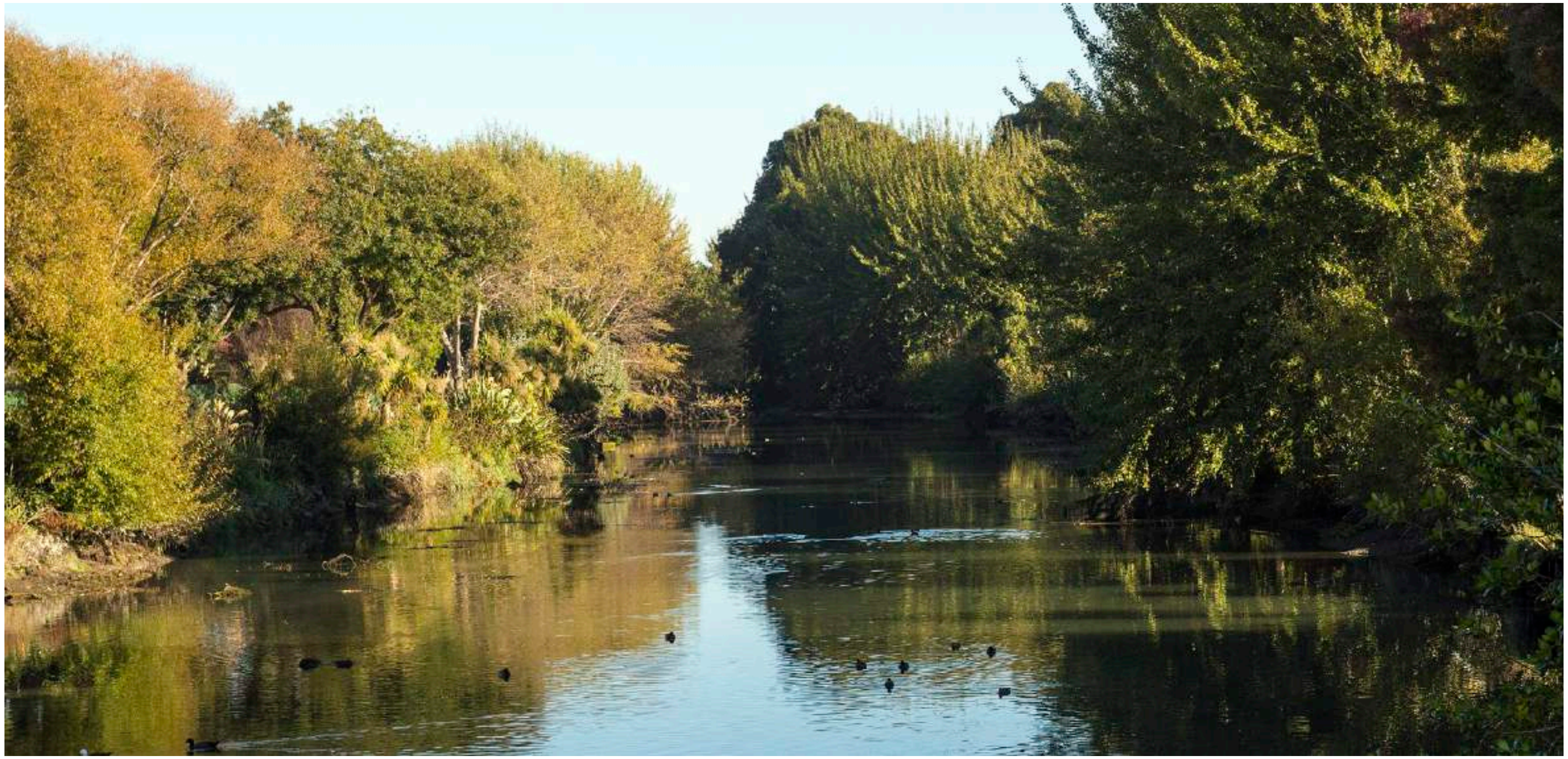
ŌPĀWAHO / HEATHCOTE RIVER CATCHMENT

TAUĀKĪ WAI PĀTAUA / VISION AND VALUES

Date: 21 DECEMBER 2016

Christchurch City Council

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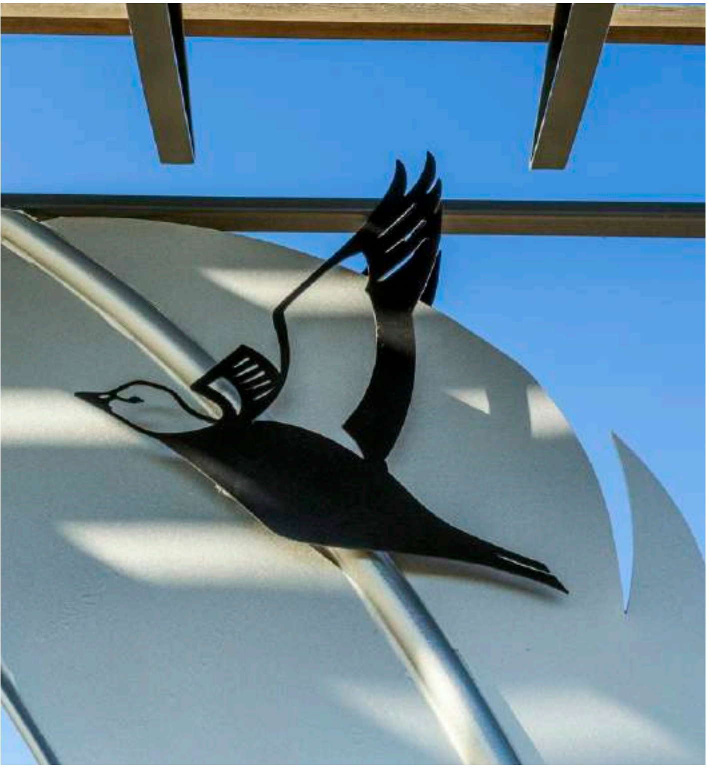

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Date: 21 DECEMBER 2016

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PART 2 SUMMARY OF TECHNICAL REPORTS TO INFORM STORMWATER MANAGEMENT/ PŪRONGO HANGARAU

Executive Summary / Whakarāpopototanga

The Ōpāwaho / Heathcote River Catchment flows from the south-west of Christchurch to the Ihutai / Avon-Heathcote Estuary. The catchment has traditionally been a significant source of mahinga kai, and a focus of natural, cultural and heritage values since earliest settlement. 1880 through to 1925 saw significant industrial pollution of the lower reaches of the river. It was not until 1970 that remaining industry had its effluent directed to the sewage treatment plant. While this resulted in improved water quality of the lower river, ongoing development and extensive settlement within the catchment over the last two centuries, combined with the more recent earthquakes of 2010/2011 have meant that catchment values are still degraded. Sediment loss from the Port Hills is a major contributor to reduced hydraulic capacity, loss of terrestrial vegetative cover and decreased in-stream habitat for fish and invertebrates.

For over 20 years, the Christchurch City Council (Council) has focussed on a multi-value and multi-party approach to the management of its waterways. By identifying six core values – ecology, drainage, culture, heritage, landscape and recreation – as the drivers for improved surface water management, the Council has begun to translate legislative requirements and community aspirations into tangible reflections of a more sustainable approach to asset management.

Vision:

The surface water resources of Christchurch support the social, cultural, economic and environmental well-being of residents, and are managed wisely for future generations.

Toitū te marae a Tangaroa, Toitū te marae a Tāne, Toitū te iwi.

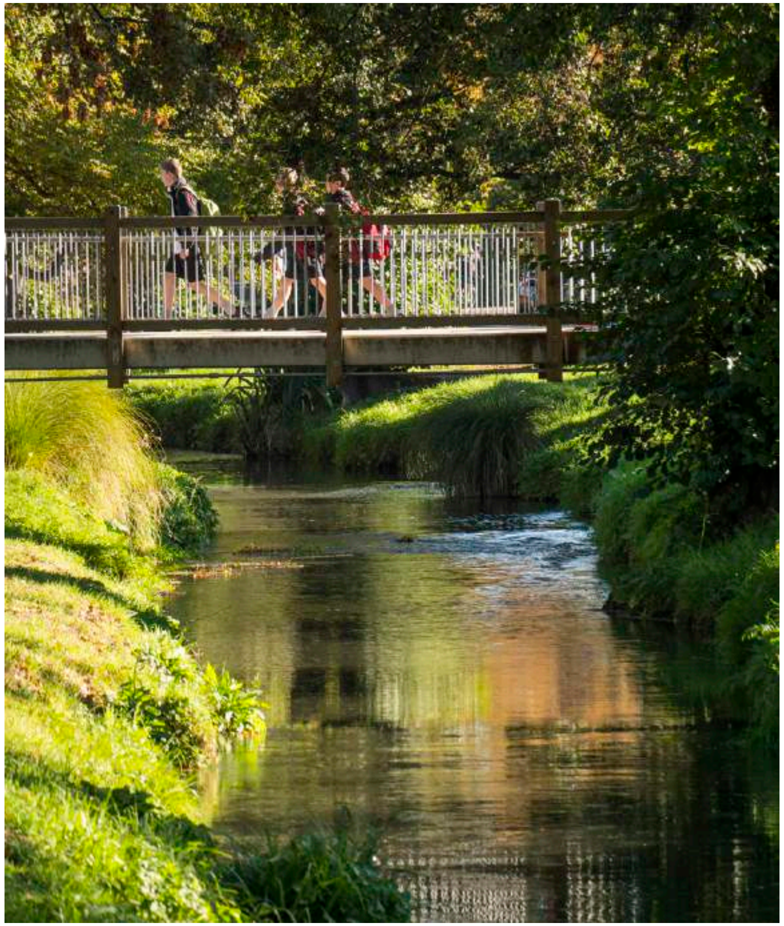
This document communicates how this vision is being realised and planned for the Ōpāwaho / Heathcote River Catchment.

Part One, Realising the vision, outlines:

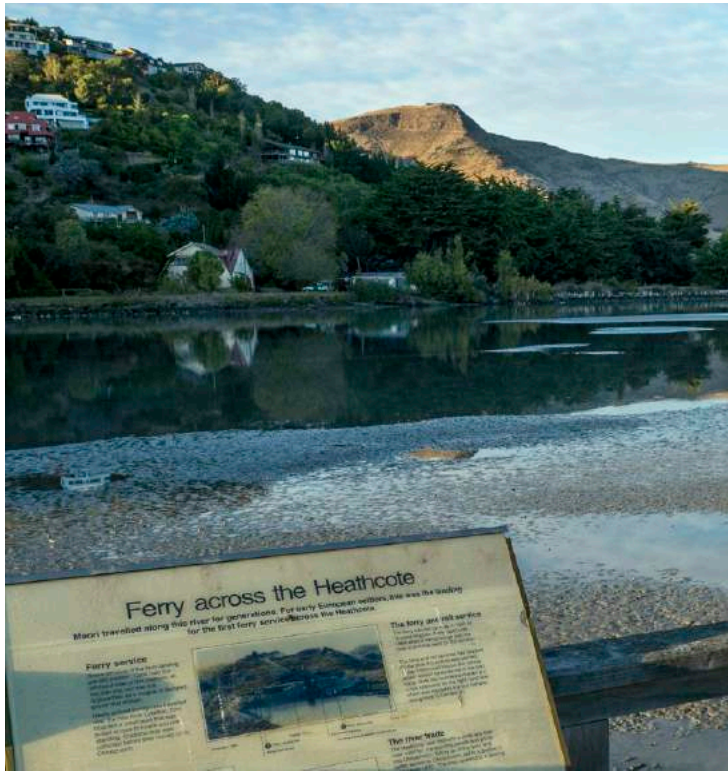
- Current state of the six values within the Ōpāwaho / Heathcote River Catchment in line with the Council's six values approach to waterway asset management.
- Surface water management - vision and approaches. Identifies nine approaches, with exemplars, to demonstrate how future protection, enhancement and management of our waterways and surface water can achieve high level outcomes across all six values.

Part Two of this document summarises a number of key technical documents that have been used to inform the development of stormwater management approaches. They detail the necessary infrastructure required for improving water quality and attenuating storm discharges into the river.

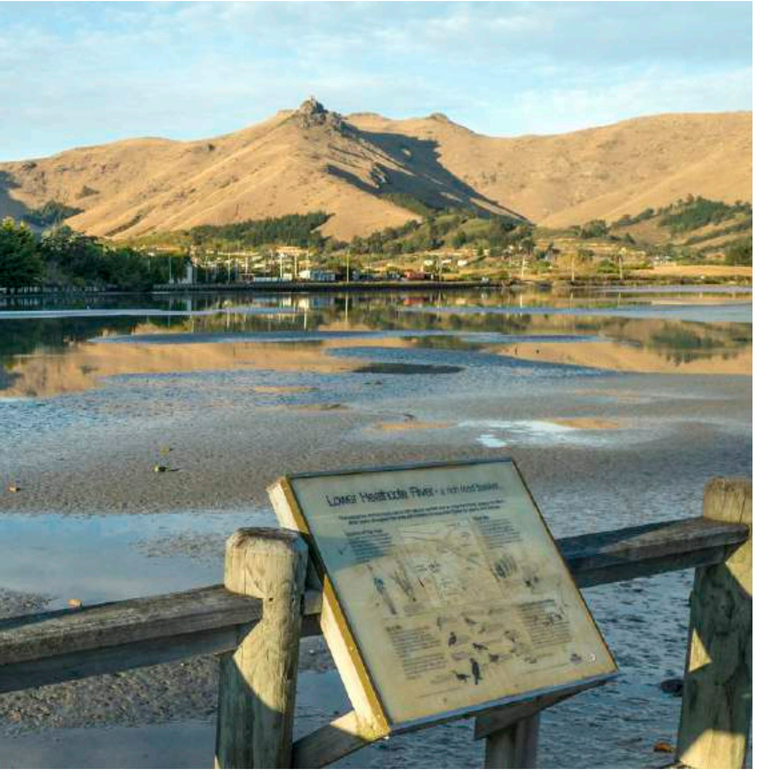
View of the lower Ōpāwaho / Heathcote River and stormwater ponds at Ferrymead



Ōpāwaho / Heathcote River in Cashmere


Ferry across the Heathcote
Ferry service

PART 1 REALISING THE VISION / Te Pae Tawhiti



Introduction / Kupu Whakataki

Purpose of this document

- To identify and summarise the current status of, and key issues within, the Ōpāwaho / Heathcote River Catchment relative to the Council's six values of waterway asset management: ecology, drainage, culture, heritage, landscape and recreation.
- To communicate and facilitate community discussions on how the surface water management approaches, or options available, might be implemented to enhance the six values and realise the vision for the Ōpāwaho / Heathcote River Catchment.
- To highlight, from over 20 years of waterway enhancement experience, city-wide projects that have achieved high level outcomes across all six values and can be used as exemplars for future work in the Ōpāwaho / Heathcote River Catchment.

The Catchment

The Ōpāwaho / Heathcote River extends for approximately 25.5 km from south-west Christchurch to its mouth at Te Ihutai / Estuary of the Ōtākaro / Avon and Ōpāwaho / Heathcote Rivers in Ferrymead. The catchment covers approximately 103 km² in the south of the city stretching north to south from the edge of the Central Business District to the top of the Port Hills and west to east from Ruapuna Park to the Ihutai /Avon-Heathcote Estuary. Land use in the catchment is predominantly residential with significant industrial areas located in Sockburn, Hornby and Woolston. The Port Hills are predominantly rural except for the lower slopes which are residential areas.

There are approximately 86 km of waterways on the hills and 105 km on the flat. The most significant river tributary is Cashmere Stream which skirts the base of the Port Hills for most of its 9.6 km length. Other tributaries of note include Hayton's and Curletts Streams, Jacksons and Bells Creeks, and Steam Wharf Stream. The piped component of the drainage network comprises approximately 1,500 km of stormwater pipeline mains above 600 mm in diameter.

Background Investigations & Technical Reports

This report is based on a range of reports, investigations and strategy documents that have been adopted and/or recognised by Council over the last 20 years including:

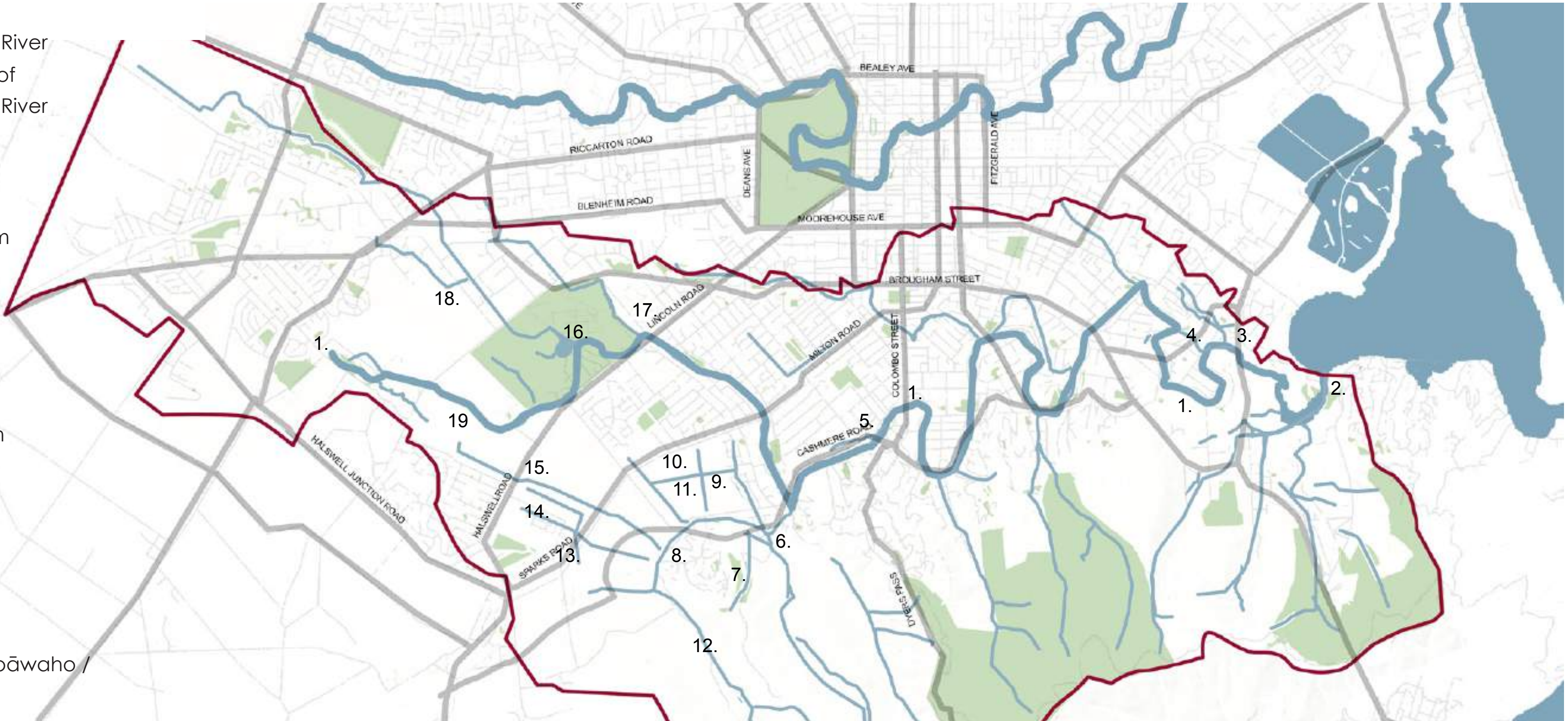
- Waterways and Wetlands Natural Asset Management Strategy (1999);
- Christchurch City Council Surface Water Strategy 2009-2039;
- Waterways and Wetlands Drainage Guide (2003);
- Infrastructure Design Standards (Part 5);
- Christchurch City Council Public Open Space Strategy 2010-2040;
- Christchurch City Council Biodiversity Strategy 2008-2035;
- State of the Takiwā - Te Ahuatanga o Te Ihutai, Cultural Health Assessment of the Avon-Heathcote Estuary and its Catchment (2007, 2012);
- Ōtautahi / Christchurch City Landscape Study (Draft, March 2015);
- Mahaanui Iwi Management Plan (2013).

Council undertakes waterway environmental monitoring reporting on an annual basis. Future reports should be read in order to understand the changing environmental state of the river.

Legend

Ōpāwaho / Heathcote River Catchment: Waterways

1. Ōpāwaho / Heathcote River
2. Ferry Rd bridge, mouth of Ōpāwaho / Heathcote River
3. Steam Wharf Stream
4. Woolston Cut
5. Beckenham Park Ponds
6. Cashmere Valley Stream
7. Worsleys Valley Stream
8. Cashmere Stream
9. Stillwells Drain
10. Sherrings Drain
11. Ballantines Drain
12. Hoon Hay Valley Stream
13. Eastman wetland
14. Milns Drain
15. Dunbars Drain
16. Wigram Basin
17. Curletts Rd Stream
18. Hayton's Stream
19. Nash Reserve, upper Ōpāwaho / Heathcote River




Steam Wharf Stream Confluence


Ferry Rd bridge, mouth of Ōpāwaho/ Heathcote River


Beckenham Park Ponds


Nash Reserve

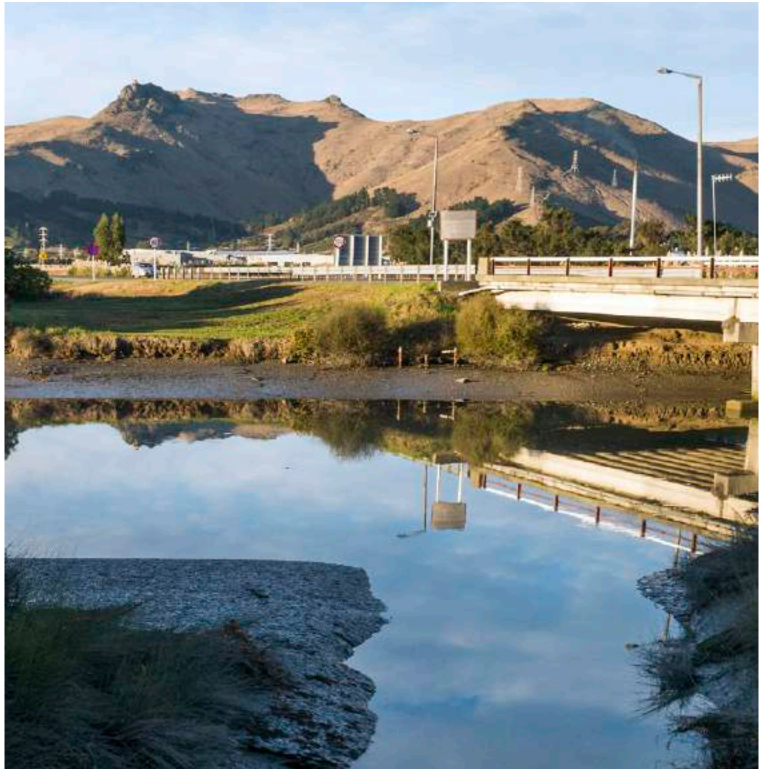

Cashmere Stream


Hayton's Stream Planting

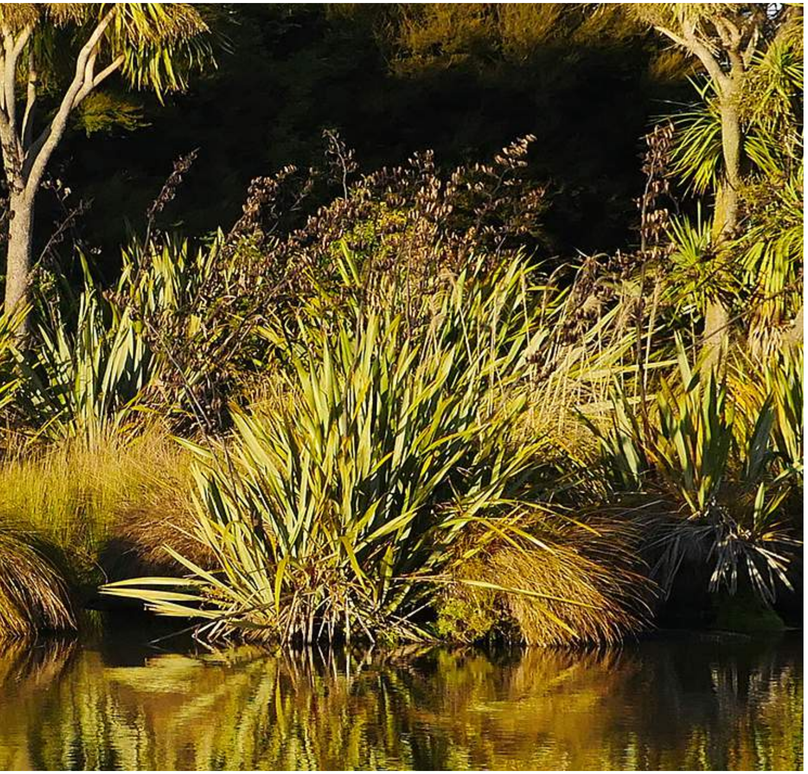

Woolston Cut


Wigram Basin


Lower Ōpāwaho/ Heathcote



1.0 CURRENT STATE OF THE SIX VALUES
Te Āhuatanga o Te Wai



Ecology Drainage Culture Heritage Landscape Recreation

1.1 Ecology

The inter-relationships between organisms and their environment.

Existing conditions & values

- Generally low riparian and in-stream habitat values across the catchment.
- Generally low aquatic species diversity, with pollution-tolerant species dominating; despite this, a number of species of conservation interest are present within the river, including Īnanga / Whitebait, Tuna / Longfin Eel, Koukoupara / Bluegill Bully, Kōura / Freshwater Crayfish and Kākahi / Freshwater Mussel.
- Poor water quality, predominantly due to high levels of *Escherichia coli*, nitrogen, phosphorus, sediment, copper and zinc.
- The catchment is typical of those affected by the human impacts of urban areas.

Issues

- Contaminants from stormwater, dewatering and other discharges, and waterfowl and dog faeces.
- Rubbish in waterways that has entered via the stormwater network or having been blown in.
- Waste water overflows during storm events.
- Siltation from stormwater, earthquakes and construction activities, and bank and channel erosion/slumping from earthquakes.
- A lack of dense native riparian vegetation, which buffers the waterways from urban development, and improves ecological habitat for aquatic species; including tall species that provide shading to the stream channel.
- Loss of the original native vegetation cover, reducing seed, fruit and nectar for native birdlife.
- Building, filling and excavating within the riparian margins of waterways.

Desired outcomes

- Improved in-stream and riparian habitat.
- Improved habitat connectivity.
- Improved water quality through treatment prior to entering the river and tributary system.
- Improved streamside habitat values.
- Increased habitat diversity.
- Improved native plant and animal diversity.
- Reduced dissolved or suspended contaminants e.g. sediment, heavy metals and hydrocarbons.
- Maintained or enhanced fast-flowing riffle habitats.
- Contaminated sediment removed.
- Increased use of evergreen tree species along river margins to reduce leaf litter and increase shade.
- No waste water overflows during storm events.


Matuku-moana / White-faced Heron


Kāruhiruhi / Pied Shag


Pūtakitaki / Paradise Shelduck

1.2 Drainage

The inter-relationships between groundwater and surface water, natural flow regimes and management of storm events.

Existing conditions and values

- Alluvial gravels commonly occur at or near the ground surface in the west, especially in sinuous zones that represent deposits from river channels across the Waimakariri River fan. These represent the most permeable surface strata in Christchurch. Alluvial silt and sand deposits occur throughout much of the southern city and to the west, between the gravel channels. They are formed predominantly from the overbank deposits during floods emanating from the ancestral river channels. The Port Hills are a consolidated mass of volcanic basalt, ash and debris overlain with wind-blown loess. Loess is very readily erodible.
- Soils to the north-west of Wigram are generally well drained silt and sandy loams underlain by free draining gravels. South and east are less permeable, higher water table influenced silt loams and silty sands interspersed with swamps, peaty areas and sand deposits.
- The groundwater system in the Ōpāwaho / Heathcote Catchment is contained in river gravels, primarily recharged by seepage losses from the Waimakariri River and rainfall infiltration on the plains.
- The Ōpāwaho / Heathcote River main-stem is fed by springs in areas south of Wigram. Plains tributaries are naturally dry but can be augmented from a water race in Buchanans Road.
- The geography of the catchment can be divided into three parts: the plains tributaries west of Wigram are a mix of residential and industrial land uses; the middle and lower catchment is a band of mostly residential or proposed residential areas between the city centre and the Port Hills; and the Port Hills have a residential component on the lower slopes but the greater area is grassland with some forestry.
- The lower reaches connect with the estuary of the Ōtākaro / Avon and Ōpāwaho / Heathcote Rivers. This area is tidally influenced to Buxton Terrace and saline to Opawa Rd.
- Wetlands have been significantly reduced in number and size compared to pre-settlement. Remnant wetland areas are found in Cashmere and Hendersons Basins, Heathcote Valley, Charlesworth Wetland and salt marsh areas in the estuary.

Issues

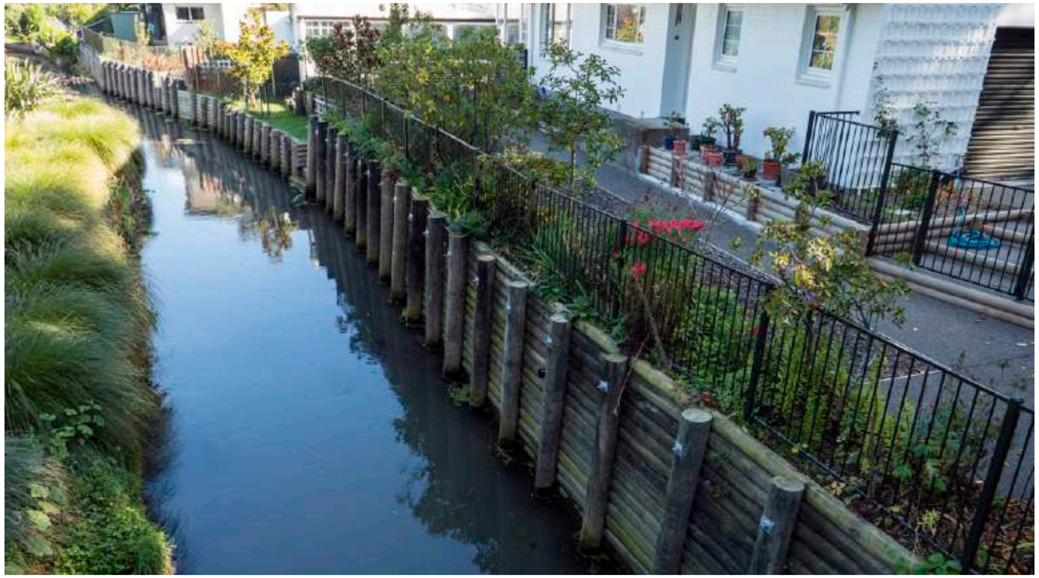
- Overall ecological health of the river is poor.
- Extensive urbanisation, discharges from roofs, vehicles and commercial / industrial areas resulting in degraded water quality.
- Wastewater overflows are occurring more frequently due to infrastructure damaged by the earthquakes.
- High sediment runoff from the Port Hills accumulating in the lower river.
- Narrow floodplains in the middle and lower river are historically at risk of flooding.
- Flood risk has been increased within the catchment due to combination of earthquakes and climate change.

Desired outcomes

- Flood risk reduced or, at least, returned to pre-earthquake levels.
- Improved water quality.
- Reduced sedimentation in tributaries and rivers.
- Minimised waste-water overflows.
- Minimised direct flow of stormwater into tributaries and rivers.
- Slow release of stormwater into receiving catchment.
- Protection and enhancement of springs and wetlands.
- Minimised threats to ground water and surface waterways from development.

Port Hills stream with high sediment load after a heavy rainfall event

Stone lined drain, Ferrymead



Cashmere Stream at Worsleys Road bridge

1.3 Culture

The communities perception of a resource and its values, indicated by community involvement in the management, celebration of past events and planning for the future.

Existing conditions & values

- The Ōpāwaho / Heathcote River is a highly significant river to manawhenua, being a key site of settlement and mahinga kai for over 600 years. It was an important part of the interconnected network of sites that spanned the length of the river and provided a link to the travelling routes over into Whakaraupō / Lyttleton Harbour, as well as to the upper Huritini / Halswell River, and beyond to the Kaiapoi and the plains in the north and west, and Te Waihora / Lake Ellesmere.
- The river takes its name for a famous pā that was situated on the banks of the river near the current township of Opawa. Ōpāwaho was known as the 'outpost pā', being a key landing point for travel between the major pā of Kaiapoi in the north and with direct access to Rāpaki, via what is known today as Rapaki Track.
- The upper tributaries of the river are known as Te Heru o Kahukura, while the middle part flowing through Spreydon is known as Waimokihi. After being joined by Cashmere Stream, it is known as Ōpāwaho / Heathcote River.
- Ohikaparuparu is the name given to the mudflats at the mouth of the river, important for mahinga kai. Two key former wetland and mahinga kai areas existed further up the catchment. This included Te Kuru, in the Cashmere area, as well as Ōtāwhito – a large wetland draining the upper Cashmere Stream area across what is generally known today as Hendersons Basin.
- The cultural significance of the Ōpāwaho / Heathcote River has been recognised within the dual place name provisions of the Ngai Tahu Claims Settlement Act 1998 as well as within numerous planning documents.
- Te Whakatau Kaupapa (1990) includes policies that are aimed at reducing contamination of waterways and improving health to support mahinga kai. The policies specifically support the use of wetlands to store and treat excess water as well as investment in technology to improve discharges and water use efficiency.
- The Mahaanui Iwi Management Plan contains a number of polices in relation to the Ōpāwaho / Heathcote River that advocate for the protection of waipuna (springs), improved stormwater and wastewater management and infrastructure, and designing the urban environment in a way that respects the wāhi taonga status of the Ōpāwaho / Heathcote River.
- Cultural health assessments undertaken in 2007 and 2012 identified the catchment of the Te Ihutai / Estuary of the Ōtākaro / Avon and Ōpawaho / Heathcote Rivers "to be in a state of poor to very poor cultural health" and made a number of recommendations to improve the cultural health of the rivers, particularly around stormwater management, and spring, wetland and riparian protection and enhancement.

Issues

- Varying degrees of/or lack of consistent attention to the protection, restoration and enhancement of the natural asset, and recognition of natural and cultural values.
- Lack of consistent progress on identification and revitalisation of mahinga kai and natural spring and wetland sites throughout the catchment.
- Continuing direct stormwater and drainage inputs into the river and tributaries without pre-treatment through swales or wetlands.
- The need to recognise the importance of Ngāi Tahu values and tikanga within all future catchment management and development initiatives.
- A limited understanding of core Ngāi Tahu values can lead to poor planning and design decisions that may conflict with cultural values or missed opportunities when undertaking work within the river.
- Mitigating the impact of the earthquakes by maximising a six values response to community aspirations.

Desired outcomes

- Provide opportunities for Ngāi Tahu Papatipu Rūnanga to exercise rangatiratanga and kaitiakitanga of the natural environment and its resources through meaningful involvement in planning and decision making.

- Recognition of the wāhi taonga status of the river to Ngāi Tahu.
- Recognise and protect sites of cultural significance including, where appropriate, the marking of these through restoration, interpretation and/or events.
- Identification, protection and enhancement of mahinga kai and natural spring and wetland sites and the improved ability to harvest mahinga kai for cultural purposes.
- Recognition of the Ngāi Tahu natural resource management framework - 'Ki Uta Ki Tai - From the mountains to the sea' - that highlights the connections between all resources and that they must be managed in a sustainable way for the generations to come.
- Protect and accentuate the stories of the land, its natural drainage and vegetation patterns, cultural features and landmarks. Work with private landowners while recognising private property rights and the need to use a range of protection methods to achieve desired outcomes as a win-win situation.


Artwork overlooking stormwater basin in Wigram Skies

Creation of Īnanga / Whitebait spawning site, Steam Wharf Stream


Artwork at The Landing, Wigram Skies

1.4 Heritage

Includes built and natural sites, features and activities of historical, social, cultural, spiritual, architectural, aesthetic, technological, craftsmanship, archaeological, scientific and contextual value.

Existing conditions & values

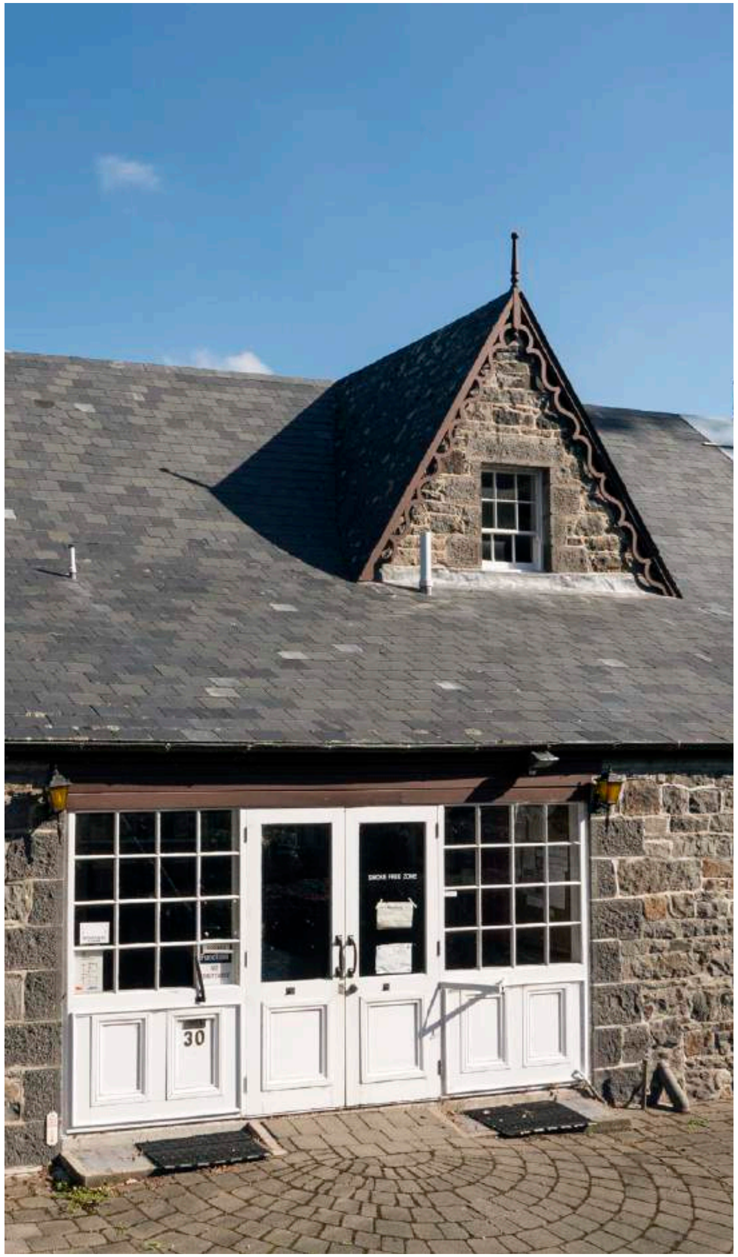
- The Ōpāwaho / Heathcote River and tributaries were one of the key connectors for both Māori and early European, as it provided strategically important linkages throughout the city area, a focus for food and resource gathering (mahinga kai), with both temporary and permanent settlement sites. These included: Ohikaparapara (near the mouth at Ferrymead); Ōpāwaho pā (near modern day Opawa township); Ōtāwhito (Upper Cashmere Stream / Hendersons Basin area); Waimokihi (Spreydon / Hoon Hay area) and Te Heru o Kahukura (Upper tributaries above Spreydon and towards Wigram).
- Significant European heritage sites, features and settings associated with the river include: historical industrial, transportation, institutional and farming sites and buildings including the ferry crossing, railway and wharf remnants at Ferrymead, Christchurch Quay, Malthouse and the former Woolston Tannery, Princess Margaret and Sunnyside (Hillmorton) Hospitals, bridges, pumping stations, early homesteads, groups of dwellings with shared characteristics such as the 1920s timber bungalows in the Beckenham Loop, Carmelite Monastery, former brickworks and associated clay quarry sites, former Sisters of the Good Shepherd (Mt Magdala) / St John of God, former Wigram Air Base, Spreydon Lodge, Spreydon Domain. The river has also historically provided for recreational activities such as swimming, walking, boating and angling.

Issues

- Some features and places of heritage value may not be identified and documented, or may not be appropriate for heritage listing in the District Plan.
- The lack of recognition of, and provision for, multiple values along the river in terms of interpretation and development.
- The need to balance natural and heritage values when in conflict with each other.
- Maintaining the pre-quake heritage values and visual character of the river as a familiar reference point/landmark/cultural anchor, and key component of the city's identity.
- Management issues associated with the lack of funding for the maintenance, conservation, preservation and/or protection of significant heritage sites and/or features.
- Lack of understanding of heritage values leading to changes and possible loss of heritage sites and fabric.
- Barriers and disincentives to enable use, adaptive re-use and continued use of built heritage.
- The alteration or disappearance of the traditional network of Ngāi Tahu settlement and mahinga kai sites associated with landscape features such as wetlands and river channels.

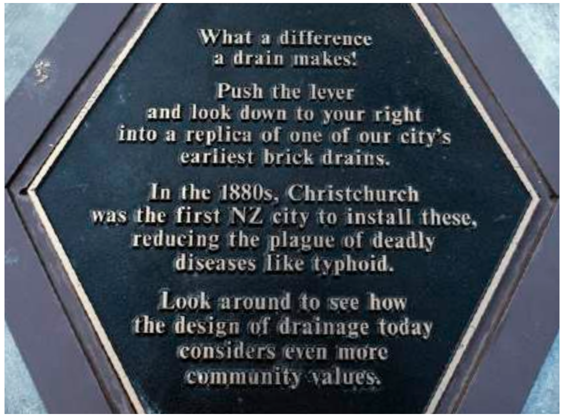
Desired outcomes

- Improved understanding, protection and/or enhancement of heritage values, built and natural heritage sites and settings, in line with best practice heritage conservation.
- Improved identification, documentation and readily accessible interpretation of heritage values.
- The use of built heritage is further encouraged and adaptive re-use is enabled.
- Improved representation of heritage patterns and elements throughout the river catchment.
- Recognition, protection and/or enhancement of the traditional network of Ngāi Tahu settlement and mahinga kai sites.



Holmcroft House

Malthouse beside the Ōpāwaho / Heathcote River



Addington brick drain plaque

Site of the historic Ferry crossing on the Lower Ōpāwaho / Heathcote River

1.5 Landscape

The special character of sites and places, their aesthetic qualities and their meaning to the community.

Existing conditions & values

- The Ōpāwaho / Heathcote River and its tributaries contribute significantly to the urban city's natural, cultural history and overall identity. The amenity of the river is particularly high where large trees form a sense of enclosure and the banks have been planted with a variety of native species. Along the course of the river sections within the suburbs of Cashmere, Beckenham, St Martins and Opawa, walking and cycle paths have been installed and the visual integrations with surrounding residential areas is particularly high.
- The drains, tributaries and long lengths of the Ōpāwaho / Heathcote River have vertical retaining walls in timber or stone that reduce the river's natural landscape values.
- Modifications to the natural catchment through the construction of roads, bridges, buildings, and changes to the natural land cover in the form of highly maintained lawns and plantings of exotic trees, have further reduced the river's natural landscape values but increased some associative values such as heritage and culture.
- Increased urbanisation and intensification has modified and reduced the diversity of natural features and values throughout the catchment and replaced them with other values.
- Post-earthquakes, natural and cultural 'survivor' landscapes and settings have become more significant in value. They include: the Beckenham Ponds, formed from natural springs in Beckenham Park. In the lower part of the river, below Woolston, and particularly near Ferrymead extensive and intact areas of native riparian vegetation still survive. The development of the Awatea Basin with its restored native riparian edge and totara-kowhai groves at its headwaters, along with the retention basins in and around Aidanfield and Canterbury Park and the initial restoration of native vegetated ponds in the Hendersons Basin area along Sparks Road, all of which provide further amenity and recreational opportunities, as well as recognising the former wetlands that spanned the catchment.
- The mouth of the Ōpāwaho / Heathcote River above the Ferrymead Bridge has tidal influence through its connection with the estuary. Industrial development occurs in close proximity to the River. The former towpath - used to tow ships upstream by horse - is now a walkway planted with vegetation.
- Changes to the Council waterway asset management strategy over the last 20 years has seen improved accessibility by the community, which has resulted in better understanding and appreciation of waterways, wetlands, and natural landscape processes.

Issues

- Development of subdivisions on the Port Hills have caused increased runoff of silt and contaminants that have detrimental impacts on water quality.
- Changes in land use and land cover impacting negatively on landscape values and features. This includes infrastructure which has not been designed to integrate well with the amenity or natural and cultural values of the river and its margins.
- Vegetation loss through urbanisation and earthquake damage.
- An inconsistent approach to visibility and legibility of natural springs, waterways and natural processes throughout the catchment, causing varying degrees of understanding of the cause and effect of processes within the landscape.

Desired outcomes

- Protection and enhancement of existing important landscape features and settings.
- Minimised negative impacts from urbanisation and intensification.
- Increased visibility and awareness of natural processes.
- Sensitive modification of natural landscapes to protect/enhance values.


Ōpāwaho / Heathcote River near Cumnor Terrace


Duncan Park retention pond

1.6 Recreation

Includes sport (formal, organised, competitive activities) and recreation (informal, unstructured leisure activities) on and beside the river and the structures that support these activities. Recreation opportunities are a combination of a setting and an activity that result in an experience. The setting in particular is dependent on the other five values, and correspondingly can generate an appreciation of those values.

Existing conditions and values

- Existing recreational facilities include tracks and paths, lighting, seats and picnic tables, artwork, plaques, buildings, vehicle and footbridges, jetties, boat ramps, boardwalks, signage, toilets, green assets (trees, gardens, grass), playgrounds, dog park, car parks.
- The Ōpāwaho / Heathcote River provides a green link through the southern suburbs of Christchurch to the estuary.
- There is almost continuous pedestrian access along both sides of the Ōpāwaho / Heathcote River from Cashmere Road to the estuary at Ferrymead bridge.
- The river provides the ideal setting for three of the most popular recreation activities nationally: walking, cycling and jogging. The river is also popular for kayaking and fishing.
- There are opportunities to observe wildlife, particularly in the lower reaches.

Issues

- The impact of some recreational requirements, particularly those with higher impacts have the potential to conflict with the other five values.
- As recreation needs and preferences continue to evolve there is demand for increased quantity and quality of recreational facilities.
- Parts of the river pass through industrial areas, particularly in the lower reaches, where the noise, smell, rubbish and polluted water detract from the recreation experience.
- Riverbank walkways are not always easily accessed and are very narrow in some areas with poor surveillance. Some are quite isolated, feel unsafe and do not comply with Crime Prevention through Environmental Design principles. There is conflict between recreational users in confined areas, e.g. pedestrians and cyclists.
- Some sections of walkway have not been formalised and are wet and muddy.
- There is poor pedestrian access around some bridges and roads.
- Graffiti and vandalism of interpretation signage is an ongoing issue.
- Earthquake damage to tracks in the lower reaches of the river.

Desired outcomes

- The greater the variety of settings, the greater the opportunities to achieve different recreation experiences and outcomes, thereby meeting the widest range of recreation preferences.
- A range of recreation zones along the river as a framework for a establishing a network of outcome (or value) focussed management areas. Group compatible sport and recreation activities. Separate conflicting interests into different zones.
- Improved water quality and access for kayaking and for contact recreation for children and dogs.
- Source to Sea shared path network for walking and cycling.
- Strategic views of the river from the riverbank.

Rowing near the mouth of the Ōpāwaho / Heathcote River at the estuary

Walkers alongside the Ōpāwaho / Heathcote River, Cashmere

2.0 SURFACE WATER MANAGEMENT APPROACHES
Ngā Mātāpono

Partnerships - Protection & Purchase - Suburban centres
Street Renewals - Linkages, Networks & Corridors - Subdivisions
Wetlands - Waterway Restoration - Suburban Greenspace

Vision:

The surface water resources of Christchurch support the social, cultural, economic and environmental well-being of residents, and are managed wisely for future generations.

Toitū te marae a Tangaroa, Toitū te marae a Tāne, Toitū te iwi.

2.1 Introduction

The Ōpāwaho / Heathcote River, including its wider catchment and tributaries, has been of significant importance to manawhenua for over 600 years prior to European settlement. The catchment was a major source of mahinga kai (i.e. customary food or resources from plant material, fish, shellfish and birds) as well as a place of settlement and occupation.

Since European settlement, the ongoing development of the city's urban environment has seen the catchment undergo a significant degree of degradation through altering natural drainage patterns, pollution, siltation and the removal of native vegetation cover. These issues since the 2010/2011 earthquakes have been exacerbated to varying degrees throughout the catchment.

Ōpāwaho / Heathcote River is an iconic symbol of Christchurch and retains high ecological, drainage, cultural, heritage, landscape and recreation values throughout the catchment. The vision statement is both a call and a reminder that the decision making for the protection, enhancement and management of the catchment of the Ōpāwaho / Heathcote River is not for the benefit of the current generation alone, but must reflect a longer term multi-value and multi-generational approach.

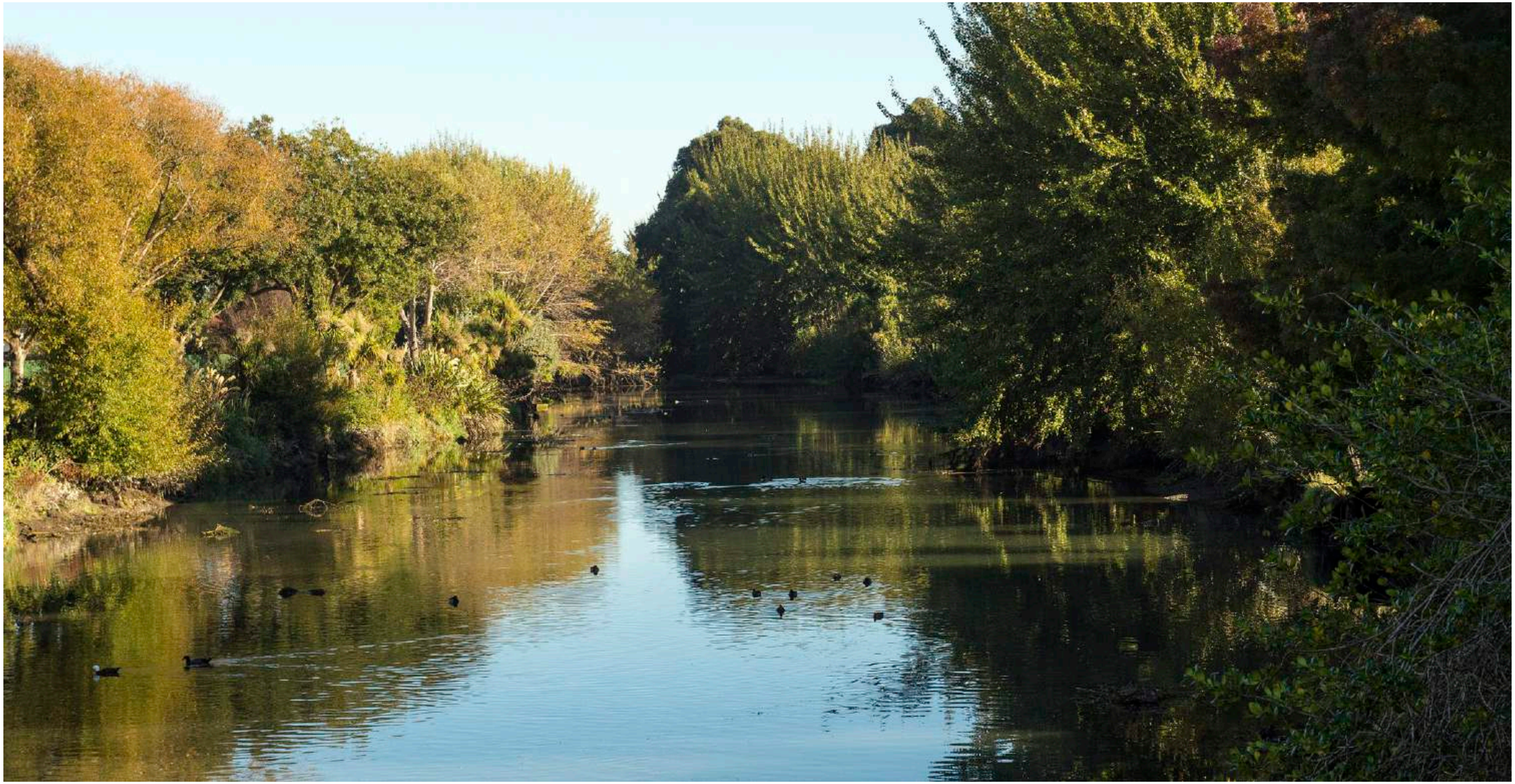
In the early 1990's, the Council was one of the first amongst local authorities in New Zealand to adopt a multi-value approach to the management of the city's land drainage system replacing the previous Christchurch Drainage Board's single-value focus on land drainage only. The Council has subsequently developed a strong and successful history of waterway protection, remediation and enhancement working with other stakeholders to achieve this.

In response to new legislative responsibilities and expectations of the Resource Management Act 1991, the newly amalgamated Christchurch City Council prepared a new City Plan which set in place provisions for the sustainable management of the City's natural and physical resources.

By identifying six core values – ecology, drainage, culture, heritage, landscape and recreation as the key drivers for surface water management, the Council has been able to introduce a broad philosophy of sustainability into a natural asset management strategy reflective of the broader community's desire for a more qualitative approach to management outcomes.

Over the last 20 years the Council has developed a range of approaches to promote the six values of waterways and stormwater management including: improving drainage capacity; enhancing landscape character; improving the quality and relevance of recreational opportunities; enhancing the diversity of ecological values; and improving cultural and heritage values.

The following approaches provide a show-case of successful city-wide project exemplars implemented by the Council, their strategic partners, developers and key interest and community groups. These approaches provide an insight into the range of solutions available to help Council to work towards improving surface water quality, surface water flows, aquatic ecosystems and waterways for contact recreation, water sports and cultural values in order to realise the long term vision for the Ōpāwaho / Heathcote River Catchment.



Ōpāwaho / Heathcote River up from the Woolston tidal barrage.

2.2 Partnerships

Partnerships provide opportunities for the Council to work with Government departments and agencies, statutory parties, private developers, and communities of interest to implement cohesive and integrated approaches that are reflective of the six values approach to sustainable land-use and surface water management. Key partnerships include:

Papatipu Rūnanga and Te Rūnanga o Ngāi Tahu

- Council is working with Ngā Papatipu Rūnanga and Mahaanui Kurataiao Ltd to develop a partnership aimed at improved involvement and collaboration over the management of waterways and water infrastructure, including stormwater, across the district.
- Te Rūnanga Ngāi Tahu and Papatipu Rūnanga are also key partners with Council and Regenerate Christchurch in the rebuild of Christchurch post the 2010/2011 earthquakes, and for the Ōpāwaho / Heathcote River, ensuring core principles and objectives of manawhenua for the city and river are realised.
- Key objectives for manawhenua associated with urban development and stormwater management include: elimination of the direct discharge of wastewater and stormwater into waterways; commitment to low impact design principles; sustainability, creativity and innovation; improving water quality in rivers and streams; restoring riparian margins; and protecting and restoring springs, wetlands and mahinga kai.
- Current subdivisions developed by Ngāi Tahu offer examples of collaboration with local authorities to achieve best practise outcomes for stormwater include: Wigram Skies.

Environment Canterbury (ECan)

- Joint Council / ECan Planning and Consents Protocol for Surface Water Management (2009)- Support and promotion of managing surface water in a more integrated and effective way that also promotes a six values approach to waterway protection and enhancement and a catchment-wide approach to improving surface water quality.

Christchurch-West Melton Zone Committee

- A Canterbury Water Management Strategy committee comprising representatives of the community, Ngā Rūnanga, ECan, Council and Selwyn District Council.
- Tasked with making non-statutory recommendation associated with water management and issues such as: groundwater quality and flow; improving surface water quality and flow; enhancing degraded ecosystems, indigenous biodiversity; enhancing and managing waterways for recreation and amenity; efficient use of water, and managing demand.
- Foster educational approaches to drive behaviour change/ proactive pollution prevention/community buy-in.
- Working with community stream care groups.

NZ Transport Agency (NZTA)

- Via key policy and guideline documents NZTA engages with the Council on the consideration and incorporation of catchment and stormwater management best practice on any roading project within the city limits.
- Recently completed projects of best practice stormwater management include the Christchurch Southern Motorway.

Cashmere Stream Care Group

- Established in 2004, when residents approached ECan concerned about the increasing sedimentation and declining health of their stream. There mission is: To protect and enhance the health of the Cashmere Stream and its catchment.
- The aims of the group are to:

  - Improve water clarity;

  - Identify sediment sources;

  - Improve stream health;

  - Enhance public areas.

Ōpāwaho-Heathcote River Network

- Established in 2015, with the purpose to facilitate a collaborative network which advocates for the regeneration of the whole of Ōpāwaho Heathcote River.
- Their vision is to have an ecologically healthy river that people take pride in, enjoy, and care for.

Southern Motorway

Ngāi Tahu, Wigram Skies subdivision, soakage and detention basins

2.3 Protection + Purchase + Acquisition

Council has initiated a number of statutory protective mechanisms that protect land from intensification/urbanisation and provide opportunities for application of a six values approach to future stormwater management and enhancement.

- The City Plan, for example, prescribes a range of waterway setback requirements - from 5 metres to 30 metres dependent on one of the five waterway classifications. For example a 5 metre setback is required for an open utility waterway and up to a 30 metre setback for a downstream river such as the Ōpāwaho / Heathcote River. Setbacks are designed to provide a buffer between development and the waterway where open space or riparian planting can provide a public amenity with opportunity for maintaining and enhancing water quality through filtering non-point discharges, and for the protection of aquatic habitat.
- In addition to protective mechanisms, since 1995 Council has purchased land as part of a long term strategy to meet its stormwater management obligations. Land purchase secures Council opportunities to implement six values aligned to enhancement and management programs as funding becomes available and project or community demand requires. Council land purchases that have since been developed as exemplars of six values design, implementation and management include Council work relating to the naturalisation of timber boxed drains back to natural waterways supports a broad range of values but most specifically landscape and ecology.
- The rezoning of rural land to residential where there are existing waterways can create issues and benefits for fauna and flora along the waterway. These waterways often have either large, old, established trees that are often unsafe and have not been maintained along the banks, or alternatively the banks are in grass, often grazed, with no trees or shrubs. When Council acquires these waterways through the subdivision process it requires the subdivision developer to make safe any trees and structures, which will often require the removal of old, unsafe trees and overgrown shrubs along the banks. Through the subdivision process the Council will encourage riparian planting along the banks to provide shade and shelter to the waterway.
- Areas within the Ōpāwaho / Heathcote River Catchment that Council has purchased and have or are in the process of being developed include:
    - Eastman Wetlands, beside Sparks Road;
    - Awatea basins, Wigram Park;
    - Douglas Clifford basins and wetland, Halswell;
    - Wigram wet pond and basin, Canterbury Park;
    - Wilmers pit, Hornby;
    - Aidanfield waterway reserves.

Eastman wetland under construction next to Henderson Basin and Sparks Road

Nash Reserve, Aidanfield provides stormwater detention, recreational and amenity values

Gully planting in Bowenvale, Port Hills to reduce sediment runoff from the hills

2.4 Suburban Centres

New suburban centres, and/or the redevelopment of existing centres, provide a multitude of opportunities to improve all six values at a local sub-catchment level through the use of sustainable and enhanced surface water treatment devices such as:

- Stormwater tree pits;
- Swales;
- Rain gardens;
- Permeable pavement;
- Storm filters;
- Green roofs.

While opportunities may be limited due to spatial or budgetary constraints there are measurable, positive, values-based reasons to incorporate enhanced stormwater treatment devices as a part of any suburban centre retrofit.

The following suburban centres within the catchment provide a range of examples and opportunities for surface water treatment devices to help improve the quality of water before it enters waterways:

- South Library;
- Countdown, Addington;
- The Landing, Wigram Skies.

Swale alongside William Brittan Ave, Halswell

The Landing, Wigram Skies

South Library rain gardens, Beckenham

2.5 Street Renewals

Street renewals provide opportunities to include a range of best practice stormwater management methods including: daylighting of streams; springs and drains; stormwater tree pits; rain gardens; wetland swales; dry swales; and permeable pavement. As such, street renewals have the potential to reduce the quantity of contaminants entering the Ōpāwaho / Heathcote River and its tributaries. They improve the quality of the water entering the system, thus providing additional six value opportunities through enhanced ecological, cultural, landscape and recreational values, and enriched interpretation and/or protection of heritage elements.

Street renewal projects that have enhanced six values and can be used as exemplars in future street renewal projects include:

- Fairfield Ave, Addington;
- Meredith St, Addington;
- Forbes Street, Addington;
- Grove Road, Addington.

Rain garden on Meredith Street, Addington

Rain garden on Fairfield Avenue, Addington

2.6 Linkages, Networks & Corridors

Linking public open space using existing and/or proposed pedestrian and cycle networks provides opportunities to enhance all six values including the creation of habitat-rich, terrestrial and aquatic, ecological corridors. Examples of stormwater management projects that have recognised the opportunity for linkages, corridors and networks, and provided strengthened ecological, cultural, landscape, heritage and recreational values include:

- Westmorland East Valley Reserve;
- Worsleys Reserve;
- Mt Vernon Valley Track;
- Pioneer Park;
- Ngā Puna Wai, Canterbury Park;
- Ernle Clark Reserve;
- Baxter Creek, Sydenham.

Mt Vernon walkway across planted watercourse

Wigram Basin, Canterbury Agricultural Park, with Port Hills beyond

Naturalisation of watercourse through Addington provides linkages through the neighbourhood

Nash Reserve, Ōpāwaho / Heathcote River, provides links across a residential area for recreation

2.7 Subdivisions

The 2010/2011 earthquakes have hastened both the development of new subdivisions and the expansion of existing ones. There are numerous recent examples where a combination of legislative and market demands have produced sub-divisional outcomes with strong representation across all six values. Some examples of waterway enhancements and landscaped facilities within recent subdivisions that could be integrated into future developments within the Ōpāwaho / Heathcote River Catchment are:

- Aidanfield;
- Wigram Skies;
- Halswell on the Park;
- Milns Estate;
- Broken Run.

Watercourse in Wigram Skies with retention basin

Naturalisation of watercourse through Aidanfield

2.8 Wetlands

Over the last 20 years Council has secured the long term protection of a number of wetlands within the Ōpāwaho / Heathcote River Catchment. Opportunities to enlarge and enhance these existing wetlands to incorporate all six values have been identified. In addition to increasing the number and quality of physical linkages between wetlands, enhancement and appropriate management within them will allow their important roles in the drainage, storage, and cleaning of surface water inputs to increase.

The original wetlands of the Ōpāwaho / Heathcote River Catchment have been mostly lost with only tiny natural remnants remaining following the cumulative effects of human modification. Those wetlands remaining that provide enhanced six values comprise riparian and aquatic vegetation along the margins and in the waters of the rivers and streams themselves. On the Port Hills, seeps and flushes, also highly modified, have remnant vegetation. The large original wetlands, including those on peat, have gone. From a low point in the 1980s however, restoration of wetlands has occurred and the decline is slowly being reversed, albeit a bit unevenly in regards to the various habitat types. Most has concentrated on riparian margins, a few shallow ponds associated with stormwater retention and the estuarine section of the Lower Ōpāwaho / Heathcote River.

In some places, artificial wetlands have been created, usually in association with stormwater or amenity ponds. The largest of these is at Ngā Puna Wai (formerly Canterbury Park) where the construction of wetlands and ponds has allowed a wider than usual floodplain zone to be created and planted with wetland species. Another area recently constructed is the Eastman Wetlands alongside Sparks Road.

Wigram Basin, Canterbury Agricultural Park

Heathcote Valley stormwater ponds

Wetland alongside Haytons Stream, Wigram Skies

2.9 Waterway Restoration

Over the last 20 years the Council has developed a range of 'tools', or design solutions, enhancement and management to promote the six values approach to waterways restoration including: improving drainage capacity; enhancing landscape character; improving the quality and diversity of recreational opportunities; enhancing terrestrial and aquatic ecological values; and improving cultural and heritage values.

Significant waterway restoration projects that strongly reflect these six values and can be used as exemplars for new projects in the future include:

- Ernle Clark Reserve - development of river banks along the main channel;
- Worsleys Reserve - Cashmere Stream;
- Haytons Stream through the Wigram Skies subdivision;
- Milns Stream west of Sparks Road;
- Dunbars Stream - Aidanfield;
- Westmorland East Valley Reserve - Cashmere Valley Stream.

Retention basin in planted water course next to Aidanfield

Dunbars Stream, Aidanfield

Milns Drain flowing into the Eastman wetland

Waterloo Road Stream flowing through industrial area

2.10 Suburban Greenspace

Areas of existing greenspace within suburban areas can be enhanced to incorporate positive responses to all six values and mitigate the impacts of urbanisation and increased surface water runoff.

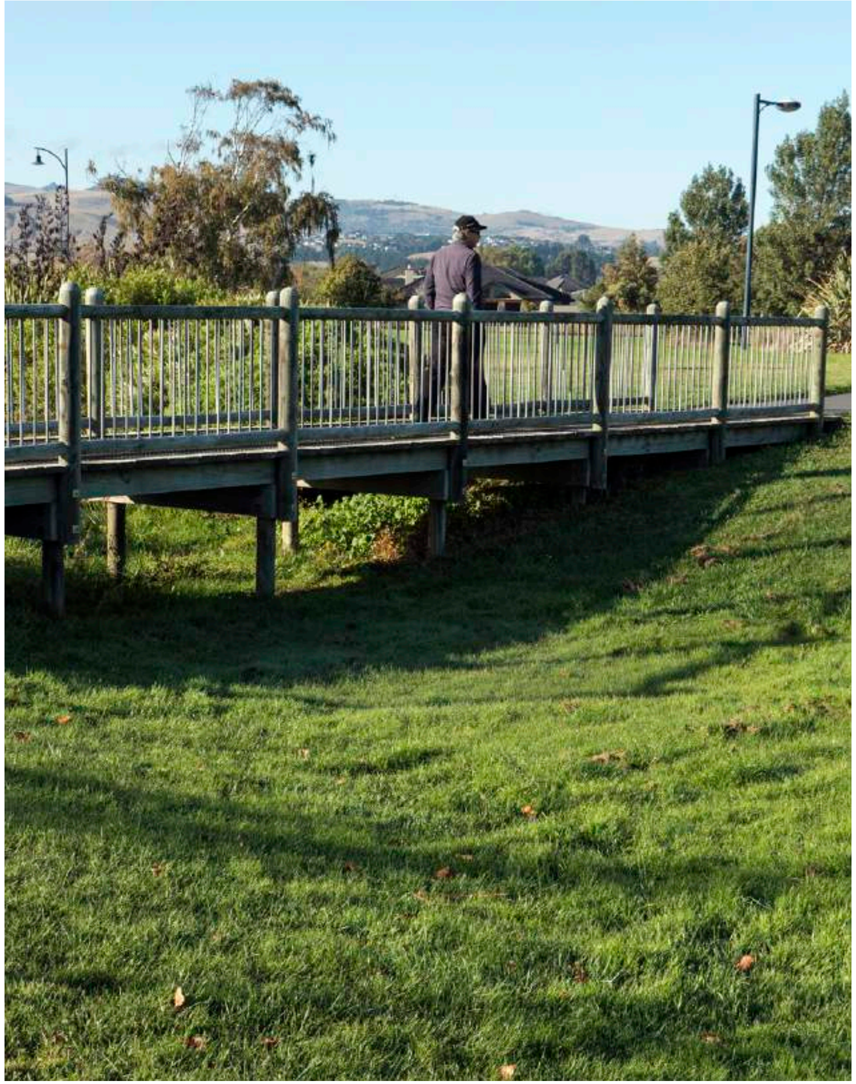
City-wide suburban greenspace projects that exemplify enhanced six values include:

- Beckenham Park;
- Worsley Reserve;
- Ernle Clark Reserve;
- Ngā Puna Wai Reserve, Canterbury Park;
- John Olliver Reserve.

Opportunities for six value treatments of suburban green space within the Ōpāwaho / Heathcote River Catchment that have been identified by Council but not yet realised include:

- Hansen Park, Opawa;
- Radley Park, Woolston;
- Remuera Reserve, Thorrington;
- Swanlake Gardens, Thorrington;
- Spreydon Domain.

Beckenham Park ponds



Water course in Halswell Domain

John Olliver Reserve Halswell

2.11 Ōpāwaho / Heathcote River Catchment: Exemplar Sites

1. Wigram Skies

13. Wigram Basin

6. Meredith Street

18. John Olliver Reserve

15. Milns Drain

10. Nash Reserve

5. South Library

8. Mt Vernon

Partnerships
1. Wigram Skies
2. CHCH Southern Motorway

Protection & Purchase
3. Eastman wetlands

Suburban centres
4. The Landing
5. South Library

Street renewals
6. Meredith Street
7. Fairfield Ave

Linkages, Networks & Corridors
8. Mt Vernon
9. Addington
10. Nash Reserve

Subdivisions
11. Wigram Skies
12. Aidanfield

Wetlands
13. Wigram Basin
14. Haytons Stream

Waterway restoration
15. Milns Drain
16. Waterloo Drain
17. Dunbars Stream

Suburban greenspace
18. John Olliver Reserve
19. Beckenham Park

2.12 Ōpāwaho / Heathcote River Catchment overlying the 1856 Black Map

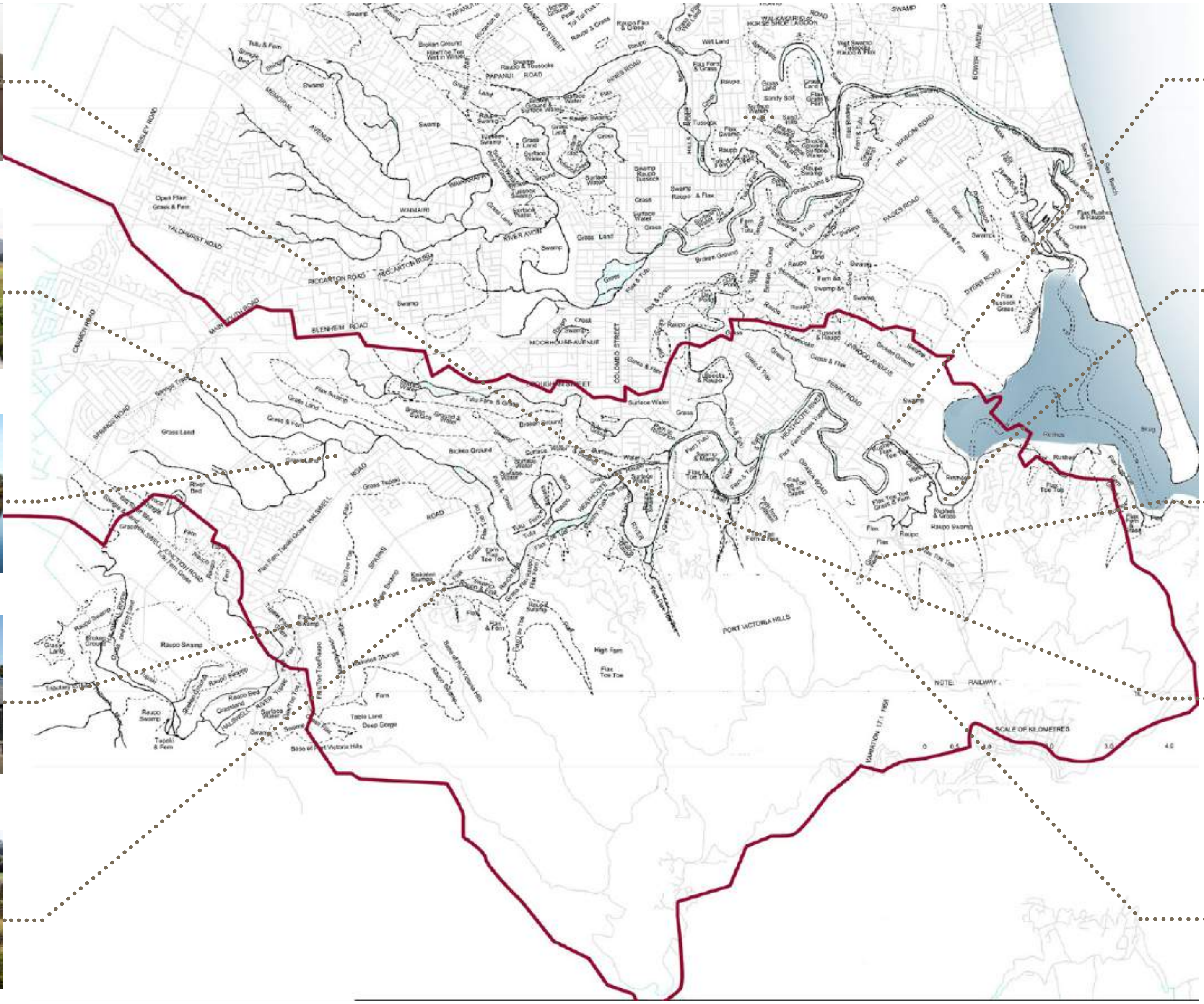
Malthouse

Hayton's Stream pond

Nga Puna wai

Holmcroft

Cashmere Stream retention basin



Steam Wharf stream

Lower Ōpāwaho / Heathcote River

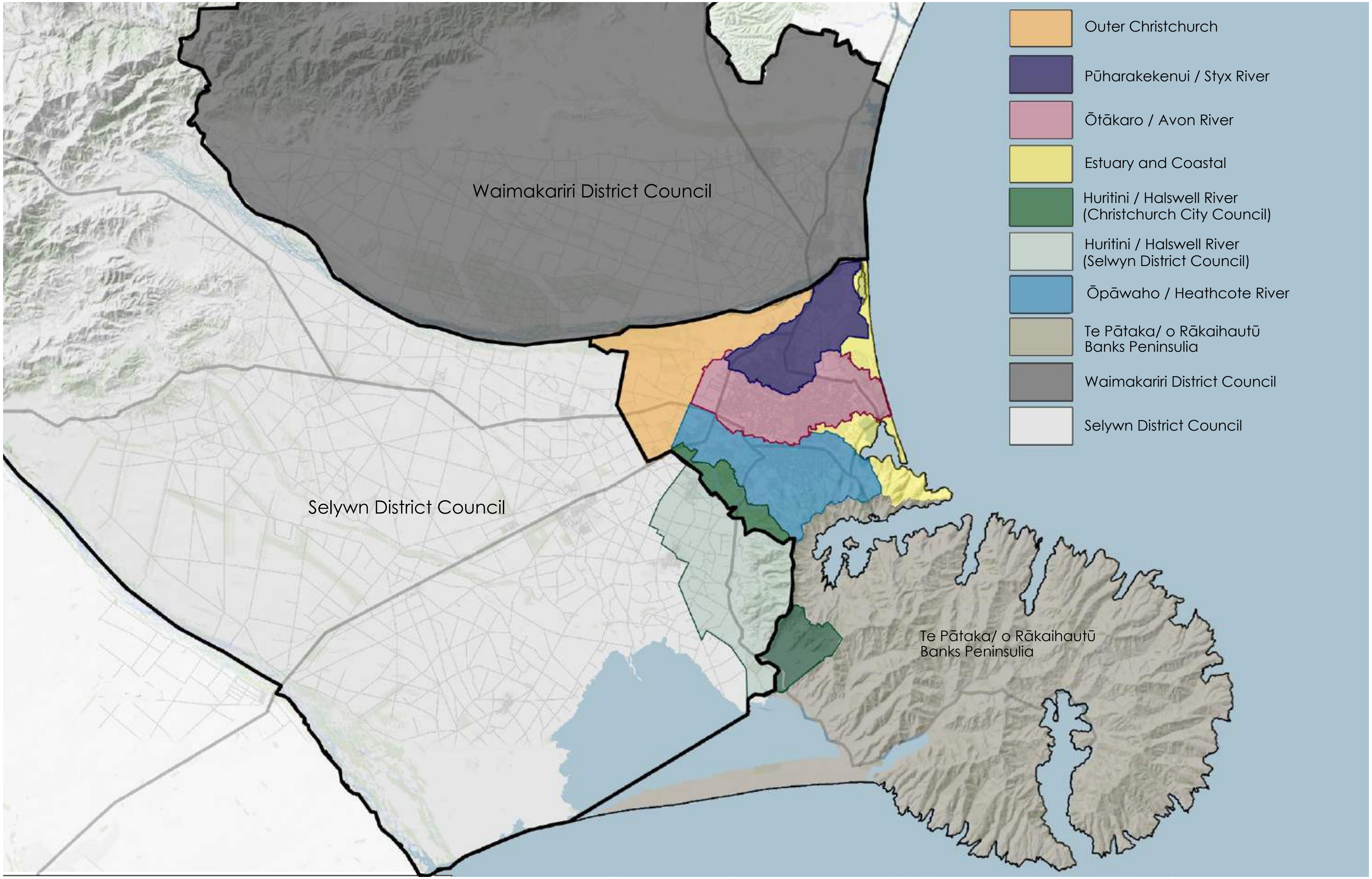
Duncan Park retention pond

Ōpāwaho / Heathcote River by Colombo

Mt Vernon

The 1856 Black Map is a survey plan (J Thomas & T Cass Chief Surveyors) that shows the original land formation, vegetation, waterways and wetlands of Christchurch at the time of European settlement. It is still relevant today as an indicator of natural drainage and vegetation types.

2.13 Context Plan: Catchment Boundaries within Christchurch



Part 2.0 SUMMARY OF TECHNICAL REPORTS
Pūrongo Hangarau

3.0 Physical Context / Te Horopaki

3.1 Geology

The Canterbury Plains are a complex of coalescing gravel fans deposited by rivers emerging from the foothills of the Southern Alps. During glacial periods valley glaciers reached almost to the foothills, delivering large amounts of eroded greywacke rock from which meltwater rivers built alluvial fans.

The Canterbury Plains are formed on more than 500 m of gravel deposited during the late Tertiary and Quaternary periods (the last 5 million years). At the coast the gravel is shallower, being underlain at 240 m by clay, sand, silt, peat and interbedded gravel deposited in an ancient coastal environment. Basement rock is generally at a depth of 1.5 to 2 km, although rock occurs at shallower levels near the Banks Peninsula hills.

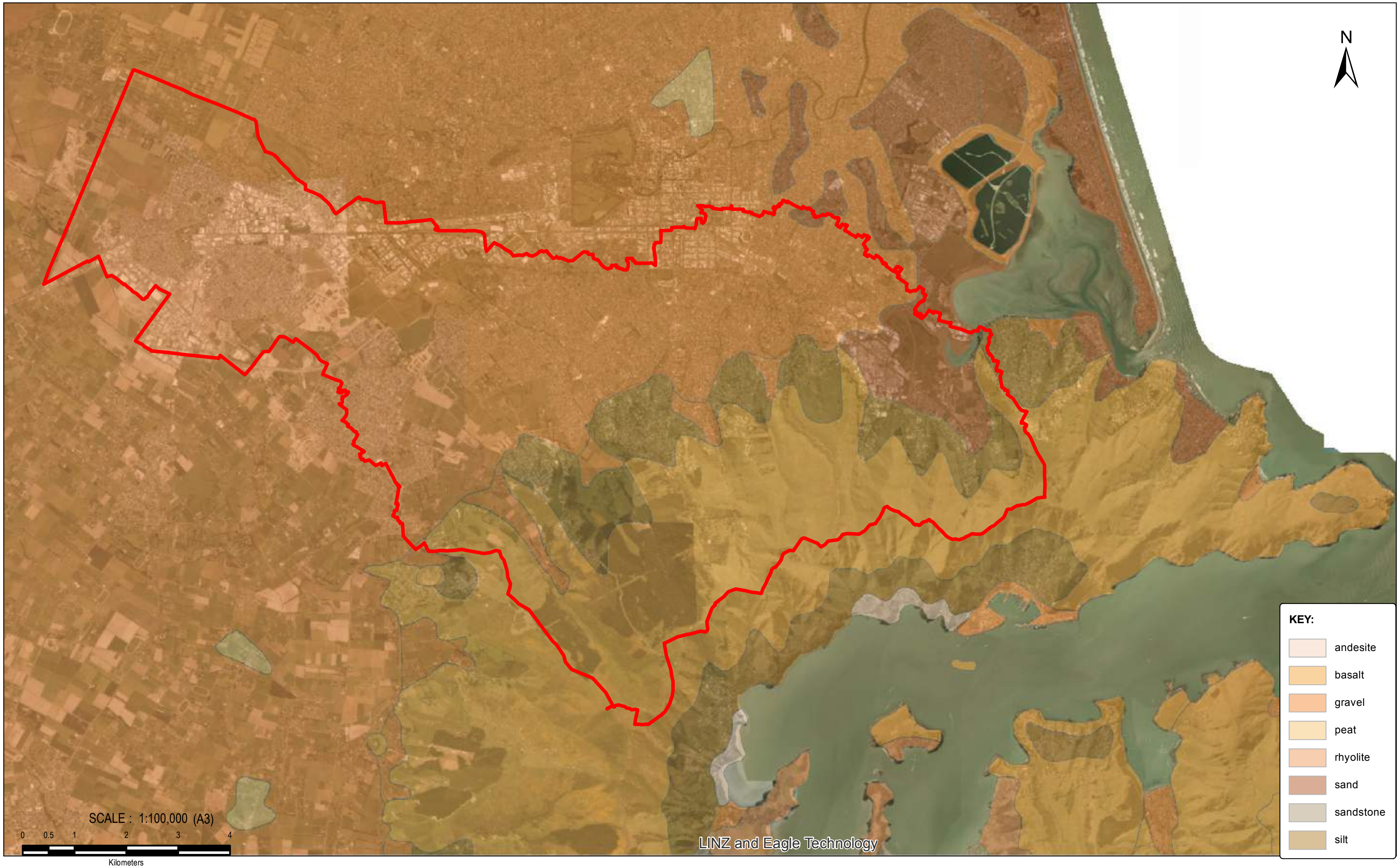
Accumulating progressively downstream, the alluvial fans extended to a coast which was several kilometres east of the present shoreline. Successive glaciations deposited gravel layers that are generally 10 – 20 m, but up to 40 m thick. During interglacial periods the rising sea created deposition areas for blue, brown and yellow sand, silt and clay with inter-bedded shell, peat and wood layers in the vicinity of the present day city. Successive climate cycles have laid down six or more gravel layers separated by significantly less permeable fine sediment. Layers can be identified in some of the 10,711 well logs in the area. Inland from Christchurch, the impermeable layers dwindle and disappear. Layers of sandy gravel between less permeable marine sediments form the aquifers from which Christchurch draws its water.

The Port Hills, which consist of basalt lava and agglomerate, form the southern rim of the volcanic crater centred in Whakaraupō / Lyttelton Harbour.

The river skirts the Port Hills for about half of its length. It probably became established in this location when occasional flood spillages from the Waimakariri River flowed down the Islington Channel and along the base of the hills, maintaining a flood passage. Runoff from the hills has kept the channel open. A great deal of sediment travels with hill streams from surface erosion, under-runners and slips, such that the river is often discoloured. It seems likely that this has been the situation since early Polynesian times when the forest cover was burnt.

Estuaries, lagoons and swamps have occupied the Christchurch area for the 10,000 years since post-glacial sea level rise caused the sea to transgress westward as far as Riccarton and Spreydon. The sea level later fell: deposition of sand and gravel from the Waimakariri River progressed eastward after the present sea level became established about 6,500-6,000 years ago. A succession of beach deposits, sand dunes, estuaries, lagoons, and interdunal swamps accumulated as progradation proceeded. Many of these features have been obliterated by urban development. Incursions by the Waimakariri River into the area deposited gravel, sand and silt.

Rock groups within the Ōpāwaho / Heathcote Catchment



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3.2 Soils

Port Hills

Wind-blown silt (loess) mantles all the hill slopes and is the principal material from which soils on rolling and hilly lands are derived. It lies deepest on the sides and tops of spurs and on rolling slopes at high levels but it is thin and discontinuous where slopes increase from rolling to steep. Consequently, on steep lands, soils are derived from mixtures of basaltic materials with loess. The lower slopes include river flats, estuarine marshes, sand dunes and fans. Alluvial fans which occupy the floors of the valleys of the Port Hills consist of material derived from basalt and loess and can be distinguished from other types of alluvium by the brownish colour. In some valleys, the lower ends of the fans have been buried by alluvium deposited by the larger rivers but in most places, the fans rise to heights over 15 m above the flood plains.

Following a hot dry summer, the soil on the hills may require 25 to 30 mm of rainfall to restore the soil moisture before water runoff begins to enter the streams.

The Plains

In past times great quantities of dust from the river-beds were lifted by strong north-west winds and deposited over the plains. This dust was sandy near the rivers, but the sediments become finer as distance from the rivers increased. Waimakariri series soils in the upper catchment received a heavy dressing of sandy material.

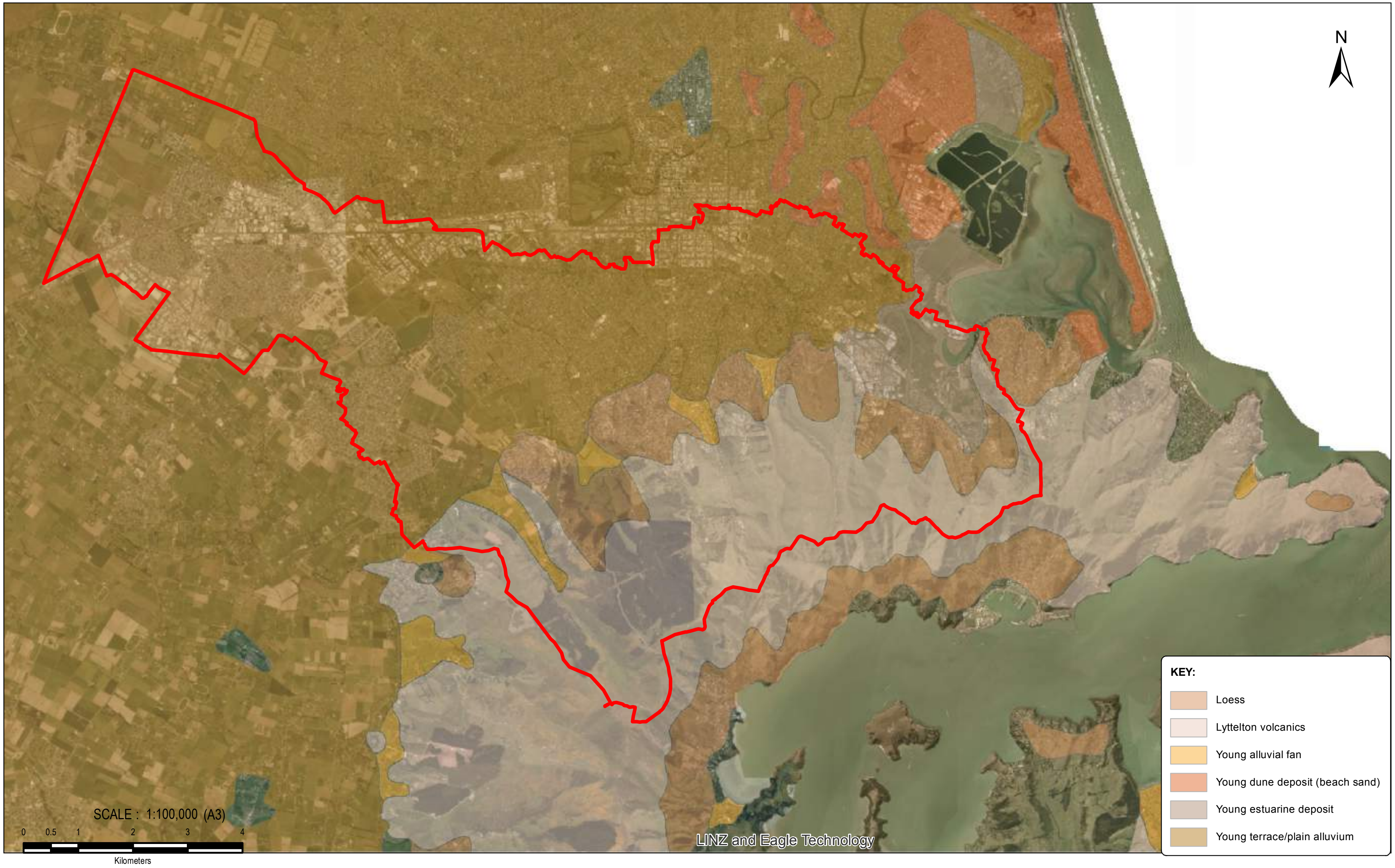
A sequence from a well drained levee in the west to poorly drained low-lying plain comprises the following soils: Waimakariri sandy loam (generally west of Hillmorton), Kaiapoi sandy and silt loam (much of the middle Heathcote Catchment from Sockburn to Woolston) and Taitapu deep silt loam (Hendersons Basin, Hoon Hay / Somerfield river corridor, and a flat east-west channel through Spreydon). In Woolston and the Heathcote Valley the Motukarara deep silt loam is similar to Kaiapoi silt loam but more poorly drained and saline. The above soils are classified as 'Recent soils' because development of their profile features has been prevented by the repeated additions of alluvium during floods. On the river flats, soils are formed on alluvium of mainly greywacke origin and their textures are predominantly silt loams. Clay loams occur in Cashmere and Bowenvale valleys and fine sands occur on the levees of the rivers. Reducing or gley conditions are produced in Taitapu soils by the presence of high water tables over long periods of time. Kaiapoi series are similar to Waimakariri except that they contain adequate moisture and are therefore much more fertile.

Physical Properties of Soils

Some Port Hills soils are very prone to erosion due to a tendency for shrinkage cracking and dispersive character. Loess possesses dispersive characteristics that vary by location and in different layers. Dispersive loess is unusually susceptible to erosion. Rain water that enters shrinkage cracks can erode either over or under resistant layers (forming rills or tunnels respectively). Reduced vegetation cover influences shrinkage cracking and increased water flows are likely to initiate erosion.

Features of interest in plains soils are permeability and erodibility. Permeability affects the rate of runoff and the soil's effectiveness as an infiltration layer in a treatment facility. Erodibility helps to determine the amount of sediment discharged from unsealed surfaces during rainfall.

Main Soil Deposits in the Ōpāwaho / Heathcote Catchment



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3.3 Groundwater

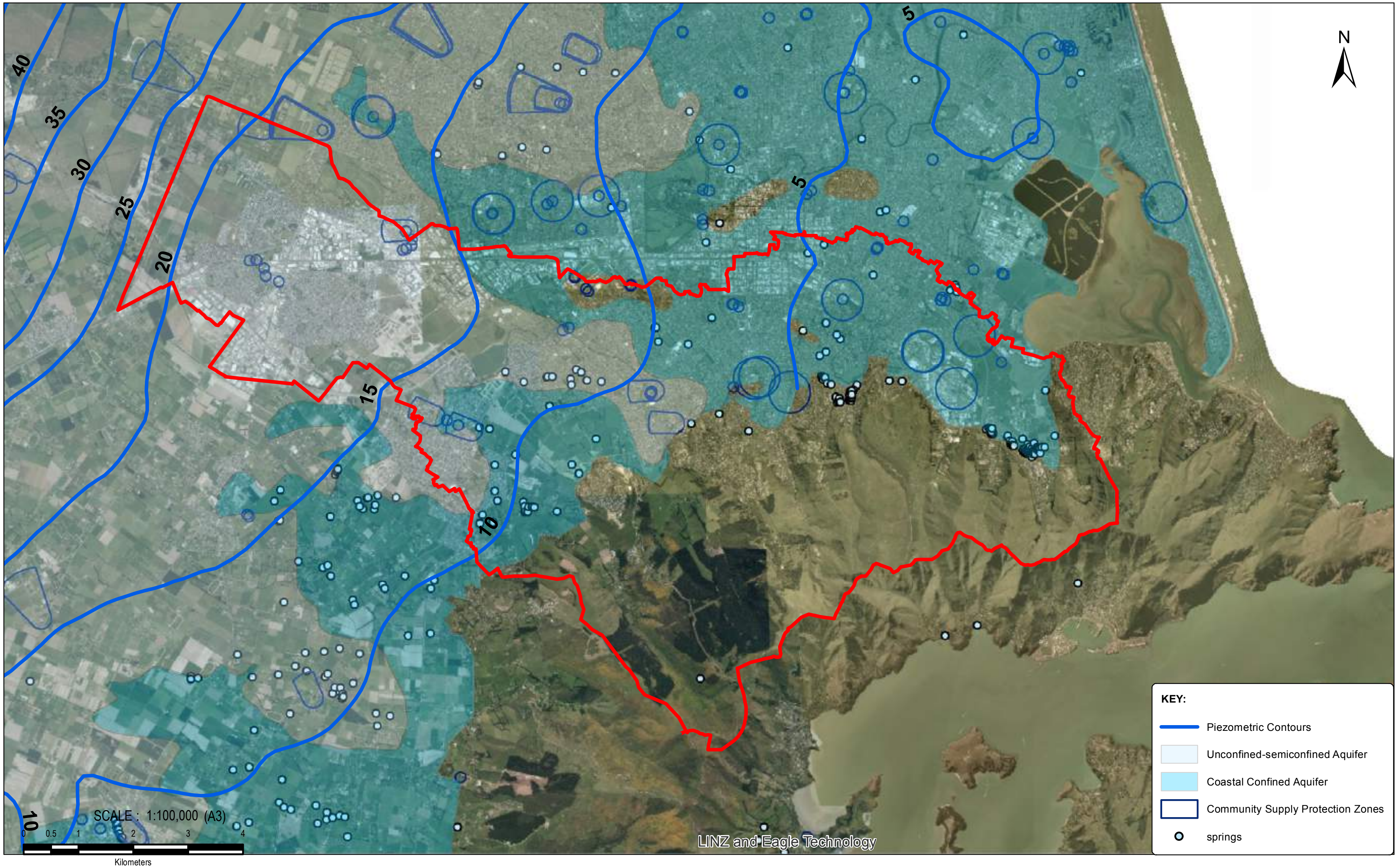
The near surface geology of the catchment is comprised of unconsolidated gravel, sand, silt and clay sized particles, deposited since the Ice Ages. Coarser grained gravel and sand deposits are derived from alluvial fans, which have spread out from the Southern Alps in the west, forming the Canterbury plains by river action. River processes laid down zones of permeable water bearing aquifers which occur at the surface around the western edge of the catchment and in more discrete, deeper, layers towards the central and eastern area. Gravels are interspersed with zones of alluvial sand and silt associated with alluvial (river) depositional processes and finer grained overbank flood deposits. The arrival of these alluvial deposits occurred during alternating periods of glacial and inter-glacial climatic conditions and associated sea level change. At times of higher sea level, finer grained estuarine and marine sediments and dune sands were deposited over alluvial deposits as far inland as Spreydon.

Groundwater occurs within pore spaces between the gravels and sands. Where these extend to the ground surface, in the west of the catchment, the stratum is classified as an unconfined aquifer and surface water can infiltrate relatively unimpeded. Where finer grained estuarine and marine strata lie over gravels they provide a cap that confines water within the gravel below. This is called a confined aquifer system. Deep below the central and eastern parts of the catchment the gravels form a layered sequence of discrete aquifers, separated by low permeability fine grained marine and estuarine deposits.

The groundwater system in the catchment is primarily recharged by seepage losses from the Waimakariri River as it flows across the gravelly plains and rainfall infiltration that occurs across the inland plains. Leakage from the stockwater races that cross the plains also contributes some groundwater recharge water. Groundwater levels are influenced by the rate of recharge entering the groundwater system and the permeability of the strata through which the groundwater moves. Groundwater is deepest at the western end of the catchment (typically around 6 m deep) and becomes shallower toward the east, approaching ground level in the vicinity of the springs that feed the Cashmere Stream. Groundwater moves in an easterly direction in response to the hydraulic gradient between the Plains and the coast. The major discharge from shallow (unconfined) groundwater occurs into springfed waterways. Further east, the groundwater trapped within the confined aquifers develops artesian pressures.

Aquifers are used extensively for water abstraction from the wells that supply the Christchurch reticulated water supply (45% of maximum consented daily abstractions), in addition to individual supplies for industrial/ commercial uses (36% of consented abstractions), agricultural (12%) and other smaller use activities. Groundwater levels fluctuate in response to changes in recharge and abstraction. They show a typical seasonal pattern with higher water levels in winter and spring (less abstraction from bores and more rainfall recharge) and lower levels in late summer and autumn (higher abstraction from bores and less rainfall recharge). These seasonal fluctuations are greatest in the west (more than 3 m between seasonal highs and lows) and become smaller in the central and eastern city where they are constrained by the discharges to waterways.

Ground Water and Springs in the Ōpāwaho / Heathcote Catchment



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3.4 Groundwater Quality

Each year about 35 wells in the Christchurch area are sampled by ECan for signs of changing groundwater quality. Groundwater quality is generally very good and the majority of samples meet New Zealand drinking water standards without treatment. This reflects the absence of bacteria and viruses, which is typical for water abstracted from a well managed aquifer. The best water quality occurs across the northern part of the city thanks to seepage of clean water from the Waimakariri River into the aquifer. Groundwater quality in the south is still good, but the water contains more dissolved substances picked up during infiltration through the land surface. Some areas near the estuary and old coastal swamps have low dissolved oxygen, which causes naturally poorer groundwater quality.

Some constituents of groundwater such as nitrogen can be detrimental in spring and stream flow, although harmless in drinking water. Groundwater quality in the catchment varies, in places showing the effects of past practices. Relatively widespread groundwater quality effects have resulted from historic burial of animal carcases and residential and industrial refuse in areas towards the western edge of the catchment. Those effects manifest themselves in higher conductivities and elevated nitrate nitrogen concentrations in bores less than 40 m deep. Groundwater quality in deeper bores from which the city draws its water supply appears to be generally better, as is groundwater quality in bores located towards the eastern edge of the catchment. This is because nitrogen from near-surface sources tends to stay within shallow groundwater and discharge into streams.

One-off sampling for cadmium and boron, which might indicate contaminants from fertiliser use, was found only in one well near an old landfill where boron concentrations were above the drinking-water maximum allowable value. Cadmium concentrations were below detection levels in all but one well, which still had very low concentrations. There was very little evidence of changing groundwater quality in Christchurch over the last ten years.

Four wells show a possible long-term decline in quality near the groundwater table to the west and south west of the city. Two of these wells target known contamination sources and the other two show a slow general change in quality.

Another five wells show improved groundwater quality in previously affected areas of southern Christchurch after better management of abstraction and discharges (Christchurch groundwater quality monitoring 2013, ECan).

Effects from urban stormwater disposal

Urban development needs new stormwater management systems, mostly because of many impermeable surfaces that reduce stormwater infiltration into the ground. Thus stormwater disposal is more likely to affect surface water quality than groundwater quantity. However effects on groundwater can include changes to the location and rate of groundwater recharge.

In greenfields developments stormwater is detained in storage facilities in order to avoid effects from flooding and stormwater contaminants. Stormwater facilities may be either detention or infiltration basins. The key difference between the two types of basins is that infiltration basins are designed to allow stormwater to infiltrate to underlying groundwater, while stormwater remains within detention basins until it can be redirected into surface waterways. Selecting which of the different types of basins to use depends on two main factors, the permeability of the underlying strata and the depth to groundwater beneath the basin.

Infiltration basins are typically more appropriate where strata are permeable and groundwater levels are relatively deep, and these conditions occur west of Hoon Hay and north of the Southern Motorway. Localised groundwater mounding effects are likely to occur beneath infiltration basins. In general, these effects are unlikely to cause significant issues if infiltration basins are carefully designed. However, mounding could cause adverse groundwater quality effects in the vicinity of old landfills or other contaminated sites.

This issue is considered on a site by site basis. Groundwater quality could be adversely affected by stormwater discharge from infiltration basins. However if the basins are appropriately constructed and located away from community drinking water supply protection zones and landfills these effects are expected to be limited.

Very limited leakage to groundwater from stormwater detention basins is expected to occur. Therefore these stormwater treatment mechanisms are expected to have very small effects on groundwater quality. Stormwater that is subsequently discharged from the basins will have improved water quality due to sedimentation of particulate matter.

Because of the large amount of inflow from the Waimakariri River and the comparatively large amount of rainfall on the plains, the reduction in groundwater recharge due to urbanisation across the confined areas of the catchment where detention basins are suitable is not expected to be significant in the context of the overall water balance and so effects are expected to be small.

3.5 Surface Water Network

The Opāwaho / Heathcote River has dry plains tributaries including the upper main stem to the north, a flowing tributary in the Cashmere Stream to the west and mostly dry tributaries on the Port Hills. It is likely that plains tributaries (Paparua Stream, Hayton Stream, Awatea Stream, Curletts Stream) were fed by spring flow until early European times. Evidence for this is that Maori used the Upper Heathcote River as a waka route as far as Owaka Road. These tributaries now receive less spring flow in the west than previously, although Paparua Stream receives tail water from a stock water race. The Upper Opāwaho / Heathcote River begins flowing from seeps or springs (depending on the season) near Templetons Road. Cashmere Stream, emerging from swampy ground, is spring fed and flows continuously. Although straightened west of Penruddock Rise, Cashmere Stream retains fair water quality and some natural fauna.

Many parts of tributaries have been realigned, modified or piped in the course of urban development, although the courses of original waterways can be seen on the Black Map (Pg.47). Paving and road construction has modified surface water movement and sewer construction has somewhat modified subsurface water movement. Whether streams have become drier as a result of drainage, water takes or a drier climate is not certain, and all these factors are likely to have played a part. Much of the middle catchment was swampy, so numerous drains were created, mostly lined or piped to facilitate urban development. An example is a very large (2.1 metre diameter) pipe in Woodard Terrace that drains the shallow basin in which Spreydon is located. Despite their size the capacity of constructed tributaries is limited, so widespread surface flooding can occur, although infrequently, on the floodplains.

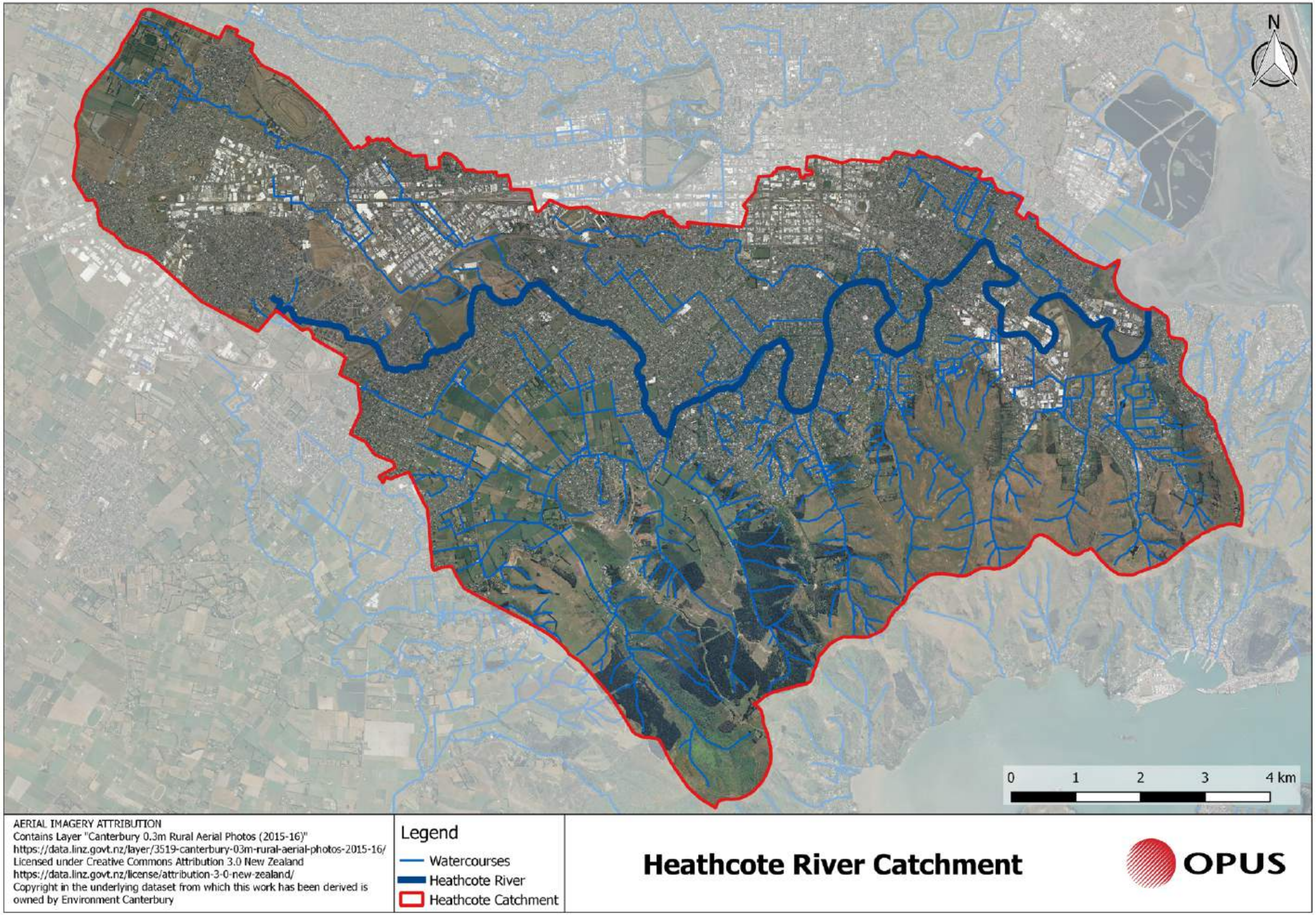
The surface water network west of Westmorland is undergoing significant modification to accommodate city growth. The Opāwaho / Heathcote River Floodplain Management Strategy requires that runoff from new development is mitigated by storage basins. Many large new basins and wetlands will be constructed, over time, in Wigram, Halswell and Cashmere stream catchment in order to detain flood water for protection of the middle river below Princess Margaret Hospital. Basins and wetlands will also trap sediment and provide water quality benefits.

The main river channel meanders in a way that is characteristic of a river in a silty floodplain. However the middle river floodplain is narrow, scarcely wider than the river-side roads. This is likely to have resulted from the way silt from the Waimakariri River arrived after flowing over-land. The river today is deeper, by approximately a metre, and wider than it was originally, but it still overtops its banks frequently and in places rather deeply. Early residential development along the river corridor occurred without full understanding of potential flood levels, and frequent major floods from the 1940s to the 1980s prompted a flood relief scheme whose components are still being implemented.

Hill waterways are very erosion-prone and for this reason are mostly lined or piped within built-up areas. They are normally dry but can carry heavily loess-laden water during rain events.

The catchment has a flat gradient east of St Martins and the river is tidally affected up to Beckenham Park. These influences lead to slower moving water, sediment deposition and greater likelihood of tidally influenced flooding. The river bed is muddy downstream of Ensors Road and water depths fluctuate with tides. The channel becomes generally deeper and wider toward the estuary. In early times it was navigable by small coastal craft up to a series of wharves in the reach between Steam Wharf Stream and Richardson Terrace, but siltation has considerably reduced water depths.

Surface Water Network of the Ōpāwaho / Heathcote Catchment



4.0 State of the Takiwā / Te Āhuatanga o te Takiwā

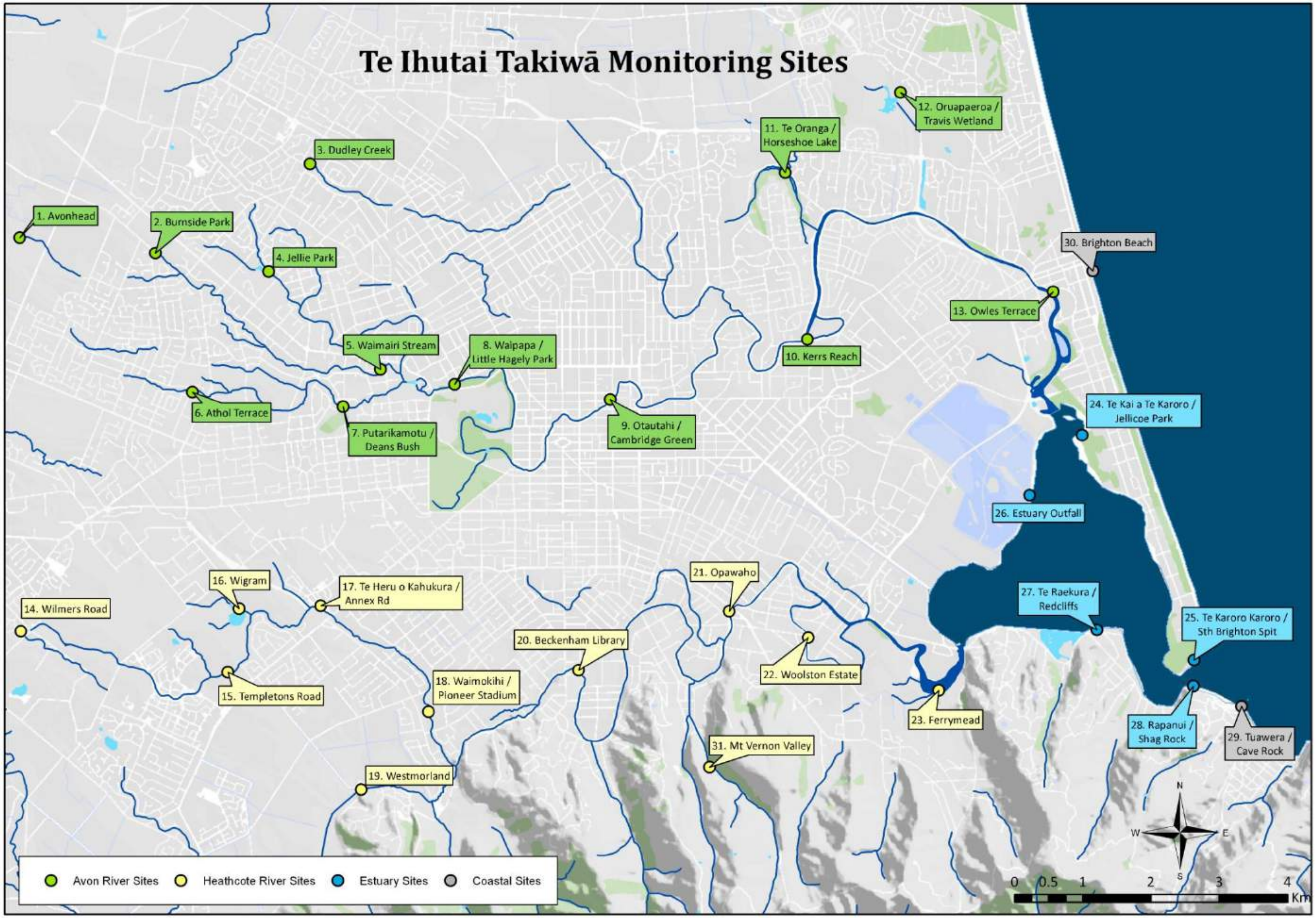
4.1 Te Āhuatanga o Te Ihutai- Cultural Health Assessment of the Avon Heathcote Estuary & its Catchment (2007 & 2012)

Cultural health assessments of the Ihutai catchment were undertaken in 2007 and 2012 by members of Ngāi Tūāhuriri and Te Hapū o Ngāti Wheke using the Ngāi Tahu Takiwā assessment tool. The 2007 study was carried out for Environment Canterbury as part of a wider research project being led by the Avon-Heathcote Estuary Ihutai Trust called 'Healthy Estuary & Rivers of the City', while the 2012 study was carried out for the Christchurch City Council.

Both studies confirmed that Ihutai waterways are in a state of poor cultural health and do not meet basic standards for cultural use. In particular, the impacts of historical and ongoing drainage and untreated stormwater, the loss of native vegetation, including wetlands, grasslands and lowland forests, and the decline of water quantity within the catchment were identified as major issues influencing the assessment. The 2012 study had similar findings to the 2007 study, with some improvements at certain sites, particularly associated with improved riparian and stormwater management as well as further degradation at others, associated with earthquake damage.

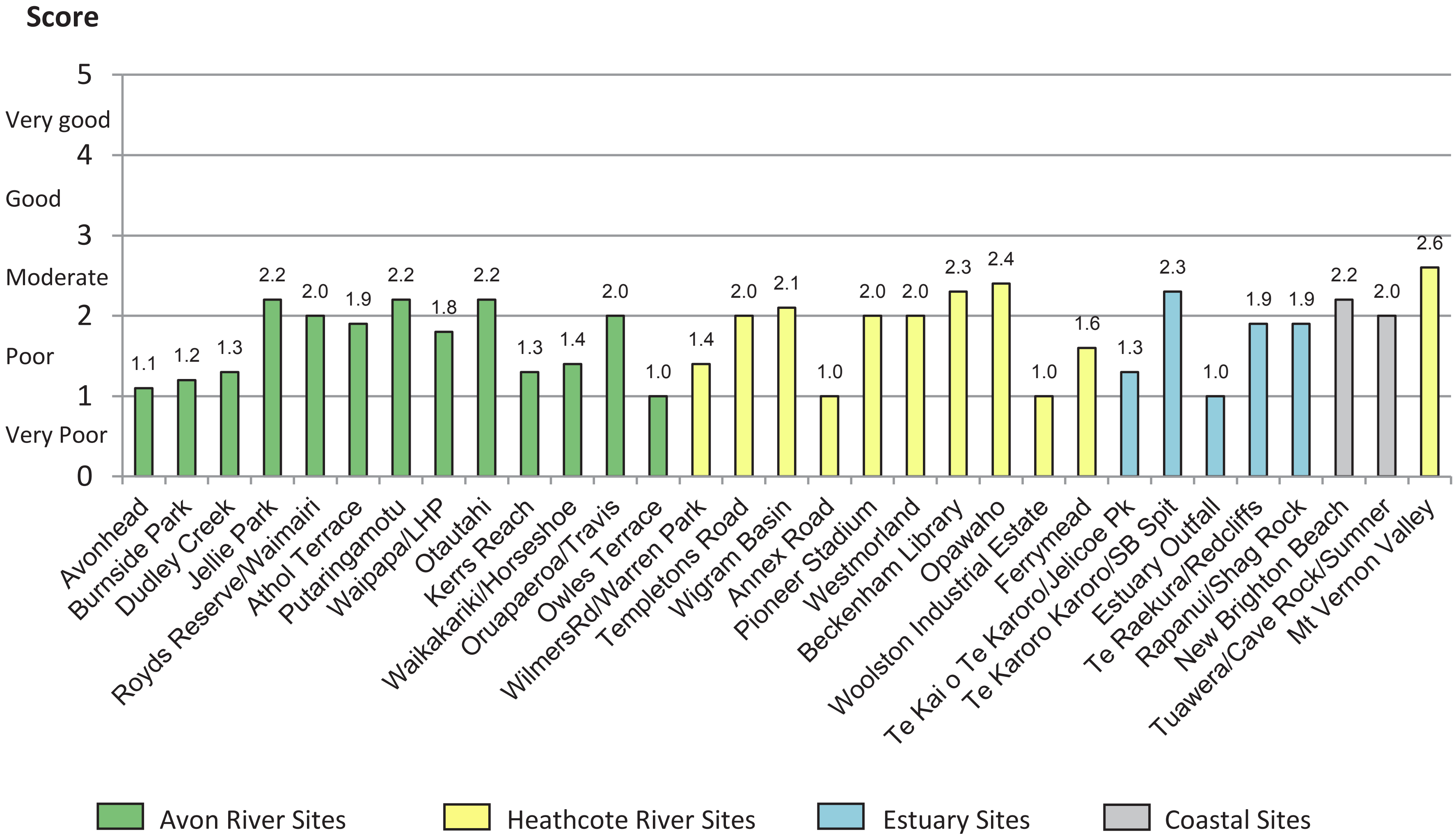
Both studies noted that stormwater inputs, wastewater discharges and the occurrence of extreme sedimentation are undermining the mauri of waterways. The 2012 study noted:
"Overall the biggest influence on poor catchment health is the historical and continuing impacts of drainage and untreated stormwater."

Both studies cited that the elimination of discharges of contaminants to water is one of the most important challenges for future management of the Ihutai catchment and that addressing this requires mechanisms to avoid new inputs (e.g. low impact urban design such as greywater recycling) and a full assessment of existing sources of contaminant discharges, particularly stormwater. The studies advocate for the elimination of wastewater and stormwater discharges from waterways through a combination of repairs, upgrades, and replacement of existing infrastructure and the use of alternative disposal technologies. Planting riparian margins along waterways and drains to restore habitat, filter run off, and reduce sediment entering waterways will further restore the mauri and cultural health waterways in the catchment were also recommended.



Te Ihutai Takiwā Monitoring Sites
1. Avonhead
2. Burnside Park
3. Dudley Creek
4. Jellie Park
5. Waimairi Stream
6. Athol Terrace
7. Putarikamotu / Deans Bush
8. Waipapa / Little Hagely Park
9. Otautahi / Cambridge Green
10. Kerrs Reach
11. Te Oranga / Horseshoe Lake
12. Oruapaeroa / Travis Wetland
13. Owles Terrace
14. Wilmers Road
15. Templetons Road
16. Wigram
17. Te Heru o Kahukura / Annex Rd
18. Waimokihi / Pioneer Stadium
19. Westmorland
20. Beckenham Library
21. Opawaho
22. Woolston Estate
23. Ferrymead
24. Te Kai a Te Karoro / Jellicoe Park
25. Te Karoro Karoro / Sth Brighton Spit
26. Estuary Outfall
27. Te Raekura / Redcliffs
28. Rapanui / Shag Rock
29. Tuawera / Cave Rock
30. Brighton Beach
31. Mt Vernon Valley
Avon River Sites
Heathcote River Sites
Estuary Sites
Coastal Sites
N
S
E
W
0 0.5 1 2 3 4
Km

Takiwā Overall Health Index scores



4.2 Management Recommendations

Both studies made a number of recommendations, with many being relevant to stormwater management, including:

- The progressive elimination of contaminant inputs throughout the catchment, including from the wastewater network and from stormwater runoff and rural land uses;
- Restoring of water quality to a level at which mahinga kai can be safely gathered;
- Further studies to investigate the source of human, agricultural, and medical contaminants located throughout the catchment, and a move towards Escherichia coli monitoring by source as a standard approach to environmental monitoring;
- The protection and enhancement of all known springs in the catchment;
- A concerted effort is required to restore and protect indigenous riparian vegetation throughout the catchment, particularly on Christchurch City Council/public land;
- The development of policy in the district plan to require native riparian buffer zones and on-site stormwater treatment systems when any land adjacent to any waterway (including drains) is subdivided or developed;
- Identification and recording of all stormwater inputs in the catchment and investigation into the effects of these inputs on water quality, including native fish, birds, insects and plants.

4.3 Te Whakamutunga / Summary

Freshwater is of the utmost importance to Ngāi Tahu culture and identity and the iwi has been actively involved in protecting and advocating for improve water management through resource management processes for over 30 years. Stormwater management is a key aspect of improved water management and the Mahaanui Iwi Management Plan (IMP) contains numerous policies that provide guidance of Ngāi Tahu perspectives in relation to stormwater, including catchment specific policies.

Overall the IMP stormwater policies encourage the consideration of actions that reciprocate the use of natural resources (regardless of effect), manage the cumulative impacts and the implementation of best management practices as well as addressing adverse effects of intensive land use on cultural values. This includes the requirement for indigenous riparian planting and on-site land based treatment and disposal systems for stormwater, such as vegetated swales, constructed wetlands and retention basins that result in zero stormwater discharges. Land based treatment systems are seen to promote cultural values, reduce erosion, protect soil and reduce sedimentation and contamination of waterways. Policies for specific catchments focus on improving urban development, particularly subdivision and the impacts of stormwater runoff to protect water quality, significant sites and mahinga kai.

While the stormwater policies state an opposition to the use of global consents for stormwater discharges, there is also clear support for integrated catchment management plans as a tool to manage stormwater and the effects of land use change and development on the environment and tangata whenua values, when they are consistent with other policies.

5.0 Freshwater Ecology / Raurop̄i Wai-māori

The aquatic ecology of the Ōpāwaho / Heathcote River and tributaries is monitored by the Council every five years. The last survey was undertaken in February and March 2015 by Boffa Miskell. This survey investigated habitat, algae, macrophytes (aquatic plants), macroinvertebrates (aquatic insects) and fish at 13 sites within the catchment.

5.1 Overview of Ecological Health of Waterways

To assess the ecological health of each of the sites in the catchment, four macroinvertebrate indices were used as indicators. For example, the Quantitative Macroinvertebrate Community Index (QMCI) was used, which determines stream health based on the sensitivity of species present to pollution and their abundance. These four indices indicated that the majority of sites in the river had poor ecological health. In addition, 54% of sites were below their respective Land and Water Regional Plan (LWRP) QMCI guidelines.

5.2 Areas with High Ecological Value

Areas with the highest ecological value were those in Cashmere Stream and the mid-section of the Ōpāwaho / Heathcote River. The top five sites, when ranked by macroinvertebrate indices, were all located upstream of the confluence of Jacksons Creek with the river. A key driver of health was reliable and reasonable flow, which generally corresponded with lower water temperatures. Some sites within the catchment also supported communities of threatened fish, including Īnanga / Whitebait, Tuna / Longfin Eel, and Koukoupara / Bluegill Bully. Koura (freshwater crayfish) were also present at some sites.

5.3 Areas with Low Ecological Value

The five most degraded sites were located in Steamwharf Stream, the lower Ōpāwaho / Heathcote (at Aynsley Terrace and Catherine Street), the middle Ōpāwaho / Heathcote (at Barrington Street) and in the headwaters of the Ōpāwaho / Heathcote (at Canterbury Agricultural Park). These sites represented some of the highest water temperatures, lowest water velocities and deepest sediments in the catchment.

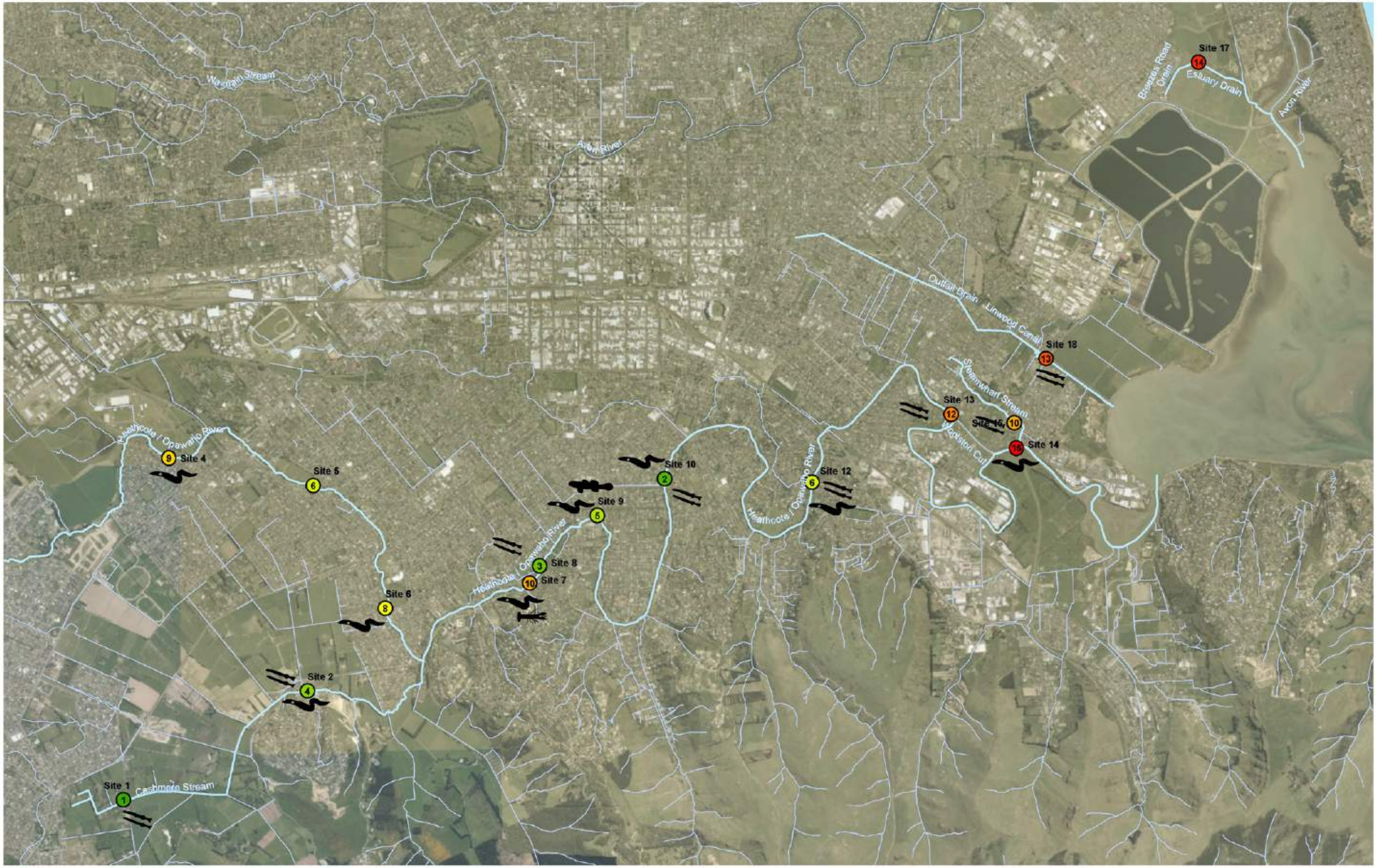
Ōpāwaho / Heathcote River downstream of Tennyson Street (ranked second best site)

Fish sampling with a Fyke Net (Care of Boffa Miskell)

Electirc fishing (Care of Boffa Miskell)

5.4 Management Recommendations

- There needs to be a multi-faceted approach (e.g. water quality and ecology) to the management of the catchment.
- Areas with high ecological value need to be maintained through appropriate management activities (e.g. stormwater treatment and maintenance of riparian margins).
- Stormwater management should continue to focus on reducing levels of contaminants (e.g. sediment, heavy metals and hydrocarbons).
- The removal of contaminated sediment within waterways should be undertaken.
- Deciduous trees in riparian margins should be replaced with evergreen species, to reduce excessive amount of leaf litter input into waterways, which affects water quality.
- Riparian and in-stream habitat should be enhanced, including the use of such things as emergent large substrates (which provide laying sites for the eggs of aquatic insects) and specialist habitat (e.g. riffles for bluegill bullies).
- Connectivity along streams should be improved by reducing the impact of in-stream structures, such as culverts and low bridges, and planting riparian margins.
- Lighting systems should be used that reduce the effects of light pollution on freshwater fauna.
- All areas of the catchment, regardless of their current ecological health, contribute to the health of the river and the estuary, and therefore should all be the focus of management/enhancement activities.



Legend

- 1 Best Condition
- Decreasing
- 15 Worst Condition

- Blue gill Bully
- Inanga
- Koura
- Long finned eel

0 — 1 km

1:35,000 @ A3

Data Sources:
Waterways data and aerial photograpgy sourced from
Projection: NZGD 2000 New Zealand Transverse Mercator

Boffa Miskell
www.boffamiskell.co.nz

HEATHCOTE AND ESTUARY SMP CATCHMENTS

Overall Ecological Health (from Boffa Miskell 2015)

Date: 29 June 2015 | Revision: 0

Plan Prepared for CCC by Boffa Miskell Limited

Project Manager: tanya.blakely@boffamiskell.co.nz | *Drawn:* BMc | *Checked:* TBl

6.0 Surface Water Quality / Kounga Waimāori

The Council monitors a range of water quality parameters at fourteen sites within the catchment on a monthly basis. The results from the 2015 annual monitoring report are summarised below.

6.1 Overview of Surface Water Quality

The Ōpāwaho / Heathcote River catchment recorded the poorest water quality of all the catchments monitored by the Council. In total, 24% of the 2,346 samples analysed during the 2015 monitoring year exceeded the guideline trigger value and all sites exceeded the trigger values for at least one parameter. Nitrate Nitrite Nitrogen had the highest rate of samples exceeding guidelines at 93%, with Haytons Stream the only site to meet the guideline recommendations. Other parameters often exceeding the guidelines included Dissolved Inorganic Nitrogen and Dissolved Reactive Phosphorus. The parameters that never exceeded their respective guideline values were dissolved lead, pH and ammonia.

Poor water quality negatively affects the ecology of waterways (plants, invertebrates and fish). Specifically, nutrients (i.e. nitrogen and phosphorus) are likely to encourage prolific growth of aquatic plants and algae, while other contaminants (e.g. copper, zinc, sediment, oxygen and ammonia) can cause negative effects on the physiology and behaviour of instream biota. High *E. coli* levels are also an indicator that contact with the water may cause a human health risk.

Parameter levels have generally remained constant since monitoring began in 2007, with water quality neither getting better or worse. However, the catchment recorded a reduction in phosphorus over time during the 2015 monitoring year. Curletts Road Stream Upstream of Ōpāwaho / Heathcote River site also recorded a 57% and 20% decrease in dissolved zinc and turbidity, respectively.

6.2 Areas of Good Water Quality

Cashmere Stream at Sutherlands Road has the best water quality within the river catchment, particularly for sediment/turbidity and phosphorus.

6.3 Areas of Poor Water Quality

The sites that recorded the worst water quality were those in Haytons Stream and Curletts Road Stream. These sites have particular issues with copper, zinc, sediment, dissolved oxygen, ammonia, nitrogen and phosphorus.

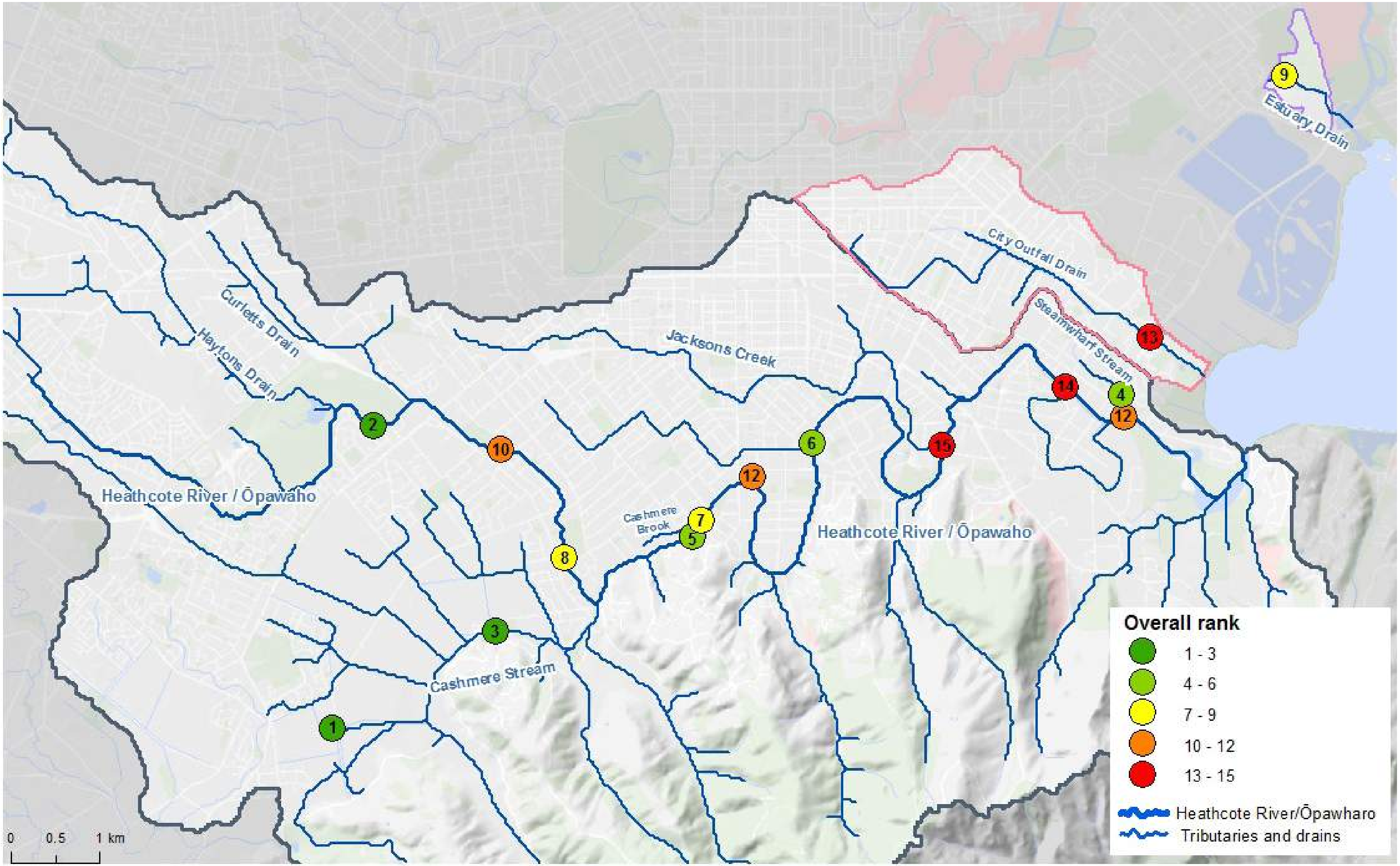
6.4 Management Recommendations

- The catchment, in particular Haytons and Curletts Road Streams, should be priority areas for reducing contaminants discharged in stormwater. This should be achieved through improvement in stormwater treatment facilities, pollution prevention programmes with landowners to reduce contaminants entering stormwater systems or waterways directly, and investigations into contaminant sources. These initiatives are already being carried out, involving a multi-agency approach (e.g. Council, ECan, Christchurch-West Melton Zone Committee and University of Canterbury), and these projects should continue to be collaboratively developed.

- Research should be undertaken into how contaminants predominantly not occurring from stormwater or other point source discharges can be reduced. For example, *E. coli* (as an indicator of pathogens) levels are heavily influenced by waterfowl, and nitrogen and phosphorus levels are impacted by springs within waterways that are contaminated from adjacent agricultural land use.

- Research should be conducted into the reasons for dry weather exceedances of such contaminants as sediment, phosphorous, copper and zinc.

Overall ranking of sites throughout the Ōpāwaho / Heathcote River catchment for water quality



7.0 Instream Sediment Quality / Kounga Parakiwai

A survey of the sediment quality within the waterways of the catchment was undertaken in 2015. Streambed sediment was sampled at 13 sites across the catchment and analysed for metals (cadmium, chromium, copper, lead, nickel and zinc), Polycyclic Aromatic Hydrocarbons (PAH), phosphorus, Total Organic Carbon (TOC) and grain size.

7.1 Overview of Instream Sediment Quality

One or more guideline values were exceeded at eight of the 13 sites sampled. The guideline levels were exceeded for lead at three sites, zinc at four sites and PAH at four sites, indicating that these are the major contaminants of concern. Copper, arsenic, cadmium, chromium and nickel concentrations in the sediment did not exceed the guideline levels at any of the sites. The sources of cadmium, copper, lead, and zinc are likely to be the same, with different sources for TOC, phosphorus, arsenic, chromium, nickel and PAH. Metal concentrations are within the range previously measured in urban stream sediments from elsewhere in Christchurch and around New Zealand.

Results from the 2015 survey compared to one carried out 30 years ago suggests that lead concentrations have decreased, but zinc concentrations have increased at some locations. For copper, cadmium, chromium and nickel there has been no clear increase or decrease in concentrations.

7.2 Areas with Good Sediment Quality

The lowest contaminant concentrations were found at the most upstream Ōpāwaho / Heathcote River site, at Tennyson Street and at sites within the tributaries - Cashmere Stream, Cashmere Brook and Steamwharf Stream. These sites did not exceed any guideline levels for any of the parameters.

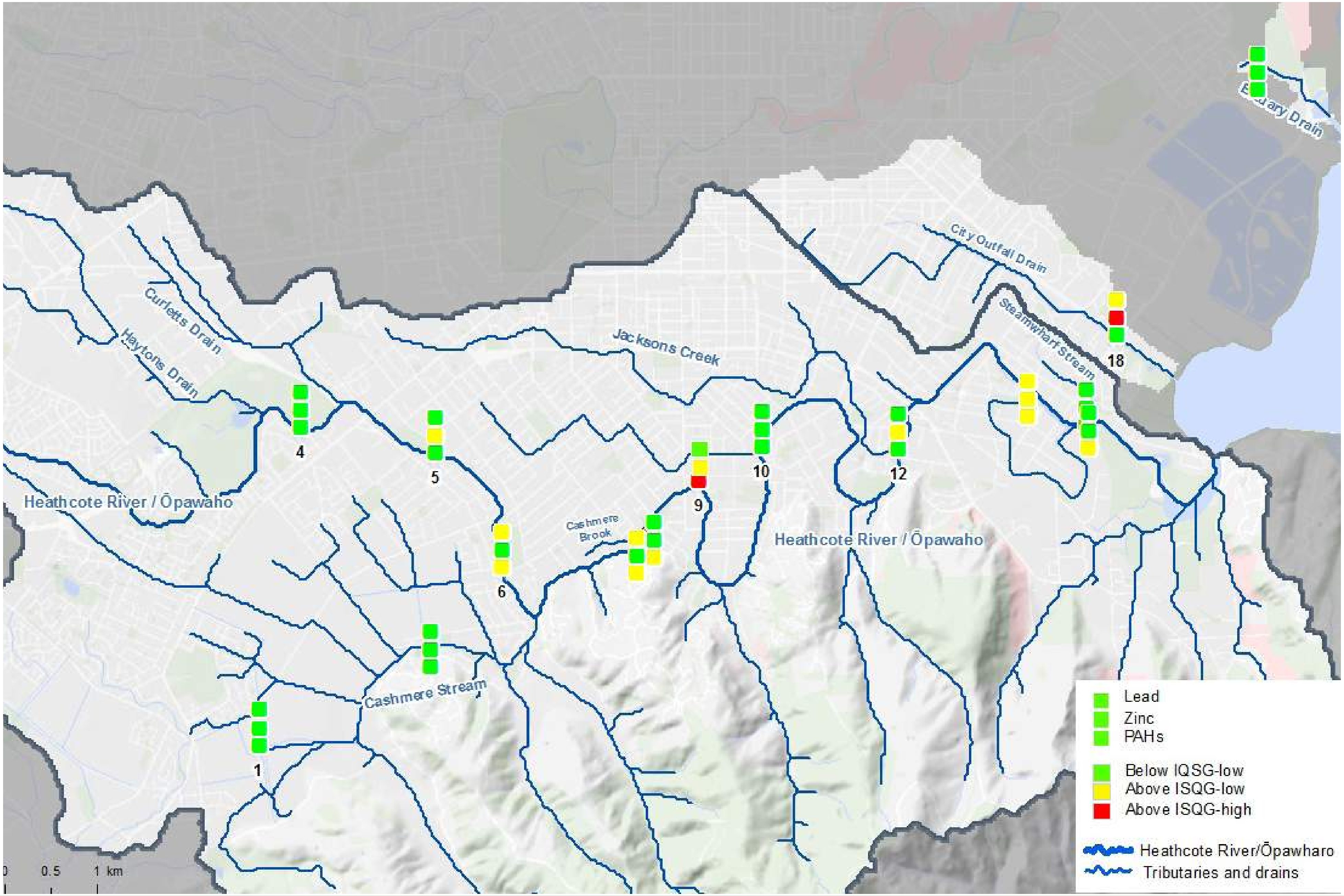
7.3 Areas with Poor Sediment Quality

The sites with the overall lowest sediment quality were three sites downstream of Aynsley Terrace, along with the site downstream of Colombo Street. The highest concentrations of metals were measured at sites close to Curletts Road Drain and in the lower reaches. High levels of PAH were recorded at the Ōpāwaho / Heathcote River site located downstream of Colombo Street. This exceedance was many times higher than the guideline level and is likely attributable to inputs from old road coal tar.

7.4 Management Recommendations

- Zinc is the primary contaminant of concern in instream sediment and source control should be undertaken to reduce inputs.
- Sites within the middle and lower catchments should be the focus of contaminant management. Although not included in the 2015 survey, Haytons Drain and Curletts Road Drain have previously been identified as having poor sediment quality, and should also be the focus of management.
- Contaminant levels can be reduced by decreasing inputs in discharges (e.g. PAH, zinc and copper in stormwater) and removing historically contaminated sediment (e.g. for all parameters, but particularly lead and areas impacted by coal tar).

Instream sediment quality results throughout the Ōpāwaho / Heathcote River catchment (comparisons against guideline values)



8.0 Flood Risk / Mōrea Waipuke

The Ōpāwaho / Heathcote River catchment collects drainage from the Port Hills along its entire length on the right hand side (as you look downstream) and flat land on its left side. All the other main catchments in Christchurch are draining flat land. The hills have quite different response to rainfall and seasonal effects than the flat land. When the hills are dry in the summer there is no significant base flow from the hills. The base flow continues on the flat land from the groundwater aquifers under the plains. The soil on the hills may require about 25 mm of rainfall to restore the soil moisture before runoff begins following a hot dry summer. Once the soil moisture has been restored then the runoff following a rainfall can be very rapid on the steep hill slopes.

Rapid runoff from the hills contributes to the flood risk and also generates sediment from the highly erosive loess soils which cover the hills. These soils are subject to sheet and tunnel gulley erosion. The sediment can accumulate in the river and drainage channels and further increases the flooding risk. The sediment in the flood water gives it a typical yellow-brown opaque colour unlike other areas of the city where floodwater can be partly transparent to the point that street markings can be seen in aerial photos through the Ōtākaro / Avon River catchment shallow flood waters.

New houses on the hills are now required to have rain tanks which moderate the flows into the steep hillside channels and thereby allow them to stabilise and avoid erosion.

The city maintains two telemetered recording rain gauges and a flow measuring flume in the Bowenvale Valley catchment so that the hydrology of the hills can be studied. There also four permanent telemetered recording water level gauges along the length of the main Ōpāwaho / Heathcote River channel and there are four additional telemetered recording rain gauges covering the flat part of the catchment. This instrumentation records and sends data every 15 minutes. Some of this data is presently displayed on the ECan website. More data will be accessible via the Council website in the future. This data is used to monitor rainfall and flooding events in real time, but it is also used to calibrate the flood models for flood mapping and setting minimum floor levels for houses and planning infrastructure in flood risk areas.

Developments in the catchment began historically in the lower Ōpāwaho / Heathcote River floodplain. This has had the effect of constraining options for providing an adequate floodway to the estuary for the major flood events. As development continues in the upper catchment the only realistic option for flood mitigation is to ensure that there is adequate flood detention to offset the flood effects of new developments and this is a key part of the Stormwater Management Plan for the catchment. Additional detention storage to retrofit existing developments is also being constructed. Fortunately, Hendersons Basin forms a large natural detention storage in the upper reaches of the catchment between Sparks Rd and Cashmere Rd near Westmoreland. This moderates the peak flows into Cashmere Stream and onwards into the Ōpāwaho / Heathcote River. The District Plan has identified Hendersons Basin as a "Flood Ponding Area" which limits development and preserves its natural flood detention storage. Additional flood detention storage is planned in the Cashmere / Worsleys valley which will mitigate the effects of development in this sub-catchment and also provide additional retrofit flood detention to compensate for earlier developments and the effects of the earthquakes.

The channel of the Lower Ōpāwaho / Heathcote River has a natural meander pattern in the floodplain and this means that flood water has a much longer, flatter and slower path to the sea than if the river was straight. The Woolston Cut is a floodway which bypasses a loop of the meander pattern. It was built in the 1980s in response to a number of flooding events in the 1970s. A programme of subsidised house raising was undertaken at the same time. Flooding of existing houses above floor level however continues in the lower Ōpāwaho / Heathcote River as happened in March 2014. Council initiatives to raise or purchase the most frequently flooded houses are again being considered.

The Christchurch District Plan has identified the areas across the city and in the Lower Ōpāwaho / Heathcote River, which could flood in a 1 in 200 year event with 1 m sea level rise as "Flood Management Areas". Any new developments must build their properties with floor levels 400 mm above the estimated flood levels. The issue of above-floor flooding will decrease as the housing stock is progressively replaced over time, however, flooding over the land will remain as will the flooding of existing buildings unless further initiatives are taken.

The 2010/2011 earthquake sequence caused settlement of the land in most of the catchment but some raising of the land in the lower floodplain. A new flood pumping scheme is under way in the Bells Creek catchment along Ferry Rd to address the earthquake increased flooding risk in that area. Further investigations are continuing as part of the Land Drainage Recovery Programme.

Other initiatives under investigation are dredging, stop-banking and bank stabilisation. Today, all of the flood management initiatives need to be seen in the context of sea level rise in the longer term. The Council presently assumes 1 m sea level rise in its planning for permanent infrastructure and the setting of minimum floor levels in buildings.

Flooding in the lower Ōpāwaho / Heathcote River March 2014 showing the typical flood water coloured by sediment from the Port Hills

Awatea Basin flood Detention facilities. This services the new Wigram Skies subdivision and retrofits parts of Hornby March 2014

9.0 Contaminanted sites / Wāhi parakino

Land can become contaminated through a variety of means including the repeated application of pesticides or herbicides, deliberate disposal of unwanted products by burial or accidental spillage of solids or liquids. Sites known to be contaminated or that may be contaminated because of past land use are listed in the Listed Land Use Register (LLUR) maintained by ECan. It records where hazardous activities and industrial land (HAIL) has been, or are thought to have been carried out. Hazardous activities and industries are listed in Schedule 3 of the Land and Water Regional Plan 2015. The LLUR is a means of applying National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations (NESCS), pursuant to Section 43 of the RMA 1991.

Development on sites listed in the LLUR is controlled through rules in both the District and Regional Plans. Proposed site activities and development are assessed by a Council Environmental Health Officer and appropriate controls are applied via land use consent conditions to protect public health.

Discharges of stormwater from contaminated land into land or to surface water are controlled by ECan through its Regional Plan and through any resource consent issued to a district council. The Council is permitted to accept low risk discharges into its stormwater network. However, no discharge may occur from any site or development area on the LLUR that is considered by Council to pose an unacceptably high risk of surface water or groundwater contamination, unless expressly authorised by both Councils. Discharges from such sites must be individually consented by ECan.

A procedure was developed for assessing the risk of residential sites listed on the LLUR and allowing inclusion of residential sites considered to be low risk. An example of a category of sites that can be processed by the Council is low risk residential earthquake rebuild sites, i.e. long term residential sites.

A Memorandum of Understanding (MoU) between Council and ECan dated July 2014 allows stormwater discharges from low risk residential rebuild sites listed on the LLUR and/or identified as having had HAIL activities to be processed by Council rather than ECan. It is anticipated that as confidence grows over time in the operation of the MoU, the list of "low risk" situations that Council can process will be extended. The list of low risk situations that can be processed by Council without input from ECan as at March 2015 is as follows:

- Sites not on the LLUR (unless a HAIL activity has been identified as having been undertaken on the site);
- Sites on the LLUR where only a portion of the site has had a hazardous activity and the construction will not disturb that part of the site;
- Sites categorised as "at or below background concentrations" or "below guideline values" for the proposed site use;
- Options more likely to be applied by the Council to control on-site and off-site contamination are to investigate contaminant levels, which may establish that the risk of contamination is low;
- Cap contaminated soil so that there is no contact between rain water and contaminants;
- Remove the contaminant or contaminated soil to a controlled landfill;
- Divert contaminated stormwater to the wastewater system, or;
- Options more likely to be applied by ECan, to control off-site contamination are to treat contaminated runoff prior to discharge.

9.1 Management of industrial sites

Stormwater Management Plans specify the Council's intentions for on-site industrial stormwater management. In time the quality of stormwater discharges into the Council's network from industrial sites will be required to be equivalent to the discharge from residential areas. Direct discharges from industrial sites to receiving waters are likely to be required to be of a higher standard. In both cases some form of on-site pre-treatment will almost always be required.

As part of a city-wide auditing process, potentially high risk industrial sites (i.e. sites with potential to discharge either particularly hazardous contaminants or typical urban contaminants at concentrations significantly higher than residential and commercial sites) will be identified via a desktop screening assessment. Council will work with landowners of any sites confirmed as high risk to ensure that the stormwater discharge can meet the required treatment standard. Where industrial site owners (or occupiers) cannot meet the required standards for discharge into the network, the site will be removed from Council's stormwater discharge consent and will require a separate resource consent from ECan for its discharge.

This approach to industrial site management will ensure that industrial stormwater discharges will improve in the medium term and begin to approach residential or commercial stormwater quality.

High risk industrial sites that bypass the Council's network and discharge stormwater directly to ground (excluding roof stormwater to ground) or directly to the rivers are not covered by the Council's stormwater discharge consent (although there is scope to accept some low risk industrial sites discharging to ground).

10.0 Contaminant Load Model / Wāhi Paitini

10.01 Introduction

Most urban activities cause some form of environmental effect either by emitting more or faster runoff or by emitting contaminants that are harmful in the environment. Most urban surfaces have some form of coating (e.g. paint or galvanising) and a transient layer of cleaning compounds, combustion products, windblown dust, etc. Most of these substances are slightly soluble in rainwater and are transported in dissolved and particulate form into the stormwater network. Upon entering a stream or river they have a toxic effect by altering habitats, depleting oxygen and reducing food supplies. The requirement on the Council to mitigate these effects is outlined in a number of sources including the Land and Water Regional Plan and discharge consents issued by ECan.

10.02 Contaminants

The Council and ECan monitor rivers, streams and stormwater for a range of water quality indicators. Contaminants of most concern are:

- Dust, grit, and particles of all types capable of being transported in stormwater, referred to as total suspended solids (TSS);
- Dissolved and particulate zinc and copper;
- Polynuclear aromatic hydrocarbons (PAHs);
- Bacteria;
- Nutrients.

Lesser contaminants, because they do not exceed guidelines, are:

- Hydrocarbons (oil and grease);
- Cadmium and lead.

10.03 Suspended Solids

Suspended solids are particles small enough to be carried in flowing water. They are damaging because they deposit on stream beds and fill the spaces between stones, hugely reducing the habitat options for instream life. Fine particles can release attached toxic compounds which harm the food chain.

Particles come from many sources including construction activity, erosion, land cultivation, combustion, industrial products, tyre and brake wear and paint coating breakdown. Even natural particles often carry adsorbed chemicals.

The greatest TSS sources in the catchment per unit area are considered to be construction sites, road works and unstable areas on the Port Hills. Most Port Hills sediment enters streams from slips and tunnel gullies in overland flow. Roads shed sediment into the stormwater network. Vehicular traffic is not a major sediment generator quantitatively, but generates a large proportion of the city's toxic copper and zinc.

10.04 Zinc

Zinc is used as a protective coating for steel on corrugated iron roofs, rooftop ventilators, lighting poles, various barriers and fences. Although a zinc layer is long lived it is slowly being dissolved by rain water. Industrial and commercial areas have large areas of unpainted galvanised roofs and are a large source of zinc. Residential areas typically have painted or tile roofs, but many of these have older paint coatings in poor condition. Because residential areas are so extensive these old roofs are a large source of zinc.

Zinc makes up about 1% by weight of tyres, in which zinc oxide is used as a vulcanising catalyst. Tyre wear releases zinc onto roads. Other zinc sources include fungicides, paint pigments and wood preservatives.

10.05 Copper

The majority of copper in urban stormwater comes from fine copper particles abraded from brake pads. These particles are so fine that about 50% are quickly dissolved by rainfall and become bioavailable, sometimes at toxic concentrations. Copper is used as a binding and anti-vibration element in brake pads, present from a few percent to 10% by weight.

Copper is also used in fungicides and moss killers, in luxury roof cladding, spouting and downpipes. Architectural copper could become a significant copper source if usage increases.

10.06 Polynuclear aromatic hydrocarbons

PAHs are created when products like coal, oil, gas, and garbage are burned incompletely, e.g. smokey combustion. PAHs are a concern because they are toxic and persistent. They may come from old streets that were originally surfaced with coal tar, although they have been resurfaced with bitumen, which does not contain PAHs. Nevertheless edge frittering and surface deterioration can release coal tar particles. There can be high PAH concentrations in nearby stream and river sediments.

10.07 Bacteria

Normal water quality monitoring measures the numbers of *E.coli* as an indicator for the presence of other, more harmful faecal pathogens. Bacteria are most concerning if they are from human sources, representing a risk of communicable diseases. *E.coli* counts are usually caused by ducks, occasionally by dogs, and sometimes by wastewater overflows during wet weather. *E.coli* counts are frequently above safe levels for contact recreation. Human sourced bacteria in water is offensive to Maori.

10.08 Nutrients

The nutrients nitrogen and phosphorus encourage the growth of exotic macrophytes (water plants). Emergent macrophytes are particularly problematic in that they can obstruct natural flow, raise water levels and form very high biomass. Excess plants inhibit fish diversity and can deplete oxygen when they decay. Nitrogen levels are higher than guidelines in the river catchment, but phosphorus seldom exceeds guidelines. Nitrogen distribution – higher in the south-west – indicates agricultural sources, or possibly old landfills, on the periphery of the city. This nitrogen enters waterways via groundwater from springs. Phosphorus can come from decaying leaves and sediment, with industry an important point source in the river catchment.

Tyre wear on the road surface is a source of contaminants

10.09 Contaminant Sources

Measurement (or, estimation) of contaminant loads is a first step to determining the best methods for controlling contaminants. Stormwater sampling in Christchurch and research elsewhere demonstrate that the most significant contaminant sources include:

- Unpainted zinc coated roofs, emitting 200 to 2500 ppb* of zinc;
- Busy roads generating 300 to 800 ppb of zinc (compared to the in-river water quality standard for zinc 30 – 50 ppb);
- Busy roads generating around 100 ppb copper;
- Copper roofs generating 80 to 100 ppb (in-river water quality standard for copper 8 – 15 ppb);
- Construction sites generating 100s to 1000s of ppm** of sediment (in-river water quality standard for sediment < 100 ppm).

10.10 Contaminant Models

The effectiveness of contaminant control measures is being assessed with the aid of contaminant models. Which model is used depends on the quality of input data. Models use a best estimate of contaminant runoff concentrations to predict suspended sediment, zinc and copper concentrations at monitoring points in the catchment. Modelling enables engineers to compare the effects of different mitigation options such as a source control (e.g. a different roof material type) versus treatment in a detention basin. This is a guide to selection of more effective and affordable mitigation options.

Modelling confirms water sampling results indicating that industrial roofs, commercial car parks and busy roads are large zinc sources, needing widespread mitigation efforts to meet water quality standards. It is clear that controlling zinc at source wherever possible is highly desirable. This also applies to copper and sediment.

Contaminants from industrial plant and processes such as leakage, spills and occasional deliberate discharges cannot be quantified and are not modelled. Port Hills sediment is not able to be quantified by any current model, though work on a suitable model is under way at the University of Canterbury.

ppb - Parts per billion* *ppm** - Parts per million*

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11.0 Stormwater Management Plan (SMP) Mahere Wai āwhā

A Stormwater Management Plan has been developed containing a list of actions and activities to allow the Council to become compliant with the water quality standards in the Land and Water Regional Plan and conditions in the Council's discharge consent. A range of methods are proposed in order to deal with a variety of contaminant types and sources (referred to in section 10). Because current best practice treatment methods are expensive and unable to fully remove contaminants from the stormwater stream.

In greenfields subdivision areas such as Awatea and Halswell there is a requirement for flood detention and it is common to build multi-purpose basins. These are effective at removing the relatively lower levels of contaminants from new development. Older areas and industrial areas typically discharge more contaminants, especially zinc, than new developments because they have more bare zinc roofs or a proportion of roofs with deteriorating paint. Flaking paint releases zinc from primer, and from the galvanising underneath.

The Plan targets the following activities for action:

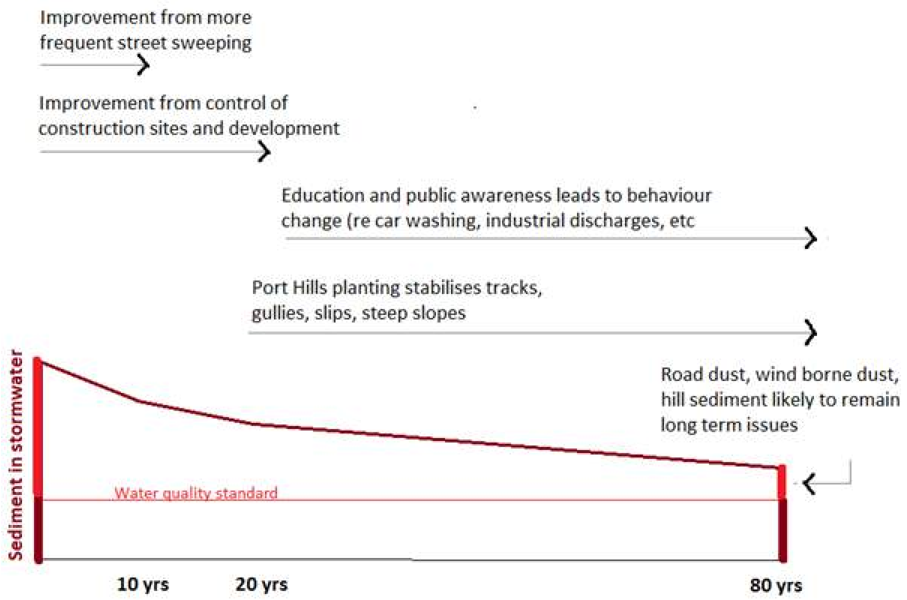
- Construction sites should control the way soil surfaces are exposed to the weather. Sites should not discharge or spill sediment onto roads or into the stormwater system, even when it is raining.
- Most urban roofs (> 90% estimated) will need to be replaced over time with materials that do not emit more zinc than new Colorsteel®. (Ultimately it may be necessary to consider a gradual change to non-steel roofs).
- Stormwater runoff from all arterial and collector roads, particularly intersections or areas of braking and acceleration, should be treated to a high standard to remove sediment and zinc.
- Brake pads containing more than a small percentage of copper must be prohibited through national legislation.
- Building claddings should no longer incorporate copper as an external cladding material. Copper is not used for spouting or downpipes.
- Industries capture contaminants on site. Site layout, stormwater capture methods and management procedures need to improve so that accidental or illegal discharges are rare.
- New developments discharge stormwater through swales, stormwater detention and treatment basins and wetlands which remove sediment and some metals.

Public education campaign about sources, effects and means of reducing or eliminating contaminants is introduced and continues over time. Behaviours that lead to poor water quality are understood and changed changes.

Because of the scale of changes required and the estimated cost of intervention measures the draft plan proposes a long term improvement programme. The term needs to allow for progressive regulatory and behaviour changes and to schedule capital improvements over an affordable time frame.

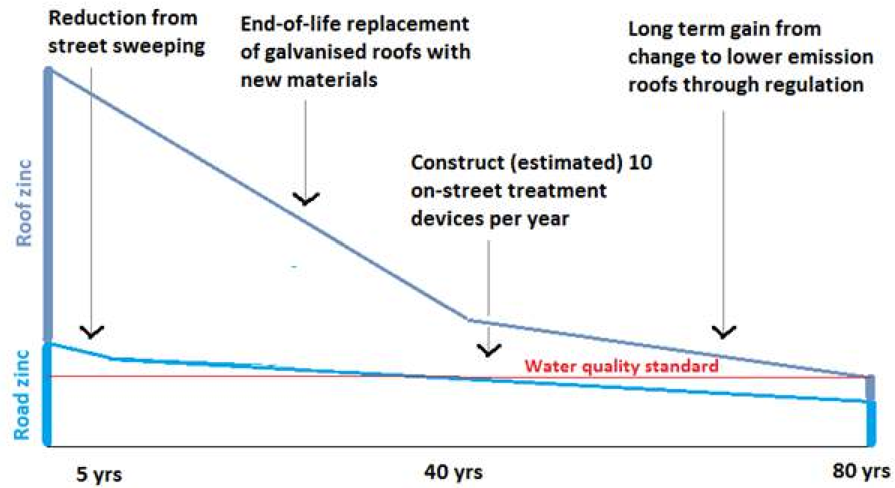
The following figures give a pictorial representation of anticipated progress on water quality improvement as the plan progresses.

Predicted sediment reductions



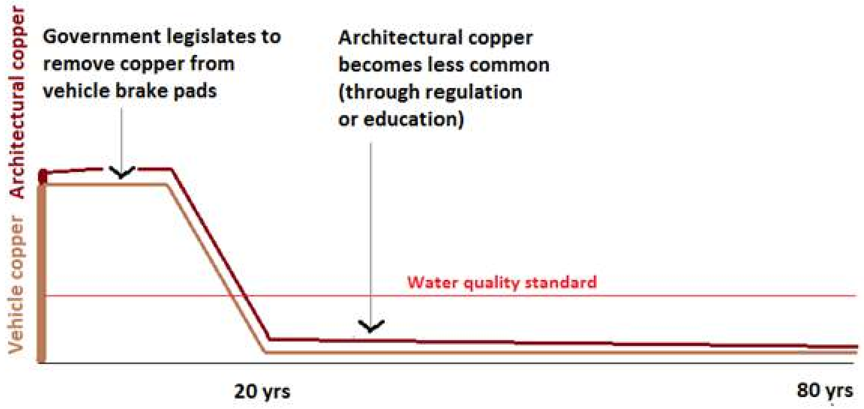
Sediment discharges into rivers can be significantly reduced but diffuse sources (e.g. road dust, dust on roofs) mean that streams and rivers will continue to be cloudy shortly after the start of rainfall.

Predicted zinc reductions



Council can meet the water quality standard for zinc if sufficient changes are implemented

Predicted copper reductions



Copper inputs to rivers can be stopped if copper is removed from brake pads.

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