
Environmental protection and restoration	• E.g. Trees for Survival (See Battle Hill) • 70plus environmental care groups	Community / WCC / GWRC	✓	✓	x	✓	✓	Ongoing	Ongoing	Ongoing
Education and awareness raising	• E.g. Education advice and information, including website information, meetings, workshops, seminars, presentations, libraries etc	Capacity /GWRC / WCC /	✓	✓	✓	✓	✓	Prepare work programme	Implement	Ongoing
Economic instruments	• Partnerships with others, subsidies and incentives for sustainable stormwater management / water sensitive urban design; GWRC/ WCC/ QE II grants for environmental enhancement such as for riparian planting	GWRC / WCC / QEII Trust	✓	✓	✓	✓	✓	--	Prepare programme	Implement
Industry training	• Workplace, on-site, classroom and/or e-training, e.g.: Take Charge and trade training through Industry Training Organisations (ITOs)	GWRC / WCC / ITOs	✓	✓	✓	✓	✓	--	Prepare programme	Implement

KEY

	Ongoing ("business as usual") work programmes and methods, realigned to reflect the receiving environment priorities identified in this report
	Special (one-off or periodic) programmes, such as 5-yearly surveys of hazardous substances locations and uses
	New methods to be introduced as needed, based on current proposals for new work programmes and as indicated by the first high priority ICMPs
	implement of new methods and ongoing

Items in **red** font are proposed methods. Items in black font are existing methods.

6 Identification and Prioritisation

This section addresses condition 7 of Consent Number WGN090219, which requires, among other things:
h) "Identification and prioritisation of areas, and a timetable for the development of catchment-specific plans to be prepared in Stage 2 of the ICMP."

This section describes the approach used to address the requirements of condition 7 h). The approach consists of prioritising identified areas for developing the Stage 2 catchment-specific plans to address adverse effects, using a multi-criteria analysis (MCA) and showing how these criteria relate to the conditions of the resource consent as well as the objectives discussed in **Section** 5.

The timetable for developing the Stage 2 ICMPs is set out in the next section.

6.1 Identifying Priority Areas for Stage 2 ICMPs

Section 2.5 outlines how the 34 stormwater sub-catchments were clustered into the eight Integrated Catchments for which eight Stage 2 ICMPs will be prepared. The clustering was based on:

- The similar characteristics of shared coastal receiving environments resulting in five distinctive coastal receiving environments
- Three major stream catchments

ICMPs for the three stream catchments (Owhiro Bay, Kaiwharawhara and Ngauranga, **Figure 7**) will be prepared later for the following reasons:

- the consent envisages fresh water issues being addressed in the future, with the initial focus being on the coastal receiving environments (this was agreed with GWRC, refer Appendix I)
- the Kaiwharawhara stream catchment has such a small coastal receiving environment that assessment of its effects has been included within the rest of the North shore of the Wellington Harbour coastal receiving environment (**Figure 29** and **Figure 25**), because there will be an overlap of effects on this very similar and contiguous receiving water environment. An ICMP for the stream catchment itself can thus be carried out after the implementation of the Stage 1 ICMP has begun to address the effects of its discharge to the coast
- for the remaining two stream catchments, priorities reflect both catchment size and land use, with the legacy influences of old landfills and other activities in the Owhiro catchment outweighing its smaller size relative to the Ngauranga catchment: a Stage 2 ICMP will therefore be developed at a later date
- the coastal receiving environment catchments are aligned with the 20 significant stormwater outfalls listed in the resource consents (**Figure 65**), and there are no significant stormwater outfalls from the Onslow, Horokiwi and Bellevue sub catchments. These three sub-catchments are in the Ngauranga Stream catchment, the discharge from which has a minimal adverse effect on its coastal receiving environment. The Stage 2 ICMP for the Ngauranga Stream catchment will therefore also be prepared at a later date.

Table 16 describes these receiving environments in terms of their physical characteristics and their recreational uses, such as swimming, fishing, diving and recreational boating.

Table 16: Characterisation of Receiving Environments

Catchment	Receiving Environment
Lambton Harbour (Northern and Southern CBD, Oriental bay)	Large stormwater discharge to a sheltered, low energy embayment and harbour Commercial port, boating Oriental Bay: swimming, boating
Evans Bay (Grafton , Rata, Hataitai, Kilbirnie, Rongotai, Miramar, Strathmore Park, Crawford)	Medium stormwater discharge to a large bay with a low energy environment: Port activities, boating, kite and wind surfing, swimming, diving,
Kaiwharawhara	Large stream catchment discharge to an open harbour coastline
Island Bay and Houghton Bay	South coast high energy environment: swimming, surfing, diving, marine reserve, boating
Owhiro Bay	Stream catchment discharge to South coast high energy environment: swimming
Lyall Bay (East and West)	South coast high energy environment: Swimming, surfing
Wellington Harbour North (Ngauranga, Horokiwi, Bellevue, Onslow)	Ngauranga Stream catchment discharge to high energy environment: boating
East Coast	High energy environment: swimming, surfing, shellfish gathering,

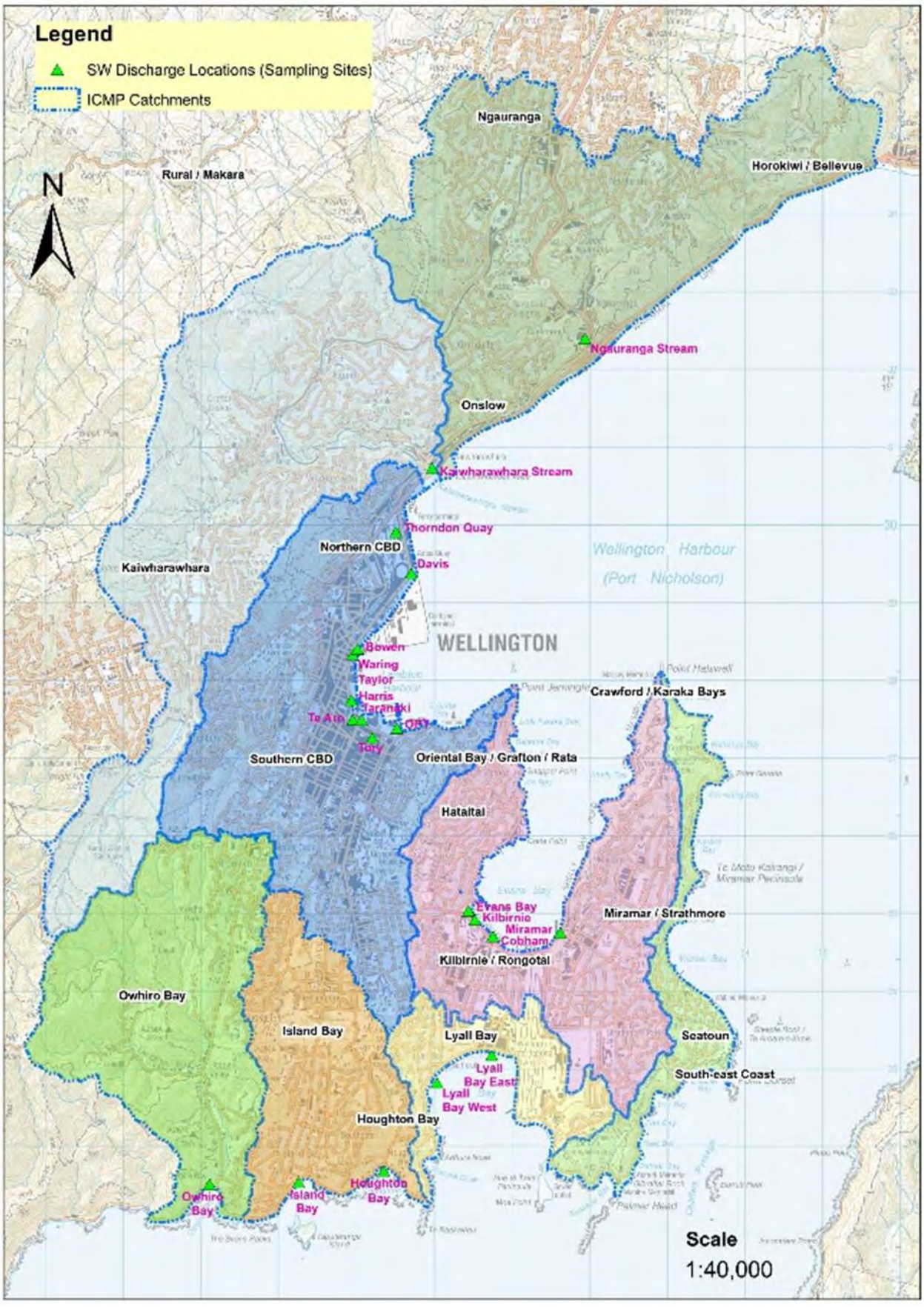


Figure 65: Significant Stormwater Outfalls Listed in the Resource Consent

6.2 Approach Adopted

This Stage 1 ICMP report achieves the following:

- It collates sufficient information on the stormwater system, its current management and its effects
- It uses the five objectives for stormwater management (Capacity, 2012, Appendix F) as a framework for managing the identified effects.

Recommendations for future stormwater management are therefore aimed at meeting the objectives, which are broadly based around avoiding, remedying or mitigating adverse effects of stormwater discharges on both the catchment itself and the receiving environment. Furthermore, integration of stormwater, wastewater and water supply management is a key consideration throughout the ICMP, and further opportunities for integrated solutions within each catchment between the different networks and infrastructures are likely to arise by coordination of the various WCC capital works programmes.

The stormwater catchments were prioritised on the basis of the nine indicators referred to in consent condition 7, using multi-criteria analysis (MCA).

Table 17 also shows how these indicators were defined and scored to ensure that indicators which are considered more important have a greater impact on the total score than indicators which are considered less important at this stage.

The following scoring system is thus used:

- 1-5 = indicator has a very high influence on the total score
- 1-4 = indicator has a high influence on the total score
- 1-3 – indicator has a lower influence on the total score (e.g. microbiological water quality is strongly but not 100% related to wastewater overflows, hence has a lower top score than wastewater overflows)

The scores in **Table 17** are not weighted, and are simply summed to produce a final score, which was used to rank the catchments in order of priority.

Consultation with iwi is in progress, however, information on cultural values was not available at the time of writing. The input from iwi will be used as part of preparing the detailed Stage 2 ICMPs. This will help frame a third order outcome reflecting cultural values, and inform the ICMP vision and mission, methods and monitoring. Similarly, while consultation with some community stakeholders is already under way, further community engagement on the basis of this report is proposed as part of preparing the detailed Stage 2 ICMPs. A communication plan is provided in Appendix H.

The results of this prioritisation process are presented in **Table 18**.

Table 17: Multi-criteria Analysis Objectives, indicators and scores for prioritising catchments

Objectives	Consent condition	Indicators	Score	Scoring guide
Catchment	7 a) ii	Extent of catchment developed into urban land use	1 to 5	0 = no development 5 = 100% development
Water Quality	7 d	Wastewater overflows	1 to 5	0= none 5 = high (> 5000 m3 per annum with 4 events per year)
Water Quality	7 d	Microbial water quality	1 to 3	0 = high water quality (low bug counts) 3 = low water quality (high bug counts)
Water Quality	7 e	Chemical contaminants in receiving environments	1 to 4	0= none 4 = high (including from legacy issues)
Water Quality	7 a) vi and 7 f))	Water quality for swimming	1 to 5	Based on Suitability for Recreation Grade (Ministry for the Environment bathing beach guidelines)
Water Quality	7 a) vi	Impacts on marine ecology	1 to 4	0 = no impacts 4 = significant impacts
Water quantity	7 c)	Flooding, as indicated in condition 7 c), including impacts due to sea level rise	1 to 5	0 = no impacts 5 = significant impacts
Amenity / community	7 a) vi	Amenity / recreational use	1 to 5	0 = no recreational use 5 = high recreational use
Amenity / community	7 a) ii	Terrestrial amenity	1 to 5	0 = no amenity value and/or usage 5 = means high amenity and/or usage
Cultural (to be developed	7 a) ii	Cultural values	1 to 5	0 = no cultural value or sensitivity 5 = high cultural value or sensitivity

Table 18: Results of Multi Criteria Analysis of Catchment Values and Issues

Table 18a: Coastal Receiving Environment Catchments

Stormwater sub-catchment/s	Area	Prioritisation Assessment											Identified potential adverse effects		Detailed sub-catchment investigation and CMPs likely to be required
		1 to 5	1 to 5	1 to 5	1 to 3	1 to 4	1 to 5	1 to 4	1 to 5	1 to 5	Total score	Priority	SW quality	SW quantity	
		Land use state	Flooding / Sea level rise impacts	Wastewater Inputs	Microbial WQ	Chemical /Sediment WQ	Swimming Grading	Marine Ecology	Amenity / Recreational Use	Terrestrial amenity					
Coastal receiving environment catchment: Lambton Harbour															
Northern CBD (Aotea North, Tinakori, Glenmore St, Aitken, Bowen and Waring-Taylor)	495.0	5	4	5	3	3	4	3	5	4	36	**1**	✓	✓	Yes
Southern CBD (Hunter, Harris, Te Aro, Taranaki, Tory and Newtown)	825.0												✓	✓	Yes
Oriental Bay	49.5												×	×	No
Coastal receiving environment catchment: Evans bay															
Crawford	100.2	3.5	3	4	3	3	2	3	5	2	28.5	**2**	×	×	No
Grafton / Rata	89.5												×	×	No
Hataitai	139.5												✓	✓	Yes

Kilbirnie / Rongotai	175.4												✓	✓	Yes
Miramar / Strathmore Park	440.5												✓	✓	Yes
Coastal receiving environment catchment: Island Bay and Houghton Bay															
Island Bay	512.0	2.5	2	3	2	1	3	1	5	3	22.5	**3**	✓	✓	Yes
Houghton Bay	87.6												✓	×	Yes
Coastal receiving environment catchment: Lyall Bay															
Lyall Bay (Lyall bay West, Lyall Bay East)	283.8	4	2	1	2	1	2	1	5	2	20	**4**	✓	✓	Yes
Coastal receiving environment catchment: East Coast															
Karaka Bays	89.0	2	1	1	1	1	1	1	5	4	17	**5**	×	×	No
Seatoun	96.2												×	×	No
South-East Coast	108.7												×	×	No

Table 18b: Stream catchments

Stormwater sub-catchment/s	**Area**	**Prioritisation Assessment**											**Identified potential adverse effects**		**Detailed sub catchment investigation and CMPs likely to be required**
		1 to 5	1 to 5	1 to 5	1 to 3	1 to 4	1 to 5	1 to 4	1 to 5	1 to 5	**Total score**	**Priority**	**SW quality**	**SW quantity**	
		Land use state	**Flooding / Sea level rise impacts**	**Wastewater Inputs**	**Microbial WQ**	**Chemical /Sediment WQ**	**Swimming Grading**	**Marine Ecology**	**Amenity / Recreational Use**	Terrestrial amenity					
Stream catchment: Kaiwharawhara															
Wellington Harbour North (Kaiwharawhara	1667	2	1	5	3	4	3	3	3	3	27	**1**	✓	✓	Yes

Stream catchment: Owhiro Bay															
Owhiro Bay	971.5	2	1	3	2	3	2	1	3	5	22	**2**	✓	×	Yes
Stream catchment: Ngauranga															
Horokiwi / Bellevue	473.0	3	2	2	2	3	0	2	2	2	18	**3**	×	×	No
Ngauranga	964.0												✓	×	Yes
Onslow	144.6												×	×	No

NOTE:

1. Information on cultural values was not available at the time of writing. It is proposed to engage with iwi during the detailed Stage 2 ICMPs, in order to enable iwi to have input to the vision and mission and frame an objective and outcomes that reflect cultural values. Similarly, while consultation with some community stakeholders is already under way, further engagement on the basis of this report is also proposed as part of preparing the detailed Stage 2 ICMPs.
2. A tick (✓) in either the Stormwater quality or Stormwater quantity column indicates that discharges from a particular stormwater sub-catchment affects one or more environmental objectives. In such cases, a detailed CMP may need to be prepared in that sub-catchment

Table 18a shows that the priorities for the coastal receiving environment catchments are in descending order of priority:

- Lambton Harbour
- Evans Bay
- Island Bay and Houghton Bay
- Lyall Bay
- East Coast

The priorities clearly reflect the combined influences of the indicators, with catchment size and the land use types described in section 4 influencing the total scores.

Table 18b shows that the priorities for the stream catchments are in descending order of priority:

- Kaiwharawhara
- Owhiro
- Ngauranga

The stream catchment priorities reflect both catchment size and land use, with the legacy influences of old landfills and other activities in the Owhiro catchment outweighing its smaller size relative to the Ngauranga catchment. The ICMP catchments identified are aligned with the 20 significant SW outfalls listed in the consent. There are no consented stormwater outfalls from Onslow, Horokiwi and Bellevue catchments, and there are very minimal adverse effects to the receiving coastal environment. Therefore, Stage 2 ICMP for Onslow, Horokiwi and Bellevue catchments will be included with the Ngauranga Stream ICMP.

The first set of Stage 2 ICMPs will thus be prepared for the five coastal receiving environment catchments (**Figure 66**), because the combined effects of flooding and contamination are expressed in coastal receiving environments and the consent relates to discharges to the coastal marine area. ICMPs for the three stream catchments will therefore be prepared later as a lower priority. The timeframes are discussed in the next section.

More detailed work may be needed in some sub-catchments within these eight coastal receiving environment and stream catchments. The need for this has been assessed on the basis of stormwater quantity and quality: land use is the primary influence on stormwater quality and quantity, and the issues listed in consent condition 7 falls into either the quantity or the quality category. Therefore, focusing on those two issues will contribute towards achieving the amenity and iwi/community objectives discussed in section 5.

Moreover, in the Stage 2 ICMPs, the focus of the integration will be on managing the effects of land use on the marine environment. However, where management issues are complex and/or area-specific, individual catchment management plans (CMPs) will need to be developed for sub-catchments within a coastal receiving environment or a stream catchment. CMPs (wastewater and stormwater) that will require development, based on our experience, see **Table 18**.

Table 18 indicates where discharges from a particular stormwater sub-catchment affect two or more of the five environmental objectives set out in section 5, by placing a tick (✓) in either the stormwater quality (SW Quality) or stormwater quantity (SW Quantity) column. The presence of a tick indicates that a more detailed CMP may need to be prepared for that sub-catchment.

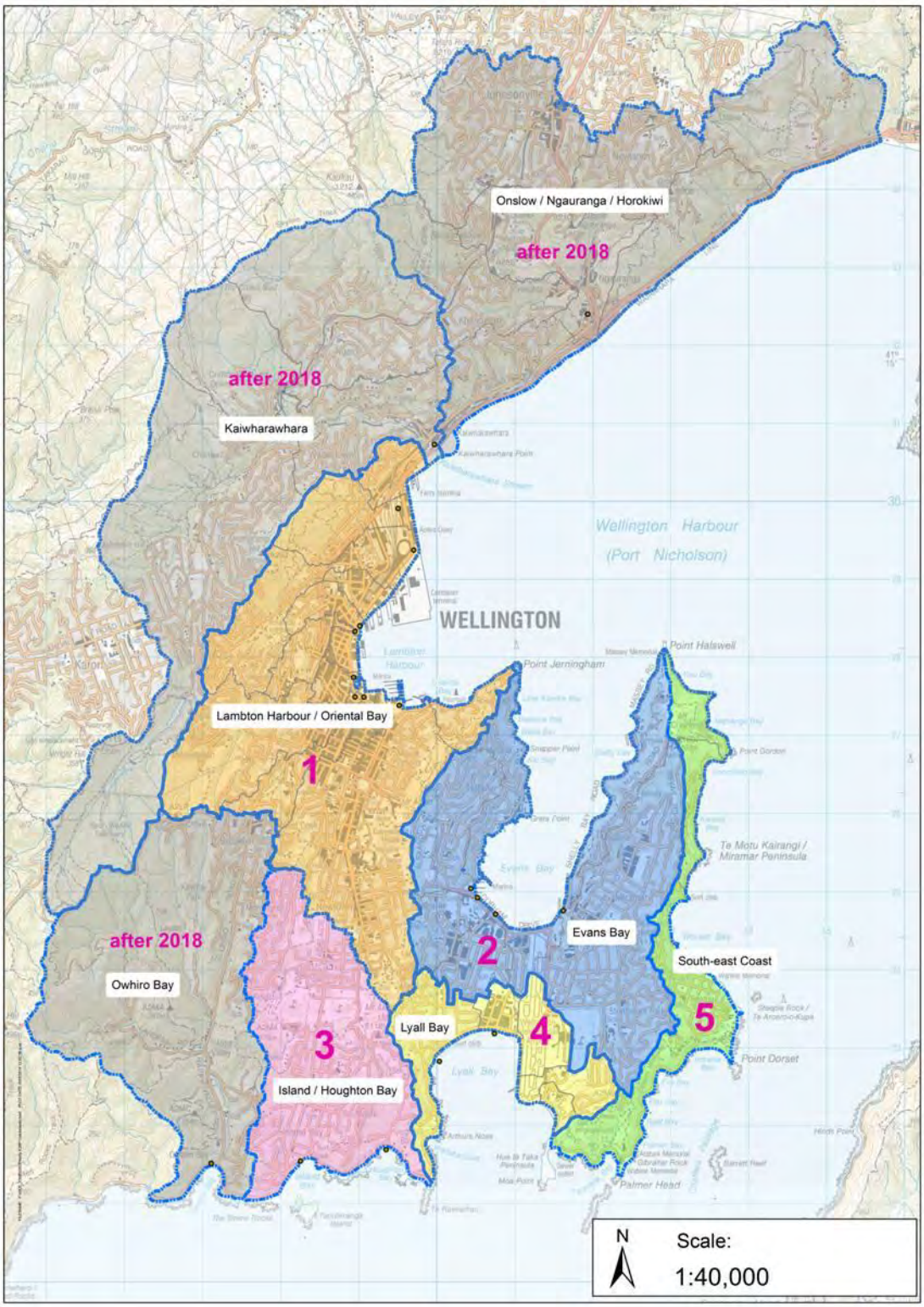


Figure 66: Stage 2 ICMP Catchment Priority Order

7 Timetable for the development of Stage 2 ICMPs

This section addresses condition 7 of the resource consent, which require, among other things:

h) "a timetable for the development of catchment-specific plans to be prepared in Stage 2 of the ICMP."

7.1 Timetable for Developing Stage 2 ICMPs

Reflecting the priorities emerging from the MCA in section 5, Table 19 provides a more detailed timetable for the work to be carried out in order develop the stage 2 ICMPs for the eight receiving environment stormwater catchments in order of priority for completion.

It may be possible to gain economies of scale from simultaneously conducting further scientific research and iwi and community engagement and developing management options relevant to a number of Stage 2 ICMPs catchments; for example, where an issue is urgent across several catchments. If so, this could bring forward the completion of some ICMPs. The dates shown in **Table 19** are thus milestone dates that could be reached earlier or later within the given time frame.

The detailed work needed to prepare the Stage 2 ICMPs may indicate a need to address issues that are beyond their current scope, such as freshwater quality. This was envisaged by the note to condition 6, which acknowledges that while the current focus is on stormwater discharges into the coastal marine area, other surface water issues such as flooding, on-site management of stormwater flows and water quality in streams and other aspects of catchment management could be added over time. As also envisaged in that note, these can be addressed as part of an "ongoing water management partnership between the Wellington City Council (as consent holder), Wellington Regional Council (as consent authority) and the community".

Hence detailed ICMPs for the three stream catchments will be addressed over a longer timeframe. Work in their respective coastal receiving environments will, however, proceeds alongside the preparation the Stage 2 ICMPs for the receiving environment catchments.

Table 19: Timetable of Preparation of Stage 2 ICMPs

No	Coastal Receiving Environment ICMP	Sub Catchment ICMP	Catchment Area (Ha)	2013 / 14		2014 / 15				2015 / 16				2016 / 17				2017 / 18			
				3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1	Lambton Harbour ICMP																				
		Southern CBD (Harris, Taranaki, Tory, Te Aro, Newtown)	825.0																		
		Northern CBD (Aotea North, Tinakori, Glenmore, Aitken, Bowen, Warring taylor, Hunter)	495.0																		
		Oriental Bay	49.5																		
2	Evans Bay ICMP																				
		Hataitai	139.5																		
		Kilbirnie + Rangotoi	175.4																		
		Miramar + Strathmore	440.5																		
		Grafton / Rata / Crawford	190.0																		
3	Houghton / Island Bay ICMP																				
		Houghton Bay	87.6																		
		Island Bay	512.0																		
4	Lyall Bay ICMP																				
		Lyall Bay (East, West, Airport South)	283.8																		
5	South-east Bays ICMP																				
		South-east Coast / Seatoun / Karaka bays	294.0																		

No	Stream Catchments ICMP	Sub Catchment CMP	Catchment Area (Ha)	2013 / 14		2014 / 15				2015 / 16				2016 / 17				2017 / 18				2018 / 19				2019 / 20				2020 / 21			
				3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1	Khaiwharawhara ICMP	Khaiwharawhara	1667.5																														
2	Wellington Harbour North ICMP	Ngauranga	964.0																														
		Onslow / Horokiwi / Bellevue	617.6																														
3	Owhiro Bay ICMP	Owhiro Bay	971.5																														

NOTE: This programme will be aligned with Regional Plans. This was agreed with GWRC (September 2013); hence no detailed ICMP will be prepared under consent number WGN090219

Detailed CMPs will be prepared; which may include:

SW Network Modelling, WW Network Modelling, Detail Contaminant Load Estimation (refining Stage 1 investigations), Contaminant Impact Assessment and Modelling (refining Stage 1findings), Review Stage 1 Catchment wide Impact Assessment, Consultation (including targets, standards or other benchmarks). Management Options, Option Assessments and Rankings (MCQ), Action programme and Time table (implementation strategy), Funding Implementation Plans (including maintenance) , Monitoring Plan

Catchment wide investigation will carry-out without detail hydraulic modelling; which may include:

Catchment wide Impact Assessment (Overall), Catchment Management Options, Implementation Strategy,
Funding Implementation Plans (including maintenance), Monitoring Plan

7.2 Assumptions, Constraints, Risks and Inter-dependencies

Completion of the Stage 2 ICMPs is dependent on a number of factors over which Capacity and Wellington City Council do not have complete control. Capacity and Wellington City Council have identified the following assumptions, constraints, risks and inter-dependencies in order to build them into the Stage 2 ICMP project management process as far as practicably possible. These may affect the timeliness of the deliverables and are briefly discussed below.

7.2.1 Assumptions

Key assumptions are:

- all network related data is available in quality assured formats for detail assessments of network related issues, future prediction of capacities and estimation of potential risk areas
- for catchments where network models have been constructed in the past, all old modelling files are available with sufficient supporting documentation concerning the modelled data files
- all environmental data is available

7.2.2 Constraints

Key constraints are:

- gaps in available information, missing relevant documentation
- information reliability matters
- missing data
- data inaccuracies

7.2.3 Risks

Key risks to completion of the projects are:

- inadequate staff resources
- lack of funding
- prioritisation of Council funding
- time (data gathering might take longer than predicted)

8 Monitoring, Evaluation and Reporting

This section looks ahead at how to demonstrate compliance with the Stage 2 ICMP requirements of condition 8 b), c) and d) and condition 9, linking back to the objectives and frameworks required by condition 5 and described in sections 2.2 and 2.3 of this report.

Improved knowledge of the individual catchments will enable the establishment of network and receiving environment performance targets that will ensure compliance with the consent conditions and promote progress towards achieving the five overarching objectives defined in section 2.2.2 (2012 Discussion Document, p 5). As set out in section 2.2 of this report, this will in turn enable tracking of the implementation of the Stage 2 ICMPs and evaluation of their effectiveness.

The ICMP process will also draw together, the interactions needed across Council to meet the objectives, with planning, infrastructure, roading, parks and building activities all contributing to progress towards achieving the objectives.

It is therefore crucial to develop indicators that are in line with the internal plan logic of each Stage 2 ICMP, so as to enable tracking of implementation, monitoring, evaluation and reporting on the effectiveness of the methods used.

Use of the order of outcomes framework will help inform this task. A suggested process is outlined in **Table 20** and **Figure 67**, both of which reference **Figure 2** and section 2.2 of this report.

The aim is to ensure consistent use and alignment of descriptions, definitions, objectives, methods and monitoring indicators, so as to provide good internal plan logic.

A significant benefit of this process is that it ensures the development and monitoring of the right indicators with respect to each benchmark, target and objective. For example, if a widely accepted the benchmark for suspended sediment is specified in terms of non-filterable residue (g/m^3), then it is important that the environmental monitoring programme specifies that samples must be taken and analysed as appropriate to that unit of measurement rather than in terms of a turbidity measure. Similarly, if a wastewater level of service benchmark is specified in terms of number of overflows per year, it is important to specify if this means any overflow at all, or only overflows that reach the coastal marine area, or only overflows that occur during storms of a particular annual exceedance probability (annual recurrence interval of storm event). Plan logic means such apparently simple but often overlooked aspects of a good plan-making are considered from the start.

It is also important to keep the list of indicators to be monitored to a minimum, with the optimum number of indicators being measured to deliver meaningful results in a cost-effective way. Again, robust plan logic helps to promote this.

As indicated in section 2.2, integrated reporting on implementation of the methods used to give effect to the Stage 2 ICMPs will be very important in assessing the effectiveness of the Stage 2 ICMPs. Using the orders of outcomes framework in diagrammatic form could facilitate this, showing the logical links between methods, indicators and objectives.

Table 20: Process to follow when developing Stage 2 ICMPs

Task	Description
1	Capture baseline indicators of network performance and receiving environment, amenity and other values and the associated issues, under the headings of the most relevant of the objectives/outcome areas (there will be overlap). This tells us "where we are now."
2	Create, affirm or modify vision of sustainable development (4th order outcome). Reframe the objectives as 4th order outcomes, including for the cultural outcomes to be prepared as part of Stage 2 ICMPs. These are used as a compass, so we can ask ourselves at every decision point, " if we do this, will it keep us going at the right pace and in the right direction towards out 4th order outcomes?" For example: • Network management: stormwater and wastewater systems support healthy people and ecosystems • Receiving water quality: coastal water and sediment quality supports healthy people and ecosystems • Stormwater quantity: people are secure from flood risk at home and work • Amenity values: natural areas support healthy people and ecosystems • Community engagement: the community is well-informed about and actively engaged in catchment management for healthy people and ecosystems. • Iwi engagement: [to be defined with and by Iwi]
3	Identify benchmark indicators of best practice network performance and receiving environment, amenity and other values/issues appropriate to each of the objectives.
4	Set 'SMART' (specific, measurable, achievable, realistic and time-based) targets for improvement, using the same indicators and objectives. This tells us "where we want to be", in measurable terms, providing our detailed 3rd order outcomes
5	Identify methods that will achieve the SMART targets and help to make measurable progress towards achieving the 3rd order outcomes. This tells us "how we will get from where we are to where we want to be." This is part of the plan that is one of our key 1st order outcomes
6	Allocate resources and responsibilities to implement methods (1st order outcomes).
7	Roll out methods and document their implementation as per Figure 3 of this report (2nd order outcomes) – this answers the question "Are we and others doing what we said we would?"
8	Monitor indicators of 3rd order outcomes: this answers the question "Are we getting from where we are now to where we want to be?"
9	Evaluate plan effectiveness and review and adapt methods and monitoring as required. This answers the question "Are we meeting our milestone targets and our objectives? If not, what else is happening? How well do we understand the system? How well are our methods aligned with the outcomes we want? Are we measuring the right things?"
10	Report findings to Wellington City and Regional Councils.

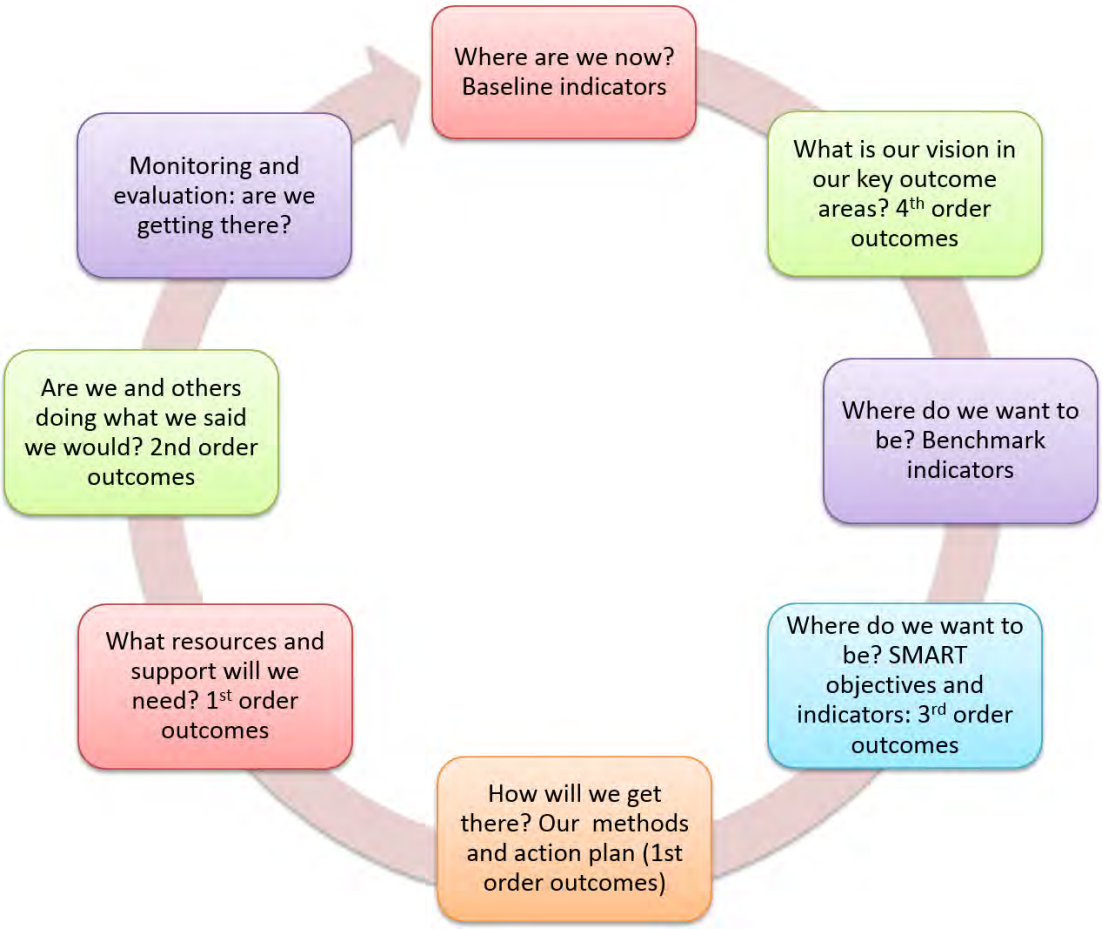


Figure 67: How to prepare Stage 2 ICMPs

NOTE: Process to follow detail ICMPS so their implementation and outcomes can be measured

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