PŪHARAKEKENUI / STYX RIVER CATCHMENT

TAUĀKĪ WAI PĀTAUA / VISION AND VALUES

Date: 27 April 2017

CHRISTCHURCH
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PŪHARAKEKENUI / STYX RIVER CATCHMENT

TAUĀKĪ WAI PĀTAUA / VISION AND VALUES

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Date: 27 April 2017

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

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The Pūharakekenui / Styx River Catchment covers an area of approximately 70 km^2, extending for 22 km from its headwaters in Harewood and Bishopdale through to Te Riu o Te Aika Kawa / Brooklands Lagoon in the east. The catchment has traditionally been a significant source of mahinga kai and a focus of natural, cultural and heritage values since earliest settlement over 600 years ago. Ongoing development and extensive settlement within the catchment over the last two centuries, combined with the more recent earthquakes of 2010/2011 have seen a degradation of catchment values including, reduced water quality due to pollution and siltation, 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 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 shown a proven ability 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 Pūharakekenui / Styx River Catchment.

Part One, Realising the Vision, outlines:

- Current state of the six values within the Pūharakekenui / Styx River Catchment relative to the Councils' six values approach to waterway asset management and the five key visions of the Styx Vision 2000-2040.
- Surface water management catchment, in line with the approaches. Eleven 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 are identified.

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.

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 river catchment relative to the Council's six values of waterway asset management: ecology, drainage, culture, heritage, landscape, and recreation, including the five key visions outlined in the Styx Vision 2000-2040.
- To communicate and facilitate community discussions on how the surface water management approaches available might be implemented within the river catchment to enhance the six values and realise the vision for the Pūharakekenui / Styx River Catchment.
- To highlight, from over 20 years of Council's 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 river catchment.

The Catchment

The Pūharakekenui / Styx River Catchment is located on the northern urban edge of Christchurch and is approximately 7000 ha in area. The principal waterways in the catchment are the Pūharakekenui / Styx River, Kāpūtahi / Kaputone Creek and Smacks Creek. The catchment also includes a number of man-made drains, natural springs and the Brooklands and Cranford Basin ponding areas.

The Pūharakekenui / Styx River is approximately 22 km in length and is a spring-fed river system which originates in the Harewood area in the north of Christchurch City. The river meanders in a north-easterly direction through reserve, pasture, horticultural areas and residential developments on its way to the sea via Te Riu o Te Aika Kawa / Brooklands Lagoon and the Waimakariri River.

The catchment is partially urbanised (34%) with a mixture of residential, industrial, amenity, conservation and transport land uses. Urban areas are largely located in the south-west of the catchment, including the suburbs of Harewood, Northwood, Redwood, Northcote and Casebrook. The majority of land (62%) in the catchment is used for farming; predominantly pasture but also forestry and agroforestry. Some rural areas, particularly surrounding Belfast and around Hills and Prestons Roads, are under development as an extension to current urban areas.

Sub-Catchments

Within the Pūharakekenui / Styx River Catchment there are 23 sub-catchments identified within the ten geographic areas from the headwaters near Christchurch International Airport to the mouth of the Pūharakekenui / Styx at Brooklands Lagoon. Each geographic area has been identified as having similarities with respect to land use, soil type, infiltration potential and groundwater depth.

Background Investigations & Technical Reports

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

- Vision 2000-2040 The Styx, Waterways, Wetlands and Surface Water.
- The Styx River/ Pūharakekenui SMP Blueprint for Surface Water Management (2012).
- Technical investigations underpinning the Pūharakekenui / Styx SMP.
- Waterways and Wetlands Natural Asset Management Strategy (1999).
- Christchurch City Council Surface Water Strategy 2009-2039.
- Waterways, Wetlands and Drainage Guide (2003).
- Infrastructure Design Standards (Part 5)(2013).
- Christchurch City Council Public Open Space Strategy 2010-2040.
- Christchurch City Council Biodiversity Strategy 2008-2035.
- Christchurch-West Melton Zone Implementation Programme (ZIP) for the Canterbury Water Management Strategy (March 2013).
- Ōtautahi/Christchurch City Landscape Study (Draft, March 2015).
- Mahaanui Iwi Management Plan (2013).

Given that 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.

Pūharakekenui / Styx River Catchment : Waterways

Legend

1. Pūharakekenui / Styx River
2. Smacks Creek
3. Kāpūtahi / Kaputone Creek
4. Wilsons Drain
5. Dudley Creek Diversion
6. Papanui Creek
7. Cranford Basin
8. Winter Road Detention Basin
9. Bullers Drain
10. Rhodes Drain
11. Kruses Drain
12. Horners Drain
13. Gibsons Drain
14. Spencerville Drain
15. Browns Drain
16. Sheppards Drain
17. Kainga Drain
18. Gardiners Drain
19. Cavendish Road Stream
20. Te Riu o Te Aika Kawa / Brooklands Lagoon

Zone Areas

A. Styx Headwaters
B. Sawyers
C. Horners/Kruses
D. Styx East (Marshlands)
E. Waitākiri / Bottle Lake
F. Styx West
G. Brooklands/Spencerville
H. Styx Central
I. Dudley Diversion
J. Belfast

Styx Mill Reserve, Pūharakekenui / Styx River

Horners Branch Drain, Procter Street Reserve

Smacks Creek

Sheldon Park, Kaputone Creek

Cranford Basin

Radcliffe Road Drain

Brooklands Lagoon/Estuary

Cavendish Road Stream

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

- Overall the Pūharakekenui / Styx River catchment is a spring-fed, lowland catchment of high ecological value relative to other waterways in urban Christchurch.
- However, the catchment is highly modified in some parts due to large areas of urbanisation.
- Kāpūtahi / Kaputone Creek, one of the principal tributaries of the Pūharakekenui / Styx River, is also one of the most polluted waterways in Christchurch.
- There are still remnants of native vegetation that retain core wetland habitats but overall the botanical values of aquatic and riparian vegetation are of low value. However, they act as an ecological corridor for upstream and downstream migration of birds, invertebrates and plants.
- The remnants of native vegetation in the catchment comprise not only core wetland habitat, but also special, naturally rare wetland habitats in the form of tiny remnant fens at Styx Mill and the Groynes. These are the last representatives of the pre-human dominant vegetation types.
- The catchment is home to many species of freshwater native fish that include both Short and Long Finned Eel / Tuna, Mohoao / Black Flounder, Īnanga / Whitebait, Kanakana / Lamprey, along with introduced Brown Trout. Kēkewai / Freshwater Crayfish are also present at some sites.
- The existence of pollution sensitive insects within the catchment, such as mayflies and caddisflies, indicates that water quality and habitat quality are good in places.
- Riparian habitat and ephemeral ponding areas along the lengths of the waterways provide important habitat and key resources for a wide range of native wetland bird species including threatened species such as Pārera / Grey Duck, Matuku / Australasian Bittern, Koau / Black Cormorant, Poaka / Pied Stilt, Turiwhatu / Banded Dotterel, and Kōtuku / White-Faced Heron.

Issues

- A lack of dense native riparian vegetation, which buffers the waterways from urban and rural land use, and improves ecological habitat for aquatic species; including tall species that provide shading to the stream channel.
- Contaminants from stormwater, waterfowl faeces, and runoff from agricultural areas.
- Siltation from earthquakes and construction activities, and bank and channel erosion/slumping from earthquakes.
- 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.
- On-going loss of mature native and exotic tree stock due to earthquake generated changes to soils, water levels and drainage.
- Poor appreciation of the ecological values of the Pūharakekenui / Styx River by adjoining property owners/managers and the general public, and a poor understanding of potential impacts on ecological values of management activities.
- Barriers to fish and invertebrate migration such as floodgates, culverts and other in-stream obstructions.
- Problem pest species such as grey willow invading wetlands and riparian margins, which restrict water flow.

Desired outcomes

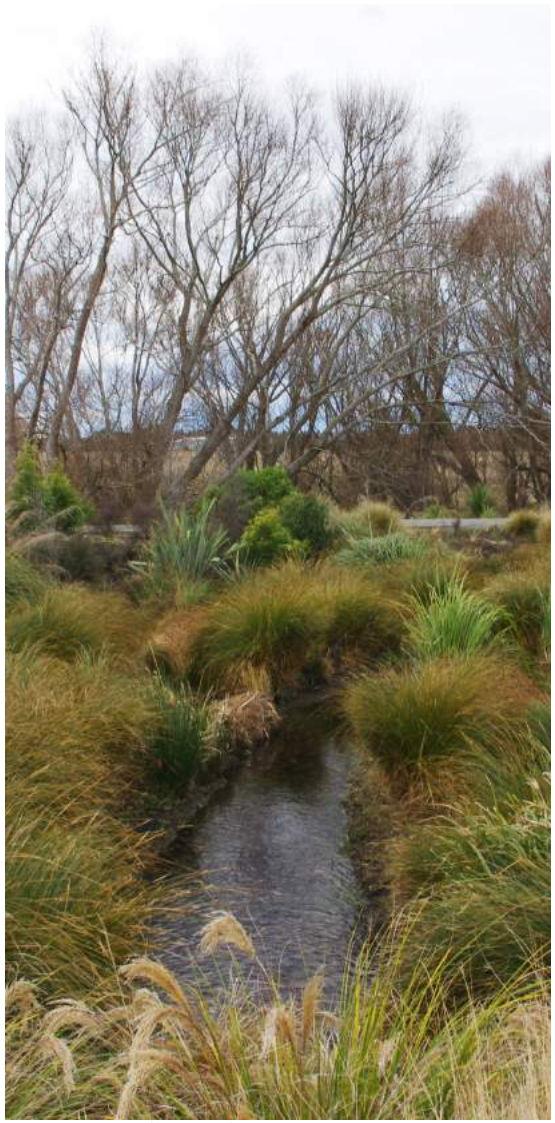
- Improved water quality through treatment of discharges (e.g. stormwater) prior to entering the waterways.
- Increased use of evergreen tree species along river margins to increase shading and reduce concentrated leaf fall in autumn.
- Conservation of the remaining areas of native vegetation, and riparian plantings.

- Maintenance and enhancement of habitats and ecological linkages along bird migration routes using riparian planting.
- Identification and management of existing areas of high ecological value.
- Restoration of areas with currently low ecological values or poor water quality through intensive management of water quality, and riparian and in-stream habitat enhancement, including pest plant control.
- The removal of contaminated sediment within waterways, to improve them as habitats for aquatic macrophytes, fish and invertebrates.
- The use of lighting systems that reduce the effects of light pollution on freshwater fauna.
- In-stream habitat enhancement where appropriate, including the use of boulders to provide laying sites for aquatic insects and specialist habitat, such as riffles for fish.
- Developing riparian and neighbouring land into suitable habitat to re-establish the locally extinct mātātā/South Island fernbird.
- Erosion protection measures, implemented in areas where bank stability is an issue, primarily in the form of riparian planting and soft-engineering options to reduce in-stream sedimentation issues.
- Protection of springs by maintaining a generous setback for all building, excavation and filling activities and identifying, highlighting and monitoring spring flow, and ensuring spring flow from underlying aquifers is maintained or improved.
- Improved predator control.
- Increased number and diversity of native aquatic macrophytes, invertebrate and fish species within the catchment.
- The catchment becomes an important refuge for sensitive aquatic macroinvertebrates in Christchurch.
- Ensure native plant communities are resilient to the impacts of historic fragmentation/isolation and future climate change.

Sharnbrook Reserve, Regents Park

Kōtuku / White Heron

Carabid Beetle



Pūharakekenui / Styx River Esplanade Reserve

1.2 Drainage

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

Existing conditions and values

The geology of the catchment is characterised by deposits of free-draining highly permeable gravels associated with the Waimakariri River in the west, interspersed with lower permeability overbank silt and sand deposits that thicken in an eastwards direction towards the coast. Productive gravel aquifers exist that change from unconfined to confined towards the coast.

- Soils that clothe the catchment range from alluvial gravels and sands, to silts. Moving east from the airport to the coast, soils become finer-grained from sandy gravels to sandy loams and silt loams. Soils near the coast have been formed from estuarine deposits, and peaty soils exist in the Marshland area. East towards the coast, soils represented within the catchment change gradually from sandy Selwyn, Waimakariri and Kaiapoi soils to silty Taitapu soils. Soil infiltration and permeability decreases as the soils become more fine-grained from west to east.
- The water table is generally shallow across the entire catchment, as evidenced by the number of surface waterways which are spring-fed. The groundwater quality is generally good due to the rapid through-flow of seepage water from the Waimakariri River, discharging into the spring-fed Pūharakekenui / Styx River, Kāpūtahi / Kaputone Creek and the Ōtukaikino River.
- The Pūharakekenui / Styx River is, along with the Ōtākaro /Avon and Ōpāwaho/ Heathcote, one of the three main spring-fed rivers in Christchurch. Principal tributaries of the Pūharakekenui / Styx River including Smacks Creek and Kāpūtahi / Kaputone Creek are also spring-fed. The location and discharge rates of the springs vary throughout the year in response to groundwater level fluctuations.
- The catchment drains from near the airport in the west, to join the Waimakairiri River at Brooklands in the east. The Pūharakekenui / Styx River is relatively steep and straight from its headwaters to east of Marshland Road.
- From Spencerville the River flows north behind coastal sand dunes to its confluence with the Waimakariri River at Brooklands. Kāpūtahi / Kaputone Creek meanders north of the river in the middle of the Pūharakekenui / Styx River catchment on a much flatter gradient.
- Wetlands have significantly reduced in number and size compared to pre-settlement. Major remnant wetland areas include: Ōtukaikino, the Styx Mill Conservation Reserve, Te Riu o Te Aika Kawa / Brooklands Lagoon, Smacks Creek and numerous ephemeral ponding areas.

Issues

- Large areas of the catchment are identified for future urbanization.
- New and existing residential developments create large areas of impervious surface, which reduces the amount of water seeping into the ground.
- Reduction in base flows, particularly in the upper reaches of Pūharakekenui / Styx River and Kāputahi / Kaputone Creek.
- Urbanization continues to create a number of water quality issues through direct discharge into catchment waterways.
- Consented discharges, storm water discharges, site developments, agriculture runoff and contaminated landfill all continue to influence and lower water quality.

Desired outcomes

- Protection, maintenance and restoration of natural drainage patterns through an improved understanding of natural surface and subsurface drainage patterns and processing supported by ongoing research and monitoring.
- Future development mitigates stormwater quality and quantity, and works with natural drainage patterns.
- Recognising natural variations due to storm events and seasonal changes, and allowing sufficient space for these to occur through building setbacks, zoning and land protection.
- Minimising threats to groundwater, surface waterways and springs from

development, including avoiding filling and construction within floodplains and ponding areas, through education, working with landowners, regulation and enforcement.

- Maximise ground soakage through minimizing hard surfaces.
- Maximise rain interception by tree canopies through encouraging extensive tree-cover in storm water facilities, public reserves, riparian areas, road reserves and private property throughout the catchment.
- Monitoring of water abstraction and its impacts on waterways and wetlands.
- Recognising and planning for the long term effects of climate change and sea level rise.
- Protection and enhancement of water quality by developing strategies to deal with non-point source pollution.
- Protection of base flows and the management of stormwater through the protection of floodplains and natural ponding areas.
- Protection of floodplains and ecological values within the catchment, while managing drainage needs.
- Restoration of the natural flow regime through detention, water quality management and ecological restoration work.
- Flood risk reduced or, at least returned to pre-earthquake levels.
- Reduced sedimentation in tributaries and rivers.
- Minimised waste water overflows and direct flow of stormwater into tributaries and rivers.
- Slow release of stormwater into receiving waters.
- Protection and enhancement of springs and wetlands.
- Construction of underground structures or services which minimise disruption of spring flows.
- Minimise the impact of waterway management practices on water levels and the health and viability of riparian habitat.
- Protection and enhancement of mahinga kai.

Lower Pūharakekenui / Styx Road, Prestons Subdivision

Pūharakekenui /Styx River Esplanade Reserve

Cavendish Road Stream, Styx Mill reserve, boxed drain before restoration

Cavendish Road Stream, Cavendish Road stream, after restoration

Radcliffe Road drain

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 Pūharakekenui / Styx River is a significant waterway and important source of mahinga kai for Ngāi Tūāhuriri. Foods gathered from the river include tuna (eel), kanakana (lampreys), Kēkewai (freshwater crayfish), as well as other native fish, plants and waterfowl. Mahinga kai practices within the catchment still continue today.
- Te Riu o Te Aika Kawa / Brooklands Lagoon is a significant area within the catchment being an important mahinga kai where a variety of shellfish, fish and plants can be gathered.
- In 1868 the Crown granted the Pūharakekenui Māori Reserve (MR 892) located between Pūharakekenui / Styx River and Te Riu o Te Aika Kawa / Brooklands Lagoon.
- Te Hapū o Kāti Urihia Ahuwhenua Trust represents the owners of the Māori reserve and work with council through the Brooklands Lagoon / Te Riu o Te Aika Kawa Area Parks Master Plan.
- The Mahaanui Iwi Management Plan also provides guidance on the management of the river and its catchment and outlines the importance of working with Te Ngāi Tūāhuriri Rūnanga and Mahaanui Kurataiao Ltd to achieve cultural outcomes.

Issues

- Lack of consistent attention to the protection, restoration and enhancement of the natural assets, and recognition of natural and cultural values within that.
- Lack of consistent progress on identification and revitalisation of mahinga kai and natural spring and wetland sites throughout the catchment.
- Continuation of direct stormwater and drainage inputs into the river and its tributaries without pre-treatment through swales or wetlands.
- 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.

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 Pūharakekenui / Styx River to Ngāi Tūāhuriri / 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 emphasizes 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.

Crofton Road, 'Sticks' sculpture

Janet Stewart Reserve, Lower Pūharakekenui /Styx Road

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

- Waitaha were the first people to settle the South Island. They were followed by Ngāti Mamoe, and Ngāi Tahu, who migrated from the East Coast of Te Ika a Maui/The North Island. Ngāi Tūāhuriri are manawhenua of the Pūharakekenui / Styx Catchment.
- The extensive wetlands and easy access to the sea made the Pūharakekenui / Styx catchment an important area for mahinga kai, the cultivation of crops and the harvesting of flax. Upstream wetlands were important for embalming practices and some of the higher terraces were used for food cultivation. Various families were given responsibility for the management and harvesting of the different plant and animal species.
- The river has historically been used to drive waterwheels as an important source of power to sawmills, flaxmills and flourmills. Land adjacent to the river was developed for a range of uses including orchards, agriculture, horticulture, industry, particularly in Belfast and recreational activities focussed around the river mouth at Brooklands Lagoon. Large parts of the area have retained their rural character and features.

Issues

- Lack of protection or recognition of Wāhi Tapu (burial) sites and other sites of significance to Ngāi Tūāhuriri.
- The alteration or disappearance of the traditional network of Ngāi Tūāhuriri / Ngāi Tahu settlements and mahinga kai sites associated with landscape features such as wetlands and river channels.
- Limited public awareness of early Māori and European heritage values within the landscape, with the lack of on-site and written interpretative materials.
- How to balance natural and multiple heritage values when they are in conflict with each other.
- 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 related fabric.
- Barriers and disincentives to enable use, adaptive re-use and continued use of built heritage adjacent to waterways.

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.
- Recognition, protection and/or enhancement of the traditional network of Ngāi Tūāhuriri / Ngāi Tahu settlement and mahinga kai sites.
- Improved identification, documentation and readily accessible interpretation of heritage values, including through the use of historic names and artworks.
- The use of built heritage is further encouraged and adaptive use is enabled.
- Improved representation of heritage patterns and elements as part of local distinctiveness, especially with respect to referencing the range of layers that have influenced our city, the character and treatment of the river and its tributaries as a key natural feature of the city's landscape.
- Provision for settings that provide heritage context and help with interpretation including the provision of physical access to foster engagement with history and deepen the communities' connection with, and understanding of, heritage values.
- Recognition of the importance of heritage and ensuring there is a wider understanding that the conservation of places takes time, commitment and resources.
- Raised awareness to encourage the community and land developers to appreciate the importance of the past through securing the long-term protection of heritage places and incorporating heritage elements into new urban developments (e.g. retention of rural landscape elements such as shelterbelts and ensure that landscaping is compatible with

heritage values). Retention of structures, fencing and landscaping associated with the rural history of the area is important as it is developed. This has been demonstrated by the Council owned property in Radcliffe Road and the retention of sample areas of box drains elsewhere.

Water wheel, Smacks Creek, up-stream from Gardiners Road

Spring, source of the Kaputone Creek, Northwood

Pūharakekenui / Styx River Esplanade Reserve

1.5 Landscape

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

Existing conditions & values

- While the remnant river terraces, sand dunes and floodplains reflect the natural processes associated with the earlier movements of the Waimakariri River and coastline in this location, the natural landscape has been extensively modified as a result of farming practices and more recently urbanisation.
- Regarded by the community as an important natural asset within the northern part of Christchurch City. Protecting these values will be critical during a period of rapid landuse change.
- Though much of the river and its tributaries flow through private property, there are many publicly owned areas such as Styx Mill, Janet Stewart Reserve and the saltmarsh landscape at the mouth of the Pūharakekenui / Styx River at Brooklands Lagoon that provide insights into the natural landscapes of pre-settlement.
- Changes to the Council's waterway asset management strategy over the last 20 years has improved accessibility to, and visibility, legibility and community understanding of waterways, wetlands and natural landscape processes.

Issues

- Loss of natural character and rural amenity as a result of landuse change and urbanisation.
- Limited views of, and access to, the river and its associated waterways and wetlands.
- Limited protection of natural landforms and regenerating native planting.
- Smaller waterways perceived and managed as utility drains.
- Lack of protection of and/or opportunities to enhance 'natural character' and the 'wilderness' experience.
- Lack of sensitive Integration of stormwater infrastructure into natural landscapes.

Desired outcomes

- Improved public accessibility and visibility along the major waterways within the catchment through establishing the 'source-to-sea' reserve network.
- Protection of land, including securing adequate riparian reserve widths that contain representative landforms that reflect the natural diversity of the catchment.
- Ensure that constructed stormwater facilities are designed in such a manner that they contribute to the natural character of the river and its tributaries. This will be achieved by ensuring adequate buffers between the river system and the built facilities, establishing naturalistic landforms and appropriate planting.
- A high level of natural character and rural amenity shall be preserved throughout the catchment through adequate separation and/or screening of land uses and activities that impact adversely on these values.
- Promoting major bridge crossings of the river (e.g. the Marshland Road Bridge) as gateways into the city through river-based interpretation, art and symbolism, improved views of the river, the creation of green corridors and the highlighting of other natural features associated with the river and catchment at each crossing point.
- Continuation of the use of innovative interpretative and integrated art elements and materials such as a series of markers along the river to be based on the word 'Styx' and the theme of 'sticks'.
- Continue to encourage people to express their relationship with the river and wider catchment through consultation, participation and partnership.
- Provision of the improved opportunities to experience the full range of landscape types based on the river's natural and cultural values.

- Strengthened support for the Council's Public Open Space Strategy 2010-2040, which recognises the importance of the Pūharakekenui / Styx River as a green corridor, and identifies important sites in both urban and rural areas where protection is necessary.

Lower Pūharakekenui / Styx, Brooklands wetlands

Englefield Park, Northwood

Pūharakekenui /Styx River rail bridge

1.6 Recreation

Includes sport (formal, organised, competitive activities) and recreation (informal, unstructured leisure activities) on and beside the river and the facilities 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

Public access along the river and its tributaries is limited and fragmented, but has increased in recent years through public land acquisitions.
There is unformed legal road along some stretches of river that is not yet developed for public use.

- There are several well developed parks along the waterways that offer access to the water and a variety of recreational opportunities.
- Existing recreational facilities include tracks and paths, boardwalks, seats and picnic tables, artwork, jetties, boat ramps, signage, toilets, green assets (trees, gardens, grass), playgrounds and car parks.
- The river provides the ideal setting for three of the most popular recreation activities: walking, cycling and jogging.
- The river is particularly suited to canoeing and kayaking and is sometimes used for races and other paddling events.
- Further access and development and provision of recreation facilities, such as jetties, walkways, seating and picnic areas would also open up other recreational opportunities based around the unique river setting.

Issues

- Natural character and rural amenity compromised by landuse changes and urbanisation.
- Pūharakekenui / Styx Reserve network not well publicised and/or appreciated.
- Limited access along river margins.
- Degraded waterways and wetlands detracting from the enjoyment of the recreational experience.
- A need to actively manage for both recreation and wildlife values.
- The need for recreational activities to respect sites of high cultural significance.
- Increase in traffic volumes on main arterial routes creating barriers for easy pedestrian access along the river.

Desired outcomes

- Provide a range of outdoor resource-based recreation experiences based on the unique river setting through the development of walkway routes, boating facilities, cycleways, and contact recreation opportunities.
- Provide opportunities to enjoy, learn about, appreciate nature and cultural values.
- Identify and protect suitable routes along the river, Kāpūtahi / Kaputone Creek and other tributary waterways (to be done in the spirit of partnership through negotiation with current landowners).
- Provide improved road crossing facilities so that roads do not become barriers to pedestrians.
- Monitor and remedy the impact of people and recreational activities on ecological values through preventing or limiting access to core habitat or sensitive areas.
- Group compatible recreation activities together. Separate conflicting interests into different zones.
- Recreation planning to incorporate other values.
- Encourage community involvement in planting and other restoration activities and on-going management of sites as a recreation activity.
- The development of a variety of service nodes that will concentrate recreational activity and provide facilities for parking, relaxation, picnicking, and education/interpretation.

Styx Mill Conservation Reserve

Northwood Park - Englefield Park, Northwood

Nunweek Park

2.0 SURFACE WATER MANAGEMENT APPROACHES
Ngā Mātāpono

Partnerships - Protection & Purchase - Suburban centres - Street renewals
Linkages, Networks & Corridors - Residential Red Zone - 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

Pūharakekenui / Styx River, including its wider catchment and tributaries, has been of significant importance to manawhenua for over 600 years prior to European settlement and was a major source of mahinga kai.

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

Pūharakekenui / Styx River is one of a number of iconic natural landscape symbols of our city and retains high ecological, drainage, cultural, heritage, landscape and recreational 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 river and its catchment is not for the benefit of the current generation alone, but must reflect a longer term, multi-value and multi-generational approach.

Vision 2000-2040 - The Styx

In 1999 an extensive round of consultation, research and community participation commenced that would highlight the concerns and opportunities presented by the river and its catchment. In addition to being a catalyst for the formation of key interest groups such as the 'Styx Living Laboratory Trust' and 'The Guardians of the Styx', as an outcome of this work the Council produced a 40 year vision document that highlighted five core visions for the river and its catchment. These five vision statements are still relevant fifteen years later and strongly support the current vision that catchment management decisions are "for us and our children after us".

Vision One:

To achieve a "Viable Springfed River Ecosystem" to complement the other representative protected ecosystems of Christchurch such as the Port Hills, Travis Wetlands and the Coastline.

Vision Two:

To create a "Source to Sea Experience" the development of an urban reserve network.

Vision Three:

To develop a "Living Laboratory" that focuses on both learning and research as practised by Dr Leonard Cockayne (1885 - 1934).

Vision Four:

To establish "The Styx" as a place to be through maintaining and enhancing the special character and identity of the area.

Vision Five:

To foster "Partnerships" through raising the quality of relationships as we move forward together.

In the early 1990's the Council was one of the first local authorities in New Zealand to adopt a multi-value approach to the management of the city's land drainage system - at the time a revolutionary replacement of 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. 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.

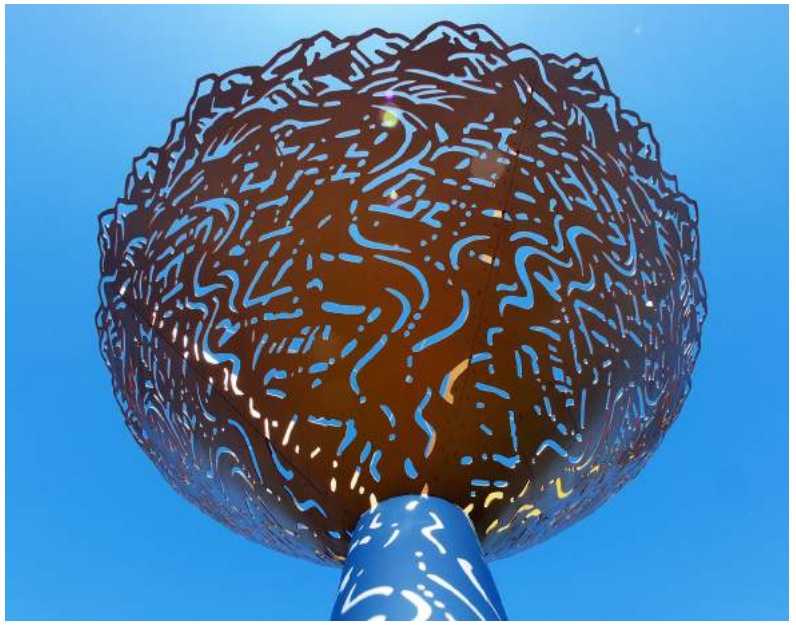
By identifying six core values – ecology, drainage, culture, heritage, landscape and recreation – as the key drivers for surface water management, the Council has been able to translate legislative requirements and a broad philosophy of sustainability into both, a natural asset management strategy, and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

This early identification of the six values approach to natural asset and surface water management formed a critical component of the 2000 version of The Styx River Vision 2000-2040 (Styx Living Laboratory Trust) that has now been carried through to this current version.

Over the last 20 years the Council has developed a range of approaches and design solutions that have been used to promote the six values of waterways and surface water 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.

To help realise the long term vision for the river and its catchment the following approaches show case successful city-wide project exemplars implemented by the Council, their strategic partners, developers and key interest and community groups. These appraches provide an insight into the range of solutions available to help the Council to work towards improving surface water quality, surface water flows, aquatic ecosystems and waterways for contact recreation, water sports and cultural values, and maximise the six values attributes within the catchment.

Art Bridge, Englefield Park, Northwood



Landscape Bowl Sculpture, Foodstuffs, Main North Road

2.2 Partnerships

Partnerships provide opportunities for the Council to work with manawhenua, government departments and agencies, statutory parties, private developers, and communities of interest to implement cohesive and integrated approaches reflective of the six values approach to sustainable land-use and surface water management. Exemplar 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 Pūharakekenui, ensuring core principles and objectives of Ngāi Tūāhuriri for the 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: Te Whāriki (Lincoln); Prestons (Burwood); and Wigram Skies.

Environment Canterbury (ECan)

- Joint Council/ECan Planning and Consents Protocol for Surface Water Management (2009) - Legislative 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 from the community, Ngāi Tahu, Council, ECan, 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.
- Fosters educational approaches to drive behaviour change/proactive pollution prevention/community buy-in buy-in to improving quality of stormwater discharges and receiving waterways and;
- Works with community stream care groups.

Styx Living Laboratory Trust

- The Styx Living Laboratory Trust (a charitable trust) was set up in 2002 to focus on learning and research in the Pūharakekenui / Styx area with a core objective being to achieve Vision 3 of the Vision 2000-2040 - The Styx through, obtaining an holistic understanding of the dynamics of the rivers' ecology, drainage, culture, heritage, landscape and recreation values.
- Through establishing long term partnerships with Council, Community Boards, ECan, Ngāi Tahu, NIWA, research institutes, universities, schools, other trusts, foundations and private individuals, the Trust has been able to assist with, restoration projects throughout the catchment, environmental awareness events, community volunteer based environmental monitoring, support for Royal Society and Summer Scholars, promotion of the scientific value of the catchment through the Trusts website (www.thestyx.org.nz), and advocacy for environmental values associated with the catchment during resource consent and plan change processes.

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 practise on any roading projects.
- Opportunities for further enhancement and mitigation work as expressions of the six values within, or adjacent to, the catchment include the Christchurch Northern Arterial and QE II Drive Four Laning project due for construction in the next five years.

Local community groups helping at Styx Mill Conservation Reserve

Local community groups helping establish the Māori medicinal plant site (Rongoa)

Local community groups helping at Styx Mill Conservation Reserve

Local community groups helping establish the Māori medicinal plant site (Rongoa)

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.

Council's primary mechanisms for the protection of riparian margins are the City Plan waterway setback requirements, a pro-active strategic land purchase policy and the acquisition of riparian land at the time of private subdivision. The City Plan, prescribes a range of waterway setback requirements (from 5 m to 30 m dependent on one of the five waterway classifications. For example a 5 m setback for an 'Open Utility Waterway' and up to a 30 m setback for a Downstream River' such as the Pūharakekenui / Styx 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 that supports a broad range of values but most specifically culture 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. Council will require the subdivision developer to tidy up the banks of waterways within any subdivision and establish riparian planting along the banks to provide shade and shelter to the waterway.

Pūharakekenui / Styx River Esplanade Reserve

Early planting 2009, Pūharakekenui / Styx River Esplanade Reserve

Pūharakekenui / Styx River Esplanade Reserve

Upper Styx residential stream renewal - Crofton Road

Upper Styx residential stream renewal - Crofton Road

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.

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 catchments' waterways:

The following suburban centres within the Pūharakekenui / Styx catchment provide a range of examples and opportunities for surface water treatment devices to help improve the quality of water before it enters the catchment's waterways;

- Northwood Shopping Centre;
- Northlands Mall;
- Styx Mill Country Club;
- Bishopdale Shopping Centre;
- Nunweek Park.

An example that can be found in the Otakaro / Avon River catchment is Hills Road Shopping Centre and surrounding neighbourhood, which Dudley Creek passes through. This project incorporated commercial, residential and community centre/education land; Council purchase of private property; the removal of box drains, boundary fences and large areas of hard surface adjacent to the Creek; major recontouring of the banks to increase waterway capacity; improved accessibility to the water's edge, improved connectivity along the Creek; and significant native planting.

Cavendish Road Stream, Cavendish Road

Northlands Mall, Kruses drain

Rain garden/vegetative swale, Tait Comunications Business Park, Harewood

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 Pūharakekenui / Styx River and its tributaries, improve the quality of the water entering the system and provide additional six value opportunities through enhanced ecological, cultural, landscape and recreation values, and enriched interpretation and/or protection of heritage elements.

Street renewal projects that have incorporated an enhanced six values approach and can be used as exemplars in future street renewal projects include, the Papanui cluster (Proctor Street, Mary Street, Grants Road, Gambia Street, Wyndham Street, Horner Street and Loftus Street)/Papanui Stream. This is a Council streets renewal project in Papanui that was integrated with the naturalisation of Papanui Stream. The wider project is an exemplar of rain gardens, swales, narrowing of carriageways and the removal of a timber-lined utility drain reconstructed as an open, natural-sided, meandering stream with diverse aquatic habitat values.

Additional street renewals found within the catchment include:

- Sisson Drive (between Northlands Mall and Papanui School);
- Riverwood Boulevard, Redwood;
- Northwood Boulevard, Northwood;
- Cavendish Road.

Swale, Redwood Springs subdivision

Horners Branch Drain, Papanui cluster

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 ecological corridors. Examples of stormwater management projects that have recognised the opportunity for linkages, corridors and networks, and provided strengthened ecological, cultural, heritage, landscape and recreational values include:

- Regents Park Reserve is part of the wider Pūharakekenui / Styx Reserve network that extends into the residential neighbourhood of Casebrook. A comprehensive network of swales, small wetland basins, a forested first flush pond and spring-fed waterways were enhanced with native planting, shared walkways and sport, recreation and conservation areas.
- Papanui Stream flows through a wider Papanui street renewal project (see Street Renewals) where Council, through property acquisition, waterway naturalisation and a co-ordinated design approach with a retirement village development, were able to provide significant pedestrian/cycle linkages along the waterway and between newly narrowed streets and the neighbouring retirement village.
- Future linkage, network and corridor opportunities identified as being able to incorporate the six values approach as part of the post-earthquake recovery program include: the Residential Red Zone of Brooklands and the city-wide Council cycleways program.
- The Vision 2000-2040 - The Styx, aims to create a "Source to Sea Experience" through the development of an Urban National Reserve where, through identification, protection and enhancement mechanisms, suitably accessible routes along the river, Kāpūtahi / Kaputone Creek and other tributary waterways are created. A completed 'Source to Sea Experience' will require a spirit of partnership between Council and private property owners to ensure a continuous link. Improved crossings for pedestrians and cyclists will be required to ensure roads do not become barriers to connectivity

Other examples of linkages, networks, waterway associated parks and corridors found within the catchment include:

- Styx Mill Conservation Reserve;
- Upper Pūharakekenui / Styx River / Crofton Road;
- Regents Park;
- Northwood-Waterford Reserve;
- Pūharakekenui / Styx River Esplanade Reserve;
- Lower Styx Conservation Reserve;
- Nunweek Park / Benmore Garden Reserve;
- Papanui Stream;
- Thompson Farm / Sunley Orchard.

Art Bridge, Englefield Park, Northwood

Sharnbrook Reserve, Regents Park

Tait Communications, Nunweek Park

2.7 Residential Red Zone

Within the Pūharakekenui / Styx River catchment the Residential Red Zone (RRZ) is limited to the area of Brooklands between the river and Brooklands Lagoon north of Earlham Street and along both sides of the Lower Styx Road. Brooklands suffered substantial damage to land and buildings in the 2010 and 2011 earthquakes. The suburb of Brooklands will be almost entirely abandoned over the next several years.

The final outcome for the RRZ has yet to be determined by Regenerate Christchurch, the Council, Ngāi Tūāhuriri, Te Rūnanga o Ngāi Tahu and a number of other Government agencies. Key interest groups such as NZ Landscape Trust, Royal Forest and Bird Protection Society of NZ, and Christchurch Civic Trust, have expressed strong interest in, and a variety of views on, how the RRZ should be managed. These views cover a range of opportunities highlighting the enormous potential for design, implementation and management responses including:

- A strong commitment to enhanced aquatic and terrestrial ecological values with opportunities to strengthen cycle and pedestrian links to other ecologically-rich and mahinga kai areas along the river and around Brooklands Lagoon.
- Diversifying and enlarging an already rich range of aquatic and terrestrial recreation pursuits.
- Interpreting, protecting and enhancing sites and activities of historical and natural significance.
- Recognising and enriching the cultural values within the Red Zone with specific reference to Ngāi Tūāhuriri / Ngāi Tahu values and objectives, including the broader community values established post-European settlement.
- Ensuring drainage opportunities, associated with groundwater, surface water, natural flow regimes and the management of these and storm events, are maximised to the benefit of both upstream and local communities, and integrated with the other five values.

Lower Styx Road, Brooklands Redzone

2.8 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 subdivision outcomes with strong representation across all six values. Some examples of the successful integration of subdivision requirements and high six values that can be showcased for future developments within the catchment include:

- Regents Park, Redwood was previously a Greenfield development featuring a timber-lined drain. As part of the development the waterway was relocated and been made into a feature within the development. This was the first partnership between a developer and the Council where the waterway development reflected the six values. It has resulted in supporting a diverse range of wildlife including the largest native bully species in New Zealand. Good drainage design has meant that few flooding issues have arisen, well landscaped waterways have resulted in neighbouring sections becoming the most desirable and fastest selling properties. Recreation waterways also form part of an open-space and walkway network in the area.
- Proposed subdivisions and other developments including Highfield and the International Golf Academy are anticipated to provide an important addition to the length of public reserve along the Pūharakekenui / Styx River, with Council working closely with such developers to ensure that the visions and goals of the Styx Vision 2000 – 2040 are realised. Where esplanade reserves alone are of insufficient width to provide adequate buffering of waterways from the impacts of development, Council works with the developer to effectively extend the width of the buffer into the private development.

Other subdivision developments incorporating a six values approach to surface water treatments include:

- Northwood;
- Prestons, Burwood (currently under development);
- Highfield Park (currently in planning);
- Redwood springs.

As part of the Styx Vision Two: To create a "Source to Sea Experience" the development of an urban reserve network, the subdivision process offers the opportunity for the Council to naturalise waterways that were previously timber lined boxed drains and to obtain esplanade reserves alongside streams and rivers. Although the width of land obtained alongside waterways or esplanade reserves may be restricted by land form (topography), existing buildings or structures, the Council does require vehicle maintenance access alongside the waterways. The maintenance access can double as informal pedestrian and cycle routes, connecting the urban reserve network and continuing the source to sea experience.

The Council may through the subdivision process, have the opportunity to purchase land for reserves adjoining the esplanade or waterways, where funding permits. The additional reserve land can be used to provide a wider reserve for pedestrian and cycle access, additional ecological planting and/or buffer planting.

Where reserve land is being obtained through the subdivision process, the Council can negotiate with the developer, if funding permits, for the reserve to be planted in accordance with an accepted landscape plan.

Northwood Subdivison, naturalised pond

Redwood Springs Subdivison, swale

Regents Park, wet pond

Alpine View Village, Prestons road

Smacks Creek, natural stream

Prestons subdivision, Lower Styx Road, created wetland

2.9 Wetlands

Over the last 20 years Council has secured the long term protection of a number of wetlands within the Pūharakekenui / Styx 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.

Existing wetlands providing enhanced six values include:

- The Styx Mill Conservation Reserve is approximately 57 ha, extending along the river for nearly 1.6 km. The reserve forms part of the natural river corridor and provides a locally rare low fertility fen wetland, wildlife ponds and native forest restoration areas. Other organisations with various types of responsibilities include the Department of Conservation, Ngāi Tahu, Ngāi Tūāhuriri, and ECan, further reinforcing the importance of partnerships in managing positive six values outcomes.
- Cranford Street Basin.
- Ōtukaikino Reserve – a 13 ha freshwater wetland reserve that is one of the few remaining original wetlands that were once common around Christchurch. Ōtukaikino is significant for its cultural values to Ngāi Tūāhuriri being designated a Wāhi Tapu site associated with burials.

Opportunities for new, enlarged or linked wetlands that could have strong six values outcomes include:

- Brooklands Residential Red Zone;
- Marshlands;
- Cranford Street Basin;
- Cavendish Road wetland;
- Horners / Kruses Basin;
- Thompsons Farm-spring protection, ephemeral ponding areas;
- Existing areas of open space with strong recreation values that may be able to incorporate new wetland systems include Bottle Lake Forest and;
- Te Riu o Te Aika Kawa / Brooklands Lagoon - a large tidal waterbody of 270 ha, with wetlands and salt marsh areas, is located to the south of the Waimakariri River mouth. The lagoon is an outstanding natural feature and is an important link in a chain of wetlands along the central Canterbury coast. While it originally formed the outlet of the Waimakariri to the sea, following extensive flood protection works it now forms an estuary where the waters of the Waimakariri and the Pūharakekenui / Styx River converge. The remaining connection of Brooklands Lagoon to the sea at the Waimakariri River mouth means that it still retains a tidal influence and important habitat values associated with its extensive mudflats. The mudflats and reed beds form the feeding grounds for a diverse range of over 74 bird species. The lagoon is a quiet and wild environment with a quite specific and diverse range of plant, bird and fish life, some of which have very high mahinga kai value to tangata whenua. The wider area includes a Māori Reserve (MR892) attesting to the cultural significance of the lagoon and its valuable natural resources. Te Hapū o Kāti Urihia Ahuwhenua Trust represents the owners of the Māori reserve and work with Council through the Brooklands Lagoon / Te Riu o Te Aika Kawa Area Parks Master Plan.

Sheppards Stream

Sharnbrook Reserve, Regents Park

Cavendish Road wetland

Prestons subdivision, Lower Styx Road, created wetland

Styx Mill Conservation Reserve

Pūharakekenui / Styx River Esplanade Reserve

2.10 Waterway Restoration

Over the last 20 years the Council has developed a range of enhancement and management 'tools', or design solutions, 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 throughout the catchment that strongly reflect the six values and can be used as exemplars for new projects in the future include:

- Kruses Drain - 303 Radcliffe Road and the Kāpūtahi / Kaputone Creek Confluence Conservation Reserve. Since 2010 the Council at this site has worked with the local community, corporate organisations, ECan, local iwi and rongoa practitioners to establish approximately 7.5 ha of native forest. Included within this site dominated by kahikatea, totara and matai trees is almost 1 km of realigned and naturalised Radcliffe Road Drain, an approximately 400 m length of naturalised Kāpūtahi / Kaputone Creek, more than 700 m of native planting along the true left bank of the Pūharakekenui / Styx River, and almost 1 ha of naturalised lakes and ponds. This site also includes a large area dedicated to growing and harvesting local Rongoa Māori plants (native plants used for traditional medicines and healing).
- Lower Kāpūtahi / Kaputone Creek - In addition to the Kāpūtahi / Kaputone Confluence Conservation Reserve downstream from Guthries Road more than 1.5 km of Kāpūtahi / Kaputone Creek has been restored, and ongoing work is programmed for future years. These areas include restoration work along significant lengths of the stream on both private land and the public reserve network that aims to protect significant waipuna/freshwater springs and includes more than 2 ha of recently planted native forest.
- Styx Mill Conservation Reserve - More than 2 km of waterway restoration and/or enhancement work has been completed on the Pūharakekenui / Styx River where it passes through the Styx Mill Conservation Reserve and includes more than 8 ha of planted native forest. This is complemented by enrichment planting into gorse and broom in a private esplanade strip upstream of the Reserve to link with established plantings along the river at the Council's Harewood Nursery on Gardiners Road. This project has resulted in more than 3.3 km of continuous waterway restoration being completed.
- Lower Pūharakekenui / Styx River Conservation Reserve - Downstream from Marshland Road, significant waterway restoration and associated forest and wetland plantings have been undertaken. Within this area is the iconic Janet Stewart Reserve which includes well established forest plantings, large areas of open water and a well-used pa harakeke (flax garden). Downstream from Janet Stewart Reserve, riparian planting extends for more than 1.2 km along the true right bank of the river, while along the opposite bank several large areas of native forest plantings covering more than 3.5 ha have been established.

St Bedes College, Redwood

BEFORE - 2003, Removal of timber boxed stream of Radcliffe Road Drain

AFTER - 2014, Naturalisation of Radcliffe Road Drain

Styx timber boxed stream (to remain as demonstration of what was there before restoration works)

Cavendish Drain after restoration

2.11 Suburban Greenspace

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

Catchment-wide suburban greenspace projects that exemplify an enhanced six values approach to suburban greenspace development and management includes the Styx Mill Conservation Park that is approximately 57 ha, extending along the river for nearly 1.6 km. The reserve forms part of the natural river corridor associated with the river and provides a diversity of wetland reserves that balance a range of significant ecological, cultural, heritage, landscape and recreational values. Future opportunities within this area will continue to be realised as increased urbanisation puts pressure on the retention and enhancement of diverse and multi-value open space.

Opportunities for further six value approaches to the development or protection of suburban green space within the Pūharakekenui / Styx River catchment identified by Council but not yet fully realised include:

- Styx Mill Conservation Park;
- Pūharakekenui / Styx River Esplanade;
- Englefield Park / Northwood Park;
- Waterford Reserve;
- Regents Park;
- Barnes Reserve;
- Papanui Stream Esplanade;
- Murchison Park;
- Cranford Basin;
- Shenley Reserve / Sheldon Park;
- Springwater Road Reserve;
- Willowbank Wildlife Reserve;
- Nunweek Park / Taits Communications Business Park;
- Saint James Park.

Northwood Park, Northwood

Regents Park, Native stream-side planting

Styx Mill Conservation Reserve

Englefield Park, Neighbourhood Park

Pūharakekenui / Styx Reserve Esplanade Reserve BEFORE - 2005, Early native revegetation planting

Pūharakekenui / Styx Reserve Esplanade Reserve AFTER - 2015, Native revegetation planting

2.12 Pūharakekenui / Styx River Catchment : Exemplar Sites

Tait Communications, Harewood

(40) Nunweek Park, Harewood

(29) Cavendish Stream, Redwood

(41) Benmore Gardens, Harewood

(3) Styx Mill Reserve, Pūharakekenui / Styx River

(20) Englefield Park, Northwood

(24)Waterford Reserve, Northwood

Papanui Drain, Paparoa Street

(27) Brooklands Lagoon/Estuary

(34) Regents Park Reserve

(19) Pūharakekenui / Styx Esplanade Reserve

(32) Lower Styx River Reserve

Partnerships

1. Sheldon Park
2. Styx River Esplanade
3. Styx Mill Reserve
4. CHCH Northern Motorway

Protection & Purchase

5. Styx Milll Reserve
6. Cavendish Road Drain/Stream
7. Styx River Esplanade

Suburban centres

8. Northlands Mall
9. Northwood Supercentre
10. Cavendish Road Business Centre

Schools

11. Paparoa School
12. St Bedes College
13. Papanui High School
14. Papanui Primary

Street renewals

15. Proctor/Grants Road
16. Sisson Drive

Linkages, Networks & Corridors

17. Styx Mill Reserve
18. Styx River Esplande
19. Papanui Stream Esplande
20. Englefield/Northwood Park
21. Regents Park
22. Barnes Reserve

Residential red zone

23. Brooklands

Subdivisions

24. Northwood
25. Regents Park
26. Redwood Springs

Wetlands

25. Styx Mill Reserve
26. Styx River Esplanade
27. Brooklands Lagon
28. Cranford Street Basin?

Waterway restoration

29. Cavendish Drain/Stream
30. Styx River Esplanade
31. Regents Park
32. Lower Styx River Reserve

Suburban greenspace

32. Northwood/Englefeild Park
33. Papanui Stream Esplanade
34. Regents Park
35. Styx River Esplanade
36. Styx Mill Reserve
37. Sheldon Park
38. Barnes Reserve
39. Lower Styx River Reserve
40. Nunweek Park
41. Benmore Gardens

2.13 Pūharakekenui / Styx River Catchment overlying the 1856 Black Maps

Styx Mill Reserve, Pūharakekenui / Styx River

Mill Stream Spring, Northwood

Broooklands Lagoon, mouth of Pūharakekenui / Styx River

Smacks Creek

Lower Pūharakekenui / Styx River Brooklands Lagoon

Start of Catchment, Nunweek Park

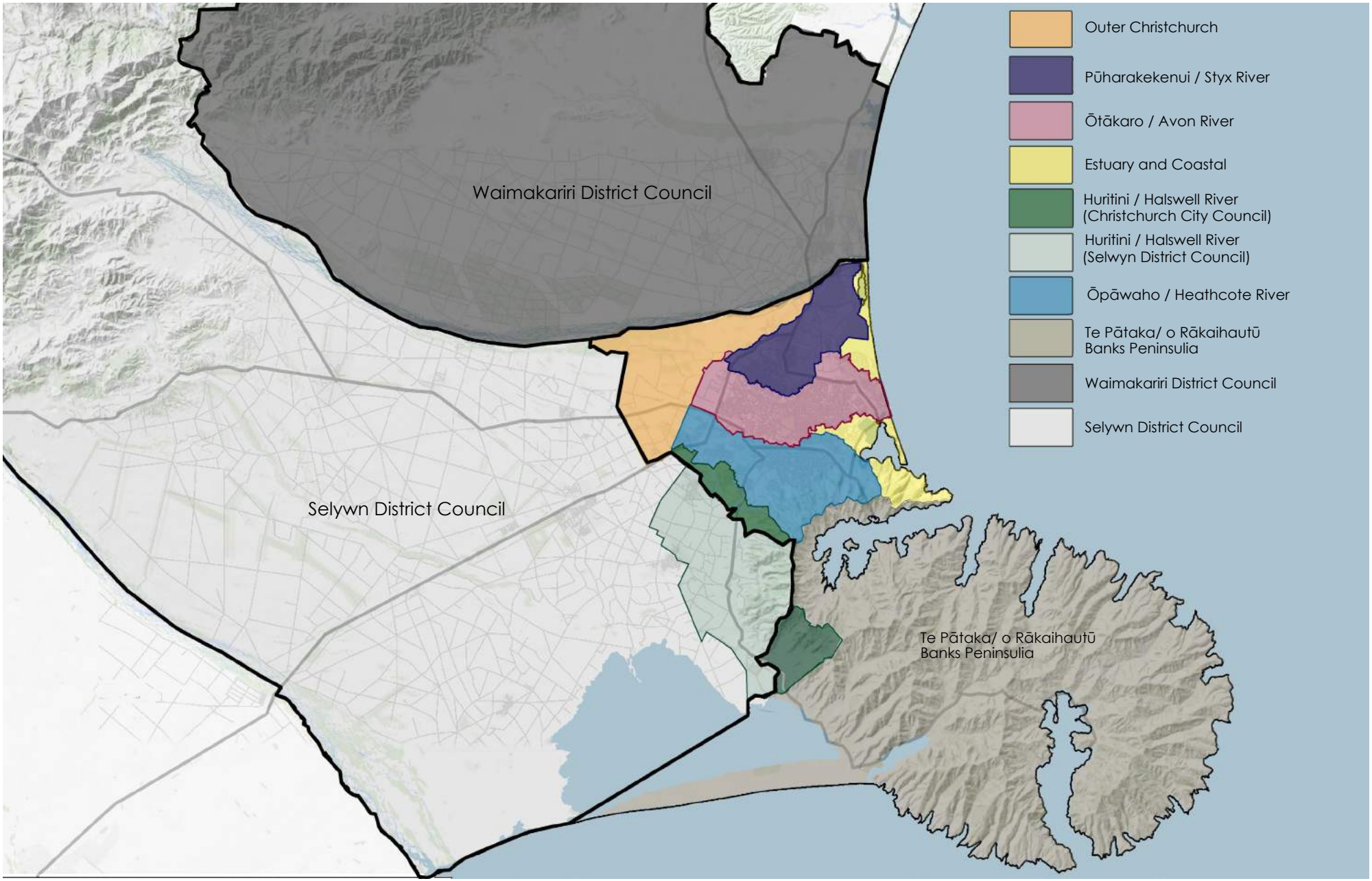
Lower Pūharakekenui / Styx River

Cranford Street Basin

Lower Pūharakekenui / Styx River

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.

2.14 Context Plan: Catchment Boundaries within Christchurch



Part 2.0 SUMMARY OF TECHNICAL REPORTS TO INFORM STORMWATER MANAGEMENT

Pūrongo Hangarau

3.0 Physical Context / Te Horopaki

3.1 Overview of Catchments

The Pūharakekenui / Styx River catchment is located on the northern urban edge of Christchurch and is approximately 7,000 ha in area. The principal waterways in the catchment are the Pūharakekenui / Styx River, Kāpūtahi / Kaputone Creek and Smacks Creek. The catchment also includes a number of man-made drains, natural springs and Brooklands and Cranford Basin ponding areas. The river is a spring-fed system which originates in the Harewood area in the north of Christchurch City. The river meanders in a north-easterly direction through reserve, pasture, horticultural areas and residential developments on its way to the sea via Brooklands Lagoon and the Waimakariri River.

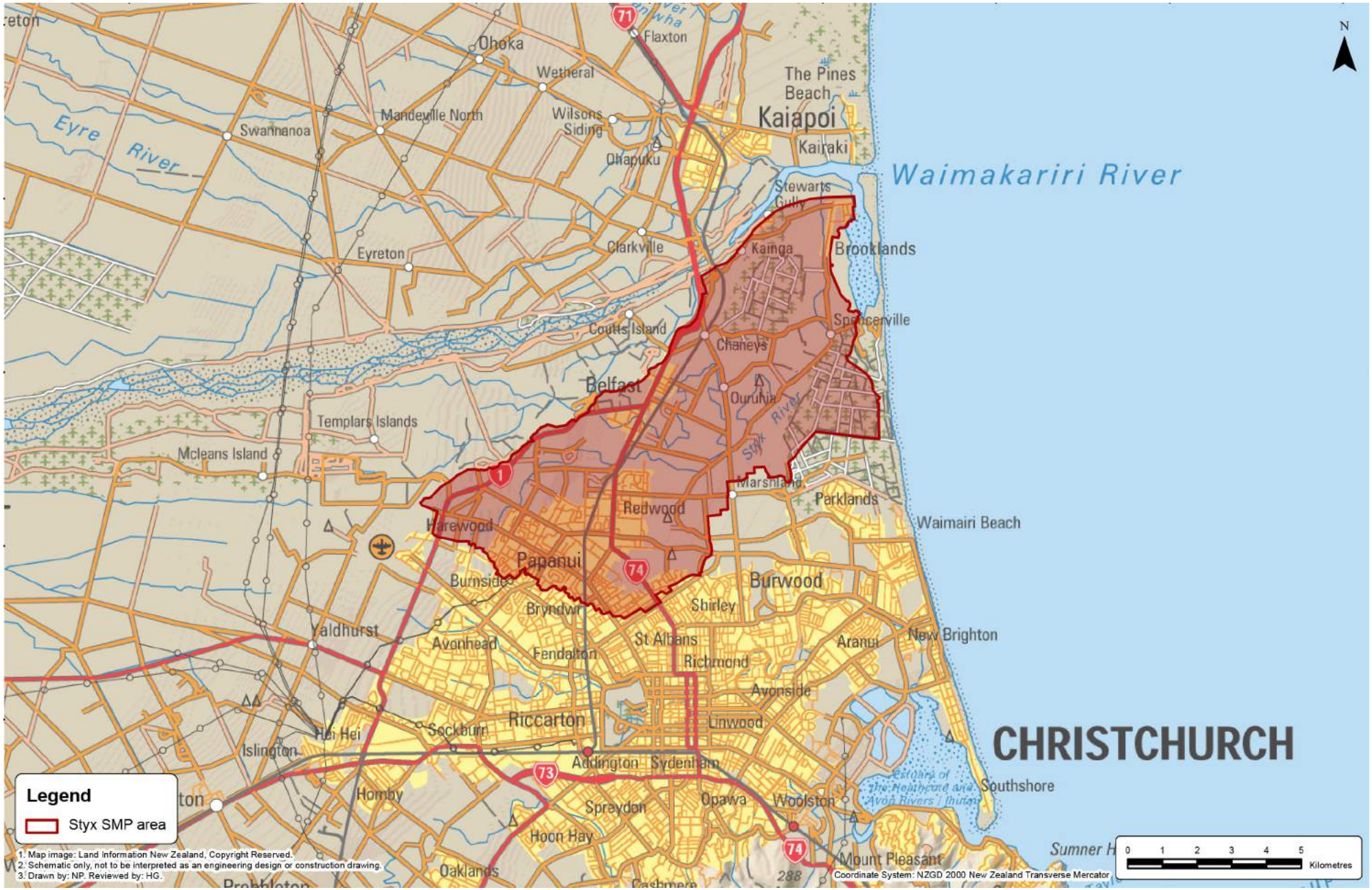
The catchment also includes the Wilsons Drain. Wilsons Drain catchment is a relatively small area (390 ha) situated to the north of the upper reaches of Kāpūtahi / Kaputone Creek. Wilsons Drain is a partially piped system that flows from the north of Belfast, under State Highway 1 before entering Otukaikino Creek. There are also some northern areas of Belfast which will discharge water into Otukaikino Creek. Cranford Basin to the south of Queen Elizabeth II Drive is capable of draining to the Ōtākaro/Avon River or the Pūharakekenui / Styx River and could be included in either catchment. It has been included in this plan to facilitate investigations within the natural ponding basin which exists on either side of Queen Elizabeth II Drive.

Waterways within the urban areas are often partially piped, or are boxed drains such as Kruses Drain.

The catchment is partially urbanised (34%) with a mixture of residential, industrial, amenity and transport land uses. Urban areas are largely located in the southwest of the catchment including the suburbs of Northwood, Redwood, Northcote and Casebrook. The majority of land (62%) in the catchment is used for farming, predominantly pasture but also forestry and agroforestry. Some rural areas, particularly surrounding Belfast and around Hills and Prestons Roads, are being to be developed as an extension to current urban areas.

The physical values of the environment of the catchment are described in this section. Summary information from detailed technical reports on groundwater, surface water quality, aquatic ecology and sediments is also included.

Pūharakekenui / Styx Surface Water Plan Area



3.2 Geology

The Canterbury Plains are a complex of coalescing fans deposited by eastward-flowing rivers emerging from the foothills of the Southern Alps. During glacial periods valley glaciers reached almost to the foothills, and 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.

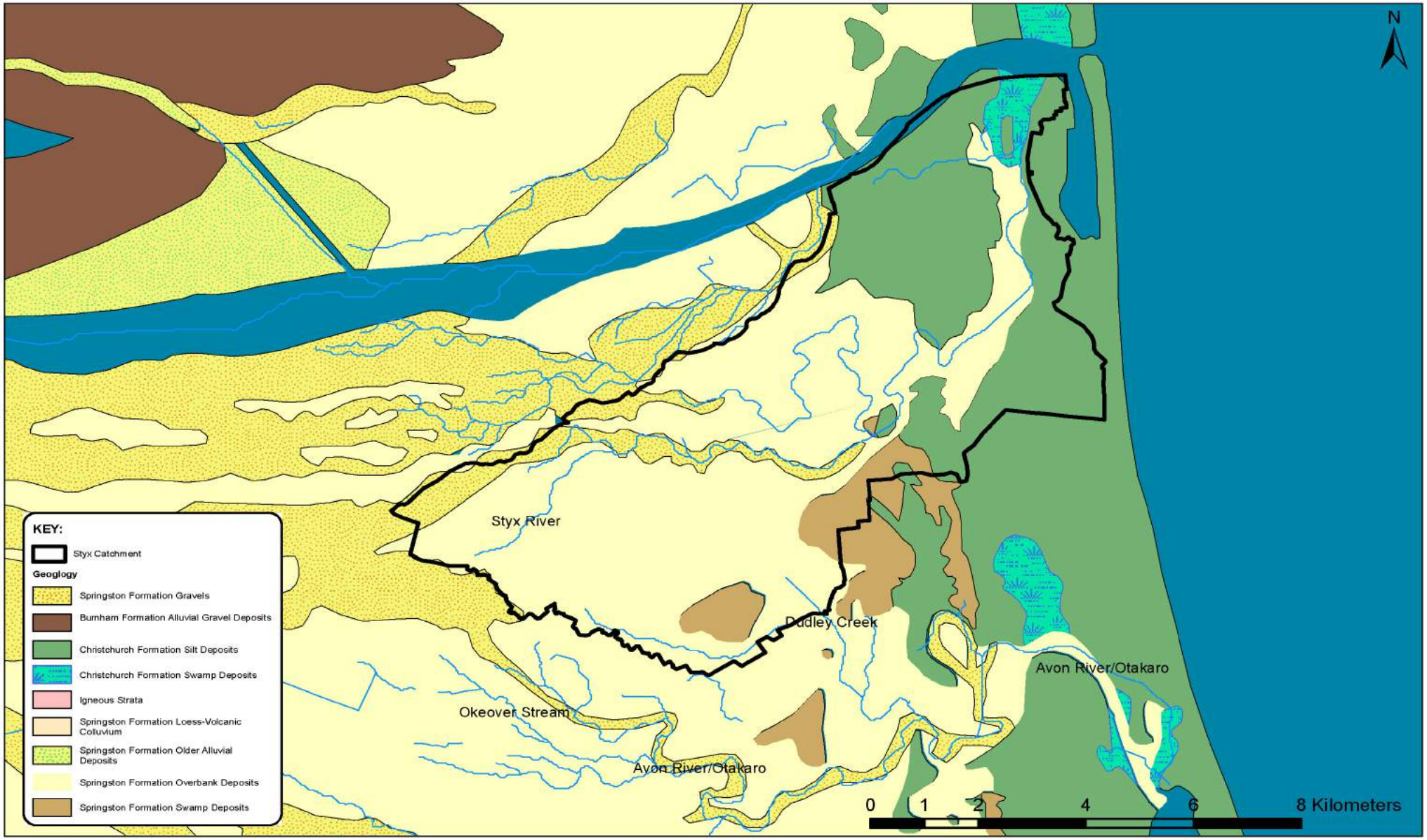
Groundwater beneath the plains is fed by percolating rainfall and seepage from the Waimakariri River (following figure). It flows toward the coast, entering each of the gravel layers which form separate aquifers, from which water exits by upward leakage or by abstraction. Deeper aquifers are fed from further up-gradient and are under artesian pressure.

Four productive aquifers are named, from deepest to shallowest, Wainoni Gravel (depth 150-170 m; age 350-380,000 years), Burwood Gravel (depth 120-130 m; age 250-310,000 years), Linwood Gravel (depth 70-90 m; age 120-200,000 years), and Riccarton Gravel (depth 40-60 m; age 14-70,000 years).

Capping the Riccarton Gravel and forming the land surface of central and eastern Christchurch is the Christchurch Formation. It is comprised of beach, estuarine, lagoonal, dune and coastal swamp deposits of gravel, sand, silt, clay, shell and peat. Extending along the coast between the Waipara and Rakaia river mouths, inland as far as Belfast, Papanui, Fendalton, Riccarton and Beckenham, it represents another river and sea deposition phase. Rising sea levels following the last glaciation reached the position of the present coastline about 9000 years ago. The maximum inland shoreline advance, to about Riccarton Bush, occurred about 6500 to 6000 years ago when sea level rose to a height similar to that of the present day. Continued deposition of sediments then caused the shore to retreat to its present position.

The geology of the Pūharakekenui/ Styx catchment includes a range of geologic deposits that are typical of the alluvial and coastal strata of the Christchurch area. These range from free draining highly permeable gravels associated with the Waimakariri River in the west, interspersed with lower permeability overbank silt and sand deposits, which thicken in an eastwards direction before dune sands begin to dominate the surface geology toward the coastal margin. The permeable alluvial gravel strata forms a sequence of productive gravel aquifers, which have been utilised by bores as deep as 222 m in the catchment. In the centre and eastern side of the catchment, several discrete gravel aquifers occur at depth, which are separated by lower permeability silty and sandy deposits formed in a marine or coastal environment.

Surface Geology of the Pūharakekenui / Styx Catchment



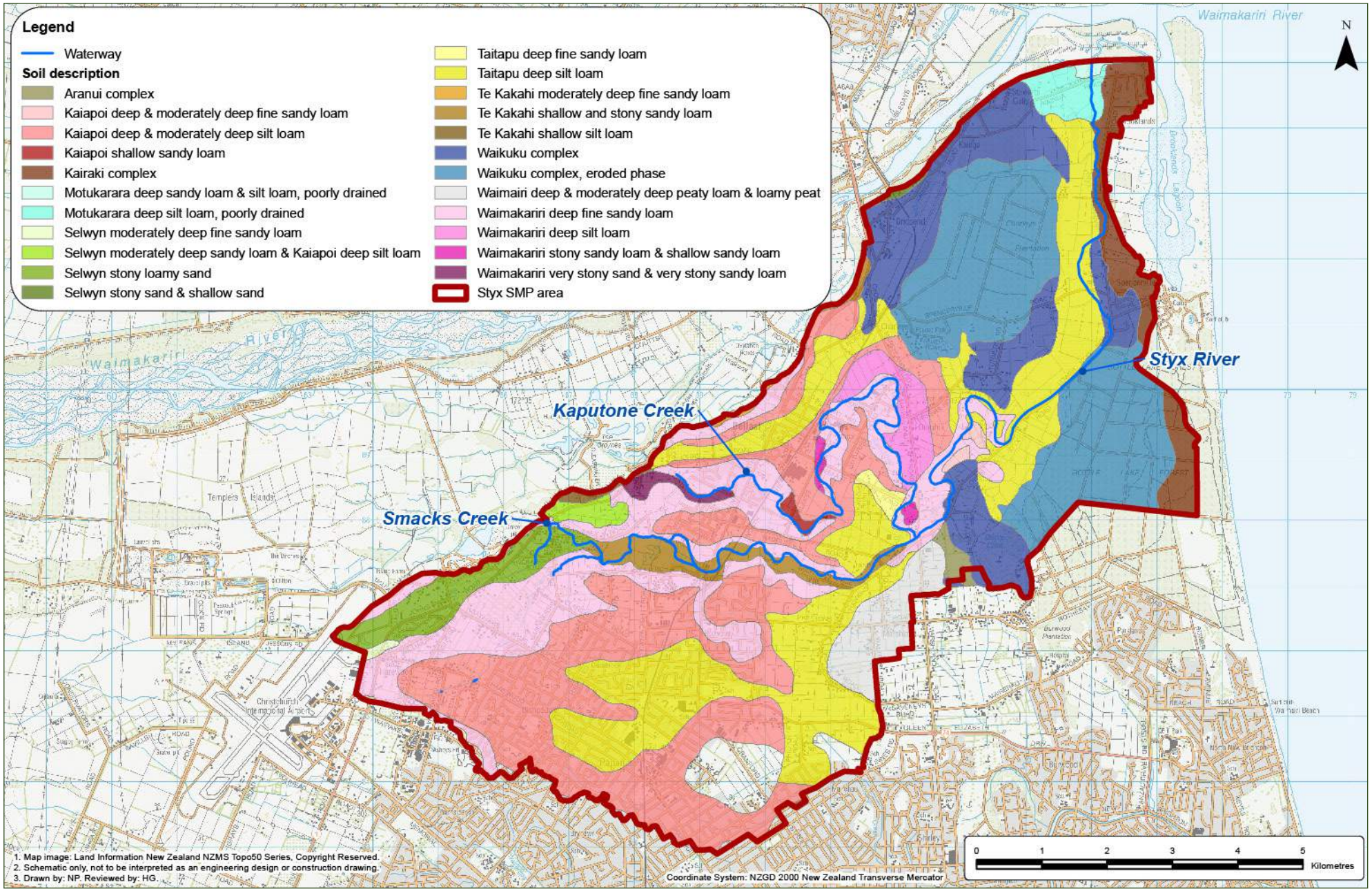
3.3 Soils

Christchurch soils are rather clearly divided between those based on outwash gravels and over-bank flows of the Waimakariri River to the west, and near-coastal deposits typical of swamps, dune areas, floodplains and estuaries nearer the coast.

The soils in the catchment range from alluvial gravels and sands to silts. Moving east from the airport to the coast, soils become finer grained from sandy gravels to sandy loams and silt loams. Soils near the coast have been formed from estuarine deposits and so organic, peaty soils exist in the Marshland area. Moving east towards the coast, the soils change gradually from sandy Selwyn, Waimakariri and Kaiapoi soils to silt Taitapu soils.

Generally soil infiltration and permeability decrease west to east as the soils become finer grained. The soil properties within the Smacks Creek sub-catchment are suitable for a proposed treatment train including soakage facilities to ground. Although, note that this form of stormwater disposal is not anticipated in this area to avoid risks of groundwater contamination. For completeness, the soil types in this sub-catchment are:

- Te Kakahi shallow and stony sandy loam;
- Taitapu deep fine sandy loam;
- Selwyn stony loamy sand; and
- Waimakariri deep fine sandy loam.


Legend
Waterway
Soil description
Aranui complex
Kaiapoi deep & moderately deep fine sandy loam
Kaiapoi deep & moderately deep silt loam
Kaiapoi shallow sandy loam
Kairaki complex
Motukarara deep sandy loam & silt loam, poorly drained
Motukarara deep silt loam, poorly drained
Selwyn moderately deep fine sandy loam
Selwyn moderately deep sandy loam & Kaiapoi deep silt loam
Selwyn stony loamy sand
Selwyn stony sand & shallow sand
Taitapu deep fine sandy loam
Taitapu deep silt loam
Te Kakahi moderately deep fine sandy loam
Te Kakahi shallow and stony sandy loam
Te Kakahi shallow silt loam
Waikuku complex
Waikuku complex, eroded phase
Waimairi deep & moderately deep peaty loam & loamy peat
Waimakariri deep fine sandy loam
Waimakariri deep silt loam
Waimakariri stony sandy loam & shallow sandy loam
Waimakariri very stony sand & very stony sandy loam
Styx SMP area
Waimakariri River
N
Styx River
Kaputone Creek
Smacks Creek
Templers Islands
Christchurch International Airport
1. Map image: Land Information New Zealand NZMS Topo50 Series, Copyright Reserved.
2. Schematic only, not to be interpreted as an engineering design or construction drawing.
3. Drawn by: NP. Reviewed by: HG.
Coordinate System: NZGD 2000 New Zealand Transverse Mercator
0 1 2 3 4 5
Kilometres

3.4 Groundwater

Geologic deposits range from free-draining highly permeable gravels associated with the Waimakariri River in the west, interspersed with lower permeability overbank silt and sand deposits that thicken in an eastwards direction towards the coast. Productive gravel aquifers exist that change from unconfined to confined towards the coast.

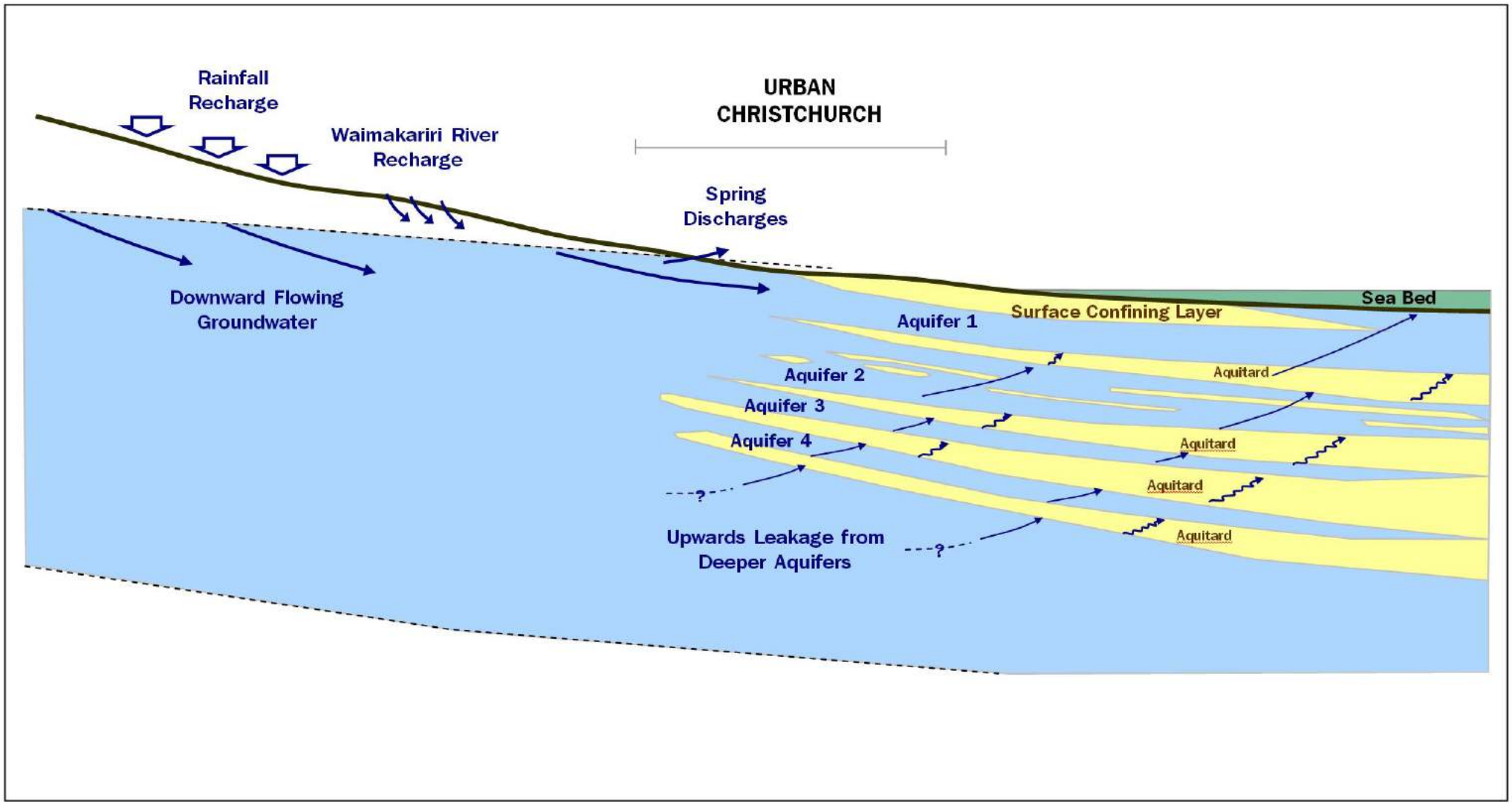
A relatively small area in the west with permeable strata and groundwater deeper than two metres is likely to be conducive to stormwater soakage systems discharging to ground. Careful site investigation will need to be carried out prior to installation of any soakage system, however because of a past history of contaminated industrial sites. Elsewhere over most of the study area, ground permeability and seasonally high shallow groundwater levels rule out the option of stormwater disposal by soakage.

Groundwater quality is generally good due to the rapid through flow of seepage water from the Waimakariri River discharging into the spring-fed Styx, Kāpūtahi / Kaputone Creek and Otukaikino Creeks. The permeable unconfined aquifer is vulnerable in the west to contamination, but in the centre and to the east of the study area it is protected by the low permeability surface sediments. Within the catchment 25% of land occurs within an ECan zone where they wish to discourage any intensification in landuse because of the risk of aquifer contamination.

The depth to the water table across the catchment is generally shallow, as evidenced by the surface waterways which are fed from springs. Regular measurements of groundwater level monitoring wells have not shown any long term change in groundwater levels in the catchment. A review of monitoring data in April 2011 showed some of the monitoring wells exhibited no effect from the earthquake, whereas some others show a short term rise in levels of around 0.75 m, which recovered to around background levels within a few days. A subsequent review in August 2011 by ECan concluded there is no clear evidence of any significant change in groundwater pressures or condition as a result of the earthquakes.

The gravel aquifers of the catchment provide a productive water resource that is used for abstraction purposes by the construction of bores. Records from ECan show 1755 bores within the catchment boundary, although 827 are recorded as being for testing or monitoring purposes. The remaining 928 bores are typically used for drinking water, stock water, irrigation and industrial purposes.

Groundwater Cross Section Through Canterbury



3.5 Springs

Groundwater in the catchment enters the waterways either as a general seepage through the stream bed or as springs which exhibit a higher concentration of groundwater discharge to the surface waterway at a discrete location.

The rate of seepage depends on the relative elevation between the groundwater levels and the water level in the stream channel as well as the hydraulic conductivity of the strata in and around the stream bed. Consequently, land use activities (including urban development and stormwater management) that affect groundwater levels will also affect spring discharges and the flows in surface waterways, which have a corresponding impact on the value of those surface waterways. The waterways are most sensitive to these effects at the western end of the catchment where there is the highest degree of hydraulic connection between the groundwater and the surface flow.

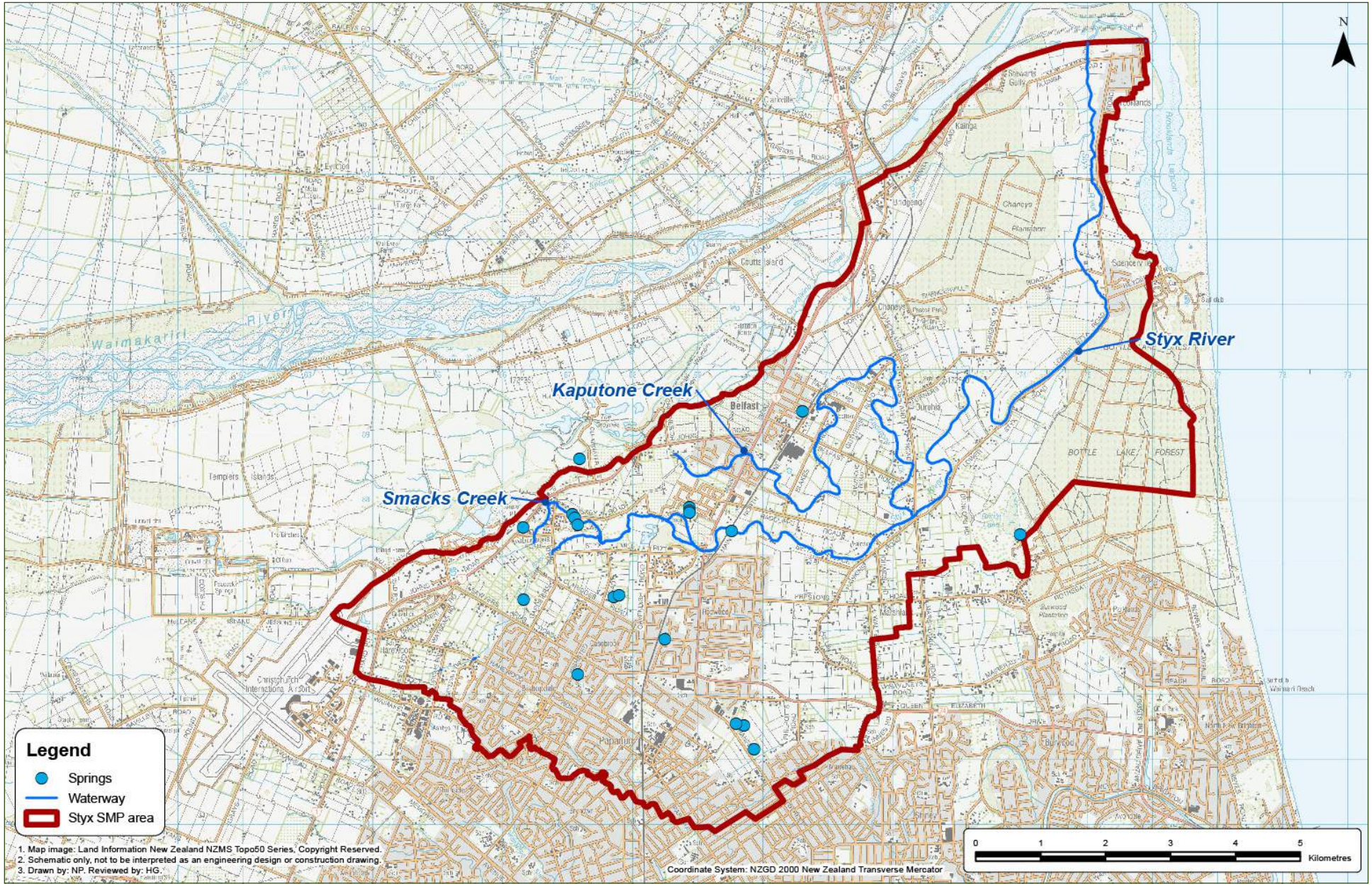
Groundwater flows to the surface at several discrete locations within the catchment. A significant natural spring beside the Pūharakekenui/ Styx River accessible from Willowview Drive, Redwood Springs has been enhanced with indigenous planting and a viewing platform. Two artificial springs have been installed as landscape features. Deep groundwater is pumped to the surface to supply the source of Kāpūtahi / Kaputone Creek on Springwater Avenue. Spring-fed baseflow in a stormwater pipeline is intercepted on Coolspring Way, Redwood Springs and discharged into a stormwater swale in the esplanade reserve.

The following types of land development activities can impact on the spring discharges:

- Local groundwater pumping to dewater a construction site;
- The diversion of springs to alternative discharge locations;
- Stormwater management and discharge locations.

The Canterbury earthquakes in September 2010 and February 2011 resulted in the occurrence two new springs in the Redwood area, which are within the catchment area. They are located in an area of pre-existing springs and therefore are likely to represent a relatively small change to the overall groundwater situation within the catchment.

Springs in the Pūharakekenui / Styx Catchment



3.6 Surface Water Network

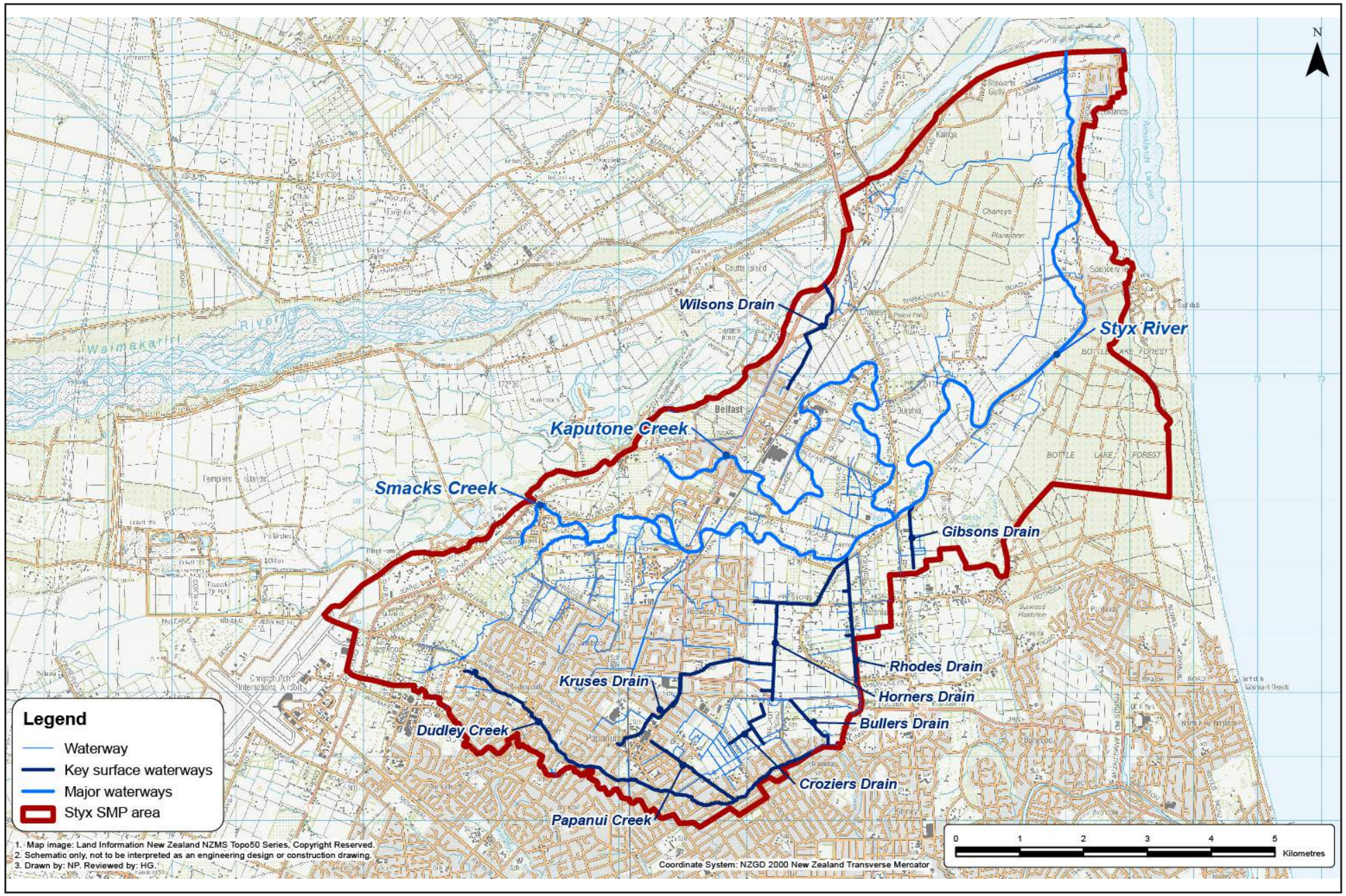
3.6.1 Waterways Description

The Pūharakekenui / Styx River is one of the three main spring-fed rivers in Christchurch, and is located on the northern urban edge of Christchurch City. It is approximately 23 km long with a predominately low lying and relatively small catchment of 7000 ha. It originates in the Harewood area and then meanders in a north-easterly direction through reserve, pasture, horticultural areas and residential developments before discharging into the sea via Brooklands Lagoon and the Waimakariri River. The upper reaches, upstream of Sawyers Arms Rd are ephemeral.

The principal tributaries of the river are Smacks Creek and Kāpūtahi / Kaputone Creek, which are also spring-fed. They also receive varying amounts of stormwater runoff following rainfall. There is a paucity of good flow data for the river due partly to weed growth and accumulation in the river channel affecting the calculation of flow rates. There is good continuous water level data in the mid and lower sections of the river and below the tide gates at the mouth of the river.

Water level in the river is measured at 15 minute intervals by a water level recorder located at Radcliffe Road. Water level is also recorded in the river by Council at Lower Styx Road, Harbour Road and downstream of the tide gates. The Radcliffe Road site is jointly operated by ECan and Council and has been operational since 1992. Water levels in the river are strongly affected by weed growth and accumulation in the river channel, particularly over the summer months. As the river is spring-fed, baseflow conditions tend to dominate. Short duration high flow events due to rainfall runoff occur periodically throughout the record.

Surface Water Network of the Pūharakekenui / Styx Catchment



Waterway	Length and Catchment Area	Description
Pūharakekenui / Styx River	22.5 km, 7000 ha	The Pūharakekenui / Styx River is a spring fed tributary of the Waimakariri River draining a north Canterbury catchment from the airport east to Brooklands Lagoon. Land use in the upper reaches in urban, intensive horticulture in the middle reaches, and pastoral farming in its lower catchment. The water quality of the river is good and in-stream ecological values high compared with other Christchurch waterways.
Kāpūtahi / Kaputone Creek	10.8 km, 543 ha	Kāpūtahi / Kaputone Creek is the largest tributary of the Pūharakekenui / Styx River and is spring fed. The upper reaches drain part of old Belfast while the lower reaches drain rural land west of Marshland Road. Kāpūtahi / Kaputone Creek has suffered from a long history as receiving waters for polluted discharges from agricultural based industries located in east Belfast. Mixture of agricultural, residential, and industrial land use. Kāpūtahi / Kaputone Creek has its headwaters located west of State Highway 74, near Northwood and has previously been observed to be dry in these upper reaches. Council has recently enhanced stream flows in the upper reaches by installing a bore and pumping into the stream.
Smacks Creek	2.5 km, 115 ha	A spring fed waterway near the headwaters of the Pūharakekenui / Styx River, the creek is narrow and discharges into the river at Willowbank Wildlife Reserve. The banks of the creek have been subject to recent urban subdivision.
Wilsons Drain	2.2 km, 270 ha	Wilsons drain is a timber lined waterway that drains north through the Waimakariri River stopbank at Chaneys to the Otukaikino Creek. The catchment comprises old Belfast connected to Johns Drain upstream and rural land downstream.
Kainga Drain	3 km, 130 ha	The drain flows east through sand dune from Kaiapoi Bridge, through Chaneys Plantation to the Pūharakekenui / Styx River south of Brooklands. The catchment drains the existing industrial area at Kaiapoi Bridge and the Pūharakekenui / Styx River floodplain at Brooklands.
Horners Drain	3 km, 400 ha	A large deep lined drain extending across farmland from Cranford Basin at Winters Road/QE II Drive to the Pūharakekenui / Styx River, including Kruses Drain within the catchment area. The control gate in Winters Road Drain at its confluence with Horners Drain can be used to divert flows north to the Pūharakekenui / Styx River, thus reducing discharges down Bullers Drain to the Ōtākaro/Avon River.
Kruses Drain	1.27 km, 250 ha	Kruses Drain is a partly piped and partly lined waterway that drains the urban suburb of Papanui before joining Horners Drain. Water discharge from Kruses Drain can flow either south or north along Horners Drain to the Ōtākaro/Avon River or Pūharakekenui / Styx River.
Winters Road Drain	665 m	Winters Road Drain flows east along Winters Road to QE II Drive and provides an outlet to either the Ōtākaro/Avon River via Bullers Drain or the Pūharakekenui / Styx RiverRiver via Kruses Drain depending on the setting of the flow control structure at Winters Road Detention Basin. The waterway drains the northern area of Dudley Diversion ponding area in Cranford Basin. This is why Cranford Basin is included in the Pūharakekenui / Styx River SMP.
Dudley Creek Diversion	1.15 km (open waterway), 3.95 km (piped), 644 ha	The Diversion intercepts most of the Dudley Creek flow in Papanui and diverts it east through Cranford Basin to Philpotts Road. The waterway diversion should not be confused with the Dudley Creek Diversion Pipeline under Innes Road. A stormwater pumping station (PS 219) near Philpotts Road raises the discharge in the Diversion to maintain low dry weather groundwater levels in Cranford Basin.

Upper Pūharakekenui / Styx at Harewood Nursery

3.6.2 Major Waterway Structures

There are a several major structures in the catchment which are relevant to stormwater management and flood risk.

Pūharakekenui / Styx River Tide-Gates

These are located at the Waimakariri River stopbank across the river northwest of Brooklands. The purpose of the tide-gates is to isolate the Brooklands ponding area from extreme high tides propagating the Waimakariri River from the sea. Storm runoff is detained behind the gates during high tides, and released to the sea during low tides.

Winters Road Detention Basin

This detention basin is located on the corner of Winters and Philpotts Roads. The basin occupies 4.36 ha and has capacity of at least 50,000 m^3. The basin facilitates discharges to the Avon as well as Pūharakekenui / Styx rivers and has never been operated to full potential because the appropriate operating procedure is not well understood.

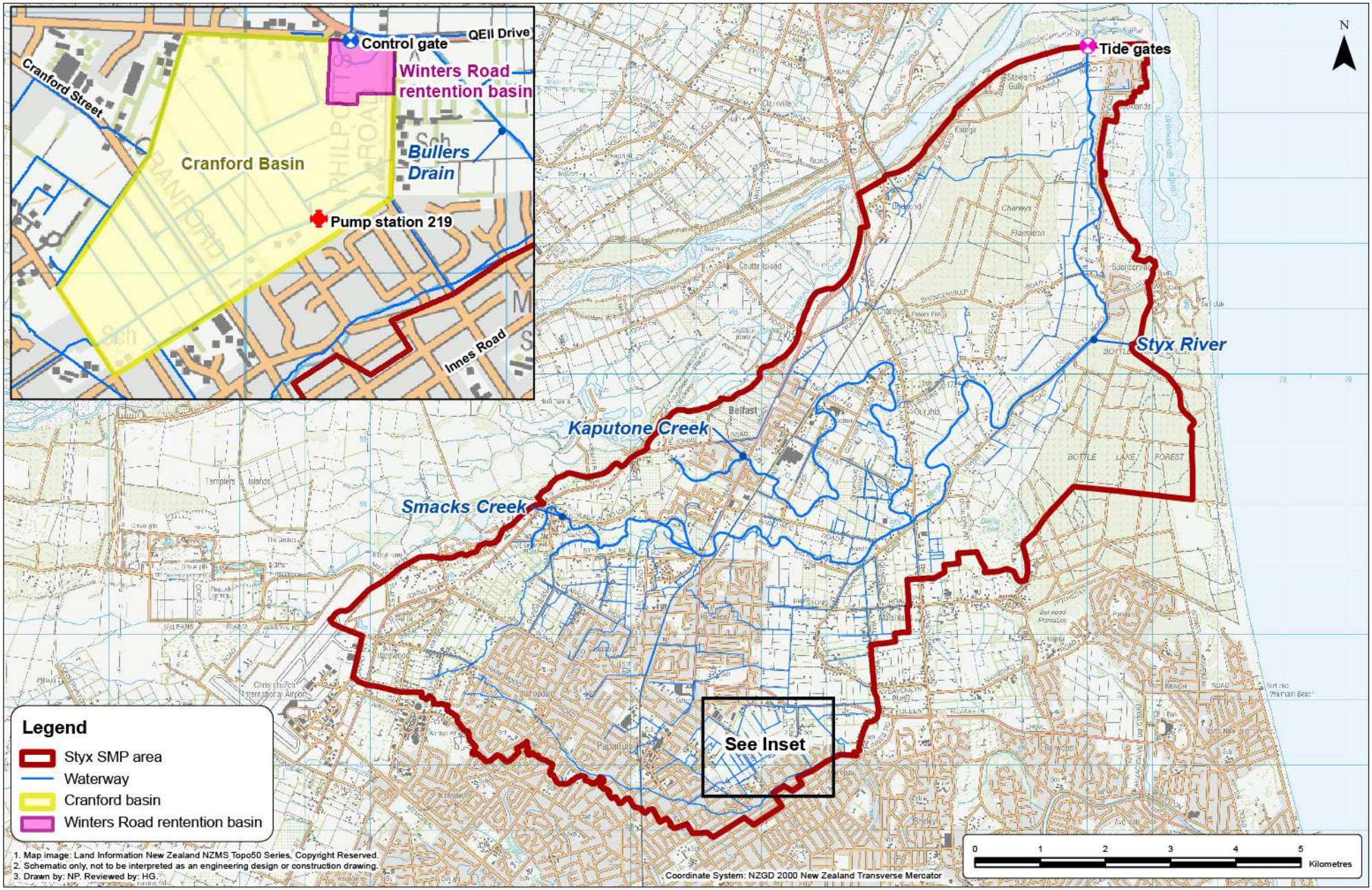
Horners Drain Lining

The drain is a timber and concrete lined drain extending north from Winters Road to join the river near the Kāpūtahi / Kaputone Creek confluence at Marshland Road. The structure cuts through an old sand dune to a maximum depth of almost 5 m, with a deep concrete lined reach along Hawkins Road representing a major asset replacement challenge and cost. Highfield Park development intends to relocate Horners Drain to the west within a broad green corridor through the proposed subdivision.

Cranford Basin Pumping Station

The basin sits as a sub-catchment between the Avon/Ōtakaro and Pūharakekenui / Styx rivers. Land gradients are such that water can be diverted from Cranford Basin catchment to the Pūharakekenui / Styx River or to the Ōtākaro/Avon River. The lowest part of Cranford Basin has a Pumping Station (PS 219) which takes water from the Dudley Creek Diversion as well as other local drainage and delivers it into the Ōtākaro/Avon River.

Major Structures in the Pūharakekenui / Styx Catchment



4.0 Freshwater Ecology / Rauropi Wai-māori

4.1 Overview of Ecological Health of Waterways within the Surface Water Plan Area

Investigations have been undertaken to assess the riparian and instream habitat, macroinvertebrate communities, fish fauna and ecological values of the river and its tributaries.

The aquatic ecological values of sites in the river were determined and used to classify waterways. The aquatic ecological values were subsequently used for ranking waterways in the catchment to retain consistency with other studies in the Christchurch area.

4.2 Areas with High Ecological Value

The Pūharakekenui / Styx River in the vicinity of the Styx Mill Reserve and Smacks Creek had predominantly high aquatic ecological values due to relatively high macroinvertebrate taxa richness, moderate trout spawning habitat and high habitat scores compared to other Christchurch waterways. The river at the Styx Mill Reserve also ranked relatively high due to the presence of kēkewai/freshwater crayfish.

Moderate ecological value sites in the river were limited to upstream of the confluence with Smacks Creek and upstream of the tide-gates near Kainga Road. These upper river sites were considered to have moderate ecological values due to a combination of moderate macroinvertebrate taxa richness and good habitat due to riparian vegetation. The river near Kainga Road is recognised as inanga spawning habitat and had relatively high macroinvertebrate taxa richness. Two reaches of the Kāpūtahi / Kaputone Creek were considered to have moderate ecological values being in the vicinity of Blakes Road and MacDonalds Road largely due to the fish communities identified.

Surveys indicate that inanga are relatively common within the catchment, juvenile inanga form the major component of the whitebait catch and the mouth of the river at Brooklands Lagoon is a highly valued location for white baiting. Notably, both brown trout and inanga have been found recently to spawn within different areas of the river catchment.

The only recognised nationally threatened fish species found in the river catchment was the longfin eel and although they appear to be relatively common at several sites, their presence within the catchment is significant and important due to their declining populations nationally.

4.3 Areas with Low Ecological Value

All of the drain sites and the remaining sections of the Pūharakekenui / Styx River, Kāpūtahi / Kaputone and Smacks Creeks were ranked as having low ecological value, this was primarily because the majority of sites had poorer instream habitat overall which did not support diverse or 'sensitive' ecological communities. In general, the drain sites were dominated by run habitat, soft bed sediments, had very little variation in channel width and depth, and little to no instream/bank cover features.

The river has higher instream habitat scores (i.e. habitat is of greater quality) than Kāpūtahi / Kaputone Creek or the drains, and that overall stream habitat conditions in the river catchment could be generally described as low to moderate.

Riparian vegetation is dominated by exotic species at most sites and is typical of other modified waterways in the Christchurch area. Stream shading is generally low, macrophyte cover is variable and periphyton cover is relatively minimal at most sampling sites. The drain sites are the poorest due to the lack of instream habitat diversity or cover features for sensitive macroinvertebrate taxa or fish. Instream habitat (measured as total habitat scores) has been was better in the Pūharakekenui / Styx River catchment sites than in the Ōtākaro/Avon or Ōpāwaho/Heathcote rivers.

Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) scores indicative of moderate to poor habitat and/or water quality are common place throughout the catchment.

4.4 Management Recommendations

There needs to be a multi-faceted approach to the management of the catchment:

- Areas with high ecological value need to be maintained, and where possible enhanced, through appropriate management activities.
- Areas with low values should be restored through intensive management of water quality, and riparian and in-stream habitat; particularly in areas that displayed high potential for ecological health (i.e., they had good instream and riparian habitat), but the poor condition of the water is affecting stream health (e.g. Kāpūtahi / Kaputone Creek).
- Stormwater management should continue to focus on reducing levels of contaminants (e.g. sediment, heavy metals and hydrocarbons), particularly in the tributaries.
- 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 where appropriate, including the use of such things as emergent large substrates (which provide laying sites for the eggs of aquatic insects) and specialist habitat.
- Connectivity along streams should be improved by reducing the impact of in-stream structures, such as culverts and low bridges.
- Lighting systems should be used that reduce the effects of light pollution on freshwater fauna.
- Management of macrophytes and periphyton should be undertaken in a preventative manner rather than mechanical removal which has deleterious effects on fauna.
- Enhance spawning habitat for inanga and trout.

5.0 State of the Takiwā / Te Āhuatanga o te Takiwā

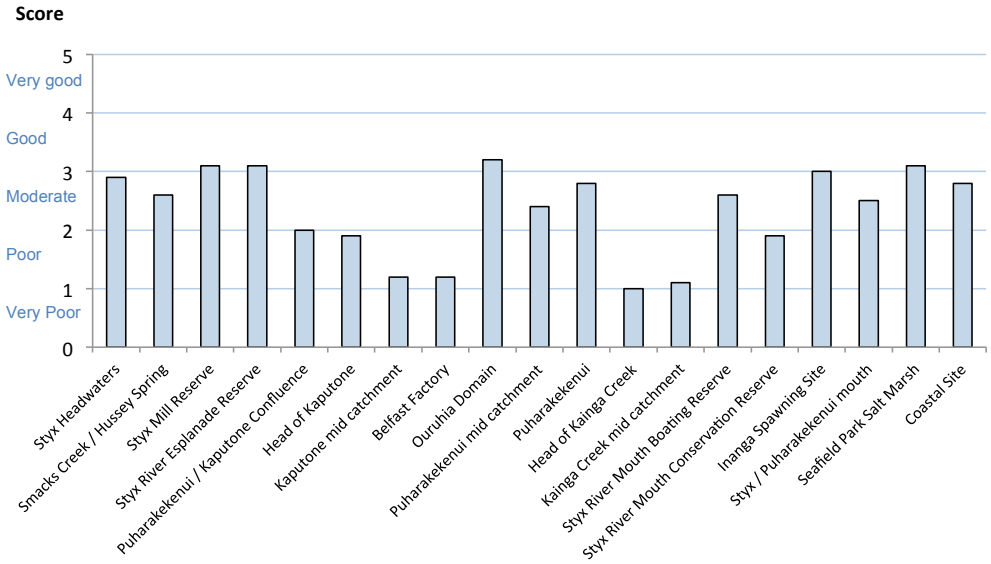
The State of the Takiwā is a catchment-wide cultural assessment of waterways conducted by a Rūnanga roopu (monitoring team) in conjunction with Mahaanui Kurataiao Limited (MKT). The 2012 assessment of the Pūharakekenui / Styx River was the first cultural health assessment of the catchment using the State of the Takiwā methodology developed by Te Rūnanga o Ngāi Tahu. The monitoring methodology includes a range of quantitative and qualitative measures including water sampling, fish, bird and vegetation surveys, mahinga kai assessments and observations of other aspects of cultural health.

The 2012 survey included 19 monitoring sites including river, coastal and estuary sites reflecting Ngāi Tahu Ki Uta Ki Tai (mountains to sea) resource management principles (opposite).

The results demonstrated that a range of culturally relevant aspects, including both instream and riparian values, were degraded at many sites. High levels of modification to waterways, compared with traditional conditions, were identified, especially in the mid-catchment areas. Examples of modifications included the effects of flood management and drainage activities and poor riparian management practices in many places. In addition, the survey results shows that while mahinga kai values are present in the catchment, opportunities for improving mahinga kai values exist at all the sites surveyed. Overall, the survey team noted many opportunities to improve cultural values associated with waterways in the catchment.

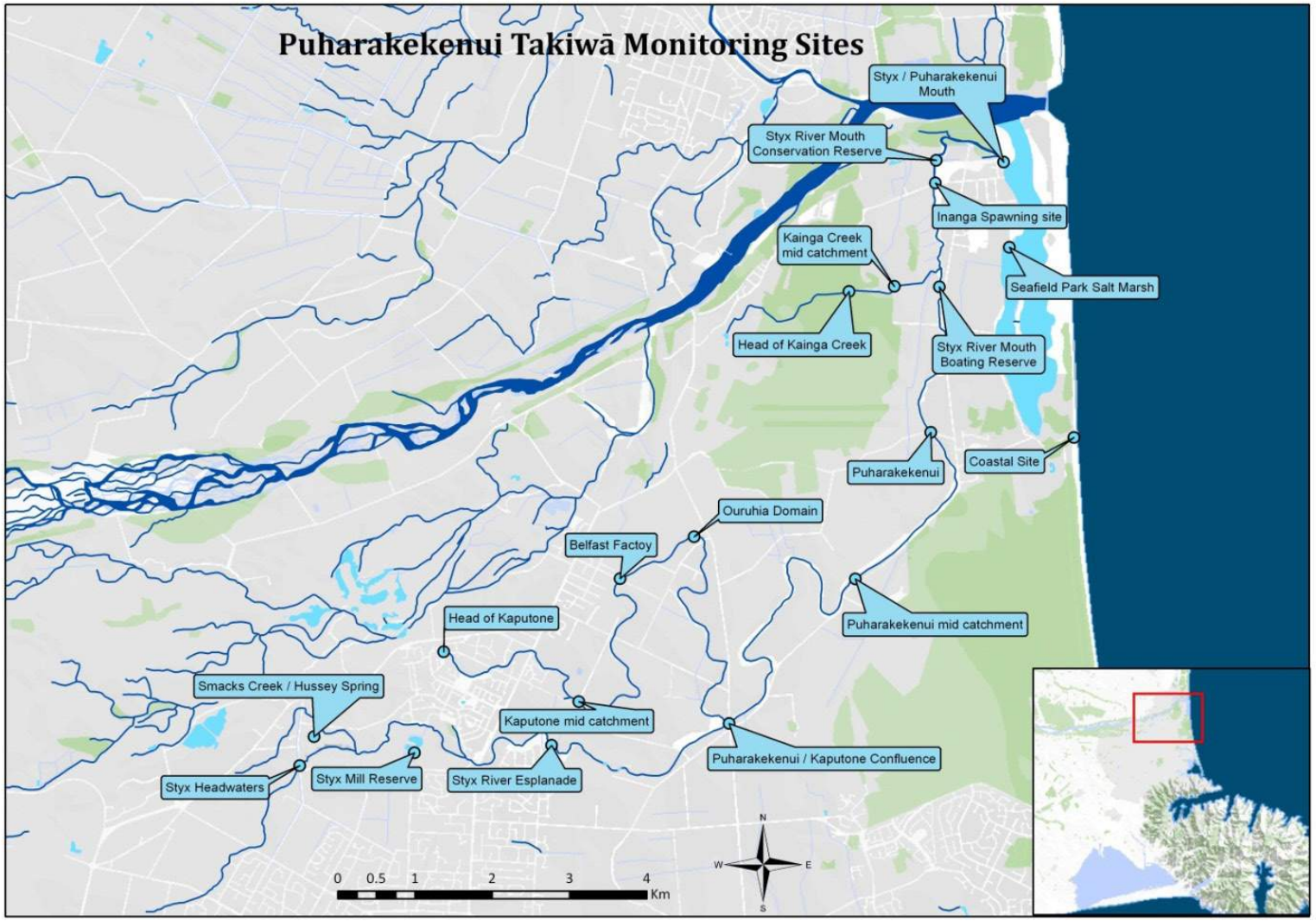
The roopu made a number of recommendations in their assessments of State of the Takiwā monitoring sites in the catchment.
Key recommendations included:

- Controls to prevent further modification of waterways
- Seek opportunities to naturalise existing waterways
- Protection of wāhi taonga and wāhi tapu
- Protection and enhancement of puna (springs) and waipuna (spring water)
- Restoration of water quality to a level at which mahinga kai can be safely gathered
- Control of pollution sources
- Fencing stock out of waterways
- Riparian planting using appropriate local indigenous species
- Control of pest and exotic species



Takiwā, Overall Health Index scores

Electric fishing and setting a Hīnaki



6.0 Groundwater Quality / Kounga Puna Wai

6.1 Overview of Groundwater Quality within the Catchment

Groundwater quality at depth is generally very good, although can be more variable at shallower depth due to the impacts of land use activities. In isolated areas, some deeper bores can display elevated concentrations of iron, manganese and sometimes arsenic. This arises from reducing groundwater conditions related to the presence of organic matter (often peat deposits) within the aquifer. With this exception, groundwater quality in the catchment is generally very good, due to the rapid through-flow of seepage water from the Waimakariri River in the western part of the area, which discharges into the spring-fed streams of the Kāpūtahi / Kaputone Creek and Pūharakekenui / Styx River.

6.2 Management Recommendations

Only a relatively small area in the west of the Pūharakekenui / Styx River catchment it is suitable for stormwater soakage systems. Elsewhere ground permeability and seasonally high shallow groundwater levels rule out the option of stormwater disposal by soakage. Careful site investigation will need to be carried out prior to installation of any soakage system, because of a past history of contaminated industrial sites.

For all urban development situations, careful consideration needs to be given to the possible interception of permeable underground flow paths that feed the springs that sustain surface waterways. It is important that the construction of underground structures or services do not divert water away from the spring discharge features, which could cause a permanent detriment to the surface waterway. Construction measures can be implemented to minimise the risk of such unintended diversions occurring.

Spring at Redwood Springs

7.0 Surface Water Quality / Kounga Waimāori

7.1 Overview of Surface Water Quality within Surface Water Plan Area

Council has been collecting and reporting on water quality data since 1989 at eight sites within the catchment; five sites are in the Pūharakekenui / Styx River mainstem; two in Kāpūtahi / Kaputone Creek; one in Smacks Creek. Environment Canterbury also monitor water quality in the river at Teapes Rd (also known as the Richards Bridge site).

Overall, the waterways in the catchment comply with the proposed NRRP water quality standards for pH, total ammonia and dissolved inorganic nitrogen (DIN), and partly complied with temperature standards. The requirement for water temperature to be less than 20°C was typically met but the requirement for water temperature to be less than 11°C between May and September was often not met. For the most part the waterways did not comply with the dissolved oxygen (DO) standard of >80% saturation nor the faecal coliform median of <100 cfu/100 mL. Similarly the dissolved reactive phosphorus (DRP) standard in the NRRP of no more than 0.002 g/m³ average annual increase was not met in any of the waterways that had datasets suitable for comparison.

Metal concentrations were generally low throughout the catchment but did show a relationship to sediment, illustrated by key stormwater contaminants (lead, zinc, copper) being elevated generally as a result of stormwater discharges and associated total suspended solids.

7.2 Areas of Good Water Quality

Water quality in the upper reaches of the river have low levels of dissolved oxygen and suspended solids, and cool temperatures, which are typical of a spring-fed waterway. Nitrate concentrations are also relatively low, reflecting the close proximity of the Waimakariri River which is the likely source of the spring-fed flow.

Water quality in Kāpūtahi / Kaputone Creek is as of generally high quality, although there are occasions when numbers of faecal indicator bacteria and ammoniacal nitrogen concentrations have been high.

Median dissolved oxygen saturation is above the 70% standard at all sites except Smacks Creek at Gardiners Road and Pūharakekenui / Styx River at Gardiners Road.

7.3 Areas of Poor Water Quality

Water quality in Smacks Creek has been noted as being of poorer quality than the Pūharakekenui / Styx River, although median numbers of faecal indicator bacteria and median ammoniacal nitrogen concentrations were lower than those reported for Kāpūtahi / Kaputone Creek.

Median dissolved reactive phosphorus (DRP) concentrations have exceed the 0.016 g/m³ standard at five of the eight sites; concentrations are typically lower in the upper reaches of the river and increase with increasing distance downstream.

Cadmium concentrations were all below detection limits except for one record where a concentration of 0.3 g/m³ was recorded in the river at Gardiners Road, which is not necessarily an indicator of poor water quality, but is noticeably different than the remainder of the catchment.

7.4 Management Recommendations

- Investigate the source of Escherchia coli in the catchment and in particular, manage the upward trends of it at Gardiners Road, Richards Bridge.
- Improvement in the water quality of tributaries should be undertaken, as this could create substantial benefits downstream in the mainstem.

- Given the impact of stormwater runoff was apparent, the focus of the SMP should be stormwater treatment systems throughout the catchment, particularly for zinc (manage type of roofing material used and/or require treatment for roofing materials).

- Investigations into DRP inputs in the waterways, particularly Marshland Road, Harbour Road and Blakes Road (Kāpūtahi / Kaputone Creek), should be carried out to help direct management efforts.

- Management options for nitrogen in the catchment, particularly Kāpūtahi / Kaputone Creek, should be considered carefully due to upward trends, many different inputs to the river, and the complex relationship of rainfall and groundwater on concentrations.

8.0 Instream Sediment Quality / Kounga Parakiwai

8.1 Overview of Instream Sediment Quality within Surface Water Plan Area

A survey of sediment quality undertaken in 2009 involved the collection of samples at 22 sites in the Pūharakekenui / Styx and assessed the physical characteristics of the sediments along with metal and polyaromatic hydrocarbon (PAH) concentrations.

Sediments from the Pūharakekenui / Styx River and Wilsons Drain catchments have shown that the concentrations of metals were variable between sites ranging from a two fold variation in nickel concentrations through to an almost twenty fold variation in cadmium, copper, lead and zinc.

The concentrations of metals in sediments from the river were generally lower in rural areas compared with other rural catchments in Christchurch with the exception of copper and lead. The sediment from urban areas was comparable to that in urban and residential areas in the Ōpāwaho/ Heathcote River and Huritini / Halswell River catchments (particularly copper, zinc and lead). Urban sites had higher concentrations of metals, except for nickel which was higher in rural.

Overall, metal concentrations are similar to those measured in sediments from streams in other local urban areas, with a few exceptions. Metal concentrations, particularly zinc and lead are sufficiently elevated in some parts of the river could be causing an adverse effect on the instream ecology. However, the sites where elevated metal concentrations occurred and macroinvertebrate community health was rated as low, instream habitat was typically poor and was just as likely to be driving the low instream ecological value at the site.

PAH concentrations in sediments within river were above the detection limit in only eight of the 18 samples analysed. Sediments from the lower reaches of the river had relatively low PAH concentrations which were similar to, or lower than, those measured in the Halswell River. PAH concentrations in the sediments from rural areas were generally similar or lower than those measured in the rural catchment of the Ōpāwaho/ Heathcote and Huritini / Halswell Rivers.

A comparison of the PAH concentrations in the sediments of the river and Wilsons Drain catchments with the ANZECC (2000) guidelines showed that:

The concentration of low molecular weight PAHs was in excess of the ISQG-low at both sites and the sample from the Pūharakekenui / Styx River also exceeded the ISQG-low for high molecular weight PAHs.

Overall, PAH concentrations are elevated at a limited number of sites in the Pūharakekenui / Styx SWP Area and are similar to those measured in sediments from streams in other local urban areas.

8.2 Areas with Good Sediment Quality

The mainstem of the Pūharakekenui / Styx in the lower catchment had low concentrations of metals in sediment compared to the other sites but was generally comparable to other catchments of similar landuse.

Sediments from the lower reaches of the river also had relatively low PAH concentrations which were similar to, or lower than, those measured in the Huritini / Halswell River.

8.3 Areas with Poor Sediment Quality

Polycyclic aromatic hydrocarbon concentrations are sufficiently high in Wilsons Drain and the Pūharakekenui / Styx River at Marshlands Road that they may result in adverse effects on the instream ecological values at the site.

Kāpūtahi / Kaputone Creek and several of the other drains had higher

metals in sediments, which may relate to the depositional nature of drains.

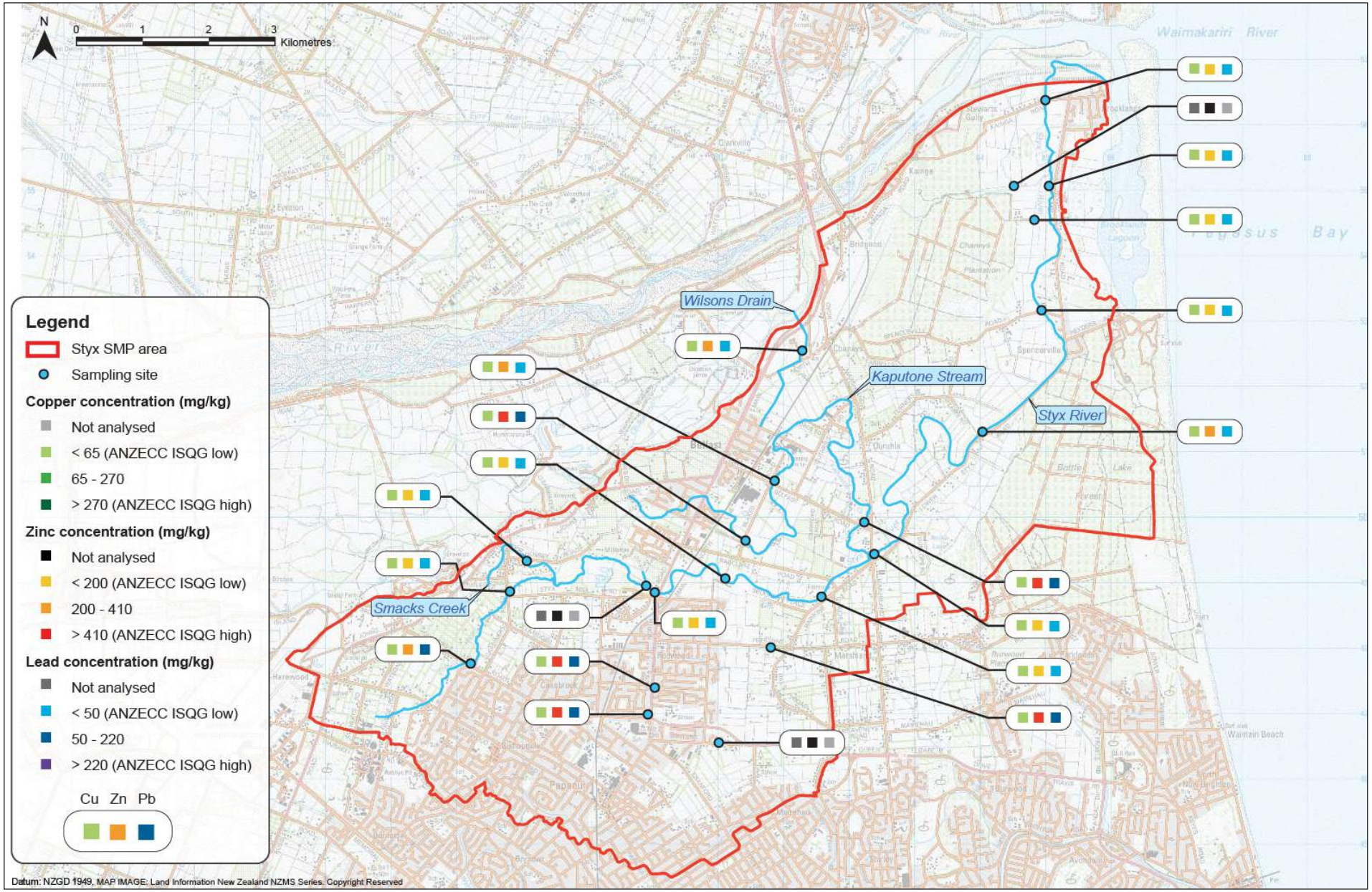
All three sites sampled in the Kāpūtahi / Kaputone Creek exceeded the zinc guidelines and two exceeded the lead guidelines. Zinc concentrations exceeded the ISQG-high at two out of the three sites.

First Flush Pond at Redwood Springs Designed to Trap Sediment

8.4 Sediment Management Recommendations

- Catchment-wide measures to control pollutants, such as source control and treatment devices, particularly in areas with high contaminant concentrations.
- Control of roading material entering stormwater system and waterways in areas where coal tar was used; given the extensive damage done during the earthquakes, it would be pertinent to develop a management plan to minimise the loss of contaminated material into the stormwater and stream systems during roading reconstructions.
- Sediment toxicity testing to elucidate effects of contaminants on freshwater fauna.
- Further studies to investigate contaminant sources in hotspot areas (from current and historical inputs).
- Removal of sediment to remove contaminants in system.
- Testing of sediments at sites not sampled during this study.
- Event based testing (in both streams and stormwater networks) to determine localised contaminant sources.
- Characterisation of the source of contamination in both the rural and urban areas, with a targeted management approach as suits each contaminant type (i.e., source of nickel in rural areas).

Comparison of Copper, Lead and Zinc to ANZECC (2000) Sediment Quality Guidelines



9.0 Flood Risk / Mōrea Waipuke

9.1 Nature of Flooding

Flood modelling for the catchment has considered four flood mitigation options with the results supporting the final recommendation to implement the partial detention option. The design storms for the modelling exercise were based on a maximum probable development (MPD) scenario which allowed for some infill housing in existing developed areas, in addition to the new development possible in the catchment. The hydrology allowed for predicted climate change over the next few decades, with existing rainfall intensity and rain depth being increased by 16%. The hydraulics also allowed for a 500 mm sea level rise (in terms of current national guidelines).

9.2 Surface Flooding

The modelling results predict a ponding level increase of about 100 mm (for the 2% AEP event) for the Brooklands floodplain can be expected. Within the Pūharakekenui / Styx River and Kāpūtahi / Kaputone Creek channels, more significant flood level increases of up to 290 mm in places could occur for the MPD, partial detention proposal.

Brooklands suffered substantial damage to land and buildings in the 2010 and 2011 earthquakes. The Christchurch Earthquake Recovery Authority (CERA) announced on 17 November 2011 that the final 417 dwellings in Brooklands were zoned red. The majority of Brooklands has been abandoned although some red zone residences are still inhabited. The small increase in the depths of flooding in the Brooklands Ponding Area above the Pūharakekenui / Styx river floodgates anticipated during extreme events is, therefore considered acceptable in the SMP as the flood damage cost would be limited to rural land.

9.3 River and Stream Flooding

Whilst more significant, the predicted rise in flood levels in the river, up to 210 mm on average every 50 years, is generally confined within river banks. The channel of Kāpūtahi / Kaputone Creek is not as well incised as the Pūharakekenui / Styx River, but any minor bank overflows in the lower reaches are over farmland rather the residential land. Potential flood damage is likely to be minor. The impact of higher river levels during more frequent events is unlikely to result in significant bank erosion due to the relatively low velocities in the river channel. These low velocities result from the flat nature of the catchment and the tide gates at Brooklands.

Consultation with farmers on the floodplain west of Brooklands and Kaputone Creek revealed that their prime 'flooding' concern is the inconvenience of frequent waterlogging and inundation of riparian margins rendering this land unsuitable for grazing. These issues are considered operational in nature and have not been addressed in the SMP because their influence on peak flood levels during major events is relatively minor. However, options such as dredging the channel bed are being considered by Council asset management staff.

9.4 Tidal Flooding

Environment Canterbury has installed a large double-hinged tide-gate structure in the Waimakariri River stopbank across the Pūharakekenui / Styx River northwest of Brooklands. The purpose of the structure is to isolate the Brooklands ponding area from extreme high tides propagating up the Waimakariri River from the sea. Storm runoff from the catchment is held back behind the tide-gates when they are closed at high tide and discharges to the sea during low tides. Rudimentary calculations indicate that the tide-gates have the capacity to discharge a high flow rate through the structure with minimal head loss.

Modelling indicated that the design duration for maximum depth and extent of ponding at Brooklands occurred after 48 hours (i.e. four tide cycles). The tide-gates operate efficiently and are in good condition (see photo opposite).

Pūharakekenui / Styx River Tide-Gates at Brooklands

9.5 High Risk Stormwater Sites

Industrial Land Use

The environmental management practices at existing and new industrial sites within the Pūharakekenui / Styx River Catchment are a key issue in relation to protecting groundwater and surface water quality. Historical site practices with little or no contaminant management are well recognised as a significant contributor to environmental effects observed in both surface waterways and groundwater.

The existing area of the catchment zoned Business is 329 ha, much of which is still vacant land. The development scenario adopted for the SMP increases the Business area to 437 ha total. The industrial land under this scenario is located in a corridor extending between Main North Road and the railway line north-east of Belfast Road to Chaneys and Kainga.

The SMP provides for the treatment and detention of stormwater runoff from new industrial land and retrofit facilities for most of the runoff from existing industrial land. The water quality of stormwater discharges from industrial sites into the Council's network will need to be of a quality that does not inhibit Council's ability to meet the receiving environment objectives. Some on-site treatment will almost always be necessary to pre-treat runoff. Sites that are unable to achieve this standard will be required to apply to Environment Canterbury for their own discharge permit.

The Hazardous Substances and New Organisms (HSNO) Act 1996, which replaced the Dangerous Goods Act, has significantly increased the requirements for more appropriate management, storage, and handling of hazardous substances. Industrial sites, in particular new sites, are significantly improving their site and environmental management practices.

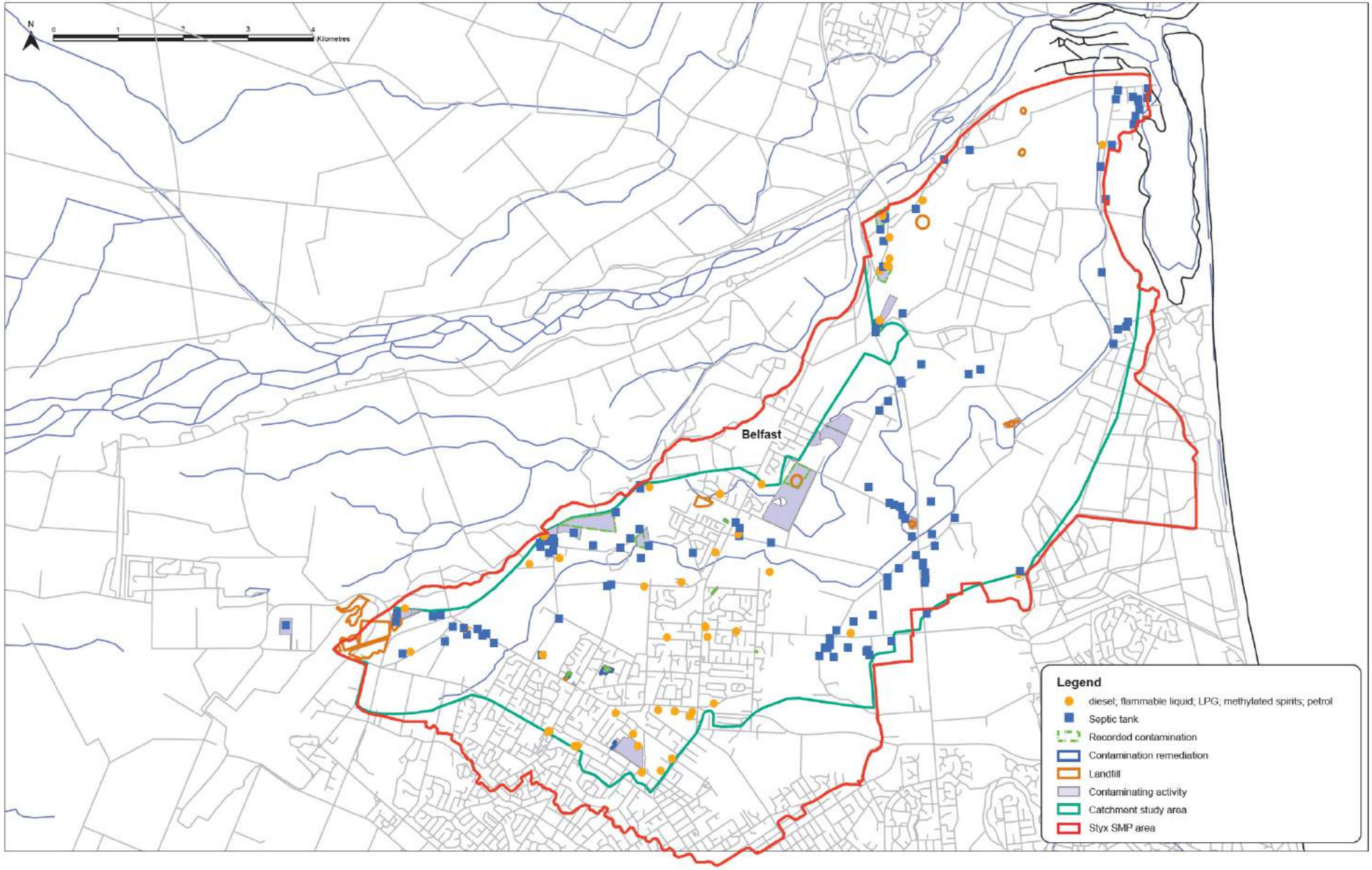
The improvement of site and environmental practices of existing industrial sites, in particular the older sites, are well recognised as a significant opportunity to improve environmental quality within the Pūharakekenui / Styx River Catchment. The Council is interested in working closely with Environment Canterbury in identifying key sites that both organisations can further promote and enforce appropriate practices and source control where required. This can be achieved through Council supporting Environment Canterbury's existing Pollution Prevention Guide programme by providing additional resources. In addition, Council will work with Environment Canterbury to identify higher risk industrial sites, and conditions of the stormwater discharge consent will ensure industrial stormwater discharges into the Council's stormwater network are managed appropriately.

Industrial Site Management

The environmental management practices at existing and new sites within the catchment are a key issue in relation to protecting groundwater and surface water quality. Kāpūtahi / Kaputone Creek and the Johns Road industrial areas (amongst other historic areas) are recognised as significant contributors to detrimental environmental effects.

Belfast has a long history of freezing works and other 'wet' industries processing agricultural products. These industries have been located east of old Belfast between the Main North Railway Line (for transport convenience) and beside Kāpūtahi / Kaputone Creek (for waste and stormwater discharge convenience). In recent decades the Belfast freezing works has discharged treated wastewater into the Waimakariri River to the north, but stormwater from the sites has continued to discharge untreated to Kāpūtahi / Kaputone Creek . The existing agricultural industries have scaled down their operations in the last decade and improved stormwater site control. As a consequence, the amount of polluted stormwater discharge to Kāpūtahi / Kaputone Creek has reduced.

It is proposed that all new industrial land will be treated and detained and retrofit facilities will be installed for most of the runoff from existing industrial land. A standard industrial pre-treatment device favoured by Council is a conveyance swale located in the sites landscaping strip. The swale requires a shutoff mechanism to trap any spillages before they enter the stormwater network.


N
0
1
2
3
4
Kilometres
Belfast
Legend
diesel; flammable liquid; LPG; methylated spirits; petrol
Septic tank
Recorded contamination
Contamination remediation
Landfill
Contaminating activity
Catchment study area
Styx SMP area

10.0 Contaminant Load Model / Wāhi Paitini

A key aspect of integrated catchment management is the management of stormwater contaminants over time. Modelling the generation of contaminants in catchment allows assessment of changes in land use and various treatment options on contaminant loads. This allows forecasting of the likely need for controls that may be required to manage contaminants to appropriate levels and thereby ensuring that changes in catchment land use over time do not result in significant increases in contaminant loads. Significant increases in contaminant loads may have adverse effects on downstream environments.

Contaminant loads and water quality predictions were calculated for the following nodes within the catchment:

- Pūharakekenui / Styx River at Gardiners Road;
- Smacks Creek;
- Pūharakekenui / Styx River at Main North Road;
- Horners Drain;
- Kāpūtahi / Kaputone Creek at Belfast Road;
- Pūharakekenui / Styx River at Marshland Road;
- Pūharakekenui / Styx River at tide-gates; and
- Wilsons Drain.

The model assessed two development scenarios:

- Existing development as at 2003; and
- Future development (2057) based on the RPS Proposed Change 1.

The model assessed three mitigation options:

- Option 1 – Dry sedimentation ponds;
- Option 2 – Dry sedimentation ponds with wetlands (as described in the SMP); and
- Option 3 – Dry sedimentation ponds with filtration systems (StormFilters®).

The model predicted modest increases in contaminant loads and changes in water quality as a result of development (and including treatment under Options 1-3). All treatment options were predicted to provide a sound level of mitigation based on estimated water quality in the lower reaches of the river. However, in the upper reaches of the river, water quality is generally predicted to require a higher level of treatment than the pond only option (Option 1).

The contaminant loads assessment confirmed therefore that the proposed SMP (Option 2) is the appropriate option for implementation because it will provide an appropriate level of contaminant removal that will enable Council to meet the receiving environment objectives. As an additional separate exercise to the main model, dry sedimentation ponds with wet ponds were also assessed. At some specific facility sites (list as per SMP) wet ponds are proposed in the SMP because of site constraints.

Timber stored adjacent to Smacks Creek

11.0 Stormwater Management Plan (SMP) Mahere Wai āwhā

In order to meet stormwater discharge consent requirements set by ECan, the Council has developed the Pūharakekenui / Styx SMP (seperate to this document), to maintain and where appropriate improve existing water quality in the receiving waters in the face of the urban growth expected. For each facility the stormwater quality treatment train downstream of new and existing urban areas will comprise of an off-line sedimentation basin followed by a constructed wetland (or constructed wet pond). General stormwater detention is provided by shallow back flooding over wetlands during infrequent storms.

Implementation of the SMP will be undertaken over a long period (35 years or more). The projection assumes that the construction of facilities (and associated expenditure) will be variable due to other planning and infrastructure constraints which impact on land development staging. The programme for the design and construction of facilities will need to be closely aligned with associated planning and infrastructure programmes, to ensure facilities are created ahead of land development.

The Canterbury earthquakes have resulted in some significant alterations to the urban limits and thus some unforeseen projects have emerged associated with the Prestons and Highfield subdivisions. These large subdivisions will provide much of the stormwater infrastructure as part of their developments which will be vested with the Council in due course. Council will require that they conform to this SMP. The same is true of the other major subdivisions such as Belfast Park and Applefield Devondale prior to the earthquakes. Generally speaking, partial detention is to be provided via first flush basins and then back flooding within wetlands.

11.1 Facilities and Devices

11.1.1 Existing Facilities

There are a several major structures in the catchment which are relevant to stormwater management and flood risk. These include the river tide-gates, Winters Road Retention Basin, Cranford Basin and Horners Drain. In addition, there is a control gate on the Winters Road Retention Basin and pump station 219 in Cranford Basin.

The river tide gates are large double-hinged gates which were installed by ECan and are located in the Waimakariri River stop bank northwest of Brooklands. They are designed to isolate the lower Pūharakekenui / Styx River floodplain from tidal inflow up the river from Brooklands Lagoon. According to the Council the tide gates operate efficiently and are in good condition. The Council calculates that the tide-gates have the capacity to discharge a large volume of floodwater with minimal head loss through the structure.

Modelling indicates that the design storm duration for maximum depth and extent of ponding in the lower floodplain occurred after a 48 hour design storm event (4 tide cycles).

Winters Road Detention Basin was built in 1981 on private farmland on the corner of Winters and Philpotts roads. The basin is 4.36 ha in area with a storage capacity of at least 50,000 m³. This basin is used to provide detention for flows which would otherwise cause flooding particularly in Bullers Drain but also along Horners Drain depending on the setting of the control gate in Winters Drain.

Cranford Basin sits as a sub-catchment between the Ōtakaro/Avon and Pūharakekenui / Styx rivers. Land gradients are such that water can be diverted from Cranford Basin catchment to the Pūharakekenui / Styx River or to the Ōtākaro/Avon River. The lowest part of Cranford Basin has a Pumping Station (PS 219) which takes water from the Dudley Creek Diversion as well as other local drainage and delivers it into the Ōtākaro/Avon River. The levels are such that it would be possible to create a channel from the

pumping well at PS 219 and deliver water to the Pūharakekenui / Styx River via Horners Drain.

The basin is in the mid reaches of the Ōtākaro/Avon River and Pūharakekenui / Styx River catchments and has the potential to provide detention to protect downstream Avon/Ōtakaro and/or Pūharakekenui / Styx rivers from flooding effects as well as retro-fitting of stormwater treatment from its own catchment.

There is a current proposal to create an extension of the Northern Arterial motorway through the basin between Cranford Street and QEII Drive. This will create a demand for compensatory storage and stormwater treatment facilities to mitigate the effects of this development. There are also zoned but undeveloped areas around Cranford Basin which could benefit from compensatory storage being provided in the basin.

The basin itself was created by the settlement of a deep layer of peat that is continuing to settle to the point that it is becoming impractical for its historic horticultural uses to continue. By stopping the continual drainage and drying out of the ground necessary for horticulture and allowing the groundwater level to come nearer to the surface, the settlement would likely be arrested and the area would thus stabilise and perform an important hydrological function for the future. The basin could be developed as a surface water management area providing significant environmental benefits. Peripheral developments with stormwater treatment and detention in the basin will then be more feasible.

It is clear that competing interests and the proximity to the centre of Christchurch make the process of finalising a plan for Cranford Basin quite a challenge. However, the tools are now available by way of computer models to assess a range of options and refine designs.

Horners Drain extends north from Winters Road and joins the Pūharakekenui / Styx River near the Kāpūtahi / Kaputone Creek confluence at Marshland Road. It is a timber and concrete lined drain, and the deep concrete reach is a major challenge in terms of replacement and cost. The Council is working with the developers of the Highfield subdivision to realign parts of this drain and deliver water more directly to the Pūharakekenui / Styx River.

Horners Drain is currently a major restriction to discharges from the upper catchment and results in significant ponding on land east of the proposed Northern Arterial route and north of QEII Drive.

Kruses Drain collects flows from the large sub-catchment around the Northwood Shopping Centre and discharges into Horners Drain at a point about one quarter of the way from QEII Drive to the Pūharakekenui / Styx River. Horners Drain is on a very flat grade and so water discharged from Kruses Drain can flow both south along Horners Drain to the Ōtākaro/Avon River and/or north along Horners drain to the Pūharakekenui / Styx River. The control gate in Winters Road Drain - immediately downstream of the Horners/Winters Drain intersection - can be used to divert flows northward to the Pūharakekenui / Styx River via Horners Drain and thus limit the discharges to the Ōtākaro/Avon River via Bullers Drain. In the larger events this control gate can also divert flows into the Winters Road Detention Basin and thus minimise uncontrolled flooding along both Bullers and Horners drains.

11.1.2 New and Retrofitted Facilities

Stormwater treatment methods and devices have been arranged from multi-value at the top to single value at the bottom of the Toolbox Treatment Hierarchy (Table 1). For any particular site, appropriate methods near the top of the table (multi-value) are preferred to single value methods lower down the table. The toolbox table lists only the 'structural' or engineering methods considered in this SMP. Other engineering methods such as green roofs, for example, have been used elsewhere. However, 'green roofs' have not been included in the Toolbox because they have not been assessed in the SMP technical studies for potential coverage and subsequent benefit.

11.1.3 Contribution to Six Values

The Pūharakekenui / Styx SMP has been prepared with consideration of its contribution to the six values and is considered to be consistent with the vision for the river and its tributaries.

Treatment Basin at Redwood Springs

Method	Constraints	Suitable Location	Catchment Size	Number of values supported
Waterway restoration	Habitat limiting waterways	Public land beside streams		6
Wetland	Space required. Proximity to houses	New growth area.	Large	6
Sedimentation basin	Space required. GWL*>1m	New growth area. Confined aquifer.	Large	4
Soil adsorption basin	Space required. GWL>2.5m	New growth area. Unconfined aquifer.	Large	5
Stormwater tree pit	Clogging after 20 years. GWL> 1m	Central City avenues	Small	4
Rain garden	GWL>0.6m	Streets retrofit	Medium	4
Wetland swale	Width required	High GWL, low gradient sites	Small/medium	3
Dry swale	Width required. GWL>1m	Wide roads. Industrial sites.	Small/medium	2
Permeable pavement	Light traffic. Clogging.	Street parking bays. On-site parking.	Small	1
Waterway sediment removal	Site access. Sediment disposal.	In-line weirs and ponds	Large	2
Propietary filtration devices	Minimum head loss	Busy roads. Industrial sites.	Small/large	1
Vacuum street sweeper	Low interception. Not available in NZ.	Busy intersections		1
Street sump cleaning	Low interception	Busy intersections		1
Stormwater tank	Flow attenuation rather than treatment	Residential intensification	Small	1

*GWL = groundwater level

11.2 Source Controls

Preventing or minimising stormwater contamination at source is generally the most effective and efficient way of avoiding adverse effects on the receiving environment. 'End-of-pipe' measures alone will not deliver the improvements desired in receiving water quality and consideration needs to be given to contamination generating activities and to non-structural controls.

Non-structural controls include source controls, monitoring and enforcement, the 2014 Water Supply, Wastewater and Stormwater Bylaw, education and working with industry. Contamination activities and potential non-structural controls are listed in the table on the opposite page. Non-structural controls benefit all six values by minimising adverse effects on waterways.

11.3 Non-Structural Approaches to Management of Industrial Site Discharges

It is recognised that management of stormwater discharges from industrial sites is a key issue in relation to protecting water quality in the SMP Area. Belfast has a history of freezing works and other industries processing agricultural products which discharge untreated stormwater to waterways such as Kāpūtahi / Kaputone Creek, although in recent years these activities have scaled down resulting in a reduction in the amount of untreated stormwater being discharged to Kāpūtahi / Kaputone Creek.

The water quality of stormwater discharges from industrial sites into the Council network is required to be equivalent to the discharge from residential areas, which is likely to almost always involve some on site pre-treatment prior to discharge to the network. Where the necessary standard cannot be met, the particular site will need to apply directly to ECan for a separate stormwater discharge permit.

Removing industrial sites from the Pūharakekenui / Styx SMP consent will be an action of last resort. This approach to industrial site management will ensure in the medium term that industrial stormwater discharges will improve and become more reflective of residential or commercial stormwater quality.

Activity	Contaminants	Present Controls	Potential Controls	Control Mechanisms
Roofs	Zinc, copper	Preference for colorsteel™ (residential). Move toward zincalume™ (industrial).	Treatment of runoff from zinc and copper surfaces.[1]	1. SMP consent condition. 2. Revised Stormwater Bylaw 2014.
On-road construction	Sediment	Erosion and Sediment Control Plans (ESCPs)	Treatment de-vices for all significant road reconstruction.	1. Interim Global Stormwater Consent conditions. 2. Construction Std. Spec. Pt 1 s. 18 & CCC std. spec re ESCP.
Building sites	Sediment	ESCP required but difficult to enforce	More site inspections	1. Building Consent. 2. SMP condition for building sites.
Subdivisions and major earthworks	Sediment	ESCP required	More site inspections	Subdivision consent
Commercial discharges onto street	Detergent, cleaners, chemicals, food and drink	Monitoring by Trade Waste team and re-porting to ECan.	1. Washdown water captured by sewer. 2. On-street treatment devices in high risk areas	Automatic valve switching between stormwater and sewer.
Vehicles	Copper and zinc	1. Occasional sump cleaning. 2. Street sweeping.	1. More sump cleaning & vac-uum sweeping. 2. Copper free brake linings.[2]	1. CCC operations contracts. 2. National initiative needed via Ministry of Transport.
Spills	Various	ECan/CCC procedures	Review procedures	
Air discharges	Various	ECan consents		pLWRP rules
Industrial	Chemicals, hydrocarbons, litter, particles, dust	Trade Waste Bylaw	More treatment on site.	Trade Waste Bylaw
Litter	Visual, ingestable solids trapped by wrappings, BOD	Sump grates & street sweeping	1. More street sweeping. 2. Education pro-gramme.	On-going education programme
Residential waste products	Oil, paint, car washdown, herbicide	Water Related Services Bylaw	1. Revised Stormwater Bylaw 2014. 2. Education programme.	On-going education programme
Animals and waterfowl	Nutrients, bacteriological	Limited control of Canada Geese	Maintain control of exotic water fowl numbers	River bank and riparian vegetation design
Wastewater discharges	Nutrients, bacteriological	Overflow reduction programme to meet Ecan consent conditions	Maintain overflow reduction programme	1. ECan consent. 2. Wastewater Recovery Programme.

[1] The contaminant load model run for the Avon catchment estimates that approximately half of zinc comes from roofs.

[2] Up to 75% of copper in Auckland stormwater comes from vehicles.

12.0 References / Kōhiko Kōrero

ANZECC 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Boffa Miskell 2007. Belfast Integrated Catchment Management Study: Aquatic Ecology. Report prepared for the Christchurch City Council. August 2007.

Christchurch City Council 2000. The Styx Vision 2000 – 2040.

Christchurch City Council 2009. Christchurch City Council Surface Water Strategy 2009 – 2039.

Christchurch City Council 2012a. Styx Stormwater Management Plan Part B: Blueprint for Surface Water Management. August 2012.

Christchurch City Council 2012b. Christchurch Rivers Water Quality Monitoring Annual Results Summary May 2011 – April 2012. Prepared by Zoë Dewson, Waterways Planner Ecologist, City Environment Group, Christchurch City Council.

EOS Ecology Ltd, Aquatic Ecology Ltd, Kingett Mitchell Ltd 2005. Aquatic values and management, South-West Christchurch integrated catchment management plan technical series, Report No. 3, July 2005.

GHD 2007. Report on Belfast Area Plan: Infrastructure Analysis and Costing. Area Revision. Report prepared by GHD for Christchurch City Council. August 2007.

Golder 2008. Planning and Consents Protocol for Surface Water Management. Catchment-wide Consents for Stormwater Discharges. Report prepared by Golder Associates (NZ) Limited for Christchurch City Council and Environment Canterbury.

Golder 2009a. Metal Concentrations in the Styx River Catchment 2007-2008. Report prepared for Christchurch City Council by Golder Associates (NZ) Limited. June 2009.

Golder 2009b. Styx River Sediment Study. Report prepared for Christchurch City Council as part of the Styx Integrated Management Plan. June 2009.

Golder 2009c. Styx River Ecology Survey Extension (Stage 2). Report prepared for Christchurch City Council by Golder Associates (NZ) Limited as part of the Styx Integrated Management Plan. November 2009.

Golder 2011. Stormwater Management Plan for South-West Christchurch. Prepared for Christchurch City Council by Golder Associates (NZ) Limited. August 2011.

Golder 2012a. Styx Stormwater Management Plan Part A: Investigations and Planning Framework. Report prepared for Christchurch City Council. October 2012.

Golder 2012b. Monitoring Programme for Styx River/ Pūharakekenui Stormwater Management Plan Version 1.0. Report prepared for Christchurch City Council by Golder Associates (NZ) Limited. August 2012.

Kennedy P, Gadd J 2003. Evaluation of road surface contaminant loadings in Waitakere City for the development of the vehicle fleet emission model-water. Report prepared by Kingett Mitchell Ltd for Ministry of Transport, December 2002. Revised October 2003.

Kennedy P, Sutherland S 2008. Urban sources of copper, lead and zinc. Prepared by Golder Associates (NZ) Limited for Auckland Regional Council. Auckland Regional Council Technical Report 2008/023.

Main, M. 2008. An Analysis of Water Quality Data in Christchurch City Waterways and the Standards in the Proposed Natural Resources Regional Plan. Report prepared for Christchurch City Council by AEL Limited. AEL Report No. 58.

PDP 2006. Assessment of Potentially Contaminated Sites and Issues for Land Development in the Belfast Area. Report prepared by Pattle Delamore Partners Ltd for Christchurch City Council. January 2006.

PDP 2008. Groundwater Assessment for Belfast Area Plan and Styx Catchment. Report prepared by Pattle Delamore Partners Ltd for Christchurch City Council. July 2008.

PDP 2009. Addendum to the Assessment of Potentially Contaminated Sites and Issues for Land Development in the Belfast Area. Report prepared by Pattle Delamore Partners Ltd for Christchurch City Council. March 2009.

Renard T, Meurk C, Phillips C, Ferriss S, Barrabe A 2004. Land Cover and Land Use Mapping of the Styx River Catchment, April 2003-June 2004. Landcare Research. Lincoln. October 2004.

Te Rūnanga o Ngāi Tahu 1999. Freshwater Policy.

Tonkin & Taylor 2007. Land stability assessment for the Belfast Area Plan. Report prepared by Tonkin & Taylor Limited for Christchurch City Council. March 2007.

USEPA 2006. National recommended water quality criteria. United States Environmental Protection Agency, Office of Water.

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