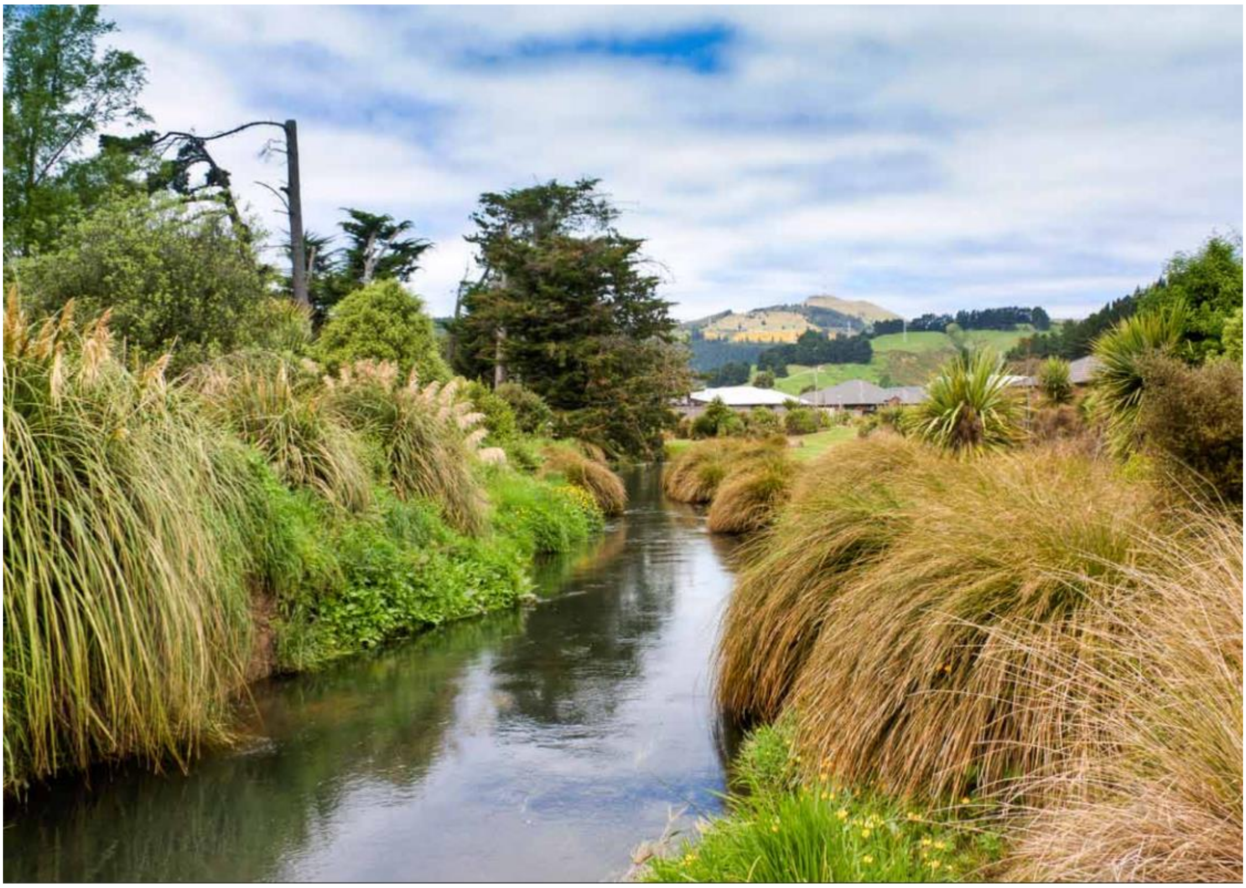
HURITINI-HALSWELL RIVER

Stormwater Management Plan



December 2021

Huritini-Halswell River

Stormwater Management Plan

Three Waters & Waste Unit
Christchurch City Council

Revision April 2025

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Version History

Version number	Version purpose	Date	File reference
1	Huritini-Halswell SMP adopted by Council November 2021 and delivered to Environment Canterbury.	December 2021	20/728012
2	Revised with corrections and additions requested by Environment Canterbury.	February 2024	22/409204
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List of Acronyms

Acronym	Definition
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average recurrence interval
BPO	Best Practicable Option
CCC	Christchurch City Council
CHI	Cultural Health Index
CLM	Contaminant Load Model
CSNDC	Comprehensive Stormwater Network Discharge Consent 2019
DIN	Dissolved Inorganic Nitrogen
DRP	Dissolved Reactive Phosphorus
ECan	Environment Canterbury
E. coli	*Escherichia coli*
GIS	Geographic Information System
GWL	Groundwater Level
HAIL	Hazardous Activities and Industries List
IPCC	Intergovernmental Panel on Climate Change
ISQG	Interim Sediment Quality Guidelines
LDRP	Land Drainage Recovery Programme
LLUR	Listed Land Use Register
LTP	Long Term Plan
LWRP	Land and Water Regional Plan
ppb	parts per billion
PAH	Polycyclic Aromatic Hydrocarbon
QMCI	Quantitative Macroinvertebrate Community Index
RL	Reduced Level (CCC Datum)
RMA	Resource Management Act
SMP	Stormwater Management Plan

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Maps

It is anticipated that the SMP will mostly be viewed on-screen. Map definition enables detail viewing with zoom-in. Maps are in A4 format to facilitate printing.

1.0 Executive Summary

Water quality and ecological health have declined in the Huritini-Halswell River and tributaries as a result of urban development. Contaminants of concern to waterways include copper, sediment and zinc. Metals in stormwater can harm many instream species, sediment smothers habitat for biota and can be anoxic or contaminated. The ecological health of most waterways in this catchment is classified as poor.

The cultural health of the catchment is also poor. Food gathering sites contain are affected by pollution and other indicators of cultural degradation and modification are also widespread. Low scores for indigenous vegetation diversity and cover are commonplace, and coastal and estuarine sites typically contain limited native vegetation in the riparian zone, which is often dominated by exotic species.

The Christchurch City Council has developed a Stormwater Management Plan (SMP) for the Huritini-Halswell River to comply with conditions of the Comprehensive Stormwater Network Discharge Consent 2019. The goal of the Consent is progressive stormwater improvement. Part of the task of progressive stormwater improvement will occur through the SMP and part will be effected through a future Strategic plan for surface water (SPSW) c2022. This is because funding for some stormwater improvements cannot be confirmed in time for the delivery of the SMP but will occur later through the statutory processes of the Long Term Plan.

In combination the SMP and SPSW will set out methods the Council will implement to progressively improve stormwater toward meeting standards and receiving environment targets in the consent. Mitigation strategies have been considered for stormwater contaminants that regularly exceed water quality targets and cause poor stream health, principally metals and sediment.

The preferred strategy, looking to the future, is that the Council prioritise the control of contaminants at source. This should principally occur through education and regulation. Capture and treatment of contaminants (where necessary) will be implemented as close to source as practicable and operational methods such as street sweeping will be used in situations where they can be effective.

Stormwater treatment systems and operational activities will play a part in water treatment, depending on the outcome of efficiency investigations. Stormwater detention basins will continue to have a dual role in improving water quality and slowing urban runoff. Planning measures, source control techniques, education and enforcement also need to be part of an integrated strategy.

Under the SMP the Council will:

- Continue to build or require facilities to mitigate the quality and quantity effects of urban development.
- Ensure the quality of stormwater from all new development sites or re-development sites is treated to best practice, and control sediment from of consented construction activities
- Consult with key stakeholders to identify a long term zinc strategy consistent with current technologies.
- Collaborate with local and regional government in a joint approach to central government seeking national measures and industry standards to reduce the discharge of building and vehicle contaminants.

- Investigate the feasibility of a District Plan rule to discourage the use of copper and zinc claddings.

The SMP programme will contribute over time, with other strategies, toward delivering on Ngāi Tahu and Regional Plan objectives by stopping some contaminants from entering rivers and streams. However, waterway restoration, sediment removal and riparian planting (for temperature control, bank stability, shading, ecological habitat and recreational uses) also need to occur to create a healthy environment. These measures are not part of the SMP programme.

The strategy for managing floodplain effects is to prioritise the mitigation of growth effects through detaining and restricting increased stormwater runoff, and the avoidance of damage through elevating new floor levels.

The Stormwater Management Plan is scheduled for review in 2035.

Figure 1: Quaifes-Murphys Basin and Wetland

Section One
Plan Initiation

2.0 Background to the Stormwater Management Plan

2.1 Purpose and Scope

The purpose of an SMP is defined in condition 6 of the Comprehensive Stormwater Network Discharge Consent (CSNDC), CRC252424, and includes contributing to meeting contaminant load reduction standards, setting (and meeting) additional contaminant load reduction targets and demonstrating the means by which stormwater discharges will be progressively improved toward meeting receiving environment objectives and targets.

The aim of the CSNDC is to limit the adverse effects of stormwater discharges on surface and groundwater quality and quantity. The CSNDC promotes progressive water quality improvement toward targets in the Land and Water Regional Plan through the use of best practicable options for stormwater quality improvement and peak flow mitigation.

Stormwater management plans (SMPs) set out the means by which the Council will comply with the conditions in the CSNDC. The SMP is given effect through the Council's Long Term Plan (LTP), which is a statutory process. Governance processes do not permit the SMP to address all environmental improvement outcomes signalled in the consent. The relative timing of LTP processes and the SMP do not permit this SMP to commit to unfunded, new initiatives that would achieve aspirational outcomes for waterway health and biodiversity improvement.

The Council proposes to respond to the CSNDC by adding a second stream of improvement planning:

COMPLIANCE STREAM	***IMPROVEMENT STREAM***
Comprehensive Stormwater Network Discharge Consent (standards and targets)	Integrated Water Strategy 2019 (aspirations, improvements)
⇩	⇩
Stormwater Management Plan	**a strategic plan for surface water** (commencing early 2022)
⇩	⇩
A plan to meet standards and targets set by consent conditions to limit stormwater contaminant discharges	A plan identifying best practicable options to deliver at-source contaminant control and desired improvements in ecology and stream health over the long term.
⇩	⇩

Both plans inform and are funded through the **Long Term Plan**

The SMP process includes:

1 Identify the existing state of the environment in the catchment.
2 Identify the contributions by existing and future activities to stormwater quality and quantity.
3 Estimate trends from urban growth, technology, lifestyle, climate, etc on water quality and quantity.
4 Devise a suite of measures (including planning, education, enforcement, source control, etc as funded in the LTP) to control or mitigate effects.
5 Confirm the effectiveness of chosen mitigation measures through contaminant load and flood modelling, to determine the best strategy for the consent targets to be met.

The Strategic Plan for Surface Water process includes:

6 Prepare a plan that will permit the CCC to meet or exceed consent condition targets.
7 Engage with Council teams and external stakeholders responsible for contaminant generating activities; obtain agreement about control measures.

2.2 Area Scope

This Stormwater Management Plan is one of seven plans being prepared over the period 2020 to 2024 for the Ōpāwaho-Heathcote, Huritini-Halswell, Pūharakekenui-Styx, Ōtākaro-Avon, Ihūtai-Estuary and Coastal, and Ōtukaikino catchments and Settlements of Te Pātaka-o-Rākaihautū/Banks Peninsula.

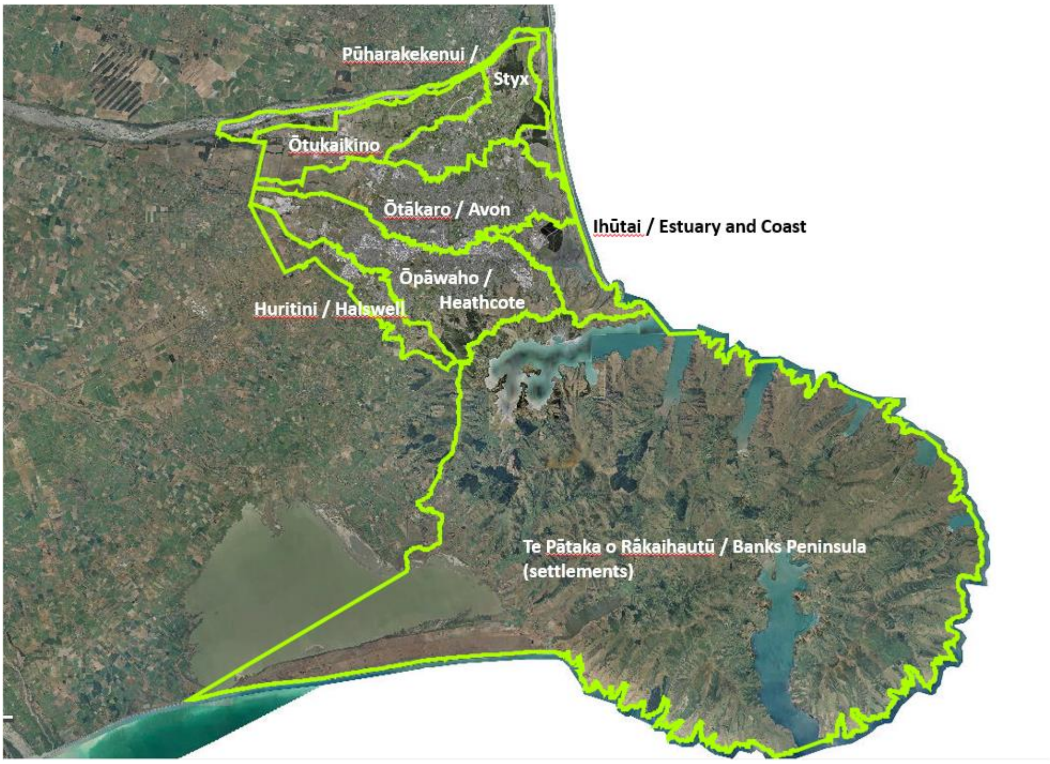

Figure 2: Area covered by the Comprehensive Stormwater Network Discharge Consent

2.3 Regional Planning Requirements

2.3.1 Canterbury Regional Policy Statement

The Canterbury Regional Policy Statement (CRPS) sets out how natural and physical resources are to be sustainably managed in an integrated way. The needs of current and future generations can be provided for by maintaining or improving environmental values. The CRPS requires that objectives, policies and methods are to be set in regional plans, including the setting of minimum water quality standards.

2.3.2 Land and Water Regional Plan

The Land and Water Regional Plan 2015 encourages the development of stormwater management plans under Rule 5.93. The intention of the rule is that SMPs will be developed to show how local authorities will meet the relevant policies on water quality.

2.3.3 Greater Christchurch Urban Development Strategy

The Greater Christchurch Urban Development Strategy (UDS) Partnership has been working collaboratively for over a decade to tackle urban issues and manage the growth of the City and its surrounding towns.

The strategy was prepared under the Local Government Act 2002 and it is to be implemented through various planning tools, including:

- Amendments to the Canterbury Regional Policy Statement (CRPS);
- Changes to regional and district plans to reflect the CRPS changes;
- Stormwater planning to give effect to the LWRP; and
- Outline Development Plans for new development areas (‘Greenfield areas’) and existing re-development areas (‘Brownfield areas’).

Preparation of this SMP plays a role in implementing the UDS.

2.3.4 Non-Statutory Documents

- Integrated Water Strategy 2019
- Strategic Plan for Surface Water c2022 (to be developed)
- Mahaanui Iwi Management Plan 2013
- Ngāi Tahu Freshwater Policy Statement (Te Rūnanga O Ngāi Tahu 1999)
- Infrastructure Design Standard (Christchurch City Council 2010)
- Waterways, Wetlands and Drainage Guide (Christchurch City Council 2003)
- Greater Christchurch Urban Development Strategy (UDS) (Christchurch City Council 2007)

2.4 The Council’s Strategic Objective for Water

The Christchurch City Council has adopted Community Outcomes to promote community wellbeing. The Water Outcome is expressed as:

Healthy water bodies	**“**Surface water quality is essential for supporting ecosystems, recreation, cultural values and the health of residents.”

2.5 The District Plan

The Christchurch District Plan promotes responsible stormwater disposal through.

Policy 8.2.3.4 – Stormwater Disposal, which states:

a. District wide:
    i. Avoid any increase in sediment and contaminants entering water bodies as a result of stormwater disposal.
    ii. Ensure that stormwater is disposed of in a manner which maintains or enhances the quality of surface water and groundwater.
    iii. Ensure that any necessary stormwater control and disposal systems and the upgrading of existing infrastructure are sufficient for the amount and rate of anticipated runoff.
    iv. Ensure that stormwater is disposed of in a manner which is consistent with maintaining public health.
b. Outside the Central City:
    i. Encourage stormwater treatment and disposal through low-impact or water-sensitive designs that imitate natural processes to manage and mitigate the adverse effects of stormwater discharges.
    ii. Ensure stormwater is disposed of in stormwater management areas so as to avoid inundation within the subdivision or on adjoining land.
    iii. Where feasible, utilise stormwater management areas for multiple uses and ensure they have a high quality interface with residential activities or commercial activities.
    iv. Incorporate and plant indigenous vegetation that is appropriate to the specific site.
    v. Ensure that realignment of any watercourse occurs in a manner that improves stormwater drainage and enhances ecological, mahinga kai and landscape values.
    vi. Ensure that stormwater management measures do not increase the potential for bird-strike to aircraft in proximity to the airport.
    vii. Encourage on-site rain-water collection for non-potable use.
    viii. Ensure there is sufficient capacity to meet the required level of service in the infrastructure design standard or if sufficient capacity is not available, ensure that the effects of development are mitigated on-site.

Policies 8.9.2.2 and 8.9.2.3 make earthworks subject to a consent. Conditions of consent for earthworks over a threshold include the requirement for an Erosion and Sediment Control (ESC) Plan. An ESC Plan is submitted and approved with a consent application and its implementation is verified by building consent officers.

2.6 South-West Area Plan

The South-West Area Plan provides a framework within the UDS for managing urban and business growth in South-West Christchurch. It was developed with community input, and sets out the visions, goals and objectives for growth in South-West Christchurch over 35 years. These visions, goals and objectives have been incorporated into the development of this SMP in relation to predicted land use and integrated surface water management.

2.7 Bylaws

The reviewed Stormwater and Land Drainage Bylaw 2022 restricts discharges of any material, hazardous substance, chemical, sewage, trade waste or other substance that causes or is likely to cause a nuisance, into the stormwater network. Minimum standards can be applied by resolution of the Council.

The Traffic and Parking Bylaw 2017 requires that any material or debris deposited on the road must be removed as soon as practicable. The Council may give any person who has deposited material or debris on a road notice to remove that material or debris. If the person does not comply, the Council may undertake the work and recover all costs from that person.

2.8 Integrated Water Strategy

Objectives 3 and 4 of the Christchurch City Council's draft Integrated Water Strategy are summarised as "enhancement of ecological, cultural and natural values and water quality improvement." The preferred Strategy option for achieving the objectives is to "continue … the implementation of the current approach to stormwater management (embodied by the development of the Stormwater Management Plans) …"

2.9 Mahaanui Iwi Management Plan

The Mahaanui Iwi Management Plan "… is an expression of kaitiakitanga and rangatiratanga…(It) provides a values-based, … policy framework for the protection and enhancement of Ngāi Tahu values, and for achieving outcomes that provide for the relationship of Ngāi Tahu with natural resources across Ngā Pākihi Whakatekateka o Waitaha and Te Pātaka o Rākaihautū (the Canterbury Plains and Banks Peninsula)". The Huritini-Halswell SMP acknowledges the Iwi Management Plan policies and can contribute to policies which fall within the scope of a stormwater management plan. There is more detail in section 10.4.

2.10 Infrastructure Design Standard

The Infrastructure Design Standard 2016 (IDS) is the Council's development code and is a revision of the Christchurch Metropolitan Code of Urban Subdivision 1987. The IDS promotes environmental protection via a values based design philosophy and consideration of bio-diversity and ecological function (5.2.3 Four Purposes)

2.11 Goals and Objectives for Surface Water Management

The Huritini-Halswell SMP is consistent with the *Integrated Water Strategy 2019* which identifies overall goals and objectives for surface water management, and supports so far as is practicable the *Mahaanui Iwi Management Plan* objectives for Te Waihora catchment (see Jolly et al, 2013).

The Council's high-level goals in the integrated water strategy are to:

Goal 1: The multiple uses of water are valued by all for the benefit of all

Goal 2: Water quality and ecosystems are protected and enhanced

Goal 3: The effects of flooding, climate change and sea level rise are understood, and the community is assisted to adapt to them

Goal 4: Water is managed in a sustainable and integrated way in line with the principles of kaitiakatanga

Te Rūnanga o Ngāi Tahu Freshwater Policy (Ngāi Tahu, 1999) lists several water quality and water quantity policies that apply throughout the Ngāi Tahu Takiwā. The *Iwi Management Plan* listed objectives for Te Waihora catchment are directly relevant to the Huritini-Halswell SMP. These are:

8) The cultural health of lowland waterways is restored, through the restoration of water quality and quantity and riparian margins.
11) The discharge of contaminants to the lake and waterways in the catchment is eliminated.

The CSNDC Environmental Monitoring Programme (EMP) will assess the ecological and cultural health of waterways and coastal areas, and therefore the success of the Huritini-Halswell SMP. The EMP assesses a range of parameters, such as macroinvertebrates, macrophytes, periphyton, siltation and a range of water quality parameters, and compared these against relevant guideline levels.

The SMP programme will contribute toward delivery on these objectives through improving water quality in the rivers and streams. Other plans and programmes must play a part in restoring riparian margins, and protecting and restoring springs and mahinga kai site in order to deliver on Tangata whenua and LWRP objectives.

Stormwater quantity effects considered in this SMP include mitigation of additional runoff generated by urban intensification and the reduction in network level-of-service in the east of the catchment as sea levels rise over the SMP planning period.

Other sources and reports on the Huritini-Halswell catchment that have informed the SMP include:

- State of the Takiwā;
- Surface water and sediment quality monitoring;
- Contaminated sites database (ECan);
- Groundwater and springs study;
- Ecological survey;
- Review of flood management matters through the various chapters of the District Plan.
- Contaminant load model;

The stormwater management plan provides a direction for surface water management for the duration of the Comprehensive Stormwater Network Discharge Consent.

Water quality has been the primary focus of investigations. To make a difference to the existing fair to poor water quality in receiving waters, it will be necessary to not only mitigate any adverse effects from new urban growth, but also implement stormwater quality mitigation measures in existing developed areas.

Flooding is controlled by the detention of all urban stormwater and the effects of flooding are controlled by requiring developed land and buildings to be elevated above anticipated flood levels.

Figure 3: Quaifes-Coxs Wetland, Quaifes Road

3.0 Principal Issues

3.1 Water Quality and Ecological Health

All waterways in the project area are modified and affected significantly by rural or urban land use, including the depletion of groundwater. Overall, stream health is similar to that of other modified lowland streams in Canterbury and New Zealand, with lower ecological value compared to other waterways nationally. However, threatened and at risk species are present in the catchment, and these waterways should be protected and enhanced.

Te Waihora/Lake Ellesmere is the receiving environment for the Huritini-Halswell River. It is recognised as a wetland of international significance under a National Water Conservation Order, 1990. The lake supports a commercial eel fishery. The seasonal nature of lake openings to the sea increases the vulnerability of Te Waihora as the receiving environment for a range of contaminants.

3.2 The Halswell District Drainage Scheme

Because of the limited capacity of the Huritini-Halswell River system, the Halswell River Rating District experiences extended flood storage on low lying agricultural land. Ponded water drains slowly. Ponding could increase and flood drainage is liable to occur more slowly as urban runoff increases.

3.3 Protecting Groundwater

The consent encourages the infiltration of stormwater into groundwater so that spring and base flows do not decline. However, downstream landowners do not want base flows to increase for reasons mentioned in section 3.2.

It is important to protect the quality of groundwater from infiltrating contaminants which can enter the Christchurch drinking water aquifers from this catchment.

Figure 4: Christchurch Boys High School Students and Lincoln University Waterwatch taking samples at Te Waihora. (source https://tewaihora.org/testing-the-water-at-te-waihora/)

Section Two
The Catchment

4.0 Catchment description

4.1 Overview

The “catchment” for the purposes of this SMP is the part of the Huritini-Halswell River catchment within Christchurch City. Its area spans most of the western fringe of the city, from the intersection of Chattertons and Langdales Roads north of Templeton to Old Tai Tapu Road where the Huritini-Halswell River leaves the city boundary. This area is 3800 hectares.

The catchment has a varied and sensitive water environment, characterised by the ephemeral upper reaches of tributaries and a number of constructed drains, natural springs, and ponding areas. The area includes Nottingham and Knights Streams and the suburbs of Wigram, Halswell, Cashmere, and Hornby. Headwaters of Huritini-Halswell River arise in

- Tail-water from a water race (and some land drainage water) in Marshs Road Drain
- Knights Stream, which is ephemeral above springs near Whincops Road,
- Nottingham Stream which is ephemeral above Muir Avenue.

There is a strong relationship between surface water and groundwater in Christchurch, particularly in South-West Christchurch, where groundwater flows from north-west of the city towards the Port Hills to emerge as the headwaters of the Huritini-Halswell and Ōpāwaho / Heathcote rivers.

4.2 Geography

The Huritini-Halswell River catchment has two distinct geological areas, the Port Hills and the Canterbury Plains.

The Port Hills are composed of bedded basalt flow and ash deposits that dip to the north-west that have been cross-cut with intrusive volcanic rock. The basalt and ash deposits are derived from the volcanoes that formed Banks Peninsula some 6 to 12 million years ago. The volcanic rocks are overlain by loess deposits deposited during the last hundreds of thousands of years. The limited interconnection of fractures within the basalt permits a minor amount of water movement. However, water emanating from the volcanic strata is reportedly often of poor quality due to high concentrations of dissolved solids (PDP 2003).

Surface geology of the Canterbury Plains in the Huritini-Halswell River catchment is dominated by unconsolidated gravel, sand, and silt. The gravels were deposited as sheet-like lobes by braided river channels, dating before European settlement, and represent the most permeable surface strata in Christchurch. Alluvial silt and sand occur throughout much of the area between the gravel lobes. The sand and silt represent over-bank deposits of river channels. In some places peat is present due to the accumulation of organic materials over the last hundreds of years. Deeper units host the aquifers which are in places confined by overlying fine-grained deposits.

The presence of a confining layer can act to protect the underlying groundwater resource. The thickness and lithological continuity of the confining layer defines three aquifer vulnerability zones within South-West Christchurch. These include:

- The eastern end of the study area, where the aquifers are confined and protected from the risk of contamination by the low permeability alluvial and marine strata.
- The transitional zone further to the west, which forms the majority of the study area, in which the uppermost confining layer is 1 m thick.
- To the west, where the upper most confining layer pinches out and the aquifers become more vulnerable to contamination from surface activities.

The confining layer also controls artesian groundwater pressures and limits the potential for infiltration of stormwater.

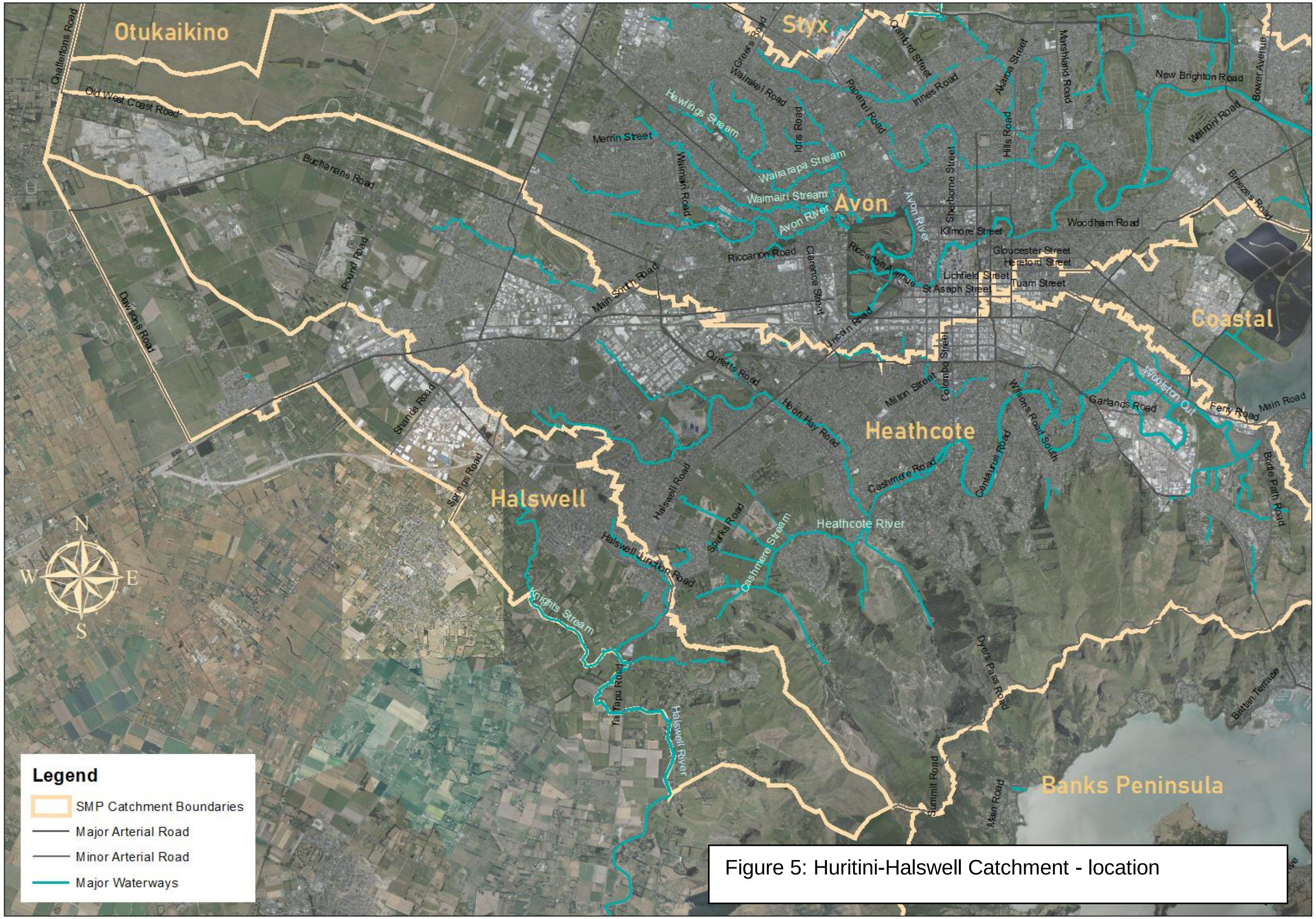

Figure 5: Huritini-Halswell Catchment - location

The Huritini-Halswell River receives appreciable flow from Knights Stream, a largely spring-fed tributary fed from rural land around Prebbleton and Templeton, and from southern part of Halswell suburb. From the Knights Stream confluence downstream until it joins SH 75 (Taitapu Rd), the channel is quite uniform in profile. Land use varies between cropping, grazing, and road reserve. Downstream of SH75 (Taitapu Road) the channel becomes shallower and more heterogeneous. After the confluence with Knights Stream, the Huritini-Halswell River meanders south for approximately 5 km to Lansdowne Valley, where the river reaches the study area boundary.

4.3 Soils

The soils of South-West Christchurch have been summarised in PDP (2003, 2005a and 2005b). There are five main types of soil in the Huritini-Halswell River catchment, including Waimakariri, Kaiapoi, Taitapu, Selwyn, and Horotane soils (Table 1). All of the soils, except for Taitapu, are recognised as suitable for urban development. Those soils classified as being unsuitable for urban use can be modified so that they are suitable, through the application of fill or by engineering techniques.

It is expected that only the Waimakariri soils would display permeability properties suitable for stormwater infiltration basins, provided they are underlain by free-draining gravels with the water table at a sufficient depth (i.e., >2.5 m).

Soils on the volcanic rocks of the Port Hills are dominated by loess (a soil derived from wind-blown particles) or colluvium (a transported soil). Loess is typically composed of clay and silt which is prone to dispersion. Dispersion results in rapid and significant amounts of erosion and can cause considerable slope instability and construction issues. Loess-derived soils are considered suitable for detention rather than infiltration basins.

Table 1: Soil types in the Huritini-Halswell River catchment and their suitability for urban use

	Location	Suitability for urban use
Waimakariri	Low terraces – north and east of the area, and along sinuous 'channels'. Generally, follows the Heathcote & Halswell River.	Suitable for urban uses but Wa0 has high horticultural value. Suitable for infiltration.
Kaiapoi	Low terraces – much of the eastern portion of the area.	Suitable for urban uses but Ka0 has high horticultural value.
Selwyn	Flood plains – long sinuous channels, extending north-west in the Halswell catchment.	Suitable for urban uses, but Sl0 and Sl1 have high horticultural value. Suitable for infiltration.
Taitapu	Low lying areas such as Henderson's Basin, middle reaches of Ōpāwaho / Heathcote River, west of Knights Stream. Limited low lying areas in the Halswell catchment.	All unsuitable.
Horotane	Cashmere Stream valley floor, southern part of catchment.	Suitable for urban uses but not for infiltration.

Note : Source - Webb et al. (1993).

In relation to soil infiltration, three broad zones of groundwater level and geology are a useful tool in assessing zones of potential infiltration:

- Groundwater depths of greater than 3 m indicate that infiltration of surface water is unlikely to cause problems, provided that the soil is sufficiently permeable; this applies to the region west of the 3 m confining layers contour, approximately west of Whincops Road. High infiltration rates (>50 mm/hour) will occur where there are alluvial gravel strata, and lower infiltration rates (<5 mm/hour) will occur in Springston silt and sand.

- Depths of less than 2.5 m indicate that infiltration of surface water is unlikely under high groundwater conditions, regardless of soil conductivity (i.e., predominantly in the south-eastern part of the project area).

Stormwater infiltration is generally governed by the distribution of gravels and silts. Areas underlain by gravels at shallow depth are suitable for infiltration, and areas underlain by the overbank silts and sandy silts are suitable for detention. To determine the infiltration potential, information contained on geological maps will be confirmed with field-based investigations for the actual sites once known.

4.4 Drainage Network

4.4.1 Natural Drainage System

Approximately the western half of the SMP catchment is situated on well-drained Waimakariri soils which infiltrate rainfall into the ground. This is true for Templeton, which discharges to ground soakage, and the industrial zone between Main South Road and Shands Road, where individual sites discharge treated stormwater into the ground.

Knights Stream extends to Halswell Junction Road, with ephemeral headwaters in the area upstream of Whincops Road. Tangata whenua have said this stream was flowing in pre-European times when it was a link in the whaka route between Ihūtai and Te Waihora (Lake Ellesmere).

Nottingham Stream joins Knights Stream near Halswell Road to become Huritini-Halswell River. At the time of European settlement there may have been springs at the head of Nottingham Stream, near Patterson Terrace. Nottingham Stream has perennial reaches up as far as Halswell Junction Road and there are springs in this area.

Five hill waterways drain into the Huritini-Halswell River in the south-east.

4.4.2 Stormwater system

The stormwater system includes roadside channels, pipes, waterways and treatment facilities, typically detention basins. Side channels receive discharges from private property and the carriageway and must function to maintain dry traffic lanes. Street sumps (catchpits) drain surface water into the pipe network. The pipe network is optimised to convey flow without retaining sediment. Its level of service is set to avoid traffic hazards in a 5 year average recurrence interval rainfall. The pipe network discharges into natural waterways; generally, after attenuation and treatment.

The industrial area east of Shands Road currently discharges stormwater into Knights Stream after it has passed through the Halswell Junction Detention Basin. From 2021 water discharged from that basin will discharge to infiltration basins between Springs and Wilmers Roads where it will receive additional treatment.

Older residential parts of west Halswell discharge untreated into Nottingham Stream via a pipe network. There is no attenuation (aside from a small catchment around Brigham Drive that delivers stormwater to ground soakage). The capacity of Nottingham Stream is limited by road culverts which may cause land flooding (but not house flooding).

Developing residential areas south-west of Halswell Junction Road discharge to Knights Stream via treatment basins and wetlands.

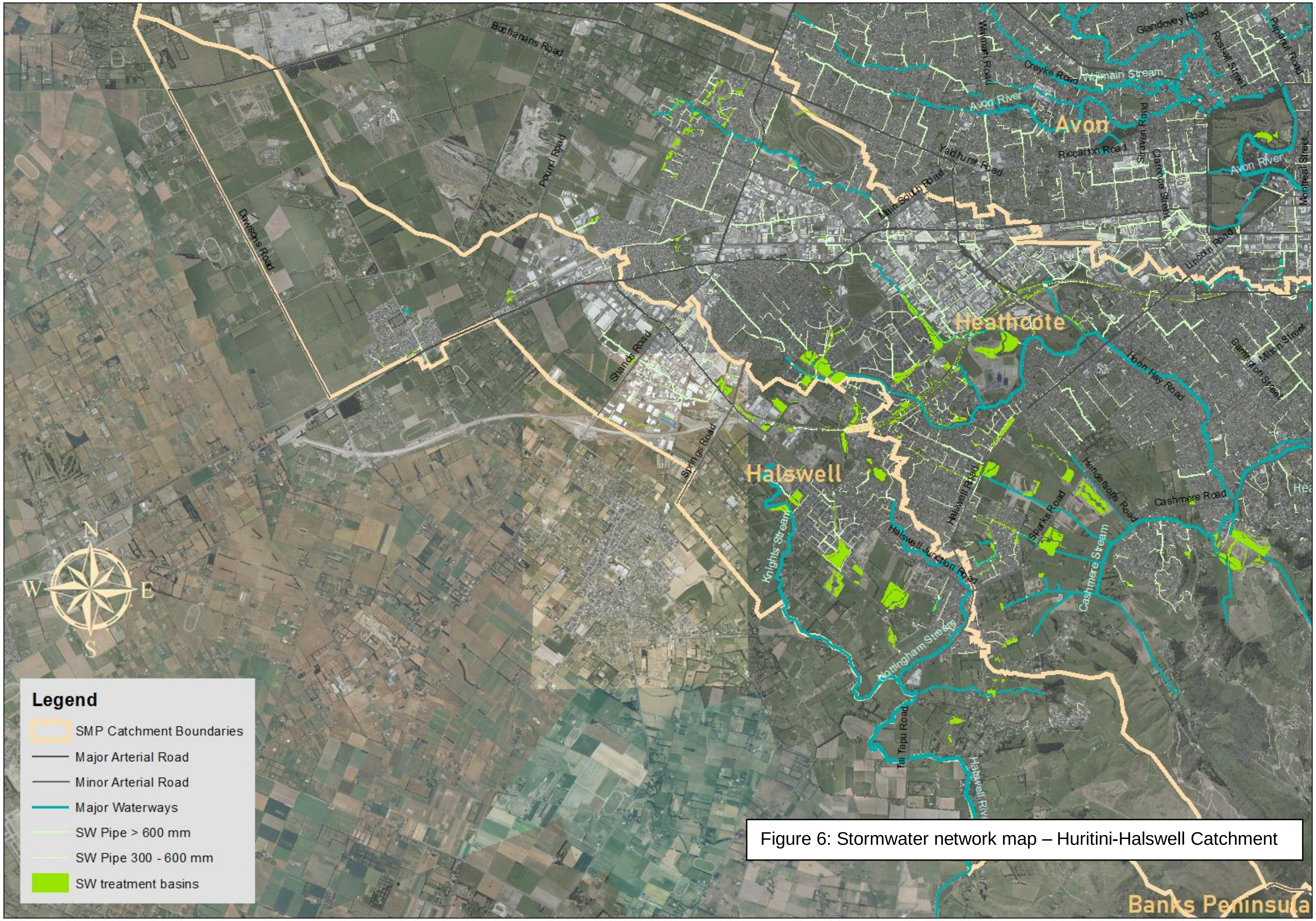

Figure 6: Stormwater network map – Huritini-Halswell Catchment

4.5 Groundwater

4.5.1 Characteristics

The Huritini-Halswell River catchment is located within the Christchurch-West Melton groundwater allocation zone. The majority of groundwater is sourced from the Waimakariri River and rainfall on the plains. In the southern part of the catchment the base of the Port Hills contributes groundwater to the adjacent sedimentary strata. The rate of recharge is not known, but a lack of high yielding wells in the volcanic rock and an apparent lack of influence on groundwater quality suggests that it is small (PDP 2003 and 2006).

Groundwater monitoring data indicates that there is considerable variation in groundwater levels throughout the area, with the depth to groundwater on the Canterbury Plains generally increasing to the north-west. Groundwater flow in this catchment is generally toward the south-east (PDP 2003).

Deeper groundwater may be consumed by abstraction, or may flow to higher strata along an upward hydraulic gradient, or will flow to the sea via offshore submarine springs (PDP 2003).

4.5.2 Springs and base-flow contributions

Numerous springs arise in the project area as artesian pressure forces groundwater up through confining layers. Springs contribute significantly to base-flows within tributaries of the Huritini-Halswell River. The base-flow of the Huritini-Halswell River at Old Tai Tapu Road Bridge is about 1,000 L/s.

The distribution of springs is controlled by the distribution and characteristics of the confining layer over the aquifer that is the source of the springs. Essentially, this means that springs are found where there is a moderate thickness of confining layer and the groundwater pressures created are sufficient to cause springs to ‘break through’. A number of springs occur within Knights Stream and near the headwaters of Cases Drain, between Whincops Road and the south end of Murphys Road.

West of the spring zone, groundwater pressures are lower and no springs occur. To the east of the springs, the surficial low permeability strata act as confining layers that are generally too thick to allow discrete spring flows to penetrate. There may still be a diffuse groundwater seepage discharge, however (PDP 2004).

The distribution of springs indicates the presence of a confining layer that arrests the seepage of surface water into the groundwater system. Therefore, spring distribution can be used to determine if surface water is likely to seep into the groundwater.

4.5.3 Groundwater use

Groundwater within the Huritini-Halswell River catchment is used mainly to supply reticulated drinking water, but also for commercial, industrial, and irrigation purposes. There are two Council pumping stations in the Huritini-Halswell River catchment. The protection of groundwater resources is a significant issue for Christchurch, given that the City’s drinking water is obtained from groundwater and, prior to the September 2010 earthquake, did not require treatment.

4.5.4 Effects of development on groundwater

One of the effects of development is to capture rainfall on impervious surfaces from which it runs off without the opportunity to recharge groundwater. This would be concerning if it reduced the flow of groundwater re-emerging as springs. The anticipated effect of development on the water balance was investigated by PDP (PDP, 2020).

Stormwater runoff from newly developed areas is managed to limit peak discharges. Runoff is directed either into infiltration basins, for infiltration into the ground, or detention basins, for slow release into the surface water network. Most future development will occur in the western part of the catchment where groundwater levels are low and sub-soils drain freely. In this part of the catchment runoff will be deliberately infiltrated into ground and a higher proportion of rainfall will enter groundwater via direct routes. By contrast, in a rural catchment a greater proportion of rainfall is held in near-surface soils from where it can be lost by evapotranspiration.

The change in pervious area and the stormwater management systems proposed are estimated to result in a 36% increase in groundwater recharge for the Christchurch City part of the Huritini-Halswell Catchment, after full development. The percentage change in base-flow in the river is estimated to be 8 to 13% (around a 50 litres per second increase).

4.5.5 Protection of Groundwater

Groundwater quality can be affected by a number of land uses (such as farm nutrients and chemicals, old landfills, septic tanks) and the quantity of groundwater can be enhanced or reduced by stormwater diversion or infiltration. The Council promotes the infiltration of stormwater into the ground to maintain spring flows in stream headwaters and stream base flows. Groundwater must be protected by treating stormwater before discharging it into the ground. Infiltration basins are to be designed according to the Infrastructure Design Standard (IDS) to ensure a high standard of treatment.

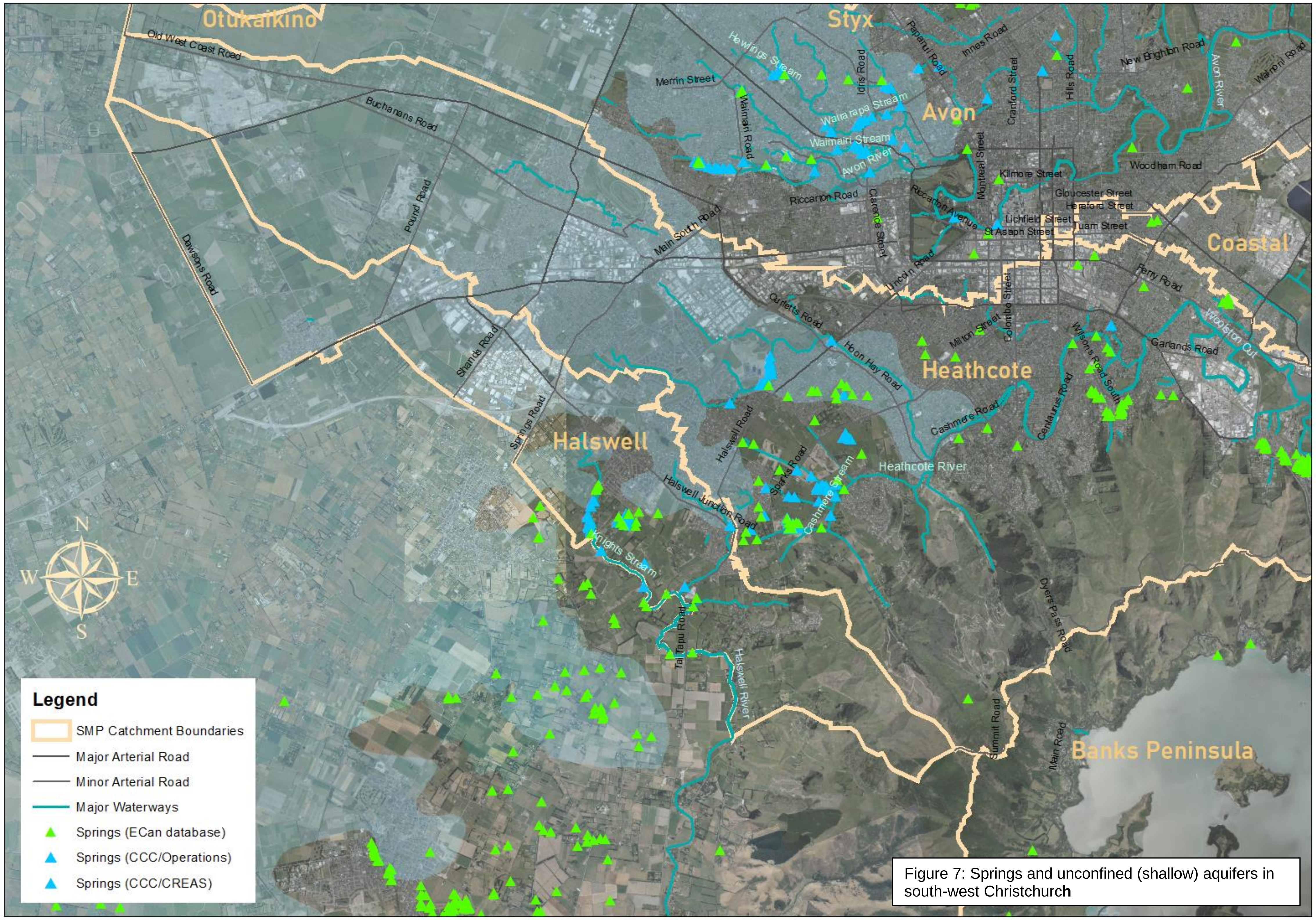

Figure 7: Springs and unconfined (shallow) aquifers in south-west Christchurch

5.0 Tangata Whenua and Cultural Values

5.1 Values

Water is a taonga (a natural resource of utmost value) and represents the life blood of the environment. Traditional values and controls on water are included in spiritual beliefs and practices. Māori hold absolute importance to water quality in relation to Mahinga kai and hygiene. The Whakapapa of a waterway would determine its use in Tohunga (spiritual), Waiwhakaheketupapaku (burial sites), Waitohi (Tohunga use i.e. removal of Tapu), Waimataitai (coastal sea mix of fresh and salt water, estuaries), Waiora (Tohunga healing water), and Mahinga kai (food source).

The maintenance of water quality and quantity is perhaps the paramount resource management issue for Tangata whenua. All waterways are a predominant feature within the landscape and should remain as a feature. A few would say that some waterways are more important than others because Tangata whenua Whakapapa directly relates to it, and is part of their identity. However, to do so would be to miss those waterways that feed into, and are part of the main waterway. A holistic approach culturally then is that all waterways are significant. Waterways begin as rain drops connecting together as streams, lake estuaries, and wetlands, all leading out to the coast; all is one.

The links to natural resources directly determined the welfare and future of the tribe. Those with resources flourished, while those without perished. Therefore, the management and maintenance of resources was the foremost concern. This acknowledged inter-dependence with the environment is central to Māori creation stories, spiritual belief, and resource management techniques. The land, water and resources in a particular area are representative of the people who reside there. They relate to the origin, history and tribal affiliations of that group, and are for them, a statement of identity.

5.2 Mana Whenua

The wider Ōtautahi area has been used for mahinga kai practises by Southern Maori, including the Ngāi Tahu whānui, for 50 generations. The archaeological record verifies occupation in this catchment since the 13th century. The primary settlement in this area was Kaiapoi Pa north of the Waimakariri River which was established by the Ngāi Tahu chief Turakautahi. This pa was serviced by the extensive wetlands that were located south of the Waimakariri River to the foot of the Port Hills, providing extensive mahinga kai resources.

In 1868 Hapakuku Kairua, a leading chief from Kaiapoi, made a claim to lands in the Hornby/Halswell area extending to the Landsdowne valley and Tai Tapu. These areas were rich mahinga kai and significant within the overall network of kāinga mahinga kai. The claim was dismissed because the land had already been alienated by the Crown. Hapakuku's claim was given further credence as his descendants and relatives imparted mahinga kai knowledge as part of the 1879 Smith Nairn Commission enquiry into Te Kereme, the Ngāi Tahu claim.

The northern reaches of the Huritini catchment near the Halswell township was referred to as Tau-awa-ā-maka and included Ōwaka, which was an area of waka portage between then Ōpāwaho and Huritini catchments. At the southern Christchurch City Council boundary of the Huritini River is Te Pohatu-whakairo or "The Carved Rock" which is a shallow limestone cave used by Ngāti mamoe as a shelter.

5.3 Te Waihora

The Huritini River is a significant tributary of Te Waihora and therefore impacts the health of this taonga. Te Waihora is a tribal taonga representing a major mahinga kai and an important source of mana. When tangata whenua first came to Te Waihora/Lake Ellesmere the lake waters extended back toward Motukarara, (and Irwell and Leeston) covering nearly twice the present-day lake area. The whole marginal area of the larger lake was also much more extensive; a vast swampland complex of tall raupo, flax/harakeke, toetoe, sedges/mania and rushes, interspersed with higher, drier strips of land where tussock grasses, tutu and bracken fern grew. There were a large number of settlements and mahinga kai sites along the spit. The vast quantity of mahinga kai contained in and around the lake included pātiki (flounder), tuna (eels), aua (yellow-eyed mullet), inanga (whitebait), pingao (sand sedge), harakeke (flax) and paru (mud for dyeing), pāteke (brown teal) and pūtakitaki (paradise shelducks).

5.4 Cultural Impact Assessment / Position Statement

Te Ngai Tuahuriri Rūnanga has issued a Position Statement on the Huritini-Halswell Catchment Stormwater Management Plan in lieu of a cultural impact assessment. The rūnanga does not oppose the SMP but raises a number of concerns which lead to 14 recommendations. Table 2 summarises the recommendations and the Council's responses.

Table 2: Response to the Position Statement

Recommendation	Action Taken	Reason
Engage with mana whenua prior to any proposed changes, enhancements, translocations and/or diversions as opposed to being consulted retrospectively.	Yes, the Council expects to engage with mana whenua as recommended.	
Ensure mana whenua are able to implement their own management strategies which include practices such as rāhui, or other customary tools and therefore is also in keeping with treaty principles.	Where mana whenua management strategies can be effected through stormwater management plans the Council will engage with mana whenua in good faith and will implement what is achievable	
Increase riparian planting throughout the catchment, especially including trees for shade cover to reduce macrophyte overgrowth	Council Units will be made aware of this recommendation directly and through two proposed plans: Healthy Water Bodies Plan, (Proposed) Surface Water Implementation Plan.	

Recommendation	Action Taken	Reason
Adopt alternative methods of weed control (e.g. Shade trees) to prevent the need for manual in-stream weed removal	Planting for shade is unable to be implemented through the SMP. Will be one of the measures in the proposed Strategic plan for surface water.	The SMP is a compliance plan responding to the consent CRC252424. There are no consent conditions relating to planting and shade.
Ensure that all waterways in the catchment are treated to the same standard and managed for mahinga kai collection in the future	We understand that this recommendation means "all waterways are equally important", and agree. More contaminated waterways are likely to be treated differently to capture contaminants, with the intention to raise water quality standards everywhere.	Agreement with the principle of Ki uta ki tai.
Conduct studies to investigate the effectiveness of current stormwater treatment facilities e.g. Stormwater basins	Yes, this is happening	The Council is required to do this by a consent condition.
Ensure the protection and enhancement of known spring sites	Policy 9.5.2.2.3 – Ngā wai in the Christchurch District Plan protects the natural character of springs. Waterway setback rules protect springs within the setbacks. CCC projects will always protect springs near water bodies.	
Where stormwater treatment facilities can't be installed, ensure that stormwater is diverted into the wastewater system, especially in industrial areas	This should be effective in principle. The Council is investigating feasibility, however it seems unlikely to become widely used.	Stormwater flows are much larger than wastewater flows and in most places there is insufficient capacity in the wastewater network.
Support State of the Takiwā reporting in the catchment; however this requires more sites that the four sites suggested in the stormwater management plan in order to capture ki uta, ki tai cultural values.	A State of the Takiwā framework is being developed in consultation with Mahaanui Kurataio and a MKT employee is being funded to do this (and other duties).	Part of the Environmental Monitoring Programme
Conduct a survey of stormwater basins to ensure fish passage	Existing stormwater basins are being surveyed and a recommendation will be	

Recommendation	Action Taken	Reason
	made listing priorities for fish passage improvement. There is a legal requirement to maintain fish passage in all new structures.	
Investigate the potential of nitrifying bioreactors to support nitrate conversion…	This appears to be an action for ECan to consider.	Nitrate discharges of concern to the Rūnanga are from agricultural land.
Enact more stringent water quality guidelines…	This is an ECan matter	Environment Canterbury is the regulator
Additional substrate (instream) to assist nitrogen conversion, instream heterogeneity and re-oxygenation.	This appears to be an action for ECan to consider in those waterways where nitrate is a problem.	Nitrate discharges of concern to the Rūnanga are from agricultural land.

5.5 Mahaanui Iwi Management Plan

Alignment between this SMP and Mahaanui Iwi Management Plan objectives are discussed in section 10.10 Role of Tangata Whenua Values in Setting Targets.

5.6 Monitoring for Mana Whenua Values

Cultural monitoring will enable the CCC and Ngāi Tahu to compare current and future condition against the State of the Takiwā Report, 2007. Cultural monitoring is required under the CSNDC, as detailed in the Environmental Monitoring Programme (EMP). The State of the Takiwā monitoring system was developed by Te Rūnanga o Ngāi Tahu to facilitate tangata whenua to gather, store, analyse and report on information relevant to the cultural health of waterways within their takiwā (tribal areas).

Sites are to be sampled five-yearly in conjunction with the monitoring of wet weather surface water quality, instream sediment quality and aquatic ecology. The sites to be monitored are based on previous State of the Takiwā sites, and some additional sites. Some sites overlap with other monitoring sites (e.g. instream sediment and aquatic ecology).

6.0 The Receiving Environment

6.1 Introduction

This section summarises results from the water quality (CCC), sediment quality and aquatic ecology surveys (Boffa Miskell) within the Huritini-Halswell River catchment (Boffa Miskell, 2016; Margetts & Marshall, 2020). A new sediment quality and aquatic ecology survey is scheduled to be carried out in 2021.

6.2 Water quality

Waterways in the Huritini-Halswell catchment are classified in the Land and Water Regional Plan as 'spring-fed – plains'.

The Council monitors water quality monthly at three sites within the catchment (displayed in Figure 8). The results from the 2019 annual monitoring report for the Huritini-Halswell River catchment are summarised below in Table 3 (Margetts & Marshall, 2020). This monitoring is part of the Council's state of the environment monitoring. A Water Quality Index (WQI) was developed for the CCC's monthly monitoring sites, based on a Canadian WQI (CCME; Canadian Council of Ministers for the Environment, 2001). The WQI compares a range of water quality parameters to their respective guidelines and summarises this into a single number ranging from 0 – 100, with 100 representing high water quality. Additional wet weather sampling occurs at selected monthly monitoring sites using grab sampling. These sites are sampled over two rain events. The timing of sampling generally does not coincide with the contaminant concentration peak, as this can be difficult to achieve without auto-samplers.

Water quality within this catchment is generally poor, although it is not the worst catchment within the City and Nottingham Stream records 'fair' water quality. Poor water quality negatively affects the ecology of waterways (plants, macrophytes, invertebrates and fish). Specifically, nutrients (i.e. nitrogen and phosphorus) are likely to encourage prolific growth of aquatic plants and algae, while other contaminants (e.g. copper, zinc, sediment, oxygen and ammonia) cause negative effects on the physiology and behaviour of instream biota.

In total, 17% of the 504 samples analysed from the Huritini-Halswell catchment during the 2019 monitoring year exceeded their respective guideline value and all sites exceeded the guideline values for at least one parameter (Table 3). Dissolved Inorganic Nitrogen (DIN) had the highest rate of samples exceeding guidelines at 72%. *Escherichia coli* also often exceeded the guidelines. The parameters that never exceeded their respective guideline values were dissolved copper and lead, Biochemical Oxygen Demand (BOD_5), temperature, pH, and ammonia.

Parameter levels have generally remained stable in the Huritini-Halswell catchment since monitoring began in 2007, with water quality neither getting better nor worse at two of the three monitoring sites. However, Nottingham Stream water quality recorded improvements over time in the 2019 monitoring report.

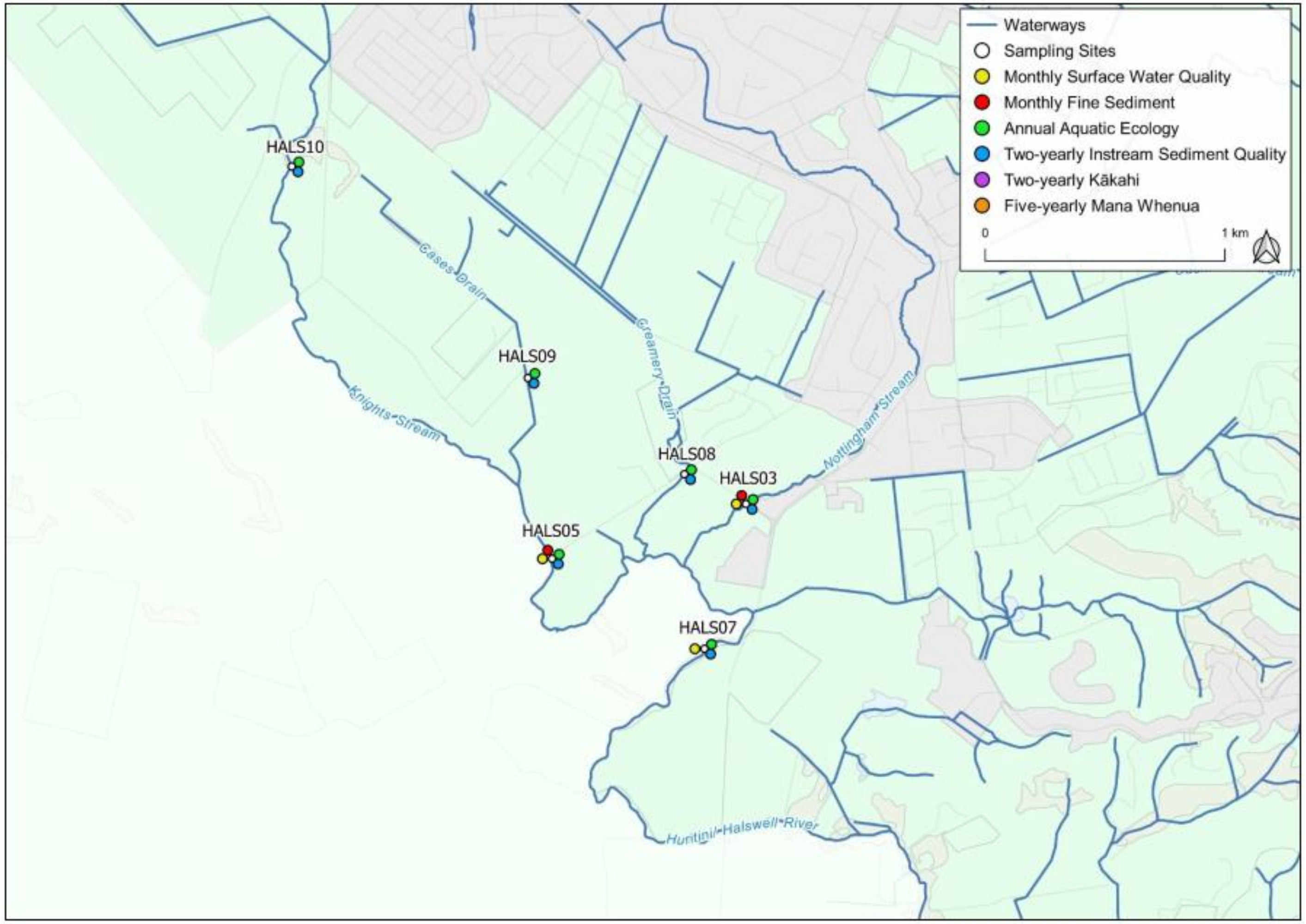

Figure 8: Location of surface water, instream sediment and aquatic ecology monitoring sites in the Huritini – Halswell SMP area (EMP version 10).

Nottingham and Knights Streams had the worst water quality in the catchment. Between them, Nottingham and Knights Streams have particular issues with nitrogen, Dissolved Reactive Phosphorus (DRP) and *E. coli*. The Huritini-Halswell River at Akaroa Highway had the best water quality in the catchment; however, no one parameter was markedly better than the two tributary streams.

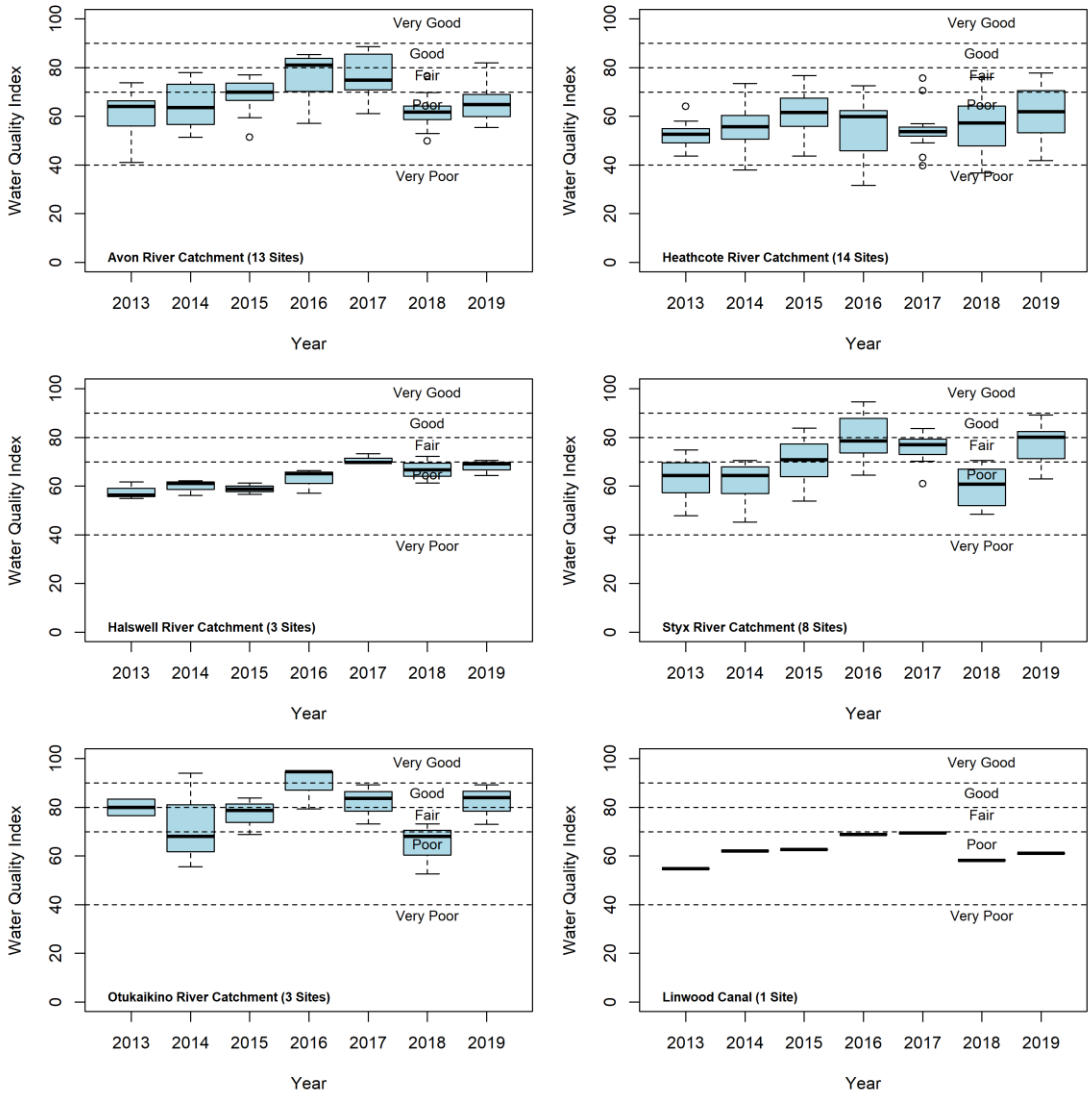

Figure 9: Water Quality Index for each catchment for the 2013 to 2019 monitoring years

Table 3 Summary of water quality parameters against CSNDC aquatic ecology guidelines

Parameter	Guideline	Number of Sites Monitored	Number of Samples Analysed	Number of Samples Not Meeting Guideline	Number of Sites Not Meeting Guidelines
Escherichia coli	95%th percentile <550/100ml	3	36	20 (55.6%)	3
Dissolved Inorganic Nitrogen	Median <1.5 mg/L	3	36	26 (72.2%)	2
Dissolved Reactive Phosphorus	Median <0.016 mg/L	3	36	16 (44.4%)	1
Nitrate	Median <3.8 mg/L and/or 95%ile <5.6 mg/L	3	36	10 (27.8%)	1 (Knights Stream)
Dissolved zinc	95th percentile ≤0.01743 mg/L	3	36	1 (2.8%)	1
Turbidity	Median <5.6 NTU	3	36	7 (19.4%)	0
Total Suspended Solids	Median <25 mg/L	3	36	4 (11.1%)	0
Dissolved oxygen	Median >70%	3	36	1 (2.8%)	0
Dissolved copper	95th percentile ≤0.0014 mg/L	3	36	0 (0%)	0
Biochemical Oxygen Demand	Median <2 mg/L	3	36	0 (0%)	0
Water temperature	Median <20°C	3	36	0 (0%)	0
pH	Median 6.5 to 8.5	3	36	0 (0%)	0
Dissolved lead	95th percentile ≤0.01089 mg/L	3	36	0 (0%)	0
Total ammonia	95th percentile <1.61 mg/L	3	36	0 (0%)	0
Total	-	3	540	121 (22.4%)	3 of 3 (100%) (for at least one parameter)

6.3 Sediment Quality

Stormwater contaminants, such as metals and hydrocarbons, can accumulate in stream sediments. These contaminated sediments can adversely affect the health of stream biota.

Stream bed sediment was sampled at five sites across the Huritini-Halswell River catchment in 2016, and were analysed for metals, Polycyclic Aromatic Hydrocarbon (PAHs), Semi-volatile Organic Carbons (SVOC), phosphorus, organic carbon and grain size (Boffa Miskell, 2016). The physical characteristics of the sediments collected in the catchment showed that the tributaries are typically dominated by fine sand and mud. Sediments from urban sub-catchments had higher concentrations of metals than those from mixed land use and rural catchments. The mixed land use sites were all in the mainstem of the Huritini-Halswell River, and the catchment was predominantly rural, with some upstream urban influences.

Total recoverable copper, lead, and zinc for all sites were below the default guideline from the ANZG (2018) sediment quality guidelines (**Error! Reference source not found.**). Where the sediment concentration is below the default guideline, it is an indicator that there is low risk of adverse effects to aquatic life. However, both zinc in Nottingham Stream and lead at one site in the Huritini-Halswell River approached the default guideline but did not exceed it. Total PAHs, normalised to 1% TOC, were also well below the ANZG (2018) default guideline for sediment quality (**Error! Reference source not found.**). Metal and PAH concentrations detected at all sites were comparatively low compared to concentrations detected in other waterways around Christchurch (e.g. Heathcote River catchment, Avon River catchment; Kingett Mitchell Ltd 2005; NIWA 2014, 2015).

SVOCs were below laboratory detection limits at all sites. There are no listed ANZG (2018) guidelines for SVOCs, total phosphorus or total organic carbon. However, the levels of total phosphorus and total organic carbon measured in 2016 were similar to levels detected in the nearby Heathcote River catchment sites (NIWA 2015).

Kingett Mitchell surveyed several sites in the Huritini-Halswell River catchment in 2005 (Kingett Mitchell Ltd 2005a), including similar locations to the sites surveyed in this study. Generally, the concentrations of copper, lead, and zinc were similar in 2016 to those detected in 2005 (Boffa Miskell 2016).

Table 4: Huritini-Halswell River sampling and ANZG (2018) sediment guidelines

Parameter	Default guideline	Number of Sites Monitored	Number of Sites Not Meeting Guidelines
Copper	<65 mg/kg dry weight	5	0 (0%)
Lead	<50 mg/kg dry weight	5	0 (0%)
Zinc	<200 mg/kg dry weight	5	0 (0%)
Total PAHs	<10 mg/kg dry weight	5	0 (0%)

6.4 Freshwater Ecology

Riparian and in-stream habitat conditions, and the macroinvertebrate and fish communities were surveyed at five sites located in the Huritini-Halswell River catchment in March 2016.

In-stream and riparian conditions, although variable among sites, were generally degraded often with low substrate indexes (indicating stream-bed substrates dominated by finer particles and generally lacking in boulders and large cobbles) and slow-flowing stream habitat. The shallow upper reaches of Nottingham Stream and Knights Stream had somewhat faster flows and coarser substrates than the lower reaches. Little shading was present at many sites, and channels were modified with limited in-stream habitat heterogeneity. Macrophyte and filamentous algal cover was generally low, and most sites were below the LWRP guidelines for urban spring-fed systems.

This ecological assessment indicated that the waterways within the Huritini-Halswell River catchment were generally of poor ecological health. Nevertheless, sites did provide habitat for ecologically important native macroinvertebrate and fish species, such as “at risk, declining” species. A previous, more wide-spread survey in the catchment noted in particular that the Quaifes Road Drain and the Huritini-Halswell River mainstem had higher ecological values compared to the other sites surveyed in the catchment (EOS Ecology et al. 2005).

6.4.1 Macroinvertebrate community

Based on the Macroinvertebrate Community Index (MCI) scores, four out of five sites were indicative of “poor” water quality, while Site 3 (Knights Stream) was indicative of “fair” water quality. The Quantitative Macroinvertebrate Community Index (QMCI), which is considered a better indicator of water quality, as it takes into account abundance and presence of macroinvertebrate taxa, showed a slightly different pattern, with Site 5 (Huritini-Halswell River Wroots Road) having the greatest QMCI scores, indicating “fair” stream health. All sites recorded a QMCI value below the consent target of 5.

The most diverse group was the true flies (Diptera) with 12 different taxa recorded at the five sites. Caddisflies (Trichoptera), and snails and bivalves (Mollusca) were the next most diverse groups, with nine and four different taxa, respectively. Numerically, snails and bivalves, and crustaceans dominated the macroinvertebrate community. Caddisflies were the only group of clean-water Ephemeroptera-Plecoptera-Tricoptera (EPT) taxa present in the catchment; mayflies and stoneflies were absent from all sites.

Taxonomic richness, EPT richness and QMCI were generally higher at all sites in 2016 than in the previous study (EOS Ecology 2011). However, the 2011 survey was conducted one month after the February 2011 Canterbury Earthquake, which may have been a factor in the apparent differences in macroinvertebrate metrics. Additionally, QMCI can be highly variable through time, as abundances of macroinvertebrates can vary / change due to a range of disturbances including both natural (e.g. floods) and anthropogenic perturbations (e.g. nutrients / stormwater discharges).

Of important note, other surveys have also recorded wai kōura (freshwater crayfish), an “at risk, declining” species, in the catchment (Aquatic Ecology Ltd, 2012; EOS Ecology et al., 2005).

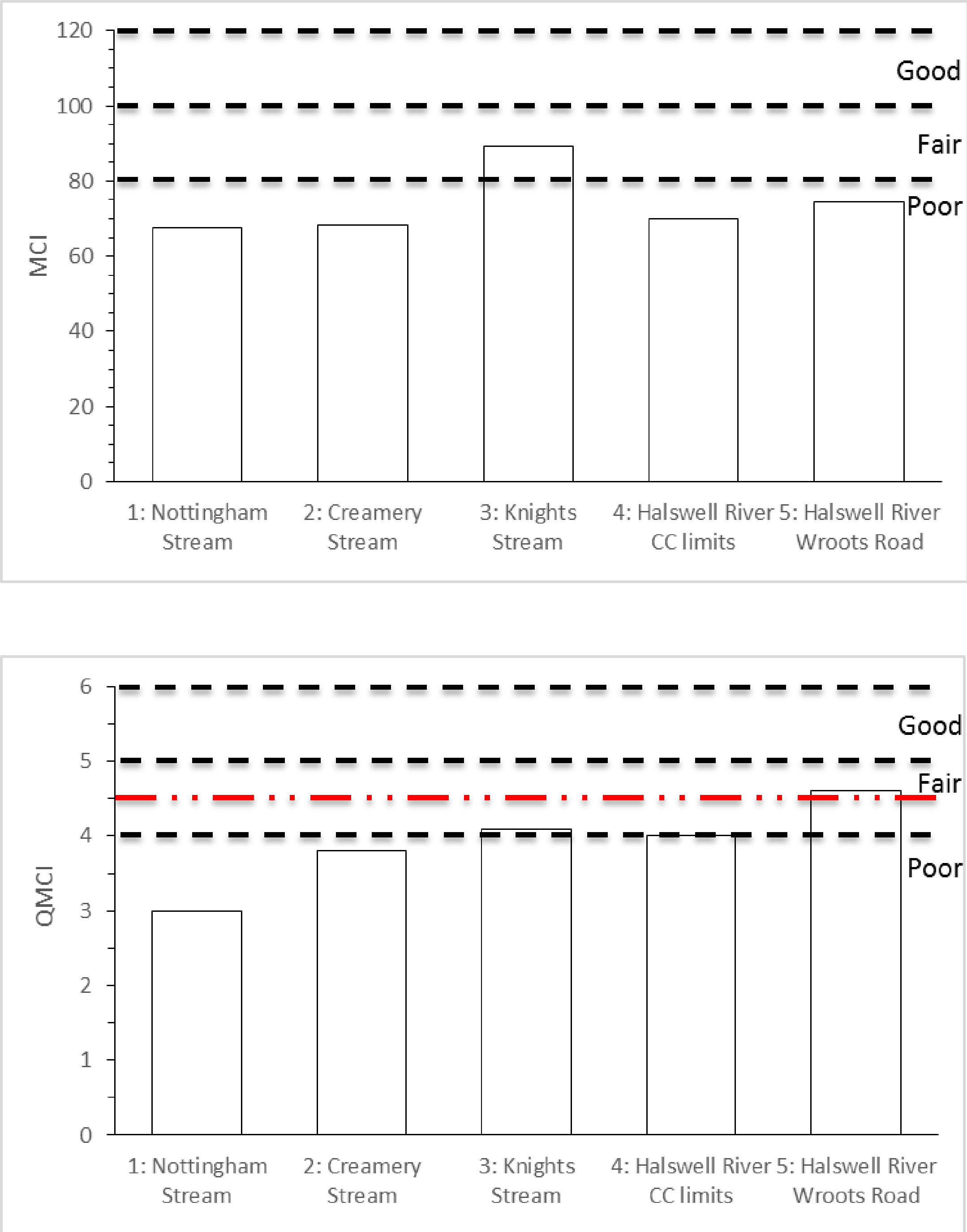

Figure 10: Macroinvertebrate Community Index (MCI) scores (top) and QMCI scores (bottom)

Five sites surveyed in the Huritini-Halswell River catchment in March 2016. The dashed lines indicate the water quality categories of Stark and Maxted (2007), where “poor” = “probable severe enrichment”, “fair” = “probable moderate enrichment”, and “good” = “doubtful quality or possible mild enrichment”. The “excellent” category has not been shown. The red line on the QMCI graph indicates an old consent target – the CSNDC now requires a target of 5.

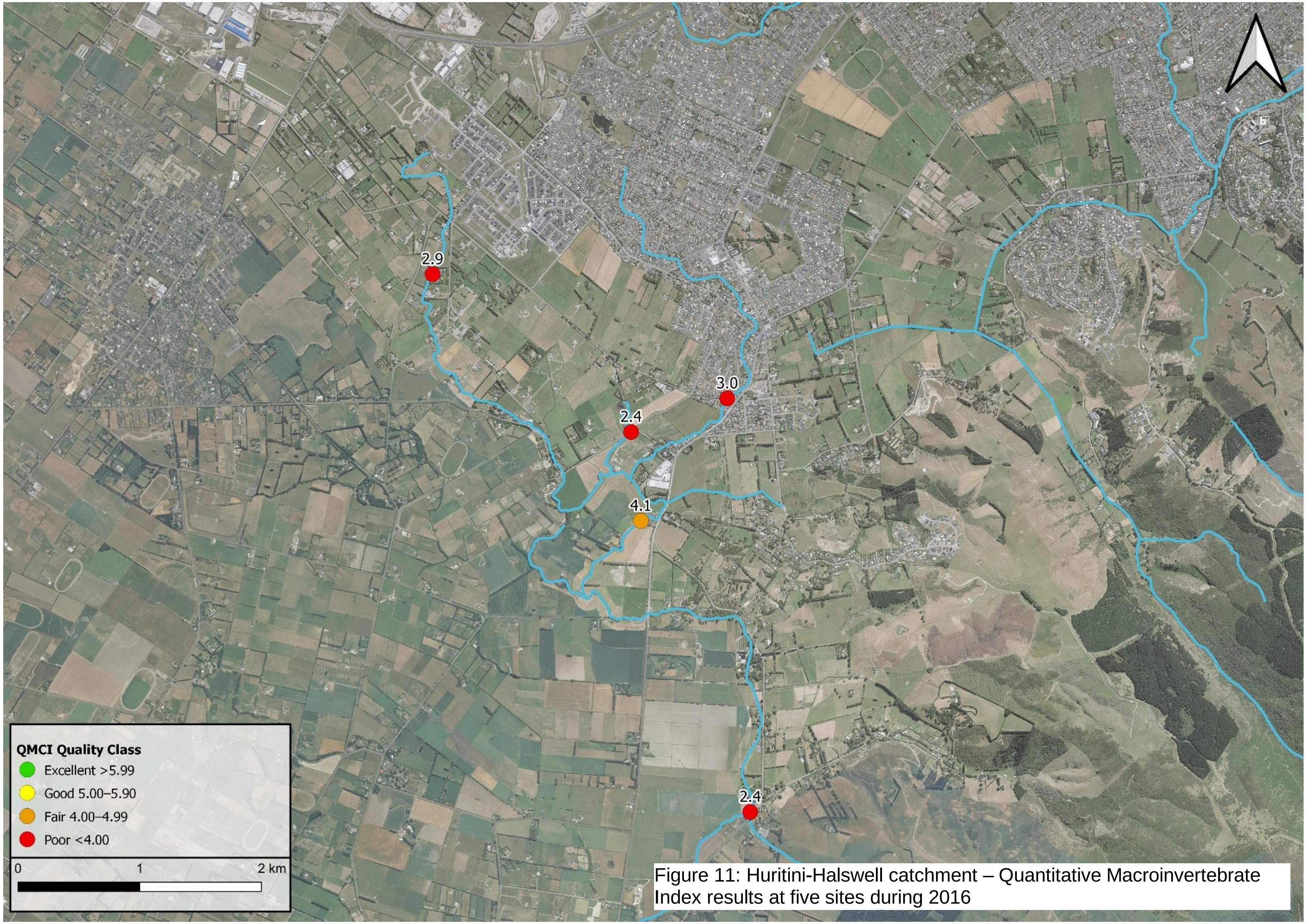

Figure 11: Huritini-Halswell catchment – Quantitative Macroinvertebrate Index results at five sites during 2016

6.4.2 Fish Community

Six species were captured from the five sites surveyed within the Huritini-Halswell River catchment in March 2016. In descending order of abundance these were: common bully (*Gobiomorphus cotidianus*), upland bully (*G. breviceps*), longfin eel (*Anguilla dieffenbachii*), shortfin eel (*A. australis*), inanga (*Galaxias maculatus*), and brown trout (*Salmo trutta*). Longfin eel and inanga have a conservation status of "at risk, declining", while the remaining three native freshwater fish species are currently listed as "not threatened" and brown trout as "introduced and naturalised" (Dunn et al., 2018).

Species richness was considered depauperate, with generally around three to six species present at a site. Upland bullies and longfin eels were the most encountered species, being found at all five sites, while inanga and brown trout were only detected at one site. However, the presence and abundance of inanga is underestimated by electric fishing techniques, so this species may have been more abundant than the study indicates. The fish community did not appear to have markedly changed over time, when comparing results from 2004, 2011, and 2016 (Aquatic Ecology Ltd, 2012; EOS Ecology et al., 2005).

Other threatened species, such as kanakana / lamprey, have also been found in the Huritini-Halswell River (New Zealand Freshwater Fish Database, accessed 13/04/20). Pest fish species (e.g., feral goldfish (*Carassius auratus*), rudd (*Scardinius erythrophthalmus*) and tench (*Tinca tinca*)) have also been recorded within the catchment (New Zealand Freshwater Fish Database, accessed 13/04/20).

6.5 Groundwater Quality

This comment on groundwater quality is extracted from a report by Environment Canterbury (ECan 2020).

"We collected groundwater samples from 42 wells across southern Christchurch during April to June 2017. Most of the wells sampled are relatively shallow, ranging in depth between 20 m and 70 m. The wells are largely screened in the Riccarton or Linwood Gravels (also known as Aquifers 1 and 2). Eight of the wells were shallow Christchurch City Council public supply wells and the remainder were used for non-potable purposes such as monitoring, irrigation of gardens and sports fields, commercial/industry supply or were no longer in use.

We analysed the samples for a range of inorganic and organic substances. We compared the results to New Zealand Drinking-Water Standards and derived conclusions about the types and levels of contaminants present. We also looked at historical data to determine long-term trends of groundwater quality in southern Christchurch.

The water quality is generally very good throughout the southern part of the city, and it has improved or remained unchanged across most of the area since the last review in 2002. There are some parameters with elevated concentrations in some wells. Three of the 42 samples had concentrations that exceeded drinking water health-based criteria: two for nitrate and one for E. coli contamination. None of these wells are used for drinking water supply. The wells that show some indication of contamination from land surface activities and old landfills are generally found towards the western part of the city, where the aquifer is unconfined.

Even after discharges or activities have ceased, legacy contamination can continue to move into and through the groundwater. However, the adverse effects from such contamination are generally localised over a small area and we did not find any risk to public drinking-water supplies."

Groundwater sample results in the ECan 2020 report show elevated zinc in the vicinity of the industrial zone, between Shands Road and Carrs Road. A possible explanation for this is the discharge of roof water from industrial buildings into the ground. This was the approved means of stormwater discharge from the Halswell Junction industrial area at a time (1977) when it was considered necessary to reduce discharges into Knights Stream, a tributary of the Huritini-Halswell River.

6.6 Effects on Tangata Whenua values

The Tangata Whenua of Te Waihora are Ngāi Tahu, for whom the area has considerable spiritual and physical significance. Tangata Whenua have some specific issues relating to:

- The degradation of the mauri (life force, embracing health and spirit) of particular springs, waterways and the lake;
- The protection and enhancement of taonga (things that are highly treasured);
- Access to, and quality of, mahinga kai (food and fibre, traditional ways);
- The degradation of wahi tapu (sacred sites such as burial grounds);
- Degradation of wahi tapu (places of sacred and extreme importance) sites and;
- Decline in stream health and mauri.

Tangata Whenua are firmly of the view that the combination of past and present lake, farm and catchment practices have left Lake Ellesmere/Te Waihora a polluted, shallow remnant of its former self. Few of the resources that originally attracted Ngāi Tahu and earlier tribes to the area are now readily available. It is for these reasons that Ngāi Tahu are working together with Environment Canterbury, Selwyn and Banks Peninsula District Councils, the Department of Conservation and the community to improve the quality of the lake and its surrounding wetland area.

Of most importance to Ngāi Tahu are those factors that threaten the health of the resources of Lake Ellesmere/Te Waihora, for example, drainage, sedimentation, water abstraction and discharge of nutrients and other pollutants into waterways that feed the lake. Of particular concern are the discharge of human effluent to lake tributaries and the on-going abstraction of water from the catchment. Together, these discharges and abstractions render waterways and their associated areas unusable or unsuitable for cultural purposes, especially mahinga kai. Restoration of mahinga kai or unique and valued flora and fauna is also a major issue for Tangata Whenua. This has had a serious and damaging impact on Ngāi Tahu tribal life.

Underlining the importance of these natural resources is the necessity to manage the resources of any given area in a sustainable manner. Over many generations, and after some serious mistakes, these principles of sustainable management were developed, refined, and codified into the laws of society.

They were then implemented through religious mechanisms and controls, such as the concepts of rāhui and tapu (sacred). (Extract from “Waitaha Wai: Lake Ellesmere /Te Waihora and its Tributaries, ECan.)

7.0 Land Use

7.1 Development and Trends

Christchurch's growth, unless artificially stimulated, is expected to be relatively modest over the next 20 years. The present population is expected to increase by between 63,000 people over the term of the consent (to 2044) and a further 6,000 people by 2055 (Trim 14/1078958). The number of households is expected to increase by 28,000 and 2,700 over the same periods. Significant changes to city form and environment could occur through, for example: surges in economic activity, changed housing preferences ranging from inner city living to rural life style blocks, or an influx of migrants.

7.2 Residential Growth

Between 2015 and 2020, residentially zoned land has been taken up at an average rate of around 8 hectares per year. At this rate of development, all currently zoned vacant residential land will be in use within 30 years. Residential development is occurring between Wigram and Owaka Roads and between Halswell Junction and Marshs Roads.

7.3 Industrial growth

Between 2015 and 2020, industrial zoned land has been taken up at an average rate of 18 hectares per year. At this rate of development, all currently zoned vacant industrial land will be in use within 16 years. Industrial development is occurring between Pounds and Shands Road

The Christchurch City Council believes that adequate land is zoned for urban purposes and has no plans at this time to expand beyond the current urban boundary. Christchurch City has sufficient development capacity to meet housing demand over the next 30+ years through redevelopment of the existing urban area and planned greenfield areas (referred to as Residential New Neighbourhoods under the Christchurch District Plan). Should urbanisation beyond the current urban limit be considered to address higher than expected (particularly residential) demand, a change will be required to the Canterbury Regional Policy Statement and the Christchurch District Plan and any proposal will be examined in terms of its appropriateness in achieving the purpose of the Resource Management Act (Sarah Oliver, Principal Advisor Planning, CCC).

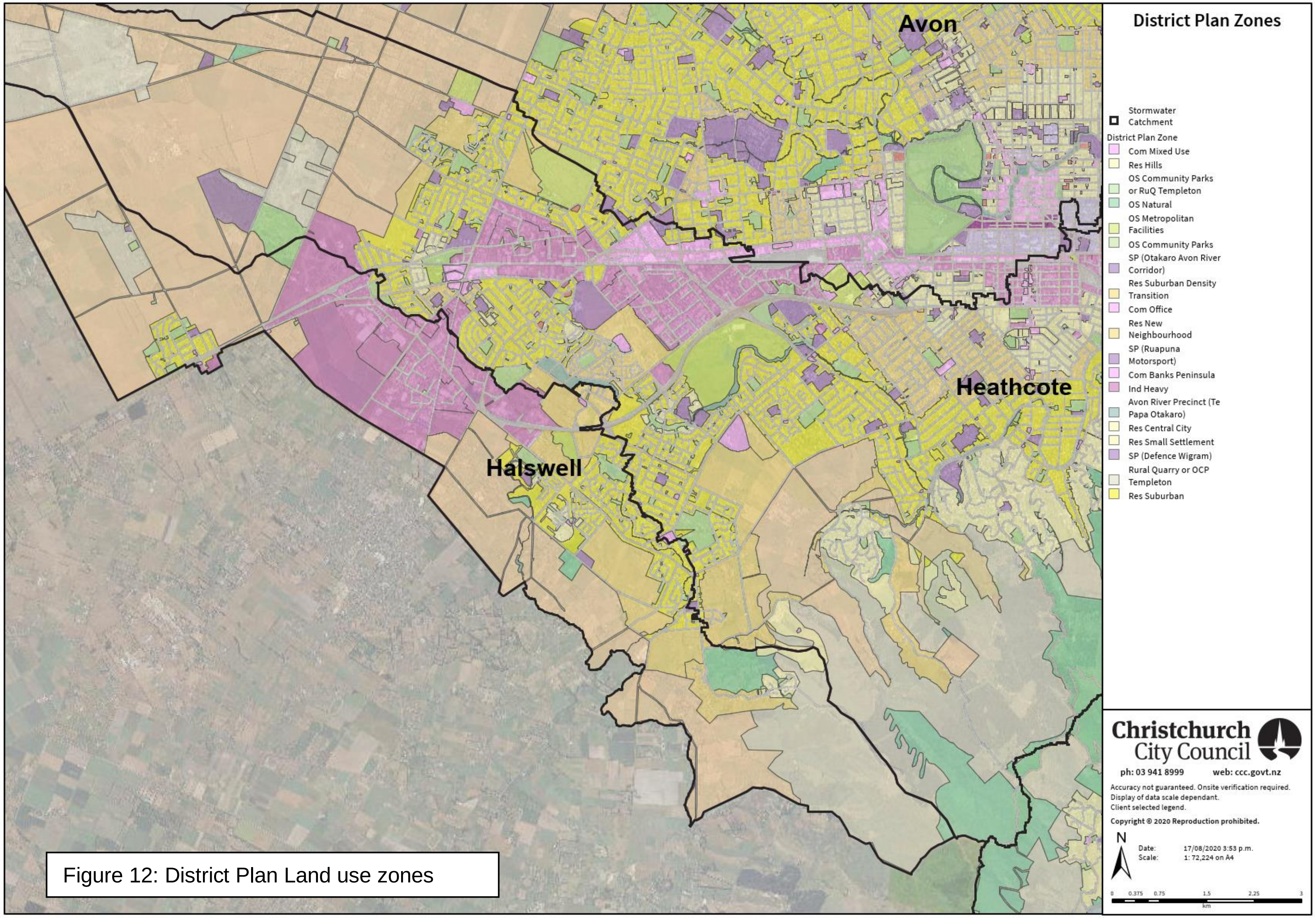

Figure 12: District Plan Land use zones

7.4 Contaminated Sites and Stormwater

7.4.1 Background

The SMP considers two types of contaminated sites:

- Sites with in-ground contaminants that may be entrained in stormwater, typically when soil is disturbed and
- Sites where on-site activities, usually industrial in nature, may release chemical or metal contaminants into stormwater (or into the ground).

(Sites which generate sediment not containing contaminants of human origin are not classed as "contaminated sites")

The National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations (NES) help to identify potentially hazardous activities and industries which are listed in the Hazardous Activities and Industries List (HAIL), found at

http://www.mfe.govt.nz/land/hazardous-activities-and-industries-list-hail#hail-web

Such sites are listed in a Listed Land Use Register when they become known to the Regional Council either through a consent application (to ECan or the CCC) or through investigations. Sampling, excavation, subdivision, removal of fuel storage tanks and changing land use on such sites may require a resource consent and remedial action.

A number of properties in the catchment are listed on the LLUR because of previous horticulture and market gardening with associated persistent pesticides and herbicides. More than half of these sites have been investigated. Review of a sample of investigations indicates that most contamination occurs in isolated small areas (e.g. associated with sheep dips) and can be removed. Remediation often occurs prior to subdivision. Even unmitigated the sites are generally at low risk of discharging contaminants into stormwater unless the sites are disturbed (e.g. during development).

7.4.2 Low Risk Sites

A Memorandum of Understanding (MoU) was agreed between CCC and ECan in July 2014 to allow stormwater discharges from low risk residential rebuild sites listed on the LLUR and/or identified as having had HAIL activities to be processed by CCC rather than ECan. It is anticipated that as confidence grows over time in the operation of the MoU, the list of "low risk" situations that CCC can process will be extended. For example, sites on the LLUR where only a portion of the site has had a hazardous activity and the construction will not disturb that part of the site is considered low risk.

7.4.3 Higher Risk Sites

High risk sites generally refers to sites with persistent or hazardous chemicals in the soil or in use on site. High risk sites include contaminated sites and some industrial sites.

Many contaminants adhere to sediments and can be mobilised into surface or ground-water when soils are disturbed. These contaminants can be managed by using good sediment control during earthworks and taking care with where soil is disposed of. More specific measures, including on-site treatment, may be needed for more mobile contaminants that cannot be controlled by typical sediment control practises.

All land use consent applications are checked against the LLUR. Where development is proposed on a site listed in the Listed Land Use Register the application is referred to the Council's Environmental Health Team. Conditions are attached to the resource consent to deal with short term and long term exposure of contaminants, often requiring site remediation.

7.4.4 Facilities Built Near LLUR Sites

Section 11.2.6 comments about proposed mitigation facilities on sites near contaminated land.

7.4.5 Industrial Sites

Industrial sites will be managed in accordance with CRC252424 Conditions 47 and 48 in a process that will occur in parallel to this SMP. The Council will:

- Gather information about and develop a desktop-based identification of industrial sites, ranking sites for risk relative to stormwater discharge;
- Audit at least 15 (principally high risk) sites per year;
- Inform audited industries of the results of audits and work closely with these industries to achieve outcomes in line with the Stormwater and Land Drainage Bylaw 2022;
- Communicate with industries about stormwater discharge standards and the means of meeting these standards.

The Council will be empowered to do these actions by the Stormwater and Land Drainage Bylaw 2022.

8.0 Contaminants in Stormwater

8.1 Introduction

Urban activities cause environmental effects either by shedding more or faster stormwater runoff or by transporting contaminants in stormwater that are harmful to the environment. Most urban surfaces have some form of coating (e.g. paint or galvanising) and a transient layer of cleaning compounds, combustion products, wind-blown dust, etc. Most of these substances are slightly soluble in rainwater and are transported in dissolved and particulate form into the stormwater network. Upon entering a stream or river contaminants cause harm by altering habitats (e.g. increasing sediment depth), reducing food supplies (e.g. due to smothering by sediment), depleting oxygen and causing toxic effects (e.g. affecting reproduction).

8.2 Contaminants and Contaminant Sources

Contaminants of most concern in rivers and streams are:

- Dust, sediment, grit and particles of all types capable of being transported in stormwater, referred to as total suspended solids (TSS). TSS include metal particles, aggregates of metallic compounds, and charged (e.g. clay) particles with attached metal ions.
- Dissolved and particulate zinc
- Dissolved and particulate copper
- Polycyclic aromatic hydrocarbons (PAHs)
- Pathogens
- Nutrients (mostly phosphorus)

Lesser contaminants, which generally do not exceed guidelines, are:

- Hydrocarbons (oil and grease)
- Cadmium and lead

8.2.1 Suspended Solids

Particle sources include construction activity, land cultivation, combustion, industrial products, tyre and brake wear and paint coating breakdown. Some particles are natural materials and some are artificial (e.g. paint chips). Natural particles are not necessarily non-polluting, as they often carry adsorbed chemicals.

Suspended solids are damaging because they deposit on stream beds and fill the spaces between stones, greatly reducing the habitat availability for instream life and smothering food. Sediment can also accumulate toxic substances, such as metals, which can be toxic to biota.

The most important particulate sources in the Huritini-Halswell Catchment are considered to be construction sites and roads.

8.2.2 Zinc

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

Zinc makes up about 1% by weight of tyres in which zinc oxide is a vulcanising catalyst. Tyre wear releases zinc onto roads. Roofs create approximately ¾ of urban zinc. Roads create approximately ¼, much of which is from tyres.

Other zinc sources include galvanised fencing and posts, fungicides, paint pigments and wood preservatives.

Many sources such as Timperley et al (2005) report that tyre derived zinc is transported onto other surfaces, including roofs, by wind. Stormwater sampling in Christchurch supports this, showing zinc runoff occurring from nominally zinc-free surfaces such as concrete tile roofs.

8.2.3 Copper

The largest amount of exposed urban copper is a binding and anti-vibration element in brake pads where it may comprise from a few percent to 5% by weight. The majority of copper in urban stormwater comes from fine copper particles abraded from brake pads. These particles are so fine that about 50% can be quickly dissolved by rainfall to become bioavailable, often at toxic concentrations.

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

8.2.4 Polycyclic aromatic hydrocarbons

PAHs are created when products like coal, oil, gas, and garbage undergo an incomplete burning process. PAHs are a concern because they do not break down very easily, they can stay in the environment for a long time. PAHs may come from coal tar sealants, diesel or industrial combustion. A number of old streets were surfaced with coal tar, although they have been resurfaced with bitumen, which does not contain PAHs. Edge frittering and surface deterioration can release coal tar particles. There can be high PAH concentrations in nearby stream and river sediments.

8.2.5 Pathogens

E. coli are sampled routinely as an indicator of the potential presence of other faecal-sourced pathogens. *E. coli* sources include faecal material from water fowl, dogs, ruminant animals, birds and humans. *E. coli* are assessed in conformity with national microbiological water quality guidelines as an indicator of human health risk.

Although there is persistent concern that wastewater overflows introduce pathogens into rivers, recent studies show there are other and potentially more significant sources such as water fowl.

Since wastewater overflows occur infrequently, and only during heavy rain when dilution and flushing also occur, they can be considered an infrequent and minor source of pathogens. Canine sourced faecal material is also less likely to be found in rivers, because of compliance with the Dog Control Bylaw 2016 (part 5; owners disposing of dog faeces), and because dog faeces enter rivers indirectly when washed in during rainfall.

Environmental Science and Research Limited (ESR) was engaged to investigate *E. coli* sources. Moriarty & Gilpin, (2015):commented[1] that water fowl are the major cause of pathogen numbers exceeding recreation guidelines. Contact recreation can be made safer principally by reduction in the numbers of water fowl. It is recommended that the Council, through education and communication, seeks a mandate from the community to reduce water fowl numbers.

[1] Additional commentary at Appendix E

8.2.6 Nutrients

Nitrogen (nitrate, Nitrate-Nitrite-Nitrogen and Dissolved Inorganic Nitrogen) concentrations decrease downstream. This trend has been observed for many years in Christchurch rivers and has been attributed to nitrogen-rich spring input in the upper catchment deriving from rural land uses (such as fertilisers and animal waste). Recent research by the CCC within the Avon River catchment has confirmed that springs contribute high levels of nitrogen and phosphorus into waterways, accounting for this downstream trend in nitrogen concentrations (Munro, 2015). Spring flows entering the upper river are thought to arise from shallow groundwater that is more influenced by agricultural inputs. Deeper groundwater containing more seepage from the Waimakariri River enters downstream parts of the river. This water contains less nitrogen and progressively dilutes in-river nutrients.

Nitrogen very seldom exceeds LWRP toxicity guidelines with respect to ammonia (this guideline varies depending on pH) and nitrate (3.8 mg/L), but frequently exceeds a non-LWRP guideline (ANZECC, 444 µg/L) set to avoid excessive instream plant growth. PDP's instream springs study (PDP, 2016) also showed substantial nitrogen inflows to Ōtākaro/Avon tributaries via spring flows, suggestive of non-urban sources (i.e. agricultural catchments).

Phosphorus can exceed guidelines in Christchurch during wet weather. Leaf decomposition can be a major source of phosphorus. Phosphorus inputs can also come from fertilisers and faecal matter.

8.2.7 Emerging contaminants

Unknown contaminants or contaminants that are not sampled for may have consequences for stream ecology that will only be discovered over time. Potential new contaminants include micro-plastics, hormones, herbicides and cleaning products (e.g. moss killers). The Council's approach to this subject will be to remain up-to-date with national and international research

Table 5: Contaminant sources

Contaminant	Source	Contribution	Possible Mitigation Methods
Sediment	Construction sites	High	Sediment & erosion controls
	Road works	High	Sediment controls
	Road surface abrasion	Medium	Treat road runoff
	Atmospheric deposition	Low	None
	Plants (leaves, etc)	Medium (seasonal)	Street sweeping
	Vehicle emissions	Low	Treat road runoff
	Residential activity (car washing, gardening)	Medium	Behaviour change
Zinc	Bare galvanised roofs	Very high	Replace with: Non-metal roofs or Pre-painted Zn-Al[2] Paint with:

[2] Pre-painted zinc-aluminium coated steel, a common residential roofing, a number of brands available.

Contaminant	Source	Contribution	Possible Mitigation Methods
			Low zinc paint On-site treatment with a device
	Old painted roofs	Very high	Replace with: Non-metal roofs or Pre-painted Zn-Al Paint with: Low zinc paint On-site treatment with a device
	Bare Zn-Al[3] roofs	High	Replace with: Non-metal roofs or Pre-painted Zn-Al Paint with: Low zinc paint On-site treatment with a device
	Vehicle tyres	High	Treat runoff from: Busiest roads Car parks Manoeuvring areas
	Industrial discharges (inferred from monitoring)	Medium	Controls on industrial sites
Copper	Brake pads	High	Legislation bans copper in brake pads
	Roofs, cladding, spouting, downpipes	Low but increasing	Ban on copper cladding
Human sourced pathogens	Sewage overflows	Infrequent but culturally offensive	Improve waste-water system capacity
Animal sourced pathogens	Waterfowl, dogs, cows and sheep	Major bacteria source	Not stormwater related. Controlled by CCC Bylaw.
Industrial discharges	Deliberate spills or poorly controlled sites	Medium	Regulation, monitoring and enforcement
Polycyclic aromatic hydrocarbons	(1) (Old) coal tar street surfaces. (2) Combustion	(1) High but isolated. (2) Low	(1) Encapsulation. Removal. (2) Monitor
Nitrogen	(1) Groundwater (2) Fertiliser (3) Faeces (human and waterfowl)	(1) High (2) Believed low (3) Believed moderate	(1) Beyond CCC control (2) Education (3) Reduce wastewater overflows and exotic waterfowl numbers
Phosphorus	(1) Industrial sources (2) Fertiliser	(1) Moderate	(1) Education, enforcement (2) Education

[3] Zinc-aluminium coated steel. Has commonly replaced galvanised iron since 1994.

Contaminant	Source	Contribution	Possible Mitigation Methods
	(3) Faeces (human and waterfowl)	(2) Believed to be a minor source (3) Believed to be moderate	(3) Reduce wastewater overflows and exotic waterfowl numbers

9.0 Flood Hazards

9.1 History

By 1980 the urban catchment of Nottingham Stream was well established, however the majority of the Huritini-Halswell catchment was rural or undeveloped.

At that time growth was commencing in the industrial area west of Springs Road. In 1977 the Christchurch Drainage Board (CDB) was refused a water right to discharge stormwater from this developing industrial area into Knights Stream. For some years stormwater was discharged into ground soakage in an old gravel pit at the junction of Springs and Halswell Junction Roads. Subsequent concern over the contamination of aquifers prompted the North Canterbury Catchment Board and Regional Water Board to request the CDB to apply for a water right to discharge to the Huritini-Halswell River system. It was requested that the discharge be kept to a minimum by using detention, and disposing of roof water directly into ground on individual sites. (CDB, 1988)

A water right was granted in 1990, with a two year term, for the discharge of stormwater into Knights Stream. The CDB appealed the decision on the basis that the term was too short and would put at risk the proposed outfall works including 1.1 km of piping. The Halswell River Rating District Committee submitted to the Court about effects from the additional effective catchment area. The appeal succeeded and in 1991 the discharge was permitted for a 5 year term, subject to detention of storm flows in the Halswell Junction Detention Basin, with a limit on peak discharge. The consent was renewed in 2000 after an extended investigation and consultation period. Little stormwater ever discharged to Knights Stream because of leakage from Halswell Junction Basin and infiltration through the floor of the surface drainage route to Knights Stream.

9.2 Flood Hazard Analysis

Historical records do not show evidence that river flooding is a hazard in existing developed areas. A flood model for Nottingham Stream (Woodward-Clyde, 1996) indicated that residential areas at the time of the study (prior to expansion under the South-West Area Plan) were not at risk from 50 year AEP flooding.

Subsequently a MIKE 2D floodplain model was developed by ECan post-earthquakes (Oliver, 2013) for the Huritini-Halswell Catchment. A model of the rural floodplain beyond the urban boundary was developed for the Halswell Drainage Scheme Review (McCracken, 2019).

In September 2023 a significantly extended river and floodplain hydraulic model for the catchment as at 2021 was delivered by Beca (Beca 2022). A model of the floodplain is added to the previous channel-only model and is significantly more accurate in urban areas distant from the river.

Table 6: Huritini-Halswell floodplain model components

Process	Software	Method
Rainfall-Runoff (Hillside)	RORB	Concentrated Non-linear Storages
Rainfall-Runoff (Flat Land)	MIKE 21 FM	Rain on Grid
Flood Plains	MIKE 21 FM	2D Shallow Water Equations
Pipe Network	MIKE Urban	MOUSE 1D St Venant and Continuity Equations
Channel Flow	MIKE 11 Classic	St Venant and Continuity Equations

Model improvements include:

- A 2016 development scenario to allow compliance with Condition 23c.
- Maximum probable development.

- Inclusion of all proposed stormwater basins
- Rainfalls anticipated under the Council's climate change planning (RCP8.5) scenario.

The model estimates water levels in 50 and 200 year annual recurrence interval (ARI) events, and updates our understanding of flood levels in relation to existing and future development levels. Significant results are:

a. In general, a 50 year ARI event is predicted to develop limited ponding on roads without a significant amount of water back-flooding onto residential property.
b. Pockets of flooding appear in the industrial area north-west of Shands Road. Some industrial building floors are likely to be inundated occasionally. This can occur because the Building Act does not permit the Council to set floor levels for industrial buildings and lots (and potentially some floors) were developed at a lower level than would apply to a dwelling.
c. Maximum water levels in the main channel are not higher under 2021 development than in the 2016 "baseline year" of Schedule 10.
d. Model results are presented in Appendix D as a map of expected land inundation in a 50 year ARI flood event. Results show that residential land is adequately protected according to the Council's design standards. Ponding shown to occur on roads, which is designed for and expected in a 50 year ARI event.

Stormwater quantity effects are managed by:

- Elevation of residential lots by land filling to conform to District Plan Development Levels. Development within a District Plan Flood Management Area is subject to minimum floor levels 400 mm above the 200 year return period estimated flood level.
- Creation of adequate stormwater drainage and secondary flow paths on roads
- Detention of stormwater in basins which are generally in or near individual subdivisions.

Detention basins are designed to maintain peak water levels in the river to not more than levels before development. Predicted maximum water levels in a 50 year ARI event are shown (for flatland areas only) in Figure 17, Figure 18 and Figure 19 in Appendix D.

9.3 Development effects on the lower river

Impervious areas created by development can be expected to generate increased stormwater runoff. Subsoil drainage has reportedly generated increased base flows. Although peak flows are controlled by detention basins the increased storm flow volumes could increase the volume and duration of runoff from the city. The 2019 Huritini-Halswell Drainage Scheme Review (McCracken, 2019) noted that this can be expected to increase the depth and extent of ponding in downstream ponding areas, which would affect farmland. Similar concerns have been expressed by the Halswell River Rating District Committee.

The Huritini-Halswell Drainage Scheme Review suggests that the storage characteristics of Council detention basins could be enhanced to alleviate flooding effects on the floodplain. Possible enhancements include automated outlet controls on basins and the creation of new basins. There have been preliminary discussions with ECan River Engineers about triggers for considering basin enhancements. The proposed modifications would come at a cost, not only in dollars but of increased risk if basins are maintained full for longer, and of damage to basin vegetation. Council engineers will take note of flood volume information from a revised river and floodplain model. The Council will consider options to reduce total downstream ponding levels if urban-sourced effects are indicated to be significant.

9.4 Water Level Monitoring Locations

Condition 7 Schedule 2(s) requires the identification of key locations for monitoring water levels and/or volumes. Both the critical duration 50 year ARI and 10 year ARI must be considered. A monitoring location on the Huritini-Halswell River at Minsons Drain is specified in Schedule 10. An additional monitoring location is proposed on Knights Stream at Quaifes Road. The location is appropriate because Knights Stream is rural downstream from this point. No monitoring point is proposed for the other tributary Nottingham Stream because only a small amount of development is discharging into that stream.

2022 Huritini-Halswell River hydraulic model (Beca Ltd).					
The development scenario for "allowable increase" is maximum probable development. Climate change RCP 8.5 scenario. Sea level rise is not relevant.					
Receiving Environment	**Monitoring Location**	**Baseline Year**	**Maximum allowable increase target at 2% Annual Exceedance Probability**	**Maximum allowable increase target at 10% Annual Exceedance Probability**	**Modelled change at 2021 in 50 year ARI scenario**
Huritini-Halswell River	Wroots Road	2016	0 mm	0 mm	decrease
Huritini-Halswell River	Minsons Drain (Early Valley Road)	2016	0 mm	0 mm	decrease
Knights Stream	Quaifes Road	2016	0 mm	0 mm	decrease

The modelled decrease in 2021 is due to the diversion of Halswell Junction Basin catchment into ground infiltration via Wilmers Basin.

Section Three
Objectives and Principles

10.0 Developing a water quality approach

10.1 Introduction

Mitigation options have been considered for contaminants that regularly exceed water quality targets and are believed to be significant causes of poor stream health. Contaminant sources include industrial waste releases which cause pollution, although they are not readily monitored.

Commonly detected contaminants that can be mitigated through the SMP are:

- Sediment (as consent conditions require control by specified means)
- Industrial discharges containing oils, cleaning compounds, nitrates/nitrites, chemicals, etc (section 11.4)

Other common contaminants such as metals typically exceed water quality targets for relatively short periods during and after rainfall. It is believed that they affect ecosystem health but the effects are not well quantified. Short term (acute) exceedances are not directly relatable to Australian and New Zealand Environment and Conservation Council (ANZECC) trigger levels. The Council feels it must do more investigation before it can establish best practicable mitigation options for short term exceedances of:

- Port Hills sediment (section 7.3)
- Zinc (section 8.2.3)
- Copper (section 8.2.4)

The Environmental Monitoring Programme reports levels of these contaminants against guidelines.

10.2 Contaminant Model

Option evaluation was informed by the Christchurch Contaminant Load Model (C-CLM) and two zinc contaminant models (O'Sullivan et al. 2017, PDP 2020) developed for the Ōpāwaho catchment.

The C-CLM is an annual load model driven by unit annual contaminant loads developed by NIWA for Auckland Regional Council for various surface types. Surfaces include galvanised, zincalume, painted and other roof types, a hierarchy of road types stratified by traffic volumes, paved areas and green areas. All sub-catchments are estimated to discharge a similar unit load of TSS. Zinc loads are strongly influenced by the zinc content of roof surfaces and vehicle traffic volumes. Industrial sub-catchments (Halswell Junction Basin, Owaka and West Hornby) and the older residential area of Nottingham Stream Headwaters are estimated to discharge the most zinc per hectare. This result is strongly influenced by the estimated number of unpainted or poorly painted galvanised iron roofs. Higher unit copper discharges from industrial sub-catchments appears to be correlated with busier arterial roads such as Springs and Halswell Junction Roads. Output from the model is reported in Appendix EE.

The two additional zinc models are a spreadsheet model (PDP) and a MEDUSA model by O'Sullivan et al. The models help to indicate potential mitigation options and point to the benefits of contaminant controls at source. There is not yet sufficient Halswell-specific TSS information to improve on the C-CLM. Copper was not modelled along with zinc because urban sources of copper appear to be directly related to traffic volumes and can be analysed on that basis. (Additionally, international legislation appears to be leading to a phasing-down of the copper content of brake pads, a potentially effective source control). A continuous, event-based contaminant load is proposed using the (University of Canterbury) MEDUSA model. The model is expected to incorporate Christchurch contaminant discharge data and to generate more accurate contaminant loads on an event and annual basis. However, it is unlikely to alter our understanding of significant contaminant sources.

It is anticipated that the C-CLM will be replace in time by a Christchurch-specific model based on MEDUSA or MUSIC. Development of the Instream Contaminant Concentration Model (ICCM) is underway, the Ōtākaro – Avon catchment is the pilot. Updates will be included in the Annual Report.

10.3 Options Consideration

Proposed detention and infiltration facilities are estimated by the C-CLM to reduce annual contaminant loads by 14-15% (Table 8). Subsequent zinc modelling for the Ōpāwaho / Heathcote SMP indicates that significant gains could be made from capturing or reducing roof-sourced zinc at source. Forms of treatment such as filters and rain gardens can perform a useful role in treating TSS, copper, zinc and other contaminants. Stormwater treatment facilities, many already in place, are also beneficial, although they are more effective in capturing particulate contaminants including sediment and particulate metals, than dissolved contaminants. Dissolved metals are likely to be the major phase of metal contaminants from roofs and roads (O'Sullivan et al 2017).

Potential mitigation options considered involve the reducing discharges of sediment and toxicants at source, e.g. by painting bare galvanised roofs and street sweeping. At the time of writing the Council is due to carry out an investigation into the effectiveness of street sweeping. However, a desktop review by NIWA (NIWA, 2011) suggests that street sweeping has limited effectiveness. The Council is investigating the likely effectiveness of and its ability to implement other on-property at-source controls, through investigations into:

- Quantifying the effects of intense, short term contaminant concentrations on ecosystems,
- Understanding the costs various mitigation options will have on communities,
- Evaluating the legality of the controls.

Potential mitigation options are summarised in 7.

There are difficulties in the choice of best practicable options (BPO) to control TSS and zinc catchment-wide, as not all are equally understood or able to be implemented:

- Metals discharges in stormwater are of short duration and there is neither a standard nor substantive scientific research that relates short term (acute) concentrations to measurable in-stream effects. It is difficult to compare the effects of different options and their differing expenditure streams.

- Acute TSS effects are also somewhat unclear, although there is agreement that particulate material on stream beds is visible and measurable.

- TSS and metals are discharged in some measure from every impervious urban surface, so effective controls may have to be widespread. The many potential mitigations have differing and sometimes uncertain efficiencies. Treatment system performance must often be inferred from overseas research in different climates and situations.

- Some potential options could mean changes to common building materials or methods and are likely to involve additional costs to individuals and businesses, which the Council does not have powers to implement.

- The Council believes that an option based on incomplete information is not the best practicable option, and that substantial expenditure on an unproven option would not be prudent.

At present the Council does not have sufficient information to commit funding for, or legal powers to adopt a number of the potential options. Considerably more information, such as the long-term costs and benefits of maintaining roof coatings, substituting roof materials or installing stormwater filters, would be required before the Council could consult on and select some options as BPOs. Work being carried out under CRC252424 Conditions 59 and 60 should provide better information. It is the expectation that additional work will be initiated through the proposed Surface Water Implementation Plan referred to in section 2.1.

10.4 Options For Selection in the SMP

The Council considers that the most practicable option at this time is to construct treatment facilities to mitigate contaminants from new developments, in a construction programme that is already funded through the Long Term Plan. The programme is mostly determined by development, with some provision to treat existing areas where possible. The facilities construction programme is a major input to the C-CLM. The C-CLM estimates the benefits of the construction programme but does not drive it. It is a simple, practicable model that estimates progress with contaminant reduction.

The Council also manages construction site sediment through an Erosion and Sediment Control Plan (under Condition 41). There is no model available for single site sediment discharge.

10.5 Less Significant Contaminants

Less significant contaminants that are sometimes detected at low levels, but do not have a mitigation strategy because they either do not exceed guidelines or have a non-stormwater source include:

- *E. coli:* implies a risk of other pathogens harmful to humans. (There are no pathogen targets in the consent. Pathogen controls are likely to be considered in the Surface Water Improvement Plan).
- Polycyclic aromatic hydrocarbons (PAHs): no consent targets. Do not exceed LWRP guidelines
- Nitrate and nitrite: no direct consent targets. Non-stormwater sources
- Phosphorus: no direct consent target. Non-stormwater sources
- Ammonia: no consent target. Does not exceed LWRP guidelines.

10.6 Potential Mitigation Options

(TSS = total suspended solids BPO = best practicable option)

Table 7: Potential mitigations for contaminants

Contaminant	Source	Potential Control Option	Comment	How the controls could be implemented
TSS, copper, zinc	New subdivisions (large sites)	Facilities in new developments to limit increases in flow rate and capture TSS. Infiltration facilities.	Partial mitigation. Mostly for new growth (greenfields). Infiltration facilities generally remove metals from stormwater more effectively.	As conditions on subdivision, resource or building consents
TSS, copper, zinc	New development (small sites)	On-site (private) devices	Partial mitigation for new development (typically brownfields)	Included in Table 10 Minimum Standards for Development
TSS (mostly sediment)	Construction & excavation sites	CCC implements and monitors on-site erosion and sediment control(1)	Difficult and often poorly managed on site	Effected through conditions on individual resource or building consents
TSS (mostly sediment)	Road works	CCC implements and monitors on-site erosion and sediment control(1)	Many contractors do this already	Required as a condition of Road Opening Permits (road works permits)
TSS	Vehicle traffic	Rain gardens, tree pits, and filters to treat runoff from busy roads. Road sweeping	Can also remove some zinc and copper. 7% of the city's roads generate an estimated 50% of metallic contaminants.	Install treatment devices over time to treat stormwater from contaminated catchments.
Copper	Vehicle brake pads	Educate residents about the value of low/no copper brake pads. Advocate with Government for legislation change	Legislation has occurred in USA. Some low-Cu pads available in NZ	Copper-free brake pads becoming available by market forces. CCC educates local auto industry and residents..

Contaminant	Source	Potential Control Option	Comment	How the controls could be implemented
Copper	Architectural copper (roofs, spouting, downpipes)	Transparent sealer applied to copper surfaces	May not be fully effective e.g. inside downpipes. Sealer must be maintained in good condition or copper will continue to discharge.	This is a current control effected through building consents.
Copper	Architectural copper (roofs, spouting, downpipes)	Investigate the feasibility of a District Plan rule to discourage the use of copper claddings.		By seeking legal advice about the practicability of such a Rule. Under way.
Copper, zinc	Roads, roofs	Divert first flush to the wastewater network	Limited capacity available in WW network	This option is one of a number of Schedule 4 (CSNDC Condition 40) investigations.
Zinc	Bare steel roofs (mostly industrial)	1. Educate and encourage use of pre-painted roofing 2. Potential District Plan rule to require roof runoff treatment on site. Potential District Plan rule to discourage the use of bare zinc roofing.		1. Educate and encourage use of pre-painted roofing 2. Investigate the feasibility of a District Plan rule to require roof runoff treatment on site. 3. Investigate the feasibility of a District Plan rule to discourage the use of bare zinc roofing.
Zinc	Poorly maintained residential roofs	Most residential roofs are painted. Educate re paint maintenance.	Old paint coatings expose zinc primer and zinc substrate. Can be half as bad as bare roof	The CCC needs to investigate various mitigation options and choose a BPO
Zinc	Poorly maintained painted roofs	Education programme re roof maintenance. Possible incentives.	Old paint coatings expose zinc primer and zinc substrate. Can be half as bad as bare roof. Roof re-painting could cost 20-30% of the cost of re-roofing.	CCC to investigate the costs & benefits of painting v renewal v civic scale stormwater treatment. Under way.
Zinc	Vehicle tyre wear	Treat runoff from major roads	Treatment is partially effective. Overseas research may discover a less toxic alternative to zinc. No current alternative.	Install road runoff treatment devices. The CCC will continue to engage with the government through MfE

Contaminant	Source	Potential Control Option	Comment	How the controls could be implemented
Industrial waste and spills	Poorly controlled industrial sites	Surveillance, education, on-site improvements, enforcement		CCC Pollution Prevention Team to visit, educate and enforce starting with high risk sites.
Pathogens (bacteria, etc)	Water fowl, dogs, cows, sheep, waste-water overflows	Reduce water fowl numbers, dog faeces controls, riparian fencing, wastewater overflow controls	Some dog and wastewater overflow controls in place.	CCC introduces controls on water fowl to restrict numbers to an agreed limit. Wastewater overflows are progressively being reduced. Riparian fencing programme instigated.
Phosphorus	Multiple potential sources	Investigate sources. Education and enforcement used to control private/industrial sources.		Education and investigations could be funded through the Community Waterways Partnership

Note (1): Current best practice erosion and sediment control is found in Environment Canterbury's *Erosion and Sediment Control Toolbox* at https://esccanterbury.co.nz/

10.7 Numerical Consent Standards

Two CSNDC Conditions create contaminant reduction targets.

Condition 19 numerical targets: The Council is to specify target contaminant load reductions to be achieved by proposed facilities and devices.

Target reductions in Table 8 are those estimated by the C-CLM[4] be effected by a combination of future facilities and anticipated changes in contaminant sources (e.g. roof renewal with less contaminating materials). Table 8 targets contribute toward city-wide targets in CRC252424 Table 2.

(Reductions result from treatment in new facilities and anticipated changes in contaminant sources.)

Table 8: Target reductions in stormwater contaminant load.

Contaminant	Target reductions in stormwater contaminant load (tonnes/year) Resulting from construction of new stormwater mitigation facilities Compared to the consent application base year 2018		
	5 years from 2018 (year 2023)	10 years from 2018 (year 2028)	25 years from 2018 (year 2043)
TSS	12.6%	14.4%	13.8%
Total Zinc	9.7%	13.7%	34.4%
Total Copper	11.1%	15.5%	35.6%

Table 8 targets are the proportion of the Condition 19 Table 2 standard attributable to the Huritini-Halswell Catchment

10.8 Schedule 7 to 10 Targets

Condition 23:

"The (Council is to) use best practicable options to mitigate the effects of the discharge of stormwater on:

(a) Surface water quality, instream sediment quality, aquatic ecology health and mana whenua values as measured by Receiving Environment Attribute Target Levels in Schedules 7 and 8.

(b) Groundwater and spring water quality as measured by Receiving Environment Attribute Target Levels in Schedule 9.

(c) Water quantity as measured by Receiving Environment Attribute Target Levels in Schedule 10."

CRC252424 Schedule 7, 8, 9 and 10 are in Appendix C.

[4] Christchurch Contaminant Load Model

10.9 Contaminant Reduction Measures

The following actions are best practicable options for the Council to implement through the SMP:

- Treatment of stormwater from new development, Section 12.1 Goals 1.1 & 1.2
- Erosion and sediment control on development and construction sites, Section 12.1 Goals 1.3–1.5
- Investigating the feasibility and legality of zinc control measures for building cladding, Section 12.1 Goal 2.2
- Auditing high-risk industrial sites and working with occupiers to remediate contaminated stormwater discharges, Section 12.1 Goal 4.2
- Working with community groups and the public to educate the community about the effects of and mitigation of stormwater contaminants, Section 12.1 Goal 5.1
- Managing flooding by ensuring that stormwater from all new development sites or re-development sites will be attenuated to a minimum standard, Section 12.1 Goal 6.1

Further work will be required to identify best practicable options (BPOs) for mitigating copper and zinc discharges from buildings, copper discharges from vehicles and sediment discharges from sources other than development sites. Implementation of such BPOs is more likely to be implemented through the Surface Water Strategic Plan referred to in section 2.1.

The Council is commissioning research into the effectiveness of contaminant reduction options and the toxicity of short duration bursts of dissolved metals in waterways during stormwater runoff. Some answers to these questions may be available within 2 – 3 years.

10.10 Role of Monitoring and Tangata Whenua Values in Setting Targets

10.10.1 Environmental Drivers

It is clear from the water quality and ecological monitoring that waterways in the catchment are in poor condition overall. It is generally understood that this is a result of altered flow regimes and contaminant discharges associated with urban development. However, it is likely that spring fed upper tributaries in newly developing areas are less contaminated than waterways such as Nottingham Stream in established areas. Treatment facilities west of Nottingham Stream catchment are considered to deal adequately with effects of development. Contaminant exceedances at Candys Road monitoring station have led to a Council project outside the SMP to investigate sources of contaminants in Nottingham Stream catchment and, if practicable, to introduce mitigation. Ideally, this would be as far upstream as practicable to benefit waterway health.

Commentary from a number of sources suggest that Te Waihora-Lake Ellesmere is the most sensitive receiving environment and activities in the SMP to treat developing areas with some retrofitting is intended to achieve a practicable level of protection for that water body.

10.10.2 Ngāi Tahu Objectives

This Plan recognises and is intended to help support the policies and objectives for water and the environment in the Te Waihora Catchment, from the Mahaanui Iwi Management Plan 2013.

10.10.3 Lessons from monitoring of treatment basins

Modelling and design decisions have been made with reference to the WWDG and international research. At the time the SMP was delivered (2021) there was insufficient monitoring of treatment basins to generate usable information. More information is available at the time of this SMP revision. Treatment facilities are being monitored during wet weather to measure treatment performance. Treatment efficiencies obtained from 2020/21 wet weather monitoring of Curletts, Wigram, Prestons and Knights Stream facilities (PDP, 2021, PDP 2023), indicate the potential for a reasonable percentage of TSS and metals removal. However, these results are interim and the Council is not yet confident to adopt these limited data for modelling and places more reliance on NIWA 2008, WWDG guidelines, Auckland Regional Council guidelines, and international research. However, treatment efficiency data continues to be collected in wet weather monitoring. The C-CLM presented at the 2019 consent hearing incorporated treatment efficiencies from sources including NIWA 2008. Modelling will benefit from further monitoring of basin, wetland and treatment devices performance.

A comment on previous monitoring is made in a memorandum titled Inferences from Performance of Treatment Basins 1993-2020 (TRIM 22/490757).

Table 9: SMP response to Iwi Management Plan policies

Iwi Management Plan	Huritini-Halswell SMP response
Policy TW4.1: To require that the management of land and water in the Te Waihora catchment recognises and provides for the relationship between catchment land use, tributary flow, drain management, water quality the coastal environment and the cultural health of Te Waihora.	The purpose of the SMP supports this policy.
Policy TW6.8: To support cultural health monitoring of mahinga kai species in Te Waihora, the lake margins and tributaries, including but not limited to: (a) Tuna, particularly longfin; (b) Pātiki; (c) Kāki anau; and (d) Kokopu, as a good indicator species.	The Environmental Monitoring Programme will carry out cultural health assessments within the city part of the catchment.
Policy TW7.1: To require that the restoration of water quality in lowland streams is addressed as a matter of priority in the takiwā, to enable Ngāi Tahu and the wider community to fish, swim and engage with our waterways as we once did.	The Goals of the SMP (section 12.1) point toward this policy
Policy TW7.2: To require that water quality issues in the catchment area addressed as per general policy on water quality and on the effects of rural land use with particular attention to: (a) The specific nature of the catchment i.e. lake as a sink at the bottom of the catchment, absorbing the pollutants that flow into it from tributaries, drains and farm run-off; and (b) The need for polluters to be held responsible for their effects on water quality and lake health.	The Goals of the SMP (section 12.1) point toward this policy

Iwi Management Plan	Huritini-Halswell SMP response
TW8.1 To require that the wāhi taonga status of wetlands, waipuna and riparian margins is recognised and provided for in the catchment, as per general policy on wetlands, waipuna and riparian margins.	Waterways and their setbacks have protection under the District Plan. Springs are protected where a land use consent application is made.

11.0 Developing a Water Quality Approach

11.1 High Risk Sites and Industries

Industrial sites will be managed using powers under the Stormwater and Land Drainage Bylaw 2022. The Bylaw requires industries to put in place best practice in the control of industrial contaminants. The Council will:

- Audit at least 15 high risk sites per year;
- Inform audited industries of the results of audits and work closely with these industries to achieve outcomes in line with the Bylaw;
- Communicate with industries about stormwater discharge standards and the means of meeting these standards.

Change will be effected through a combination of education and enforcement.

- Education will be carried out through an Industry Liaison Group (to be set up).
- Enforcement will occur as Pollution Prevention Officers identify and visit high-risk industrial sites and work with industries to improve site management.

Contamination risks are controlled to a significant degree by acceptance of trade wastes into the wastewater system. This is authorised through Trade Waste Consents which permit a degree of oversight and site control.

The Christchurch City Council's objective is that stormwater entering into the CCC's network is managed according to best practice, especially where the discharge occurs directly into a waterway. On-site pre-treatment may be required unless contaminant levels are less than LWRP Schedule 5 standards.

Where industrial site occupiers do not meet the required standards for discharge into the network, the site will be removed from the CSNDC and will require a separate resource consent from ECan for its discharge. A condition is included in the CSNDC for this process and all industrial sites excluded from the resource consent will be listed on Schedule 1 attached to the consent.

Future needs include:

- More interaction with industries by the CCC; communication, awareness and education
- Improved knowledge of the environmental effects of compounds discharged by industrial sites
- Ongoing site checks until the CCC is confident that all risky sites are controlled adequately
- Upgrades on non-compliant sites

11.2 New Development

Contaminants, particularly sediments, generated by development are controlled by rules in the District Plan and the Stormwater Bylaw 2022.

11.2.1 Operational controls on stormwater and sediment

The management of sites which may experience erosion and/or discharge sediment during development works is controlled by conditions of either resource consents or building consents, as applicable, for both earthworks and building. The Stormwater and Land Drainage Bylaw 2022 specifies standards for activities not controlled by consents.

Standards for sediment discharges are set by the Sediment Discharge Management Plan 2022 (SDMP). The sediment discharge management process is intended to work as follows:

1. Allowable TSS (total suspended solids) concentration trigger levels for discharges to the stormwater network are set by the SDMP.
2. An erosion and sediment control plan (ESCP) is prepared by a 'suitably qualified and experienced professional' as determined by a site risk assessment
3. The TSS concentration trigger levels for the site are included in authorisations or conditions where possible.
4. The ESC measures are implemented onsite and monitored.

11.2.2 Constructed stormwater treatment systems

District Plan rules require new developments to incorporate stormwater quantity and quality mitigation. Treatment systems may comprise detention basins, infiltration basins, rain gardens, swales and filters. The majority of development in the Huritini-Halswell catchment is expected to be mitigated, multi-lot development. Both stormwater quantity and quality mitigation will be required:

i. Stormwater from development will be detained in storage so that post-development peak flows do not exceed pre-development peaks up to the 2% AEP critical duration event for the catchment.

ii. Stormwater contaminants are to be treated by the best practicable option as measured by Receiving Environment Attribute Target Levels in CRC252424 Schedule 7.

11.2.3 Mitigating individual site stormwater

Individual developments are required to treat stormwater to mitigate any change in quantity or quality arising from the development. The minimum standard for stormwater treatment is in Table 10.The minimum standards for stormwater detention and treatment associated with new development follow in Table 10.

Table 10: Minimum standards for stormwater detention and treatment

Site type	Requirements
For and during land disturbance activities	An Erosion and Sediment Control Plan is required
Residential and commercial development on hill sites (>5°slope) up to 5,000 m^2 in area	No discharge onto or into land where the slope exceeds 5 degrees. All hill sites are required to implement stormwater storage to mitigate flooding and stream erosion unless: • The redevelopment does not increase the overall impervious surface coverage of the site, or; • The development is part of a subdivision development which has been designed to mitigate the stormwater runoff from its allotments (in which case advice from a Christchurch City Council Stormwater Planning Engineer should be sought). All hill sites adding more than 150m^2 of new hardstand area must treat the 'first flush'(1) of stormwater runoff from the new hardstand surfaces (or an equivalent area of other pollution-generating hardstand) unless provision of a treatment system is demonstrated to be unfeasible.
Residential and commercial development	Flat sites are required to provide stormwater storage to mitigate flooding effects if:

on flat (<5°slope), urban areas up to 5,000 m^2 in area	• The additional impervious area added is greater than 150m²; **and** • The resultant impervious area covers more than 70% of the total site area; **and** • The site is not part of a subdivision development which has been designed to mitigate the stormwater runoff from its allotments (in which case advice from a Christchurch City Council Stormwater Planning Engineer should be sought). Flat sites adding more than 150m^2 of new hardstand area must treat the 'first flush'(1) of stormwater runoff from the new hardstand surfaces (or an equivalent area of other pollution-generating hardstand) unless provision of a treatment system is demonstrated to be unfeasible.
All areas	Site management and spill procedures: – Procedures are to be implemented to prevent the discharge of hazardous substances or spilled contaminants discharging into any land or surface waters via any conveyance path

Notes:

1. The first flush is the first 25 mm of runoff
2. The CCC has discretion to waive the requirement for first flush treatment of hardstand areas on large residential sites with a low impervious percentage where the amount of pollution-generating hardstand being added is considered to have less than minor effect.

11.2.4 Treatment Facilities

All stormwater from new development will discharge via combined quantity and quality treatment facilities. The majority of new facilities will be west of Springs Road, and will be in areas where there are no streams or stormwater mains. New facilities in this area will be infiltration basins. This assumption was part of the basis for the Pattle Delamore Partners estimates (PDP 2020) reported in section 11.4.

Development under this SMP is consistent with the South-West ICMP 2010. The ICMP is a plan to mitigate growth effects in the Wigram and Awatea sub-catchments (principally Wigram and areas west of Wigram) by the construction of detention and infiltration basins. Facilities will primarily serve both new developments and established areas, funded by developers and the Council respectively. Wilmers Basin will provide additional treatment for the industrial area draining to Halswell Junction Basin. Halswell Quarry Pond will treat an existing residential area on Kennedys Bush Road. Placement of some basins proposed in the South-West ICMP have changed for reasons related to land ownership and development planning. The majority of designs are carried out by engineering consultants on behalf of developers.

Stormwater should be discharged into the ground after treatment where discharge to ground is possible. This is preferred to minimise pipe infrastructure and to maintain groundwater flows. **Error! Reference source not found.** shows zones where discharge to ground is likely or unlikely to be possible.
Figure 13, Figure 14 and Figure 15 display the location of existing and proposed treatment facilities and the catchments treated by facilities (or groups of facilities). **Error! Reference source not found.**. Indicative dimensions of proposed basins are based on land use and area as per the table.

Table 11: Treatment facilities proposed within the term of the SMP

Sub-catchment	Treatment Group ID	Sw Basin ID	Retrofit	Contributing area (Ha)	Land Use	FF Basin Area (m^2)	FF Basin Volume (m^3)	Wetland Area (m^2)	Total detention Volume	Treatment train
Greens West Basins (Kennedys Green) 511 Halswell Roadd	5714	1036 and 1037		33.0	Residential	5,422m^2	2,986 m^3	7,791 m^2	4,998 m^3	First flush (dry) + wetland
Greens East Basins (Riverstone) 511 Halswell Roadd	5441	1033-1035		27.1	Residential	4,998 m^2	2,739 m^3	5,712 m^2	16,369m^3	First flush (dry) + wetland
Nottingham 101 Sabys Road	5438	1030-1032		15.7 Ha	Residential	1,444 m^2	1,817 m^3	5,788 m^2	8,127 m^3	First flush (dry) + wetland

Rossendale 137A Old Tai Tapu Road	5437	1039-1041		89.2 Ha	Residential	4,586 m^2+ 1,815 m^2	1,328 m^3	No wetland	5,700 m^3 + 4,200 m^3 + 35,000 m^3 + 23,000 m^3	First flush (dry)
Coxs-Quaifes 60 Quaifes Road	5142	1004 - 1006	3.6 Ha of existing residential development	92.9 Ha	Residential and Rural Basin	26,454 m^2	10,100 m^3	20,196 m^2	14,400 m^3 + 20,400 m^3 12,800 m^3	First flush (dry) + wetland
Wilmers Basin 46 Wilmers Road	5163	1022 - 1023	100%	100 Ha	Commercial/ Industrial		10,125 m^3	No wetland	77,500 m^3	First flush (dry)
Creamery	5140	190, 191, 1049	100%	64.3 Ha	Residential	2,492 m^2	5,040 m^3	No wetland	11,472 m^3	First flush (wet)
NTP Shands West (Mānia) 637 Main South Road	5445	1061 - 1062		42 Ha	Industrial	1,386 m^2	1,574 m^3	No wetland	9,670 m^3	First flush (dry) + Rapid Soakage

NTP Shands East (Mānia) 320 Shands Road	5444	1059 - 1060			Industrial	683 m^2	2,100 m^3	No Wetland	10,555 m^3	First flush (dry) + Rapid Soakage
Calder Stewart (Hornby Quadrant) 661 Main South Road	5457	1057 - 1058		33.8 Ha	Industrial	4,286 m^2	3,800 m^3	No wetland	7, 300m^3	First flush (dry) + Rapid Soakage
Columbia 288 Springs Road	5443	1055-1056		20.5 Ha	Industrial	3,813 m^2	2,306 m^3	No wetland	9,225 m^3	First flush (dry)
Racetrack 300 Springs Road	5442	1053-1054		11.9 Ha	Industrial	1,180 m^2	1,300 m^3	No wetland	5,400 m^3	First flush (dry)

Notes: Green numbers from SW ICMP Overview Spreadsheet.

1.

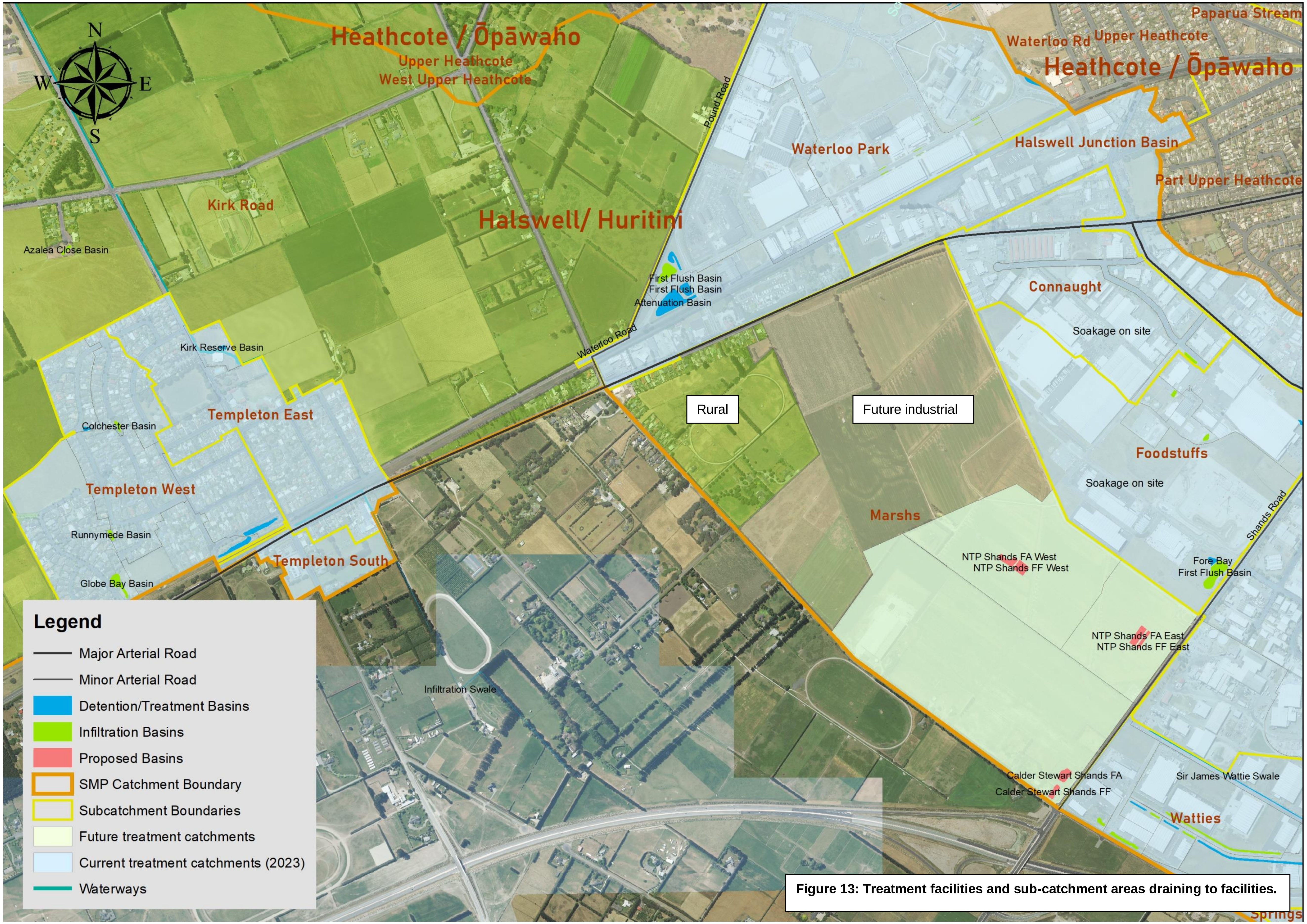

Figure 13: Treatment facilities and sub-catchment areas draining to facilities.

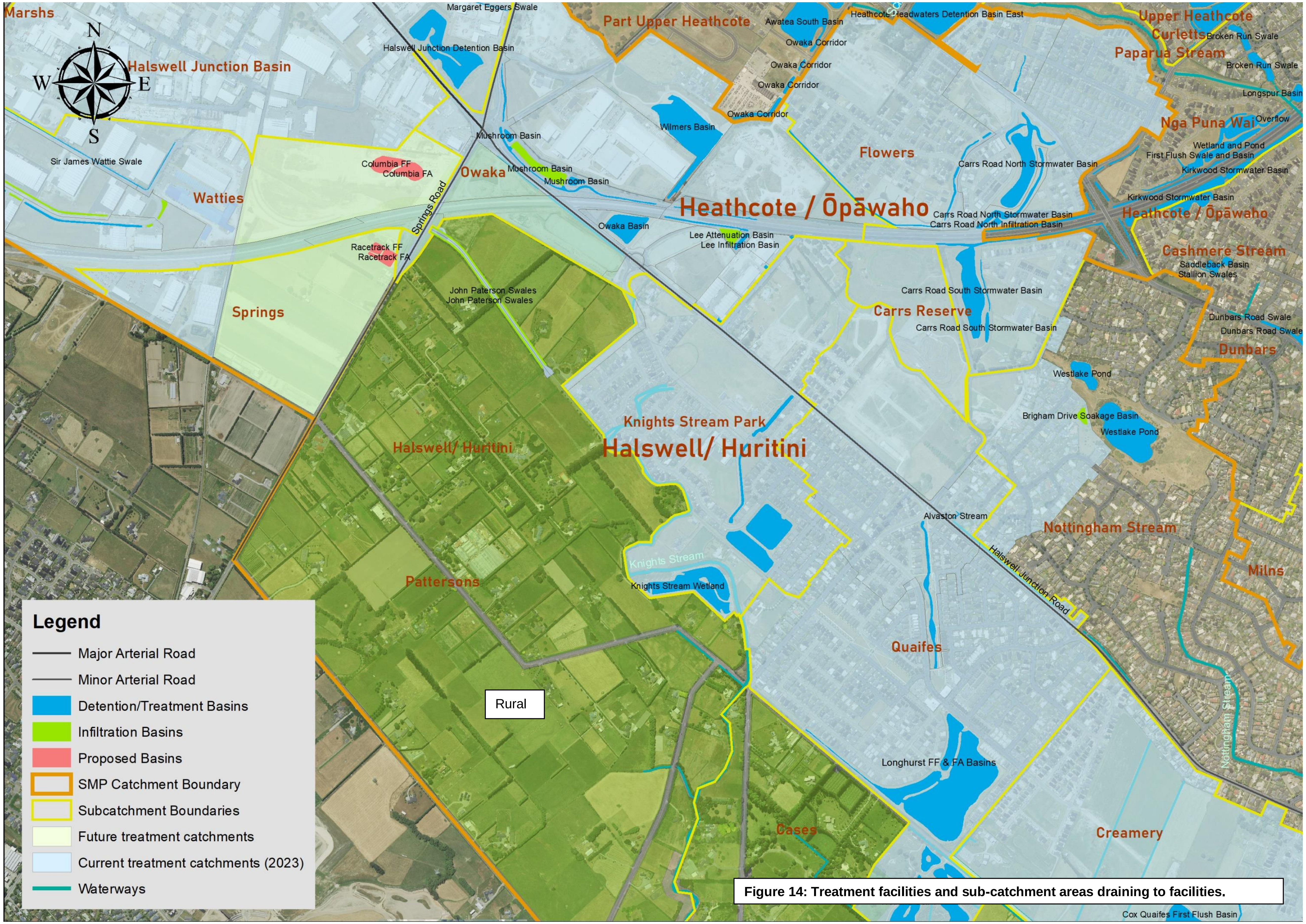

Figure 14: Treatment facilities and sub-catchment areas draining to facilities.

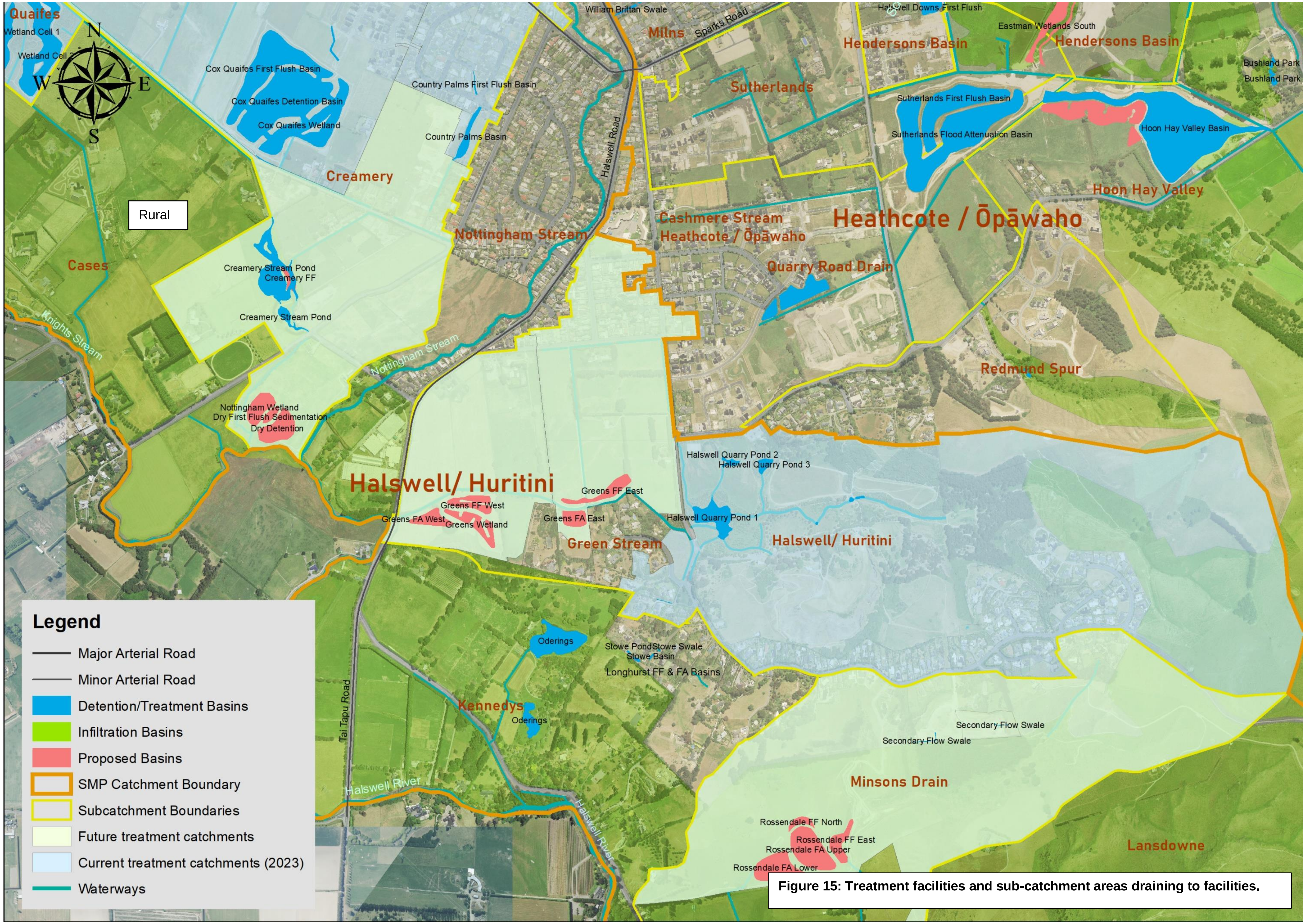

Figure 15: Treatment facilities and sub-catchment areas draining to facilities.

11.2.5 Avoiding Groundwater Mounding

Groundwater rises locally to some degree (mounding) when an infiltration basin is discharging. Adverse effects (either waterlogging of adjacent land or impeded drainage) can be avoided by carefully locating basins with reference to groundwater depth. Groundwater depth is not expected to be limiting for basins west of Whincops Road which will be situated on or overlying gravel. Mounding is less likely where permeable gravels underlie a basin.

Groundwater Quantity and Quality Assessment for the Heathcote Catchment (PDP, 2016) indicates, based on modelling, that "…the extent of mounding (beneath basins) is expected to be limited. Under a worst case scenario infiltration could cause groundwater levels to rise by up to 3 m during a 50 year storm event." Unless it is shown by groundwater records and modelling to be safe to do so, basins will be located where groundwater is not expected to be shallower than this depth year-round.

Where groundwater may rise either to ground level or the basin floor level the designer must make provision, as appropriate, to discharge at a slower rate and/or storm stormwater until infiltration is no longer impeded or acquire or remediate adjacent land that would be subject to waterlogging

Infiltration basin site selection and design is to conform to sections 6.5.3 and 6.5.4 in the WWDG.

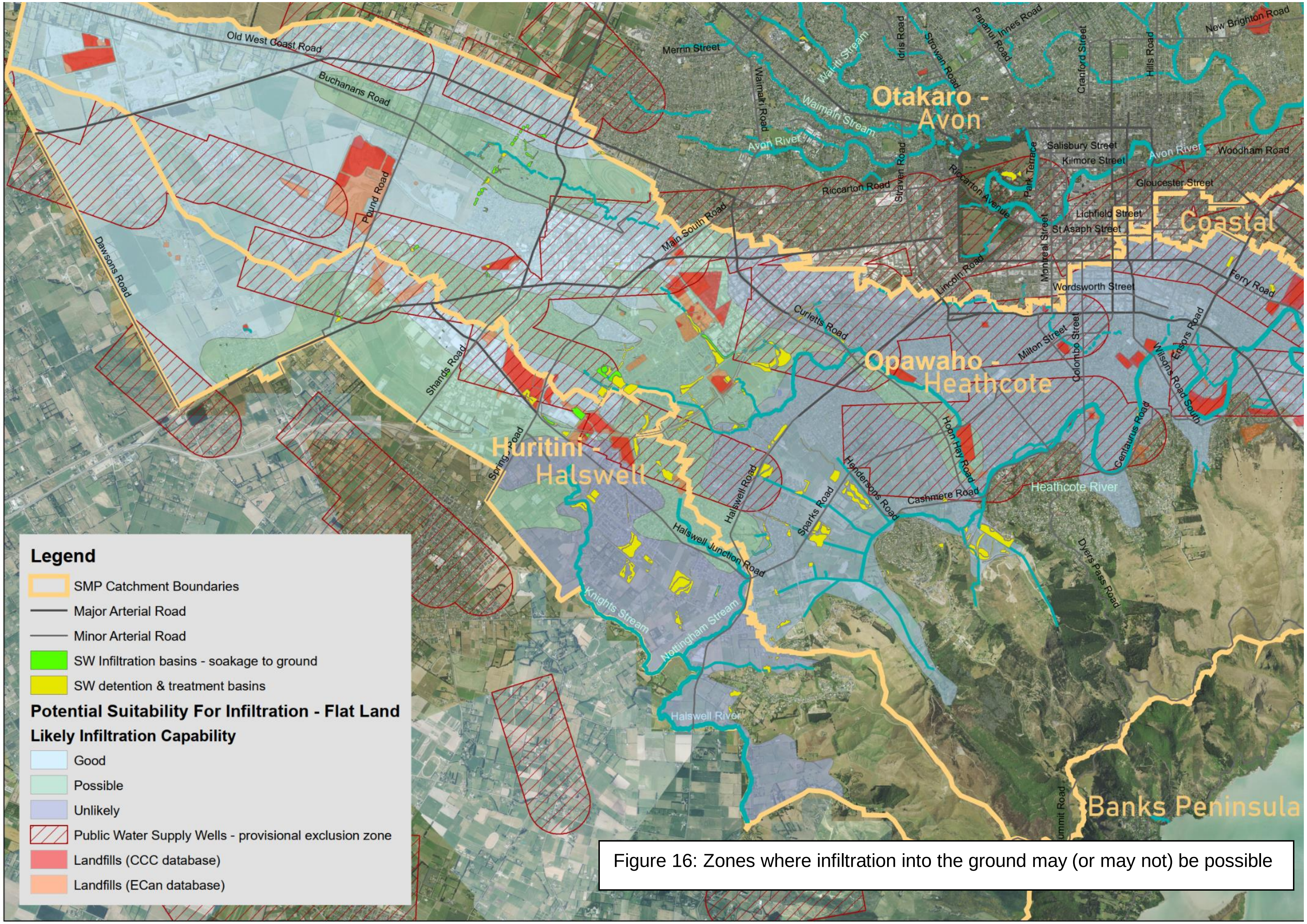

Figure 16: Zones where infiltration into the ground may (or may not) be possible

11.2.6 Treatment facilities and contaminated land

Schedule 2(f), Condition 7, requires a description and justification for separation distances between proposed stormwater facilities and contaminated sites. Contaminated sites are identified as sites appearing in the Environment Canterbury Listed Land Use Register.

Groundwater mounding is to be modelled for infiltration facilities near old landfills. Design of such facilities should ensure that groundwater mounding does not intersect contaminated material.

This limitation is not extended to surface contamination which is unlikely to be reached by groundwater mounding.

Table 12: Proposed facilities. Justification for separation distances from contaminated sites

Facility Name, Type, Address	Catchment	Basin type and size	Nearby HAIL site(s), Investigation number, Separation distance	Reason for the location of this installation
Greens West Basins FF & FA 511 Halswell Rd	Residential	Dry FF sedimentation 0.44 Ha Dry detention ? Ha	511 Halswell Rd Investigation #254955 Same property	Basin placement is determined by topography and land availability. Contamination in small amounts and isolated locations. Contaminants can be removed during basin construction.
Greens East Basins FF & FA 511 Halswell Rd	Residential	Dry FF sedimentation 0.44 Ha Dry detention 3.81 Ha	511 Halswell Rd Investigation #254955 Same property	Basin placement is determined by topography and land availability. Contamination in small amounts and isolated locations. Contaminants can be removed during basin construction.
Nottingham FF, FA, & WL 101 Sabys Road	Residential (Old Halswell)	Dry FF sedimentation 1 Ha (preliminary) Dry detention 3 Ha (preliminary) Wetland 2 Ha (preliminary)	101 Sabys Road No nearby HAIL site	n/a
Rossendale East FF 137A Old Tai Tapu Rd	Residential	Dry sedimentation 1.14 Ha	137A Old Tai Tapu Road Investigation #125383 Same property	Basin placement is determined by topography and land availability. Contamination in small amounts and isolated locations. Contaminants can be removed during basin construction.

Rossendale North FF 137A Old Tai Tapu Rd	Residential	Dry sedimentation 1.2 Ha	137A Old Tai Tapu Road Investigation #125383 Same property	Basin placement is determined by topography and land availability. Contamination in small amounts and isolated locations. Contaminants can be removed during basin construction.
Rossendale Upper FA 137A Old Tai Tapu Road	Residential	Dry detention 3.54 Ha	137A Old Tai Tapu Road Investigation #125383 Same property	Basin placement is determined by topography and land availability. Contamination in small amounts and isolated locations. Contaminants can be removed during basin construction.
Rossendale Lower FA 137A Old Tai Tapu Rd	Residential	Dry detention 3.04 Ha	137A Old Tai Tapu Road Investigation #125383 Same property	Basin placement is determined by topography and land availability. Contamination in small amounts and isolated locations. Contaminants can be removed during basin construction.
NTP Shands West FF & FA 637 Main South Road	Industrial 33 Ha approx	FF & FA Infiltration Dimensions not supplied	320 Shands Road Investigation #249784 Adjacent property	Low levels (< NES standards) of contaminants on adjacent site unlikely to pose a risk.
NTP Shands East FF & FA 320 Shands Road	Industrial 29 Ha approx	FF & FA Infiltration Dimensions not supplied	320 Shands Road Investigation #249784 Same property	Levels of contaminants tested for significantly below the Residential 10% Produce values (NES, Table B2)
Calder Stewart/ Shands FF & FA 661 Main South Road	Industrial 67 Ha	Swale, FF & FA Infiltration Dimensions not supplied	661 Main South Road Investigation #141768 Same property	Surface contamination in a single location away from proposed basin/swale locations.
Columbia FF & FA 288 Springs Road	Industrial 12.9 Ha	FF & FA Infiltration Dimensions not supplied	288 Springs Road Recent information by email S Koviessen, ECan (prior Investigation #139684)	Evidence of uncontrolled land-filling on this site. Potentially unsuitable for infiltration without full remediation within the infiltration area and vicinity.
Racetrack FF & FA 300 Springs Road	Industrial 7.3 Ha	FF & FA infiltration 0.36 Ha	300 Springs Road No nearby HAIL site	n/a

FF first flush basin

FA full flood attenuation and stormwater treatment basin

WL wetland

11.3 Effects of stormwater on groundwater quality

New stormwater management systems are created during urban development as new impermeable surfaces reduce stormwater infiltration into the ground. Thus stormwater disposal is more likely to affect surface water than groundwater quantity. However, effects on groundwater can include changes to the location and rate of groundwater recharge.

In Greenfields developments stormwater is detained in storage facilities to avoid effects from flooding and stormwater contaminants. Stormwater facilities may be either detention or infiltration basins. Selecting which type of basin to use depends on the permeability of the underlying strata and the depth to groundwater beneath the basin. Infiltration basins are typically more appropriate where strata are permeable and groundwater levels are relatively deep, and these conditions occur west of Hoon Hay and north of the Southern Motorway. Some localised groundwater mounding effects occur beneath infiltration basins. In general, these effects need not occur if infiltration basins are carefully designed.

Groundwater quality could be adversely affected by stormwater discharge from infiltration basins. However if the basins are appropriately constructed, and located away from community drinking water supply protection zones and landfills the effects are expected to be limited. Very limited leakage to groundwater from stormwater detention-only basins is expected to occur. Groundwater mounding could cause adverse groundwater quality effects in the vicinity of old landfills or other contaminated sites. This issue will continue to be considered on a site-by-site basis. These stormwater treatment mechanisms are expected to have very small effects on groundwater quality.

11.4 Changes to springs and base-flow

Existing land use in the Huritini-Halswell catchment consists of a mix of residential, industrial, commercial and open space areas. Future development will increase the amount of impervious area and introduce new drainage patterns in new developments, which may affect the infiltration of rain into the ground and base-flow in the river. Developing areas are mostly in the west of the catchment where soils are permeable and there is a preference to infiltrate stormwater into the ground in that area.

Pattle Delamore Partners investigated the expected effects of urban development on the water balance, base flow and springs (PDP 2020) (PDP 2022). This included consideration of new subdivisions in more space-intensive zonings where imperviousness is typically higher than in older areas. Because of the large amount of inflow from the Waimakariri River and the comparatively large amount of rainfall on the plains, the reduction in groundwater recharge due to urbanisation across those parts of the catchment where detention basins are suitable is more than made up by additional infiltration via proposed infiltration basins.

It was found that due to anticipated future stormwater detention and infiltration into the ground:

a. Anticipated development should result in a 36% increase in groundwater recharge in this catchment, via infiltration basins.

b. Base-flow in the upper Huritini-Halswell River could increase by 8 to 13% due to the increased infiltration post-development.

Council intends to monitor base flows with a new flow recorder in Creamery Stream at Sabys Road. This is to meet Condition 7 Schedule 2(l) and to respond to consultation with the Halswell River Drainage District Committee.

The Halswell River Drainage District Committee raised concerns that increased baseflows would harm farmland. Parts of the lower Halswell River floodplain hold ponded water in flood events larger than about 5 years average recurrence interval. The drainage of flood water is impeded by flat river gradients. The concern is that higher base flows will prolong the duration of agricultural land inundation after heavy rain. The CCC will test this scenario by modelling in a subsequent phase to the Huritini-Halswell hydraulic model.

If the concerns are justified the CCC will investigate active flood management in its detention basins (by mechanical gates or other means) to detain flood water for longer and reduce effects on the flood plain.

Figure 7 shows there is a significant number of springs located in catchment. ECan has raised concerns that future development within the catchment (including building new stormwater basins) could result in adverse effects on the spring flows. To address these concerns CCC will undertake visual monitoring of two spring locations within the catchment (Knights Stream just south of Marshs Road and Quaifes Rd at Drain No 1). This spring monitoring and its associated analysis and reporting will be detailed in the CSNDC Environmental Monitoring Programme.

11.5 Designing basins to minimise bird strike risk to aviation

Christchurch District Plan Policy 6.7.2.1.2 – *Avoidance or mitigation of navigational or operational impediments* – is a policy to avoid or mitigate the potential effects of activities that could interfere with the safe navigation and control of aircraft, including activities that could interfere with visibility or increase the possibility of bird-strike.

Planners and designers are required to consider the potential for new water bodies to increase the risk of bird strike. New water bodies within 13 kilometres of airport runway thresholds can provide habitat that will attract waterfowl and bring their flight lines into intersection with aircraft flight lines. The risk potential should be quantified via a Bird Strike Risk Assessment carried out by a person with suitable ornithological training, with reference to a risk assessment template supplied by Christchurch International Airport Ltd.

New stormwater facilities within a defined zone extending 3 km from airport runway thresholds (see District Plan Appendix 6.11.7.5) must meet activity standards in section 6.7.4.3 of the Christchurch District Plan. These activity standards are applied at the time of subdivision and provide a standard of bird strike protection, within that zone, approved through the District Plan Hearings process.

Section Four
Stormwater Outcomes

12.0 The Plan – Objectives

These objectives address the issues arising from Sections 3 and 5 through 11.

12.1 Objectives and Goals

<u>Objective 1. Control sediment discharges</u>

Our goals are

1.1 *Ensure the quality of stormwater from all new development sites or re-development sites is treated to best practice (with Table 7, section 11.4 being the minimum standard)*

1.2 *100% of stormwater treatment facilities contributing to complying with consent condition 19 Table 2 are constructed and conform to WWDG standards.*

1.3 *By 2025 sediment discharges reported to the Council from consented construction activities on the flat number less than 5% of all construction sites on the flat.*

1.4 *By 2025 sediment discharges reported to the Council from consented construction activities on the hills number less than 10% of all construction sites on the hills.*

1.5 *Investigate the feasibility of techniques for remediating adverse effects of sediment discharges on receiving environments by 2022 (Schedule 3f)*

1.6 *Analyse options for carrying out street sweeping, sump cleaning, and diversion to wastewater trials in 2020/21 (Schedule 4b & d)*

<u>Recommended for consideration through the Surface Water Strategic Plan</u>

1.7 *The Council works with farmers to control sediment from erosion sites on Port Hills farms by 2030, with subsidies as required to expedite controls.*

1.8 *Road sediment is reduced by a best practicable option determined by the results of street sweeping, sump cleaning and alternative treatment trials (Schedule 4c, f, g & h.)*

Goal	Task	Mechanism	Task Components	Timing
Sediment (urban)				
1.1 New developments	Plan and oversee installation of detention basins, wetlands & swales	District Plan (Development contributions) and Long Term Plan	Normal planning processes.	Ongoing
1.3 & 1.4 Construction & excavation sites	On-site sediment and erosion control effected through Erosion and Sediment Control Plans	CCC enforcement powers under the Building Act 2004.	Train Building Inspectors. Implement an enforcement process.	ESC now part of resource consents for earthworks and building

Goal	Task	Mechanism	Task Components	Timing
			Contractor(s) on standby for cleanup when breaches occur.	
1.6 Road runoff contains sediment	Investigate & develop methods to treat runoff from arterial roads,	Increase frequency of street sweeping, rain gardens	1. Street sweeping trials. 2. Construct rain gardens where feasible.	Commencing 2021

Objective 2. Control zinc contaminants

Our goals are

2.1 [repeats Goal 1.2] *All the facilities required to meet contaminant load reduction standards (Table 2 in the consent conditions) are constructed.*

2.2 *By 2022 the CCC will have investigated zinc mitigation measures and carried out cost/benefit analyses toward identifying their effectiveness as best practicable options.*

2.3 *By 2025 the Council has consulted with key stakeholders and identified a long term zinc strategy consistent with current technologies.*

2.4 *The CCC collaborates with local and regional government in a joint submission to central government seeking national measures and industry standards to reduce the discharge of building and vehicle contaminants.*

Goal	Task	Mechanism	Task Components	Timing
Zinc				
2.2 & 2.3 Bare zinc coated roofs emit zinc	Investigate/consult acceptable material for new roofs. (Choices non-metallic or pre-painted zinc/aluminium.)	District Plan rule (if possible) otherwise investigate Regional Rule or legislation	Investigate environmental harm and costs/benefits of alternative materials. Consult widely.	Under way
2.2 & 2.3 Bare zinc coated roofs, esp. industrial	Encourage owners to paint bare roofs. Consider subsidy to paint existing bare roofs	Education, incentives	Investigate environmental harm and costs/benefits of alternative materials. Educate via Community Water Partnership.	
2.2 & 2.3 Ageing pre-coated roofing likely to emit zinc	Research zinc emissions from ageing pre-coated roofing	Sampling roof runoff	Sample runoff from ageing roofs, monitor trends, liaise with industry.	
2.4 Vehicle (tyre) zinc	Research and implement best practicable means of zinc removal from busy roads	Catchment scale filtration systems. Wetlands & rain gardens if space is available	Research and trials	Under way 2021

<u>Recommended for consideration through the Surface Water Strategic Plan</u>

2.5 By 2025 a civic-scale facility (or array of devices) will be installed in at least one urban sub-catchment to treat runoff from busy roads. By 2029 similar facilities/devices will be installed in at least three urban sub-catchments

2.6 The Council adopts a zinc limitation strategy based on identified best practicable options.

2.7 The Council engages in research into and trials means of trapping roof-sourced zinc on site.

Objective 3. Control copper contaminants

Our goals are

3.1 The CCC seeks to consult with the government, through the Ministry for the Environment, about legislation to limit the copper content in vehicle brake pads.

3.2 The CCC does not permit stormwater discharges into the network from unprotected copper cladding, spouting or downpipes.

3.3 The CCC will investigate the feasibility of a District Plan rule to prevent the use of copper claddings.

Goal	Task	Mechanism	Task Components	Timing
Copper				
3.1 Vehicle brake pads	Request legislation requiring low/no copper in brake pads	Combined regional and local authority approach to government re legislation to apply nation-wide.	Liaison between local and regional councils. Representation to government via NZTA, MfE	Unknown
3.2 & 3.3 Architectural copper (roofs, spouting, downpipes)	Prohibit the use of unprotected architectural copper. Seek to limit or eliminated the use of architectural copper.	NZ-wide legislation; possible District Plan rule; otherwise investigate Regional Rule	Liaise with government thru MfE. Investigate and consult.	Unknown

Objective 4. Control industrial site contaminants

Our goals are

4.1 A database of industrial sites considered to be medium or high risk is compiled, based on the best available information, by 2025

4.2 High risk industrial sites are audited by the approved procedure under the CSNDC

Goal	Task	Mechanism	Task Components	Timing
4.1 Limited information about industrial sites.	Gather data to improve database of industrial site information.	Desktop analysis, questionnaires, Chamber of Commerce	Desktop analysis, mailouts, questionnaires, industry liaison	Starting 2021
4.2 Industries unaware of effects of discharges to stormwater	Develop awareness among all industries of the harmful effects of contaminated discharges.	Educate via mail-outs. Educate during site audits.	Inspect sites in risk order. Communicate results and expectations	Starting 2021
4.2 Some industries failing to control harmful substances	Ensure that harmful substances are contained, tracked, and disposed of safely	Audit sites and follow up with education and enforcement.	Protocols for site controls developed jointly by CCC, ECan and industry. Site audits.	Phase in over c 5 years
4.2 Non-compliant discharges	Trace and eliminate discharges	Audit sites and follow up with education and enforcement.	Communicate the issue to industry & visit industries. Generate improvement plan. Engage and obtain compliance.	Phase in over c 5 years

Objective 5. Engagement and education

Our goals are:

5.1 By 2025 the Council will be working with community groups to engage with the public to educate participants about current stormwater practice and enable the public to take action to stop contaminants at source.

5.2 By 2025 the Council will be engaging regularly with the Ministry for the Environment to collaborate on contaminant reduction initiatives.

Goal	Task	Mechanism	Task Components	Timing
5.1 Valuing Water Resources	Education and engagement to empower community groups Each new generation values waterways	Joint partnership prog to effectively co-ordinate existing education and engagement of community groups	Partner delivery (CCC, ECan, Ngāi Tahu, CWMS) with stream care and other community groups	Community Water Partnership programme to be considered in 2021 LTP
5.1 Communication strategy	Develop a long term communication strategy	Strategy development	Understand community thinking about waterways. Agree message and means of communicating.	After 2021 LTP
5.1 Promote community action	Encourage supportive community groups	More direct support for active groups. Provide information and involve in planning	Assist groups to develop goals and action plans. Share CCC planning. Fund and track funding. Monitor results.	After 2021 LTP

Objective 6. Manage Flooding

Our goals are

6.1 The quantity of stormwater from all new development sites or re-development sites will be attenuated to at least the minimum standard of section 11.5

6.2 Protection for houses will continue to be achieved through full mitigation of water quantity effects during development and controls on new floor levels

Goal	Task	Mechanism	Task Components	Timing
6.1 Control extra stormwater from new development	Limit the increase in peak stormwater runoff.	Stormwater from new subdivisions is controlled through basins. Stormwater from larger individual sites attenuated on site.		Ongoing
6.2 Minimise flooding caused by city growth & change	Monitor changes to impervious areas and stormwater network capacity and compensate if necessary	Regular computer-based flood modelling.	Models kept up-to-date as the city changes. Compare models with flood events. Plan for flood mitigation as necessary.	Ongoing

Objective 7. Maintain stream base-flows and spring flows

Our goals are

7.1 Stormwater will be infiltrated into the ground where practicable, after treatment, in order to maintain as much as possible the pre-development water balance.

Note: Infiltration of stormwater into the ground, after acceptable treatment, is the Council's preferred means of stormwater discharge.

Action Plan for Flooding				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
7.1 Maintain base flows	Infiltrate stormwater into ground where practicable.	Stormwater networks in new development prioritise detention and infiltration.	Normal planning processes	Ongoing

13.0 Conclusion

The purpose of the Comprehensive Stormwater Network Discharge Consent is to drive planning and actions that will progressively improve the quality of stormwater discharges.

Actions the Council can take through the stormwater management plan will contribute to this but must be accompanied by other actions if the purpose of the Consent, and Council's Community Outcome (Healthy Environment) and the Mahaanui Iwi Management Plan objectives are to be realised. Further actions, by the Council and others, include:

- Raise awareness and educate citizens on how to stop contaminants at source from entering stormwater
- Remove contaminants from stormwater and waste streams before they enter natural water,
- Restore and plant riparian margins
- Improve instream habitat by sediment removal, introducing additional habitat (such as riffles and fish refuges), and riparian tree planting (for temperature control, bank stability and shelter).
- Introduce more environmentally friendly drainage practices (e.g. trees to shade streams and suppress macrophytes and terrestrial weeds).
- Improve terrestrial biodiversity to improve food sources for instream life.

Progressive improvement can occur through:

Table 13: Contributing to progressive stormwater improvement

Activity	Motivation for the Activity
The Council regulating and acting under regulations to stop the discharge of contaminants	As required by conditions of CRC252424 (CSNDC)
The Council investigating new means of controlling contaminants at source (e.g. by materials substitution or innovative means of treatment).	As required by conditions of CRC252424 (CSNDC)
The Council and others implementing new or improved contaminant mitigation practices	Through the proposed strategic plan for surface water (est. 2022) (referred to in section 2.1)
The Council and others making progressive environmental improvements such as restoring waterways and their corridors to a natural state, and improving the abundance of native species, in particular, mahinga kai	Community Outcome (Healthy Environment)
Citizen-based awareness and advocacy for clean water and improved biodiversity.	Kaitiakitanga
Advocacy by Ngāi Tahu for the mana of water and waterways	Kaitiakitanga. Kawanatanga. Mahaanui Iwi Management Plan

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Appendix A Schedule 2 matters

Table 14: Schedule 2 matters to be included in SMPs: CRC252424 Condition 7

Matters for inclusion in SMPs	Where addressed in the SMP
a. Specific guidelines for implementation of stormwater management to achieve the purpose of SMPs;	The SMP is the guideline
b. A definition of the extent of the stormwater infrastructure, that forms the stormwater network within the SMP area for the purposes of this consent;	4.4
c. A contaminant load reduction target(s) for each catchment within that SMP area and a description of the process and considerations used in setting the contaminant load reduction target(s) required by Condition 6(b) using the best reasonably practicable model or method and input data;	10.7, 10.2, 10.3, 10.4
d. A description of statutory and non-statutory planning mechanisms being used by the Consent Holder to achieve compliance with the conditions of this consent including the requirement to improve discharge water quality. These mechanisms shall include: i. Relevant objectives, policies, standards and rules in the Christchurch District Plan; ii. Relevant bylaws; and iii. Relevant strategies, codes, standards and guidelines;	2.3 through 2.7
e. Mitigation methods to achieve compliance with the conditions of this resource consent including the requirement to improve discharge water quality under Condition 23, and to meet the contaminant load reduction targets for each catchment as determined through the SMPs and the standards for the whole of Christchurch set in Condition 19. These methods shall include: i. Stormwater mitigation facilities and devices; ii. Erosion and sediment control guidelines; iii. Education and awareness initiatives on source control systems and site management programmes;	Section 11

iv. Support for third party initiatives on source control reduction methods; v. Prioritising stormwater treatment in catchments: that discharge in proximity to areas of high ecological or cultural value, such as habitat for threatened species or Areas of Significant Natural Value under the Regional Coastal Environment Plan (Canterbury Regional Council, 2012); and areas with high contaminant loads;	10.10.1
f. Locations and identification of Christchurch City Council water quality and water quantity mitigation facilities and devices; including a description and justification for separation distances between mitigation facilities or devices and any contaminated land;	11.2.4, Figures 12-14
g. Identification of areas planned for future development and a description of the Consent Holder's consideration to retrofit water quality and quantity mitigation for existing catchments through these developments where reasonably practicable;	7.1, 7.2, 7.3 and 11.2.4
h. Identification of areas subject to known flood hazards;	9.2
i. A description of how environmental monitoring and assessment of tangata whenua values have been used to develop water quality mitigation methods and practices;	10.10
j. Results from and interpretation of water quantity and quality modelling, including identification of sub-catchments with high levels of contaminants;	10.2
k. Mapping of existing information from Canterbury Regional Council and the Consent Holder showing locations where discrete spring vents occur;	4.5.2, Figure 7
l. Consideration of any effects of the diversion and discharge of stormwater on base-flow in waterways and springs and details of monitoring that will be undertaken of any waterways and springs that could be affected by stormwater management changes anticipated within the life of the SMP;	11.4
m. A cultural impact assessment;	5.4

n. A summary of outcomes resulting from any collaboration with Papatipu Rūnanga on SMP development;	MKT advised that the Position Statement is sufficient.
o. An assessment of the effectiveness of water quality or quantity mitigation methods established under previous SMPs and identification of any changes in methods or designs resulting from the assessment;	10.10.3
p. Assessment and description of any additional or new modelling, monitoring and mitigation methods being implemented by the Consent Holder;	11.4 (base flow monitoring)
q. A summary of feedback obtained in accordance with Condition 8 and if / how that feedback has been incorporated into the SMP;	Appendix B
r. If the Consent Holder intends to use land not owned or managed by the Consent Holder for stormwater management, a description of the specific consultation undertaken with the affected land owner;	Not applicable
s. Identification of key monitoring locations in addition to those identified in Schedule 10 where modelled assessments of water levels and/or volumes shall be made. For all monitoring locations, water level reductions or tolerances for increases shall be set for the critical 2% and 10% AEP events in accordance with the objective and ATLs in Schedule 10 and shall be reported with the model update results required under Condition 55;	9.4
t. Procedures, to be developed in consultation with Christchurch International Airport Limited, for the management of the risk of bird strike for any facility owned or managed by the Christchurch City Council within 3 kilometres of the airport;	11.5
u. A description of any relevant options assessments undertaken to identify the drivers behind mitigation measures selected; and	10.3, 10.4
v. An assessment of the potential change to the overall water balance for the SMP area arising from the change in pervious area and the stormwater management systems proposed.	11.4

Appendix B Feedback on the Stormwater Management Plan

Feedback from the Technical Peer Review Panel and the Council's response

1. Hydrogeology Review

The Hydrogeology Reviewer made many comments; in general suggesting that the SMP gave insufficient consideration to the importance of groundwater, gave insufficient guidance about where stormwater should be infiltrated via infiltration basins, and gave insufficient guidance on how groundwater should be protected. It noted several errors and omissions.

The CCC accepted most of the Reviewer's comments and added further explanations and maps to clarify the matters raised. Errors and omissions were corrected. Suggestions about protecting groundwater were actioned; however the CCC avoided some wording that would imply that it has a groundwater protection role.

2. Ecology Review

The Ecology Reviewer commented that the SMP is generally fit for purpose and suggested minor additions and alterations which were accepted and included.

3. Contaminated Site and Land Management Review

The Contaminated Land Reviewer found that the SMP is generally fit for purpose. The Reviewer referred to closed landfills, noting that leachate is not treated as stormwater; noted that the CCC should be aware of the possibility of coal tar surfacing on older streets. Both of these issues are covered by Council processes and the comments are not proceeded with.

4. Erosion and Sediment Control Review

The Erosion and Sediment Control Reviewer considered that the erosion and sediment control requirements in the consent have generally been met. The Reviewer recommended that Environment Canterbury's Erosion and Sediment Control Toolbox be referenced, which has been done.

Feedback from Public Consultation and the Council's response

Christchurch International Airport Ltd

Christchurch International Airport Ltd (CIAL) supports the key purposes of the plan and commends measures to minimise bird strike risk. Citing International Civil Aviation Authority guidance CIAL asks that the creation of new water bodies be curtailed within 13 km of the airport runway threshold in order to move the flight paths of waterfowl away from the operating paths of aircraft.

CIAL had made a similar submission to the District Plan review and a District Plan Rule decision was made by the Commissioners. Council engineers met with CIAL and agreed additional SMP content to improve protection for aircraft from water fowl.

Halswell Residents Association

The Halswell Residents Association feels that the plan should promote on-site rainwater capture, noting that this has not been achieved through the District Plan. It should identify roads as significantly affecting stormwater quality. It proposed that timelines for achieving sediment discharge and copper targets need to be shorter; likewise the time to compile a database of industrial sites. The submission suggested that Quaifes Road Drain has not been insufficiently protected during subdivision.

Staff responded that on-site rainwater capture would more likely be effected through the District Plan. The SMP does not have a separate mechanism to implement on-site rain-water capture nor is it certain that this is a best practicable option for flat-land areas. The SMP does briefly link roads and stormwater quality. Target completion dates for specified activities appear to be misinterpreted by the Association as start dates. The SMP has set completion dates to allow time for becoming compliant.

Waipuna/Halswell-Hornby-Riccarton Community Board

Waipuna/Halswell-Hornby-Riccarton Community Board supports the SMP. The Board is concerned about the proximity of stormwater basins to three contaminated sites. Staff responded that a new Owaka Basin is clear of dumped contaminants, and other sites will be tested for contaminants before new basins are built.

Oil Companies

The oil companies support source controls and wish to know more about how these will be effected. They are concerned that additional on-site stormwater treatment for zinc and copper may be required on petroleum industry sites e.g. in car parking areas (and private sites in general), which they would consider inequitable. They regard roads as more significant contaminant sources. The oil companies disagree that stormwater quality from industrial sites should be equivalent to that from residential sites.

Staff responded that references to source control are commentary rather than policy, and on-site mitigation is more likely to be specified for new sites rather than all sites. The wording was amended to remove areas of disagreement.

New Zealand Steel Ltd

NZ Steel asked that the SMP use generic naming rather than registered trade names, and that change has been made. NZ Steel asked to be more directly involved in developing zinc reduction strategies, saying that it has done considerable research on the environmental effects of its products. There are no such strategies in the SMP but NZ Steel will be engaged in the strategic plan process for surface water development, including any zinc reduction strategies. NZ Steel advocates for mitigation strategies for existing rather than new roofs.

Waipuna/Halswell-Hornby-Riccarton Community Board

Waipuna/Halswell-Hornby-Riccarton Community Board supports the SMP. The Board is concerned about the proximity of stormwater basins to three contaminated sites. Staff responded that a new Owaka Basin is clear of dumped contaminants, and other sites will be tested for contaminants if and before new basins are built on them.

Halswell River Rating District Liaison Committee

Ratepayers in the Halswell River Rating District are concerned that increased base flows from subsoil drainage and the increased volume of runoff, both from new subdivisions will increase the depth and duration of ponding in downstream ponding areas which occupy farm land.

The Council responded that its engineers are waiting for results from the Halswell River flood model which will be completed in 2022. Engineers will consider options to reduce total downstream ponding levels if urban effects are indicated to be significant. Automated outlet controls on basins and the creation of new basins can be considered. Council engineers will consider these options in consultation with the Halswell River Rating District Liaison Committee and Canterbury Regional Council engineers.

Individual submissions

Feedback was received from six individuals. Common themes in individual submissions were that the Council should be more proactive and innovative and should act more quickly to mitigate contaminant discharges, reduce flooding and restore waterways.

The Council acknowledged the comments

Appendix C Attribute Target Levels, Schedules 7 to 10

Waterways, Coastal and Groundwater Receiving Environment Attribute Target Levels in Schedules 7 to 10 from Condition 23, Consent CRC252424.

Schedule 7: Receiving Environment Objectives and Attribute Target Levels for Waterways

- *The EMP outlines the methodology for the monitoring of Attributes and how these will be compared against Attribute Target Levels.*
- *TBC-A = To Be Confirmed once a full year of monitoring allows hardness modified values to be calculated, in accordance with Condition 52.*
- *TBC-B = To Be Confirmed following engagement with Papatipu Rūnanga, through an update to the EMP, in accordance with Condition 54.*

Objective	Attribute	Attribute Target Level	Basis for Target
Adverse effects on ecological values do not occur due to stormwater inputs	QMCI	Lower limit QMCI scores: • Spring-fed – plains – urban waterways: 3.5 • Spring-fed – plains waterways: 5 • Banks Peninsula waterways: 5	QMCI is an indicator of aquatic ecological health, with higher numbers indicative of better quality habitats, due to a higher abundance of more sensitive species. QMCI scores are taken from the guidelines in Table 1a of the LWRP (Canterbury Regional Council, 2018). This metric is designed for wade able sites and should therefore be used with caution for non-wade able sites. These targets can be achieved through reducing contaminant loads and waterway restoration.
Adverse effects on water clarity and aquatic biota do not occur due to sediment inputs	Fine sediment (<2 mm diameter) percent cover of stream bed TSS concentrations in surface water	Upper limit fine sediment percent cover of stream bed: • Spring-fed – plains – urban waterways: 30% • Spring-fed – plains waterways: 20% • Banks Peninsula waterways: 20% Upper limit concentration of TSS in surface water: 25 mg/L No statistically significant increase in TSS concentrations in surface water	Sediment (particularly from construction) can decrease the clarity of the water, and can negatively affect the photosynthesis of plants and therefore primary productivity within streams, interfere with feeding through the smothering of food supply, and can clog suitable habitat for species. The sediment cover Target Levels are taken from the standards for the original Styx and South-West Stormwater Management Plan consents, and are based on Table 1a of the LWRP (Canterbury Regional Council, 2018). These targets should be used with caution at sites that likely naturally have soft-bottom channels. These targets can be achieved through reducing contaminant loads (particularly using erosion and sediment control) and instream sediment removal.

Adverse effects on aquatic biota do not occur due to copper, lead and zinc inputs in surface water	Zinc, copper and lead concentrations in surface water	Upper limit concentration of dissolved zinc: • Ōtākaro/ Avon River catchment: 0.0297 mg/L • Ōpāwaho/ Heathcote River catchment: 0.04526 mg/L • Cashmere Stream: 0.00724 mg/L • Huritīni / Halswell River catchment: 0.01919 mg/L • Pūharakekenui/ Styx River catchment: 0.01214 mg/L • Ōtūkaikino River catchment: 0.00868 mg/L • Linwood Canal: 0.146 mg/L • Banks Peninsula catchments: TBC-A	These metals can be toxic to aquatic organisms, negatively affecting such things as fecundity, maturation, respiration, physical structure and behavior. The CCC has developed these hardness modified trigger values in accordance with the methodology in the 'Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand' (ANZECC, 2000) guidelines, and the species protection level relevant to each waterway in the LWRP (Canterbury Regional Council, 2017). This calculation document can be provided on request. These targets can be achieved primarily through reducing contaminant loads.
		Upper limit concentration of dissolved copper: • Ōtākaro/ Avon River catchment: 0.00356 mg/L • Ōpāwaho/ Heathcote River catchment: 0.00543 mg/L • Cashmere Stream: 0.00302 mg/L • Huritīni / Halswell River catchment: 0.00336 mg/L • Pūharakekenui/ Styx River catchment: 0.00212 mg/L • Ōtūkaikino River catchment: 0.00152 mg/L • Linwood Canal: 0.0175 mg/L • Banks Peninsula catchments: TBC-A	

Objective	Attribute	Attribute Target Level	Basis for Target
		Upper limit concentration of dissolved lead: • Ōtākaro/ Avon River catchment: 0.01554 mg/L • Ōpāwaho/ Heathcote River catchment: 0.02916 mg/L • Cashmere Stream: 0.00521 mg/L • Huritīni / Halswell River catchment: 0.01257 mg/L • Pūharakekenui/ Styx River catchment: 0.00634 mg/L • Ōtūkaikino River catchment: 0.00384 mg/L • Linwood Canal: 0.167 mg/L • Banks Peninsula catchments: TBC-A No statistically significant increase in copper, lead and zinc concentrations	
Excessive growth of macrophytes and filamentous algae does not occur due to nutrient inputs	Total macrophyte and filamentous algae (>20 mm length) cover of stream bed	Upper limit total macrophyte cover of the stream bed: Spring-fed – plains – urban waterways: 60% Spring-fed – plains waterways: 50% Banks Peninsula waterways: 30% Upper limit filamentous algae cover of the stream bed:	Macrophyte and algae cover are indicators of the quality of aquatic habitat. Targets are taken from Table 1a of the LWRP (Canterbury Regional Council, 2018). Improvement towards these targets can be achieved by reduction in nutrient concentrations and riparian planting to shade the waterways.

Objective	Attribute	Attribute Target Level	Basis for Target
		Spring-fed – plains – urban waterways: 30% Spring-fed – plains waterways: 30% Banks Peninsula waterways: 20%	
Adverse effects on aquatic biota do not occur due to zinc, copper, lead and PAHs in instream sediment	Zinc, copper, lead and PAHs concentrations in instream sediment	Upper limit concentration of total recoverable metals for all classifications: Copper = 65 mg/kg dry weight Lead = 50 mg/kg dry weight Zinc = 200 mg/kg dry weight Total PAHs = 4 10 mg/kg dry weight No statistically significant increase in copper, lead, zinc and Total PAHs	Meta Metals can bind to sediment and remain in waterways, potentially negatively affecting biota. These trigger values are based on the ANZECC guidelines (ANZECC, 2018). These targets can be achieved through reducing contaminant loads and instream sediment removal.
Adverse effects on Mana Whenua values do not occur due to stormwater inputs	Waterway Cultural Health Index and State of Takiwā scores	Lower limit averaged Waterway Cultural Health Index and State of Takiwā scores for all classifications: Spring-fed – plains – urban waterways: TBC-B Spring-fed – plains waterways: TBC-B Banks Peninsula waterways: TBC-B	The Waterway Cultural Health Index assesses cultural values and indicators of environmental health, such as mahinga kai (food gathering). These indices are on a scale of 1 - 5, with higher scores indicative of greater cultural values. No guidelines are available currently for the different types of waterways, so these targets will be developed specifically for this consent, with higher targets for waterways with higher values. These targets can be achieved through reducing contaminant loads and habitat restoration.

Schedule 8: Receiving Environment Objectives and Attribute Target Levels for Coastal Waters

- *The EMP outlines the methodology for the monitoring of Attributes and how these will be compared against Attribute Target Levels.*
- *TBC-B = To Be Confirmed following consultation with Papatipu Rūnanga, through an update to the EMP, in accordance with Condition 54.*

Objective	Attribute	Attribute Target Level	Basis for Target
Adverse effects on water clarity and aquatic biota do not occur due to sediment inputs	TSS concentrations in surface water	No statistically significant increase in TSS concentrations	Elevated levels of TSS in the water column decrease the clarity of the water and can adversely affect aquatic plants, invertebrates and fish. For example, sediment can affect photosynthesis of plants and therefore primary productivity, interfere with feeding through the smothering of food supply, and can clog suitable habitat for species. There is no guideline available for this parameter, so no change in concentrations is proposed to be conservative. The target will be achieved by reducing contaminant loads (particularly using erosion and sediment control measures).
Adverse effects on aquatic biota do not occur due to copper, lead and zinc inputs in surface water	Copper, lead and zinc concentrations in surface water	Maximum dissolved metal concentrations for all classes (with the exception of the Operational Area of the Port of Lyttelton): Copper: 0.0013 mg/L Lead: 0.0044 mg/L Zinc: 0.015 mg/L No statistically significant increase in copper, lead and zinc concentrations	Metals, in particular, copper, lead and zinc, can be toxic to aquatic organisms, negatively affecting such things as fecundity, maturation, respiration, physical structure and behavior (Harding, 2005). These targets are taken from the ANZECC (2000) guidelines for the protection of 95% of species. The Operational Area of the Port of Lyttelton is affected by direct discharges from boats that will make monitoring of the effects of stormwater difficult, therefore the targets are not applicable to this area. These targets will be achieved by reducing contaminant loads.
Adverse effects on Mana Whenua values do not occur due to stormwater inputs	Marine Cultural Health Index and State of Takiwā scores	Minimum averaged Marine Cultural Heath Index and State of Takiwā scores for all classes: TBC-B	The Marine Cultural Health Index and State of Takiwā scores assesses cultural values and indicators of environmental health, such as mahinga kai (food gathering). These indices are on a scale of 1 - 5, with higher scores indicative of greater cultural values. No guidelines are available currently for coastal areas, so this target will be developed specifically for this consent. These targets can be achieved through reducing contaminant loads.

Schedule 9: Receiving Environment Objectives and Attribute Target Levels for Groundwater and Springs

- *The EMP outlines the methodology for the monitoring of Attributes and how these will be compared against Attribute Target Levels*

Objective	Attribute	Attribute Target Level	Basis for Target
Protect drinking water quality	Copper, lead, zinc and *Escherichia coli* concentrations in drinking water	Concentration to not exceed: Dissolved Copper: 0.5 mg/L Dissolved Lead: 0.0025 mg/L Dissolved Zinc:0.375 mg/L No statistically significant increase in the concentration of *Escherichia coli* at drinking water supply wells	The most important use of Christchurch groundwater is the supply of the urban reticulated drinking water supply. Contaminants in stormwater that infiltrate into the ground could impact on the quality of water supply wells and/or springs. The compliance criteria for a potable and wholesome water supply are specified in the Drinking Water Standards for New Zealand 2005 (Revised 2008). Metals and *E.coli* were chosen for these targets, as these are contaminants present in stormwater. The target values for copper and lead are a quarter of the Maximum Acceptable Value (MAV) or Guideline Value (GV) taken from the Drinking Water Standards for New Zealand 2005 (revised 2008). This is to ensure investigations occur before the water quality limits in the LWRP are exceeded, which are that concentrations are not to exceed 50% of the MAV. An equivalent criteria has also been applied to the zinc target, which is not included in the LWRP water quality limits, but has a guideline in the drinking water standards.
Avoid widespread adverse effects on shallow groundwater quality	Electrical conductivity in groundwater	No statistically significant increase in electrical conductivity	Contaminants in stormwater that infiltrate into the ground could impact on groundwater quality. Long term groundwater quality at monitoring wells is undertaken by Canterbury Regional Council. Those monitoring points that occur within the urban area could be impacted by CCC stormwater management activities. Electrical conductivity is to be used as an indicator for identifying any general changes in groundwater quality related to recharge.

Schedule 10: Receiving Environment Attribute Target Levels for Water Quantity

MODELLED CATCHMENTS

Objective for the management of stormwater quantity:

To mitigate the risk of inundation, damage to downstream property or infrastructure or human safety through management of stormwater run-off volumes and peak flows. The extent of mitigation shall be assessed against the achievement of attribute target level(s) for each receiving environment.

Attribute Target Level: Modelled flood levels for the relevant AEP for the assessment year critical duration event shall not increase more than the Maximum Increase listed below when compared to the same modelled AEP for the baseline year impervious scenario critical duration, as determined using CCC flood models. The baseline year scenario and assessment year scenario shall be identical except for changes to the impervious area, mitigation measures and the inclusion of any new network(s) that has arisen between the dates of the two scenarios and within the city limits. All non-variant scenario parameters shall be as at the assessment year scenario. The critical duration shall be assessed at the monitoring location of the attribute target level. Non-variant scenario parameters include, but are not limited to, channel cross-sections, roughness and floodplain shape. Prior to undertaking the assessment, the appropriateness of the non-variant scenario parameters shall be assessed and updated if necessary.

WATER LEVEL REDUCTIONS OR TOLERANCES FOR INCREASES

Receiving Environment	Monitoring Location	Baseline Year	Annual Exceedance Probability	Maximum Increase (mm)
Ōtākaro/ Avon River	Gloucester Street Bridge	2014	2%	50
Pūharakekenui/ Styx River	Harbor Road Bridge	2012	2%	100
Ōpāwaho/ Heathcote River	Ferniehurst Street	1991	2%	30
Huritīni/ Halswell River	Minsons Drain confluence*	2016	2%	0

NON-MODELLED CATCHMENTS

Receiving Environment	Attribute Target Level	Basis for Target	Notes
Ōtūkaikino River	Discharges from all new greenfield development into the Christchurch City Council network are mitigated using the "Partial Detention" strategy outlined in the Pūharakekenui/ Styx SMP until such time as a monitoring location can be set during review of the SMP	As measured through the CCC discharge authorisation compliance process for Resource and Building Consents until such time as an Baseline Year can be set during review of the SMP	See Note 1 below.

CCC has just begun monitoring the Ōtūkaikino at Dickeys Road Bridge. Council does not currently model flooding in the Ōtūkaikino River.
Flooding occurs primarily due to backwater effects in the Waimakariri River. Therefore, a best practice approach to mitigation of development will be implemented until such time as maximum Increase can be set during review of the SMP

Appendix D Flood Model Results

Figures 17, 18 and 19 show expected maximum water extent and depth on the floodplain in a 50 year ARI event.

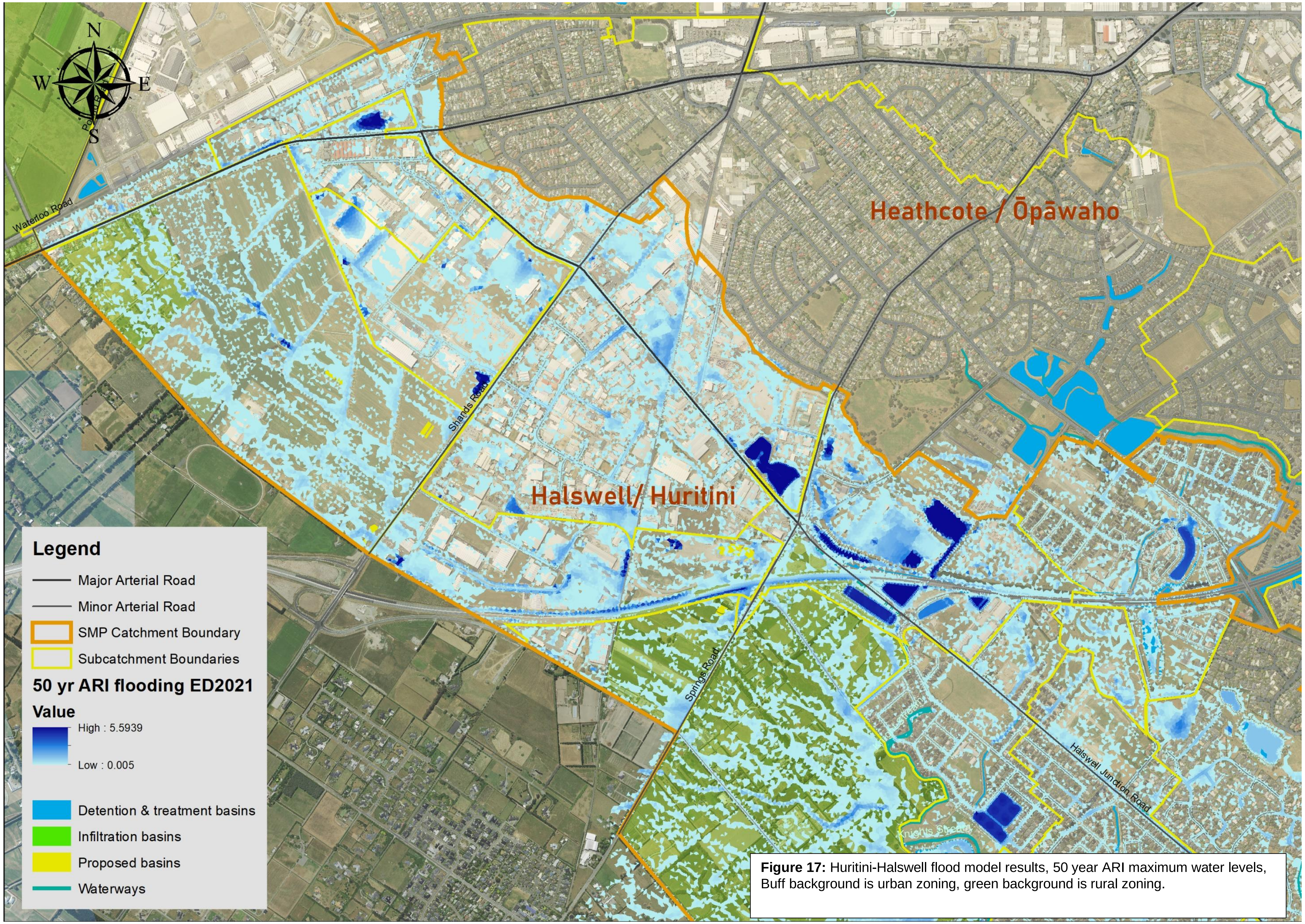

Figure 17: Huritini-Halswell flood model results, 50 year ARI maximum water levels, Buff background is urban zoning, green background is rural zoning.

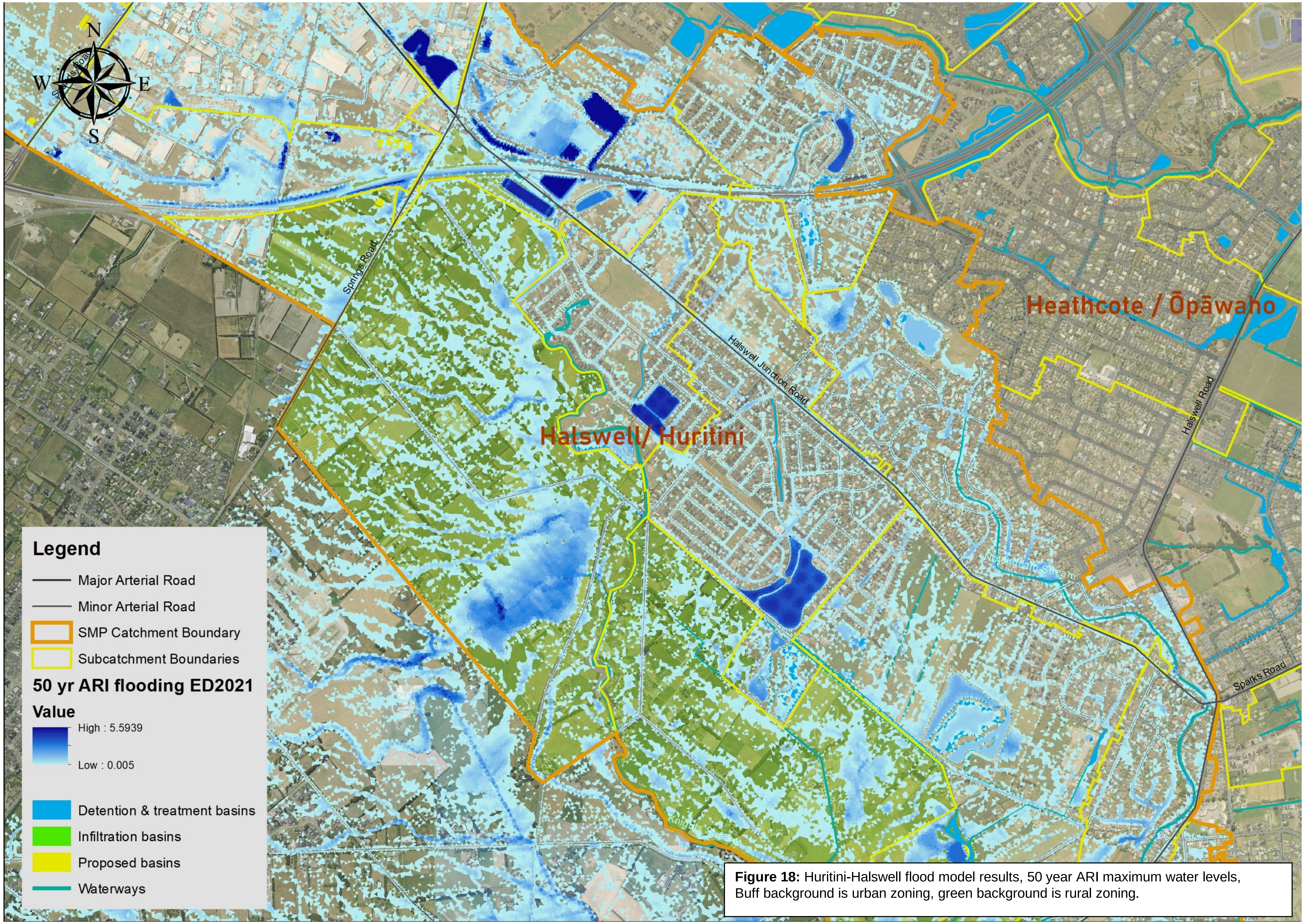

Figure 18: Huritini-Halswell flood model results, 50 year ARI maximum water levels, Buff background is urban zoning, green background is rural zoning.

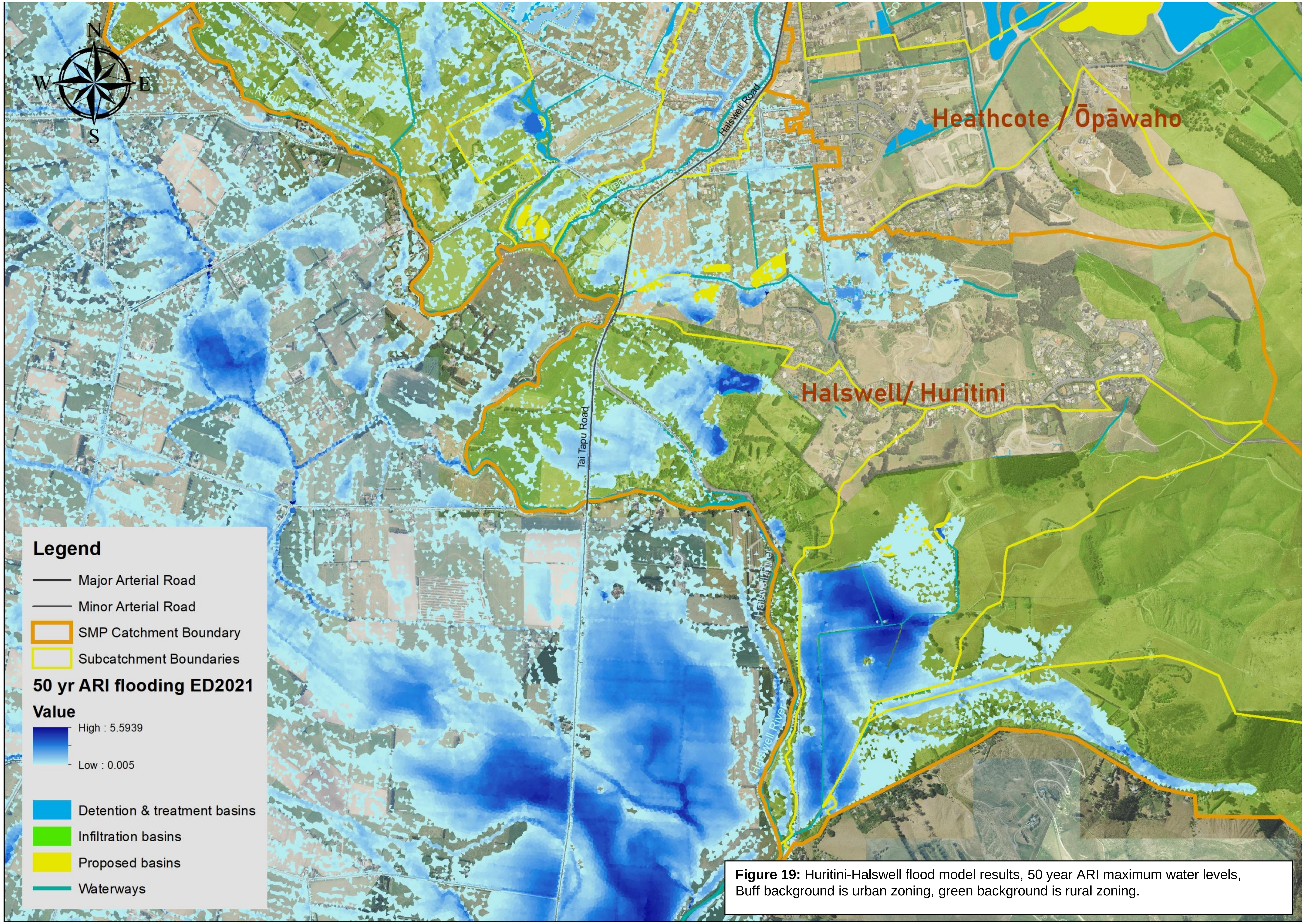

Figure 19: Huritini-Halswell flood model results, 50 year ARI maximum water levels, Buff background is urban zoning, green background is rural zoning.

Appendix E Christchurch Contaminant Load Model 2018 Output

Huritini-Halswell Catchment		**Catchment in 2018 if not treated**						**CSNDC Base Case (Treatment as at 2018)**						**Modelled 10 year case with proposed SMP mitigation**					
	Area	TSS no treatmt	Zn no treatmt	Cu no treatmt	TSS no treatmt	Zn no treatmt	Cu no treatmt	TSS in base case	Zn in base case	Cu in base case	TSS in base case	Zn in base case	Cu in base case	TSS in 10 yr case	Zn in 10 yr case	Cu in 10 yr case	TSS in 10 yr case	Zn in 10 yr case	Cu in 10 yr case
Sub-catchment	(Ha)	(t/yr)	(kg/yr)	(kg/yr)	(t/Ha/yr)	(kg/Ha/yr)	(kg/Ha/yr)	(t/yr)	(kg/yr)	(kg/yr)	(t/Ha/yr)	(kg/Ha/yr)	(kg/Ha/yr)	(t/yr)	(kg/yr)	(kg/yr)	(t/Ha/yr)	(kg/Ha/yr)	(kg/Ha/yr)
Cases Drain	81	15.9	7.8	1.2	0.2	0.10	0.01	14	7	1	0.2	0.09	0.01	14	7	1	0.2	0.09	0.01
Carrs Road	132	19.3	100.0	19.0	0.1	0.76	0.14	17	90	16	0.1	0.68	0.12	8	33	7	0.1	0.25	0.05
Chesmars Drain	154	29.5	21.1	2.4	0.2	0.14	0.02	26	19	2	0.2	0.12	0.01	26	18	2	0.2	0.12	0.01
Creamery Stream	258	64.8	78.9	11.9	0.3	0.31	0.05	57	71	10	0.2	0.28	0.04	29	79	11	0.1	0.31	0.04
Halswell Quarry	219	46.6	72.2	7.1	0.2	0.33	0.03	41	65	6	0.2	0.30	0.03	32	58	5	0.1	0.26	0.02
Halswell Junction Basin	240	40.9	1122.2	161.9	0.2	4.68	0.67	36	1010	136	0.2	4.21	0.57	36	1003	135	0.2	4.18	0.56
Knights Confluence	34	6.8	4.4	1.2	0.2	0.13	0.04	6	4	1	0.2	0.12	0.03	6	4	1	0.2	0.12	0.03
Knights Stream Headwaters	89	17.0	196.7	38.1	0.2	2.21	0.43	15	177	32	0.2	1.99	0.36	15	148	27	0.2	1.66	0.30
Lansdowne Valley	736	151.1	60.0	7.1	0.2	0.08	0.01	133	54	6	0.2	0.07	0.01	116	50	5	0.2	0.07	0.01
Marshs Road	203	28.4	67.8	14.3	0.1	0.33	0.07	25	61	12	0.1	0.30	0.06	25	57	11	0.1	0.28	0.05
Nottingham Headwaters	130	35.2	298.9	34.5	0.3	2.30	0.27	31	269	29	0.2	2.07	0.22	31	267	29	0.2	2.05	0.22
Nottingham Stream	52	18.2	66.7	9.5	0.3	1.28	0.18	16	60	8	0.3	1.15	0.15	12	57	8	0.2	1.10	0.15
Owaka	53	12.5	275.6	54.8	0.2	5.20	1.03	11	248	46	0.2	4.68	0.87	7	106	20	0.1	2.00	0.38
West Hornby	360	65.9	1040.0	204.8	0.2	2.89	0.57	58	936	172	0.2	2.60	0.48	59	764	141	0.2	2.12	0.39
All Halswell (total)	2741	552	3412	568				486	3071	477				416	2651	403			

Halswell Junction Basin sub-catchment is discharging into land via Wilmers Basin, an infiltration basin. Contaminants from this catchment are substantially removed by a soil filter. There is no discharge of contaminants to surface water.

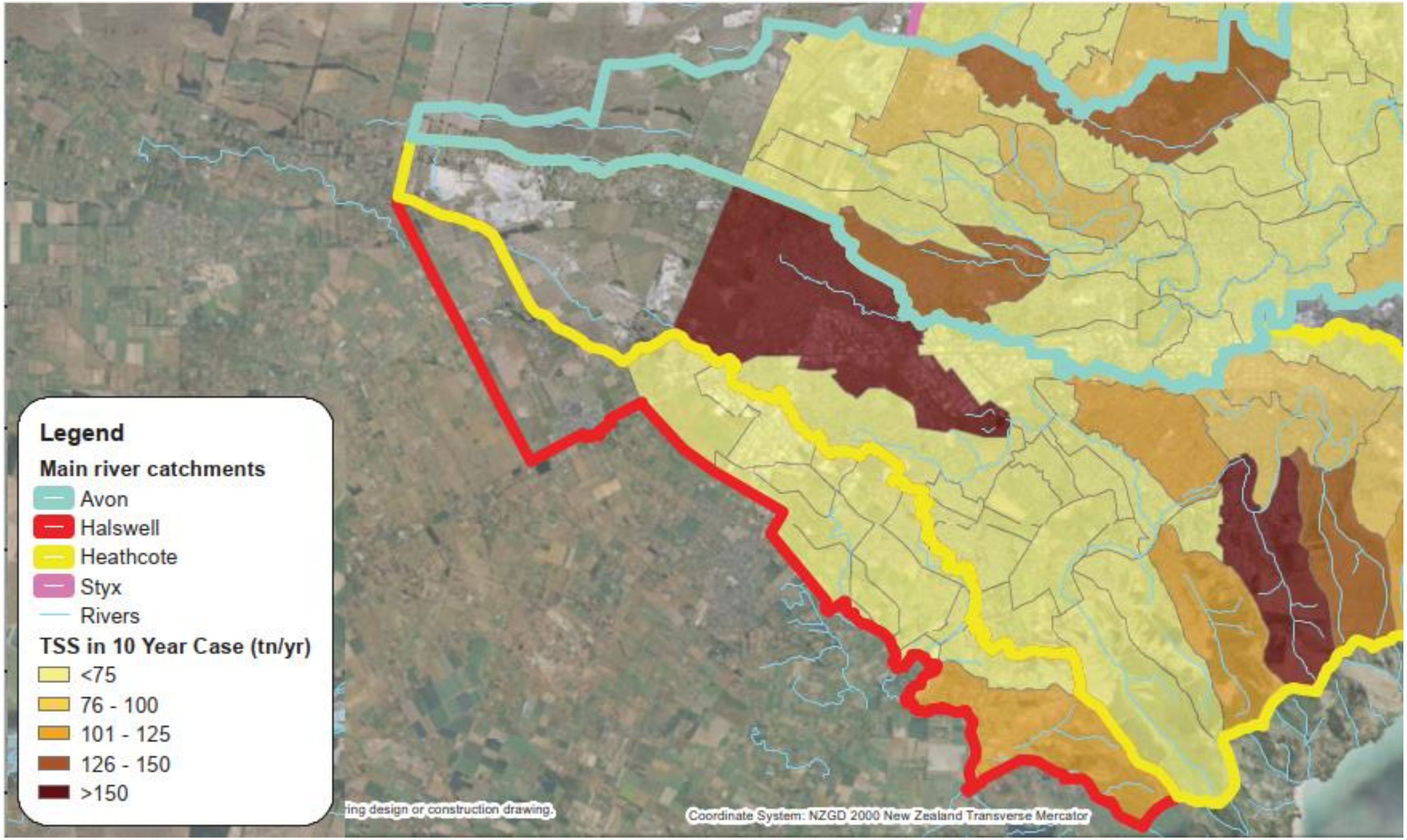

Figure 20: Annual TSS load, tonnes/year, for Huritini-Halswell sub-catchments, as estimated by the Christchurch Contaminant Load Model for year 2028, after mitigation with proposed facilities.

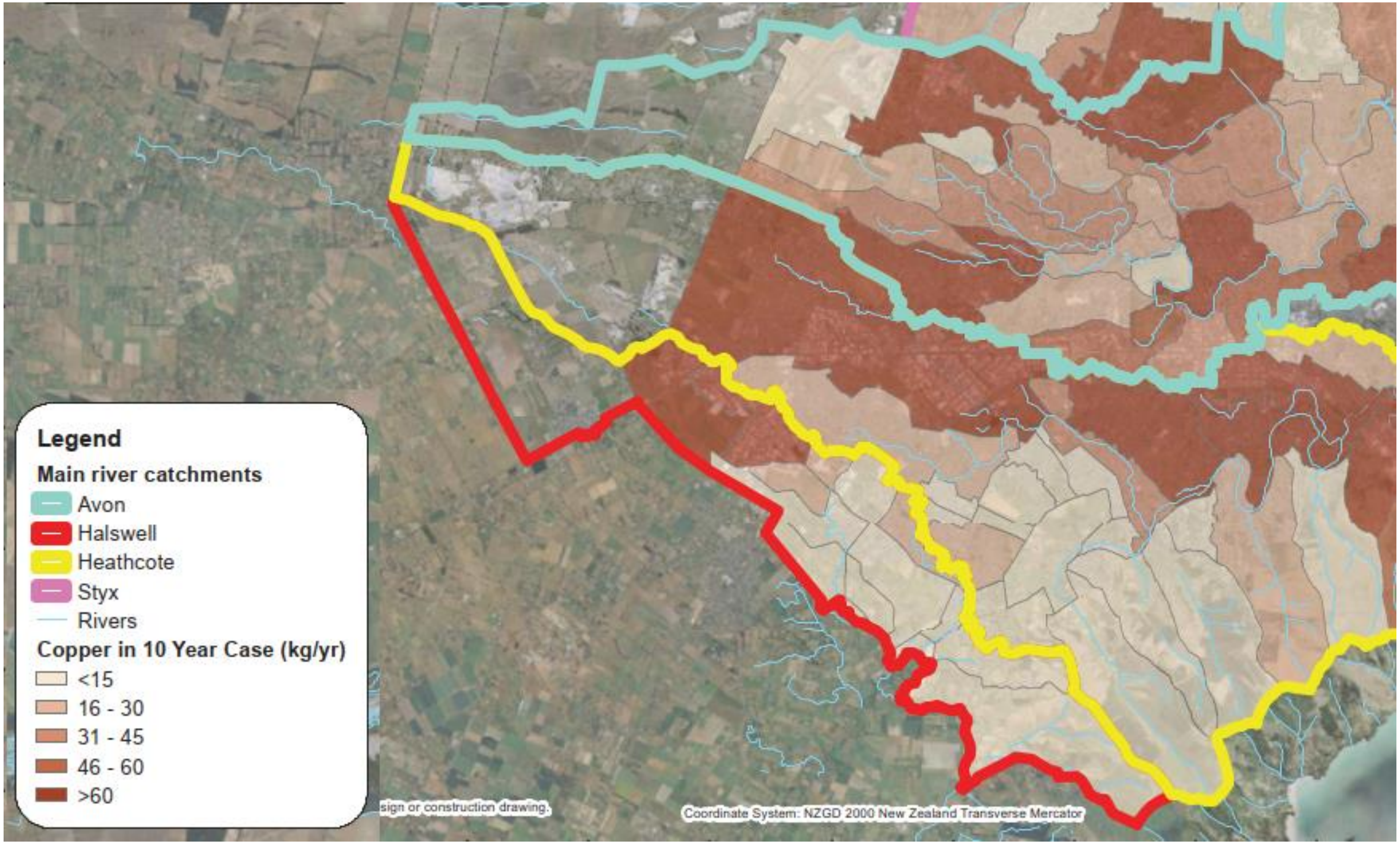

Figure 21: Annual Copper load, kg/year, for Huritini-Halswell sub-catchments, as estimated by the Christchurch Contaminant Load Model for year 2028, after mitigation with proposed facilities.

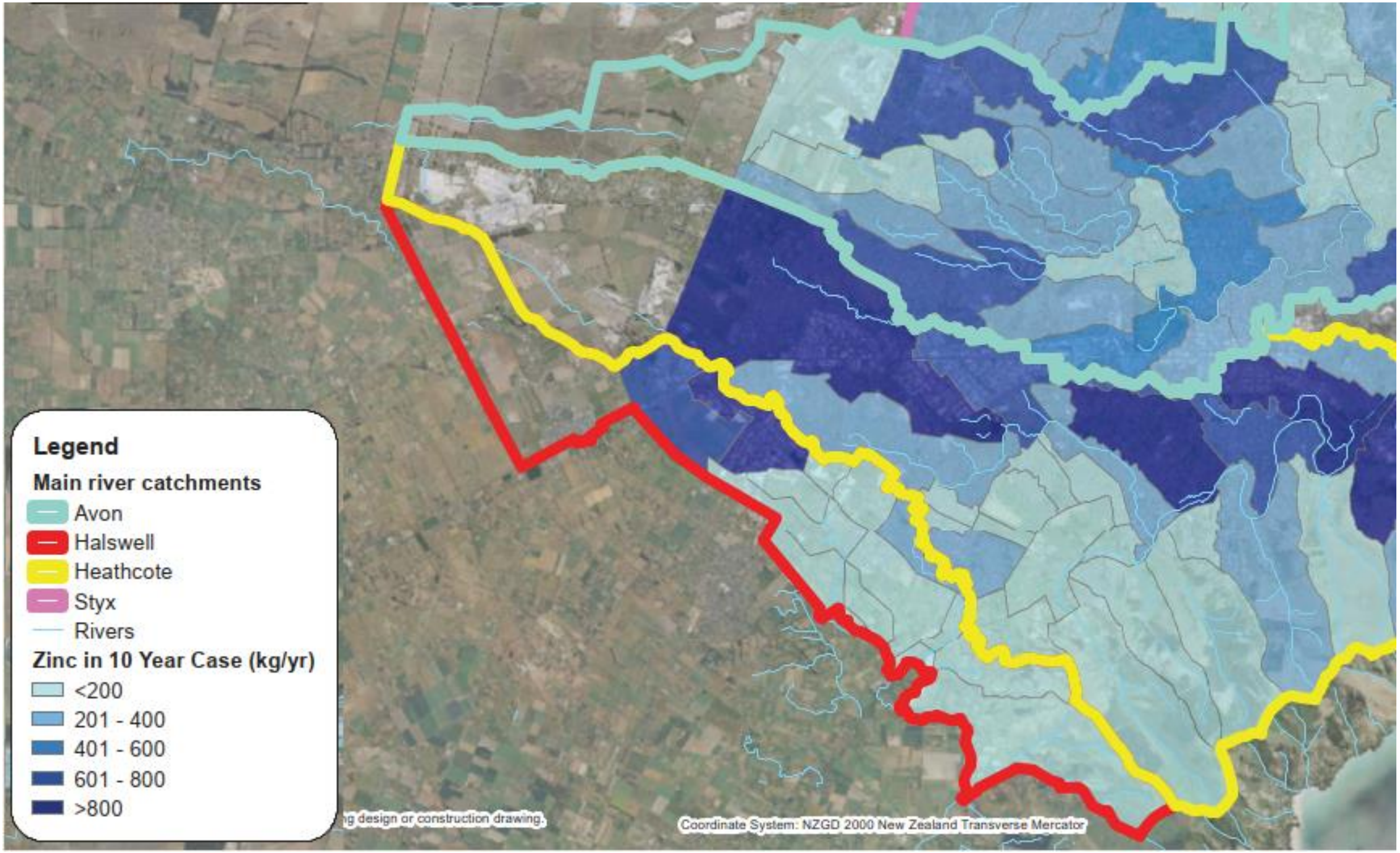

Figure 22: Annual zinc load, kg/year, for Huritini-Halswell sub-catchments, as estimated by the Christchurch Contaminant Load Model for year 2028, after mitigation with proposed facilities.