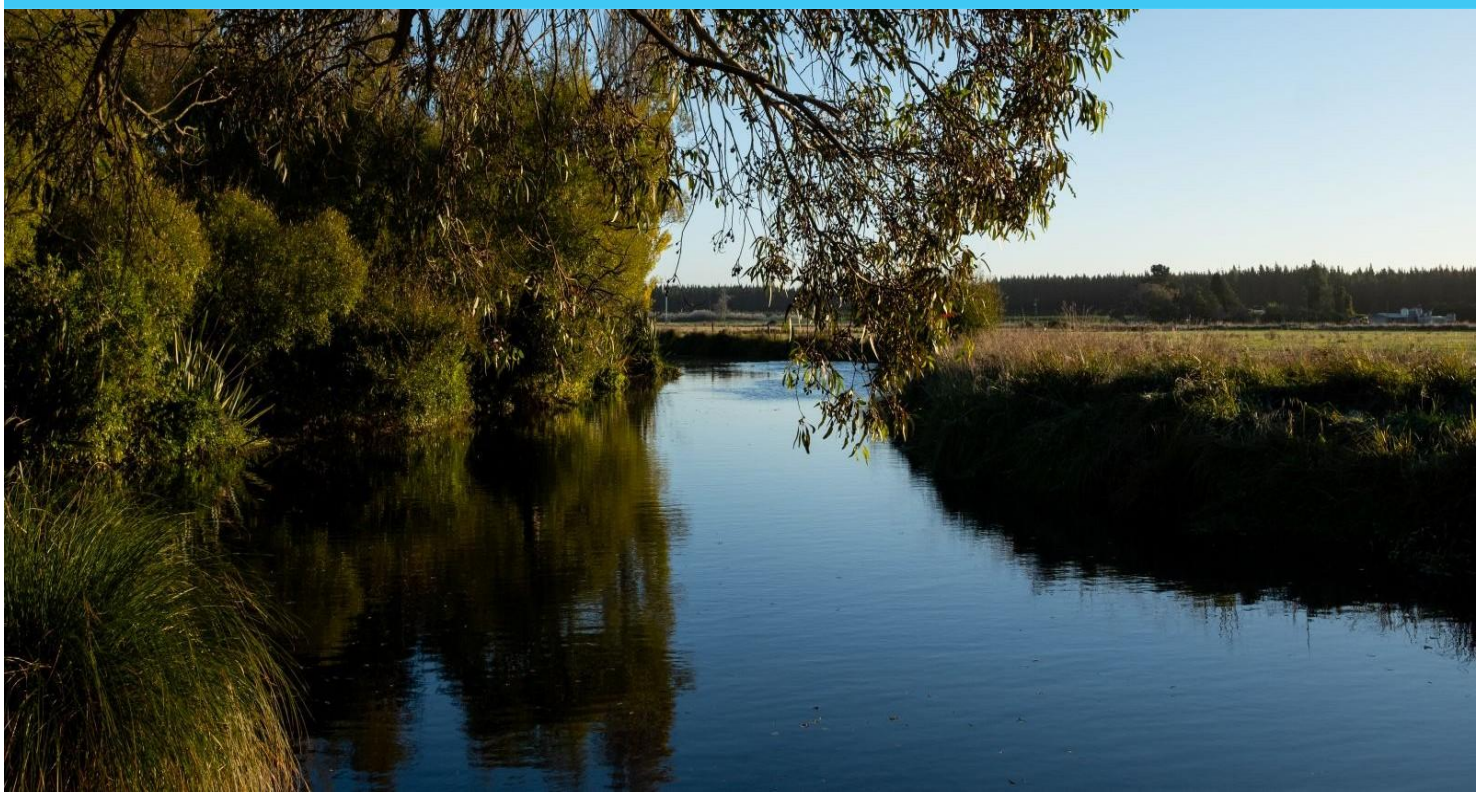
Environmental Monitoring Programme

for the Comprehensive Stormwater Network Discharge Consent for Ōtautahi/Christchurch City and Te Pātaka o Rākaihautū/Banks Peninsula



November 2025

Environmental Monitoring Programme

For the Comprehensive Stormwater Network Discharge Consent

Version 11

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Table of Contents

1. Introduction

1.1 Background and Purpose

In accordance with the consent conditions of the Comprehensive Stormwater Network Discharge Consent (CSNDC), the primary purpose of this Environmental Monitoring Programme (EMP) is to assess the extent of mitigation of effects of stormwater discharges from the Christchurch City Council stormwater network on the receiving environment. Some of the monitoring will also have the added benefit of informing the refinement and improvement of waterway health and stormwater management practices in general.

This EMP includes details (including site info and methodology) of the monitoring of:

- Infiltration facilities;
- Groundwater;
- Surface water levels;
- Surface water quality;
- Instream sediment quality;
- Aquatic ecology; and
- Mana whenua values.

This programme includes additional monitoring to that required under the consent conditions. This is to provide additional information useful to improve waterway health and mitigate the effects of stormwater discharges under this consent, such as prioritisation of areas for management. It is also useful information that can be used for the purposes of achieving CCC plans, strategies and policies. Some of this information will not specifically be linked to consent conditions, but will be included in the monitoring report, as detailed throughout the document.

1.2 Current Environmental Monitoring Programme

The Christchurch City Council (CCC) currently carries out monitoring of treatment facilities, surface water levels, surface water quality, instream sediment quality and aquatic ecology throughout Christchurch. This monitoring is to fulfil the requirements of:

- monitoring programmes for existing stormwater discharge consents from Environment Canterbury (ECan) (Table 1);
- CCC policies and strategies (e.g. District Plan and Surface Water Strategy); and
- to provide information for the operation and development of the stormwater and wastewater networks.

Table 1. Existing Christchurch City Council stormwater discharge consent monitoring programmes

Title	Consent	Reference
Interim Global Stormwater Consent Monitoring Plan	CRC090292	Dewson & Rodrigo, 2009
Monitoring Programme for South-West Christchurch Stormwater Management Plan	CRC120223	Golder Associates, 2011
Monitoring Programme for the Pūharakekenui/Styx River Stormwater Management Plan	CRC122598	Golder Associates, 2012

The results of this monitoring are currently summarised annually in reports submitted to ECan to fulfil the conditions of the three current stormwater consents. These reports are also used Council-wide for a number of other reasons (e.g. to assess community outcomes). The existing monitoring programme will be formalised into this one document, and updated for the purposes of both the CSNDC and other CCC requirements.

One of the purposes of the Interim Global Stormwater Consent (IGSC) monitoring plan was "to collect information relating to the impacts of stormwater from various land-uses within a range of SWMP catchments, and the performance of various stormwater devices used to treat stormwater" (Dewson & Rodrigo, 2009). This baseline data has been used to better understand the impacts of stormwater within the city and help in the development of stormwater management practices. Because of this wider objective, the monitoring programme for the IGSC was more comprehensive than is intended for the CSNDC. The CSNDC EMP will focus on measuring whether the Receiving Environment Objectives and Attribute Target Levels, as specified in the resource consent conditions, are being met.

2. Soil Quality Monitoring at Infiltration Facilities

2.1 Purpose for Monitoring under this Consent

The purpose of this monitoring is to ensure that the infiltration treatment facilities do not accumulate contaminants to a point where they may negatively impact ground or surface water quality, or pose a human health risk.

2.2 Soil Quality Monitoring

Under the IGSC, soil quality monitoring took place at five sites which were selected to represent infiltration or soakage systems and dry detention ponds servicing a range of land-uses across the city. It is proposed to continue to monitor those sites, but also add in one representative rain garden site. Soils within the five IGSC representative facilities were monitored in 2010 and 2015, and this will continue on a five-yearly basis. This information will help determine the rate of contaminant accumulation and at what point remediation measures need to take place. The sites and parameters to be analysed are shown in Table 2 and in Figure 1, with coordinates provided in Appendix A.

Table 2. Soil sampling monitoring of stormwater devices. Cu = total recoverable copper; Zn = total recoverable zinc; Pb = total recoverable lead; As = total recoverable arsenic; Cd = total recoverable cadmium; Cr = total recoverable chromium; Ni = total

Location	Type of System	Land Use	Year System Constructed	Parameters to be Tested
Denton Park	Soakage Basin	Residential	1997	Cu, Zn, Pb, PAH
Beckenham Library	Detention Swale	Car Park	2005	Cu, Zn, Pb, PAH
Tumara Park	Infiltration and Detention	Large Residential	2003	Cu, Zn, Pb, PAH
Hornby Industrial Park	Infiltration Basin	Industrial	1995	As, Cd, Cr, Cu, Ni, Pb, Zn, PAH, SVOCs
Richmond Housing Complex	Swale and First- flush Basin	High Density Housing	2007	Cu, Zn, Pb, PAH
Grove Road	Rain Garden	Commercial	2015	Cu, Zn, Pb, PAH

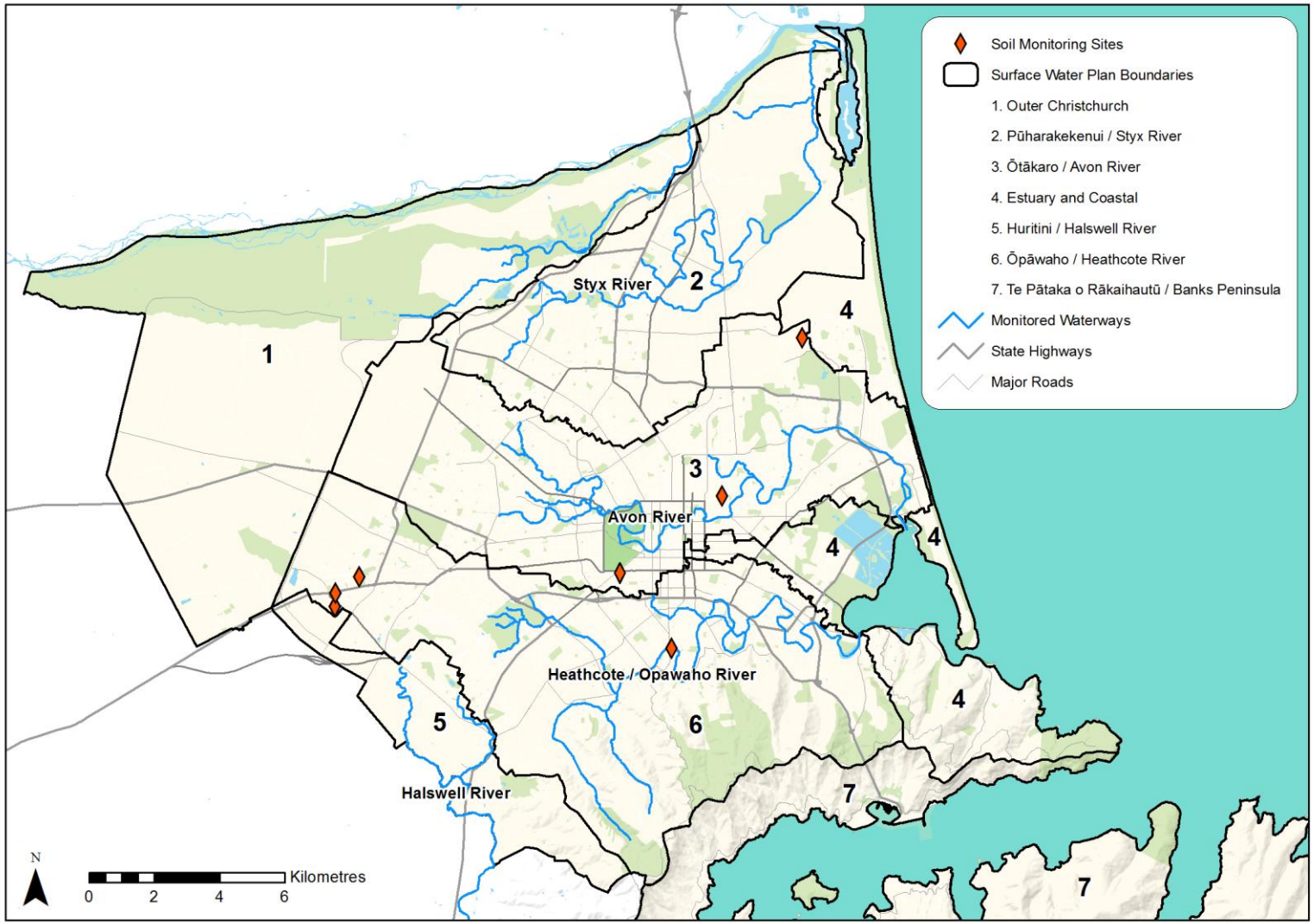

Figure 1. Location of soil monitoring sites

2.3 Soil Sampling Protocol

Representative samples of the soil shall be collected from the relevant soil adsorption basin. The sample shall be collected from a depth of between zero and 50 millimetres below the ground surface at the point of lowest elevation. All samples shall be collected using a stainless steel trowel pre-cleaned with phosphate free detergent and transferred immediately into jars or containers provided by the laboratory. Field personnel shall wear gloves at all times during sampling.

A completed chain of custody shall accompany all samples dispatched to an external testing laboratory. Samples shall be stored in a chilly bin on ice until delivery to the laboratory. At each sampling location a field sheet shall be completed describing the site characteristics and photographs taken of the basin surface.

2.4 Analysis

Analysis of soil adsorption basin samples shall be undertaken by an IANZ accredited laboratory. Detection limits for each parameter shall be suitable to enable comparison of the results with relevant guidelines and trigger levels for reporting purposes.

The soil sample results shall be compared against the most appropriate and relevant soil quality guideline values for recreational use and any other standard pertaining to protection of ground and surface water quality. The following documents will be assessed as to their suitability for comparison with the results:

- National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (Ministry for the Environment, 2012); In particular, the recreation standards in Table B2: Soil contaminant standards for health (SCSs(health)) for inorganic substances;
- Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (Ministry for the Environment, 1999);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000); and
- Trigger values for soil quality contained in other Christchurch City Council stormwater discharge consent conditions.

The guidelines that are deemed most suitable for comparing the soil sample results will be accompanied by a justification for their use and suitability.

2.5 Reporting

The annual monitoring report for the consent shall include a report on the visual inspections and soil quality monitoring undertaken during the previous calendar year. This report shall include:

- A summary of the visual inspections undertaken;
- A summary of any soil quality monitoring;
- Identification of key issues and any trends noted;
- Summary of any notifications made to ECan and why;
- Responses undertaken to any issues identified; and
- Recommendations for changes to the maintenance and operation of the facilities.

3. Groundwater

The Council's stormwater network has the potential to affect groundwater quality and quantity; therefore, the objective of the groundwater monitoring programme shall be to provide ongoing information on groundwater levels and groundwater quality so that current trends can be determined and compared with historical patterns. To achieve this objective in the most efficient manner, use will be made of existing monitoring programmes operated by both Council and ECan.

3.1 Purpose for Monitoring under this Consent

The purpose of this monitoring is to (1) measure whether stormwater discharges are causing adverse effects on groundwater quality or quantity, (2) determine compliance with the consent conditions, and (3) inform Council of the performance of its stormwater mitigation. This monitoring covers a range of parameters present in stormwater (such as metals), but also additional parameters to give a better understanding of shallow groundwater quality overall. A map of stormwater infiltration basins and stormwater catchment zones is provided in Figure 2.

3.2 City-wide Groundwater Quantity

3.2.1 Background and previous monitoring

Excavation and changes in surface infiltration associated with stormwater infrastructure can locally raise or lower the water table. The Council monitors groundwater quantity (groundwater levels) of the water table through various programmes, as follows:

3.2.2 City-wide long term shallow groundwater levels

The Council has maintained and added to the hydrometric1 network which was established by the Christchurch Drainage Board. This network consists of monitoring sites for surface water levels and flows, sea level, rainfall and groundwater levels. The Council engages a subcontractor, NIWA, to maintain the hydrometric network and collect the data. Groundwater level monitoring began in the 1960s and sites have been added over time. Currently the network consists of 27 groundwater level sites, which are displayed in Figure 3. This network of groundwater level monitoring bores helps to identify patterns of water level change, some of which may be affected by stormwater management systems. Continued monitoring of the groundwater levels within this network is a requirement of this consent.

[1] Hydrometry refers to the measurement of all elements in the hydrological cycle. In this context, the hydrometric network refers to the measurement of rainfall, surface water levels and flows, and groundwater levels.

3.2.3 Other water level monitoring

The Council has also inherited a network of piezometers which was established by the Earthquake Commission (now the Natural Hazard Commission) following the Canterbury earthquake sequence. The Council engages a subcontractor, Aqualinc, to periodically download data from the automated data loggers. The downloaded groundwater level data is passed on to ECan and published on their website.

In addition to the more general city-wide monitoring described above, a detailed AECOM (2022) study involving the monitoring of three infiltration basin facilities to assess localised changes in shallow groundwater quality was also undertaken by Council. These project-specific bores were drilled in Kakapo Basin, Outlook Basin and Awatea Basins.

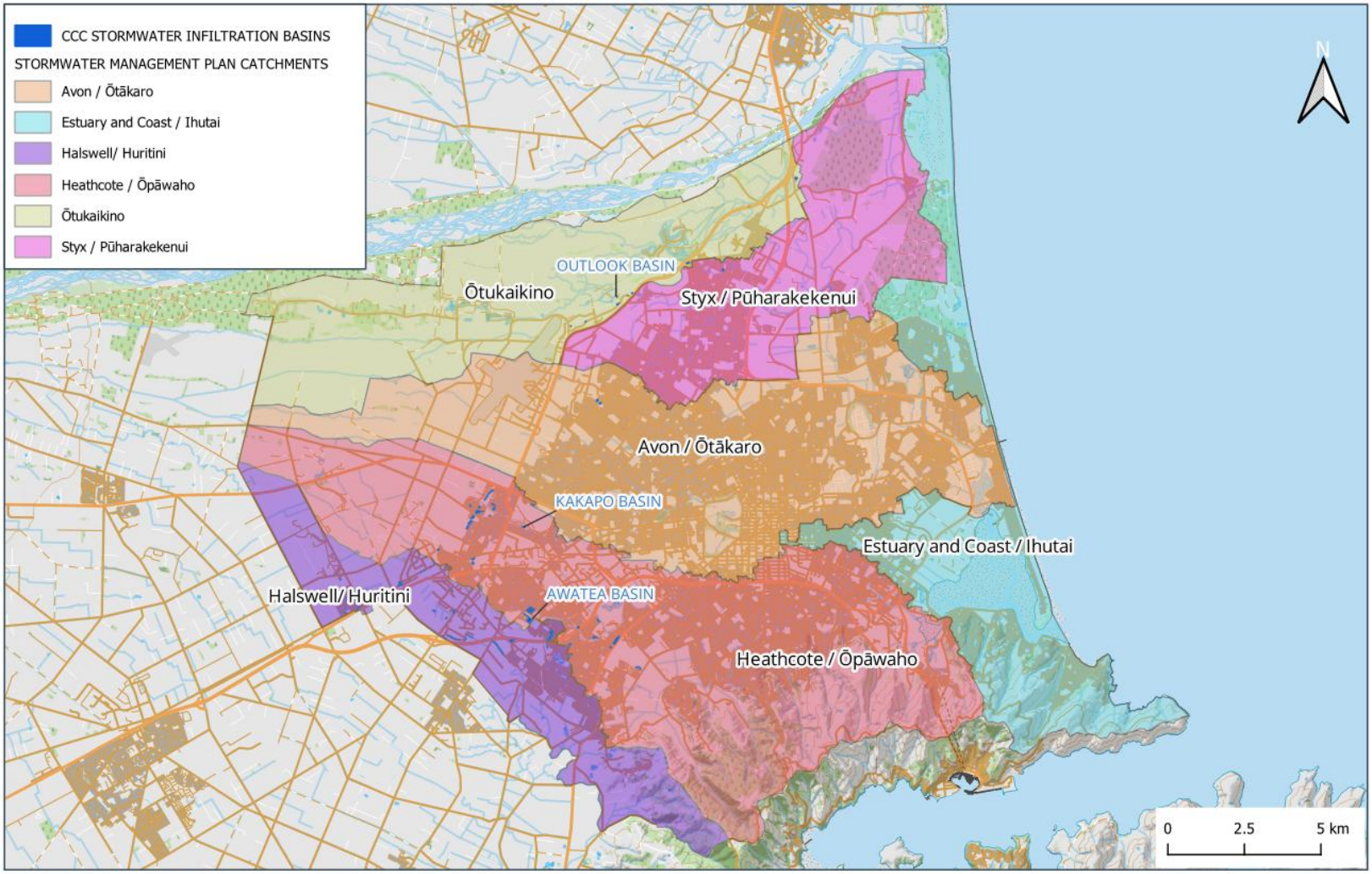

Figure 2. Location of Stormwater Infiltration Basins and Stormwater Management Plan Catchment Zones.

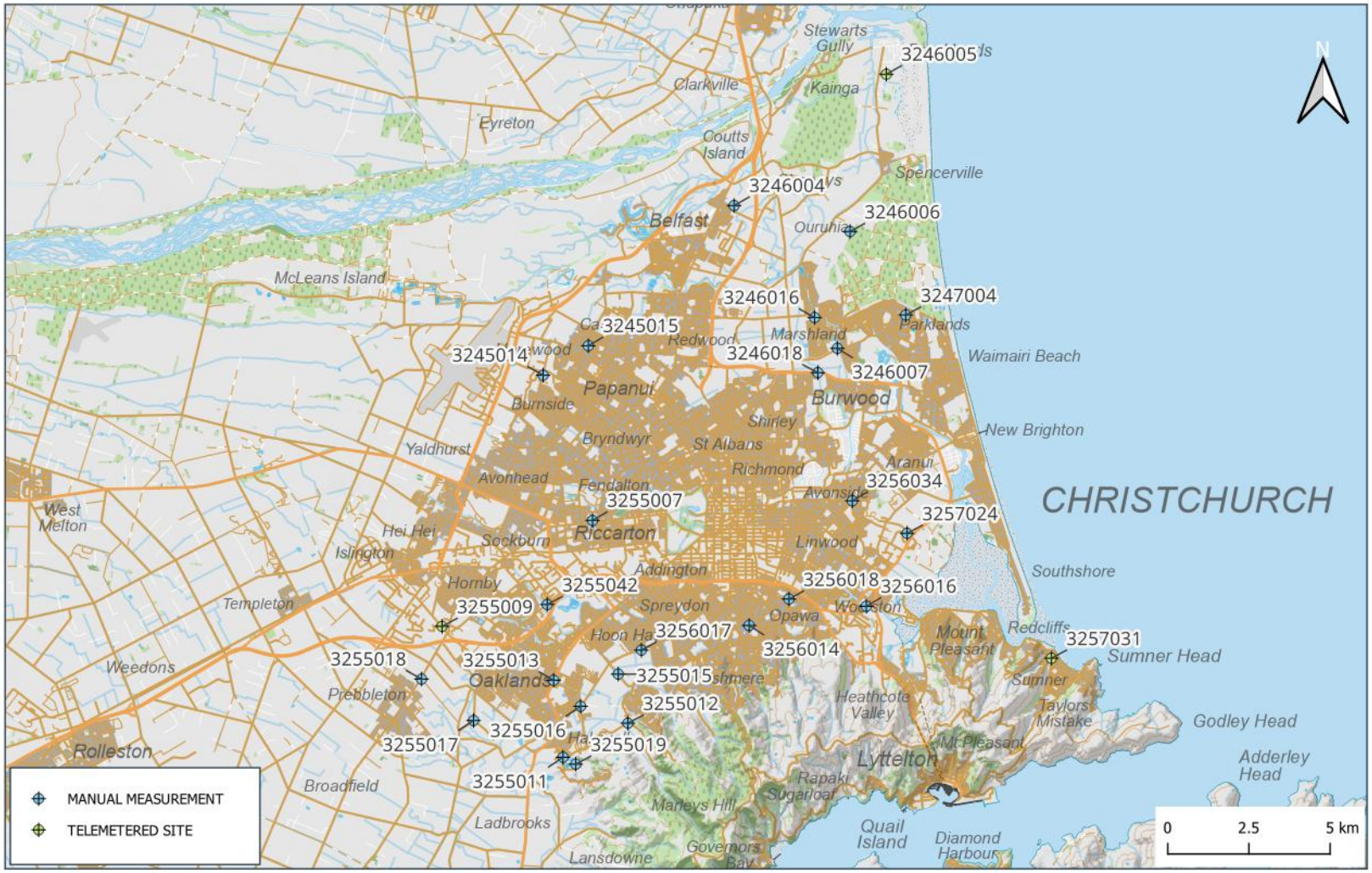

Figure 3. Location of long-term CCC groundwater level monitoring bores (2024)

3.3 City-wide Groundwater Quality

3.3.1 Background

Stormwater discharges into both land and surface water can result in adverse effects on groundwater quality, particularly if groundwater is shallow and unconfined. Christchurch partially overlies a system of confined aquifers termed the Christchurch Confined Aquifer System, which comprises at least four confined aquifers in central and eastern Christchurch, displayed in Figure 4 below (Begg et al., 2015). The aquifers are hosted within gravels (Riccarton Gravel, Linwood Gravel, Burwood Gravel, Wainoni Gravel) which are interbedded with and confined by lower permeability sands, silts, peats and clays (Christchurch Fm, Bromley Fm, Heathcote Fm, Shirley Fm; Talbot et al., 1986). Thicknesses and depths of the aquifers and confining layers vary locally across Christchurch and generally deepen towards the coast. Approximate depths of the first four confined aquifers are provided in Table 3 below (Begg et al., 2015; Talbot et al., 1986). Recharge to the confined aquifer system occurs via land surface recharge west of the city and from surface water loss from the Waimakariri River (Talbot et al., 1986).

The western extent of the uppermost confining layer (Christchurch Fm) extends ca. 5–13 km inland from the coastline across the area between the mouth of the Waimakariri River and Banks Peninsula (western extent displayed on Figure 4; Brown & Weeber, 1992). Hence, the groundwater system/Riccarton Gravels are considered unconfined within the western parts of the city with the deeper gravels being either unconfined or semi-confined due to the presence of lenses of silts and sands. Most of the stormwater infiltration basins are situated to the west of this confining layer, as this is where higher permeability sediments/gravels exist with sufficient thickness above the water table to allow for groundwater infiltration to occur. In the coastal areas, sand dune strata can occur at the ground surface, which forms part of the surface confining layer to the deeper gravel aquifers. These sandy zones are utilised by some stormwater infiltration basins.

Table 3. Approximate depths of aquifers beneath the Christchurch area

	Depth (approximate m bgl)	
Aquifer	Coastal	Inland
Riccarton Gravel	40–60	0-40
Linwood Gravel	70-100	40-90
Burwood Gravel	110-130	90-110
Wainoni Gravel	140-160	110-140

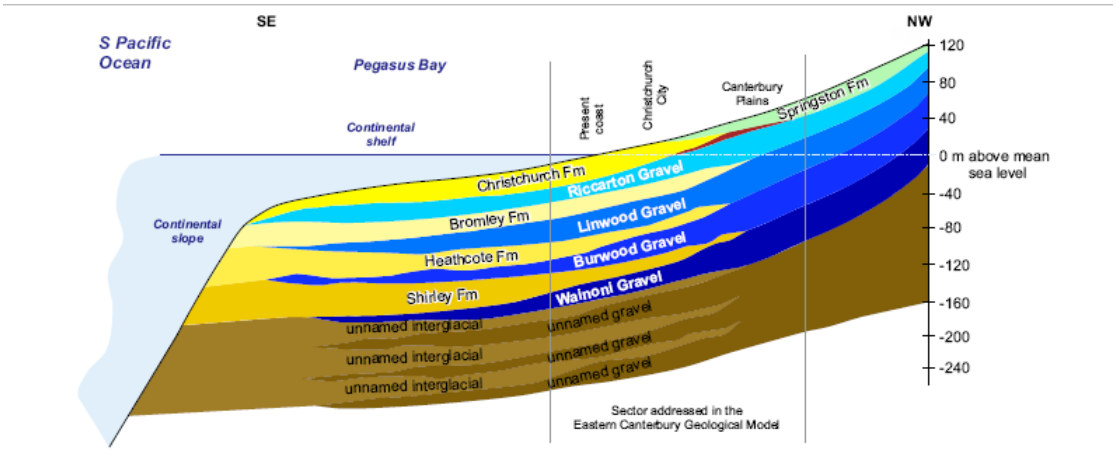

Figure 4. Diagrammatic cross-section of the Christchurch confined aquifer system. Figure adapted from Begg et al. (2015).

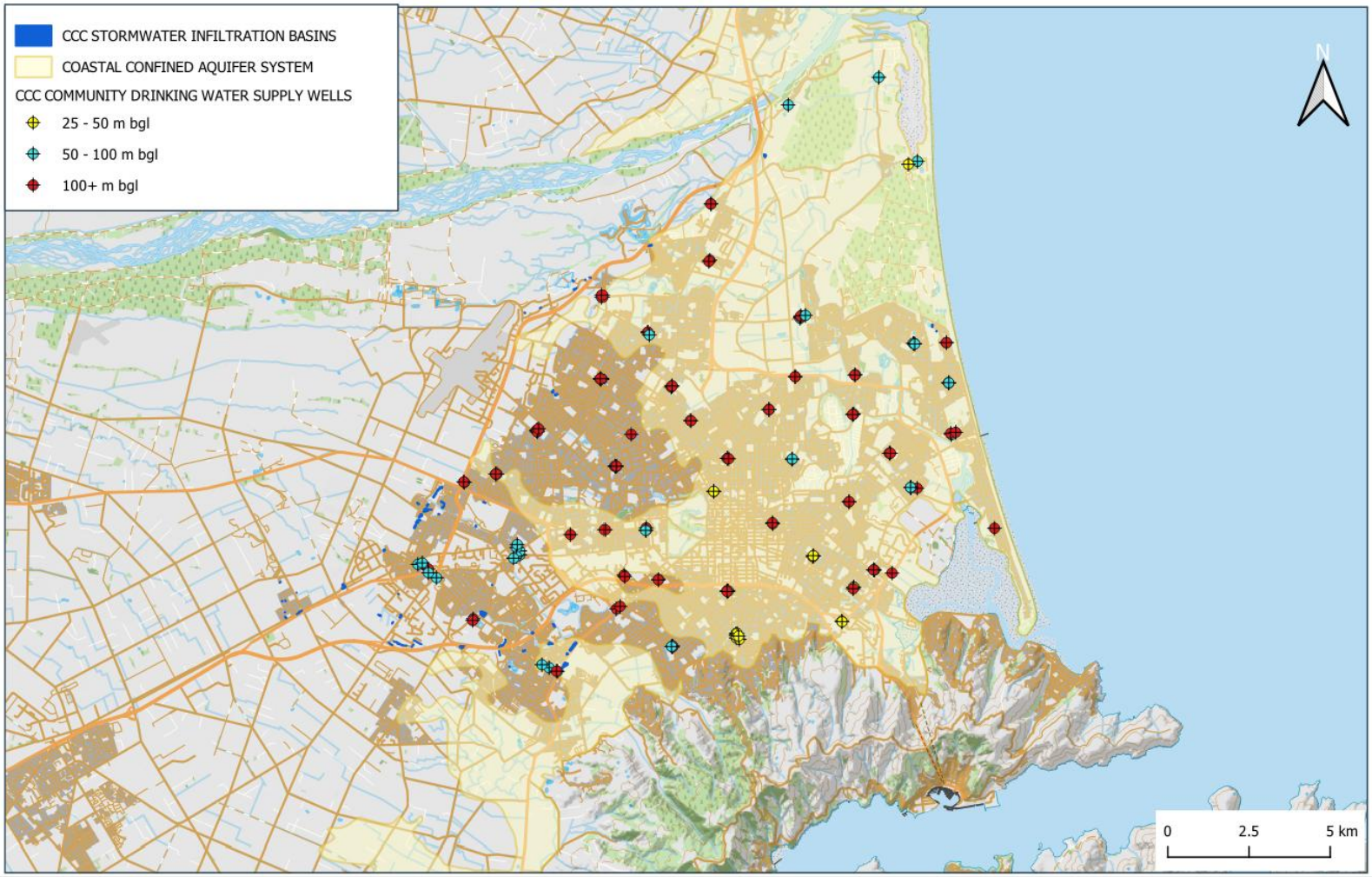

Figure 5. Locations and depth of CCC community drinking water supply wells, and extent of the uppermost confining layer of the Christchurch confined aquifer system

Water quality within CCC community drinking water supply wells (DW supply wells) is unlikely to be affected by stormwater discharges, as most of the public water supply is abstracted from wells screened from depths of over 50 m bgl (i.e. within the Linwood, Burwood, and Wainoni Gravels), see Figure 4. However, some shallow CCC DW supply wells and private wells (potentially affected by unconfined groundwater) still exist.

Water quality monitoring in accordance with Taumata Arowai: Drinking Water Quality Assurance Rules (2022-rev.2024) is carried out at the CCC DW supply wells/treatment plants and provides a picture of the state of groundwater quality in these wells.

The city-wide groundwater quality monitoring detailed in this EMP is focused on the shallow groundwater table within 400 m of stormwater treatment and infiltration areas and does not include monitoring of the confined aquifers within the Christchurch confined aquifer system (Figure 4).

3.4 Springs

Springs contribute to sustaining baseflows within Christchurch's lowland streams and are considered to be primarily fed from the uppermost confined aquifer, the Riccarton Gravels, although there may be contributions from the water table aquifer or from gravel seams within the upper confining strata (Springston Formation or Christchurch Formation) (Cameron, 1993; Stewart et al., 2018). Springs typically occur in locations where the uppermost confining layer is thin, or absent, and groundwater is able to find a pathway to emerge at the ground surface (Stewart et al., 2018). Spring flow is dependent on a number of hydrological and geologic factors including the amount and frequency of water inflow, the hydraulic conductivity of the strata, the water pressures within the strata, and the hydraulic gradient (Smith, 2003). Development and the associated changes in surface imperviousness and the placement of stormwater basins can influence the location and discharge of springs by altering local groundwater flow paths and modifying water table elevations. Excavation and changes in surface infiltration associated with stormwater infrastructure can locally raise or lower the water table, potentially redirecting groundwater flow toward or away from existing spring outlets. The degree of impact depends on the hydraulic connectivity between the basin, associated infrastructure and the characteristics of the near surface strata.

3.5 Monitoring required as part of this consent

The following monitoring shall be undertaken as part of this consent:

- Continued city-wide monitoring of groundwater levels at the network of 27 long-term CCC groundwater level monitoring bores;
- Detailed monitoring of groundwater levels and groundwater quality at 6 stormwater basins; and

3.5.1 Monitoring of spring appearance, flow and location at select sites.

The monitoring requirements are outlined in the following sections

.

3.5.2 City-wide long term shallow groundwater levels

The network of 27 groundwater level sites within Christchurch City shall be monitored by NIWA (Appendix B). All sites in the groundwater network can be measured manually with the exception of the Halswell Retention Basin (3255009), Dartford St (3246005) and Sumner sites (3257031) which are telemetered level sensors. Manual groundwater levels shall be measured on either a weekly or fortnightly basis, depending on site status requirements. Following rainfall events equalling greater than 20 mm in a 24-hour period, groundwater measurements should be delayed by 2 days.

3.5.3 Detailed monitoring of select stormwater basins

Monitoring of shallow groundwater quality and levels shall be conducted at six stormwater infiltration basins city-wide using monitoring bores that are screened across the water table (locations displayed in Figure 6). Routine (quarterly) as well as wet-weather monitoring should be carried out. The sites were selected to cover a range of environmental factors such as size of stormwater infiltration zone, geology, depth to groundwater, proximity to nearby streams with which there may be hydraulic connectivity, and land use. A table of the sites, monitoring requirements and identified downgradient monitoring bores are provided in Appendix C. Monitoring requirements are detailed in the sections below.

3.5.4 Water level and electrical conductivity monitoring

Water levels and electrical conductivity should be continuously monitored within the identified downgradient monitoring bores at all six stormwater basins outlined in Appendix C using automated data loggers. Ideally, parameters should be recorded at 15-minute intervals to capture short-term fluctuations. This will be reviewed after 2 years of monitoring to determine if this frequency is necessary.

3.5.5 Quarterly stormwater basin water quality monitoring

Quarterly groundwater quality sampling shall be undertaken within the identified downgradient bores at the six basins identified in Appendix C each year. The location and construction details of monitoring bores yet to be installed shall be confirmed in consultation with an Environment Canterbury groundwater scientist. Groundwater sampling methodologies are provided in section 3.5.8.

The groundwater samples should be analysed for the parameters as set out in Table 4 below by an International Accreditation New Zealand (IANZ) laboratory:

Parameter	Attribute Target Level
Dissolved Copper	≤0.5 mg/L
Dissolved Lead	≤0.0025 mg/L
Dissolved Zinc	≤0.0375 mg/L
Electrical Conductivity	No statistically significant increase

Table 4. Water quality parameters and attribute target levels as defined in Schedule 9 of this consent

3.5.6 Wet-weather stormwater basin water quality monitoring

Wet-weather sampling shall be undertaken at the same six sites as are sampled quarterly. During wet-weather sampling, water from the stormwater basin as well as groundwater quality in the associated monitoring bore should additionally be sampled to provide a point of comparison to the groundwater sampling results. Sampling shall be conducted following four rainfall events per year that result in sufficient stormwater accumulation within the basins.

Wet-weather sampling shall be triggered based on the following criteria:

- A minimum of 3 mm of rainfall within a 24-hour period (based on modelling by Tom Parsons for the Avon Stormwater Management Plan that this is sufficient to obtain the first flush (5-25 mm) of contaminants); and
- At least 72 hours of dry conditions prior to the onset of rainfall (based on advice that even 24 hours is sufficient time for contaminants to accumulate).

Sampling shall be conducted within 12 to 72 hours following a qualifying rainfall event, with the optimal timing to be further refined based on insights gained from the continuous electrical conductivity monitoring data. Both surface water and groundwater samples should be analysed for the same parameters as set out in Table 4 above. Field methodologies for both groundwater and surface water sampling (i.e. stormwater basin sampling) are provided in section 3.5.8.

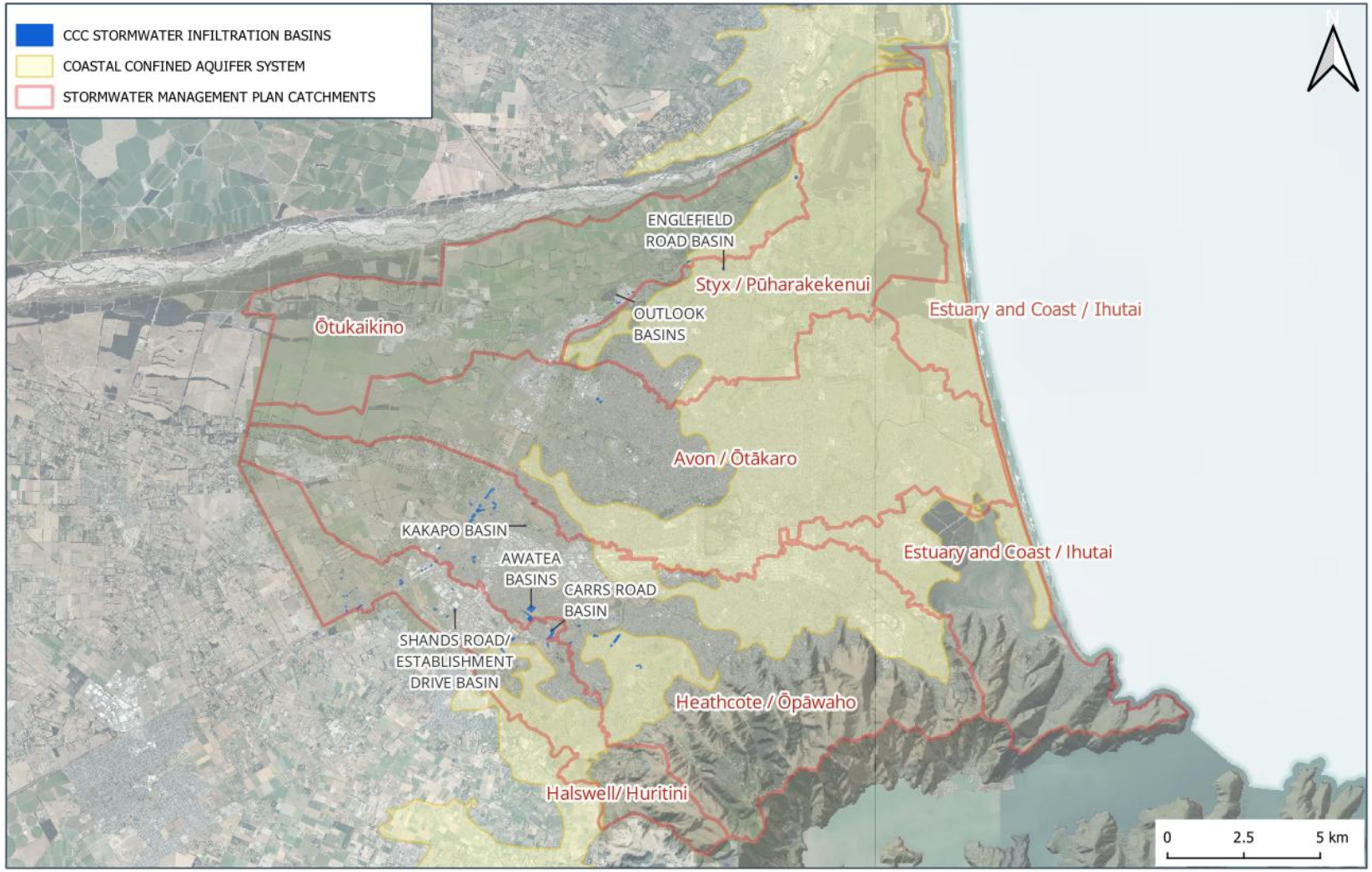

Figure 6. Locations of basins to be monitored to meet the requirements of this EMP

3.5.7 Spring monitoring

Monitoring of spring appearance, flow and location shall be conducted at Knights Stream and Quaifes Road Drain No 1 within the Halswell - Huritini Stormwater Management Plan Catchment, and at Grassmere Block/Cranford Basin within the Avon - Ōtākaro Stormwater Management Plan Catchment, once operational. A map of the Quaifes Road and Knights Stream sites are provided in Figure 7, and includes springs M36/5395-99, and M36/5392. A map of the Grassmere Block/Cranford Basin site will be added to the EMP once the spring monitoring site(s) have been confirmed in consultation with an Environment Canterbury groundwater scientist. The data obtained will be utilised to discern any noticeable changes in flow and water level. Spring monitoring should comprise of:

- Water level monitoring at the sites, using a HiLo water level monitor or similar, the results of which are transferred to the Council's database every 6 months for analysis and archiving; and

- Ad hoc spring monitoring of spring appearance and location by nearby school groups throughout the school year, and/or neighbourhood interest groups, the results of which will be provided to Council and Environment Canterbury at the end of every school year for analysis and archiving.

3.5.8 Water sampling methodologies

Groundwater quality within downgradient monitoring bores

Groundwater samples shall be collected using low-flow sampling techniques, whereby groundwater is drawn from the bore at a sufficiently low rate to minimise drawdown and turbulence, ensuring that water is drawn primarily from the surrounding aquifer rather than the bore casing. Samples of groundwater from each site shall be collected and analysed as per follows:

- A dedicated or decontaminated submersible pump shall be used for sampling. The pump must be thoroughly cleaned prior to use, and any disposable tubing shall be single-use and dedicated to the specific bore being sampled to avoid cross-contamination.
- The pump intake should be positioned as close as practicable to the water table to ensure representative sampling of the aquifer zone most likely to reflect recent recharge and potential contaminant inputs.
- Prior to sampling, stabilisation of field water quality parameters (pH, specific conductance, temperature, dissolved oxygen) should be achieved. To do this, field water quality parameters should be recorded at intervals of at least one flow-through cell volume between measurement readings. Water levels should also be recorded, and drawdown of the water level should ideally be maintained at less than 0.1 m. Water quality samples can be taken when at least four measurements of field water quality parameters have been recorded, with the differences between the last two measurements falling within the following stabilisation limits (NEMS 2019a):
- Water temperature: ± 0.2 °C;
- Specific conductivity: ±3 % (±5 % of <100 µS at 25°C);
- pH: ±0.1 pH unit; and
- Dissolved oxygen: ±0.3 mg/L.
- Groundwater samples for laboratory testing should be collected directly into laboratory-prepared sample bottles from the bore sample point. Unpreserved sample bottles shall be rinsed at least twice with the groundwater to be sampled prior to collecting the final sample. Bottles pre-dosed with preservatives (e.g. acids for metal analysis) must not be rinsed and must not be overfilled to avoid loss of preservative. For the analysis of dissolved metals, field filtration using a 0.45 µm filter is preferred over laboratory filtration, as it minimises the potential for changes in sample chemistry during transport and storage.

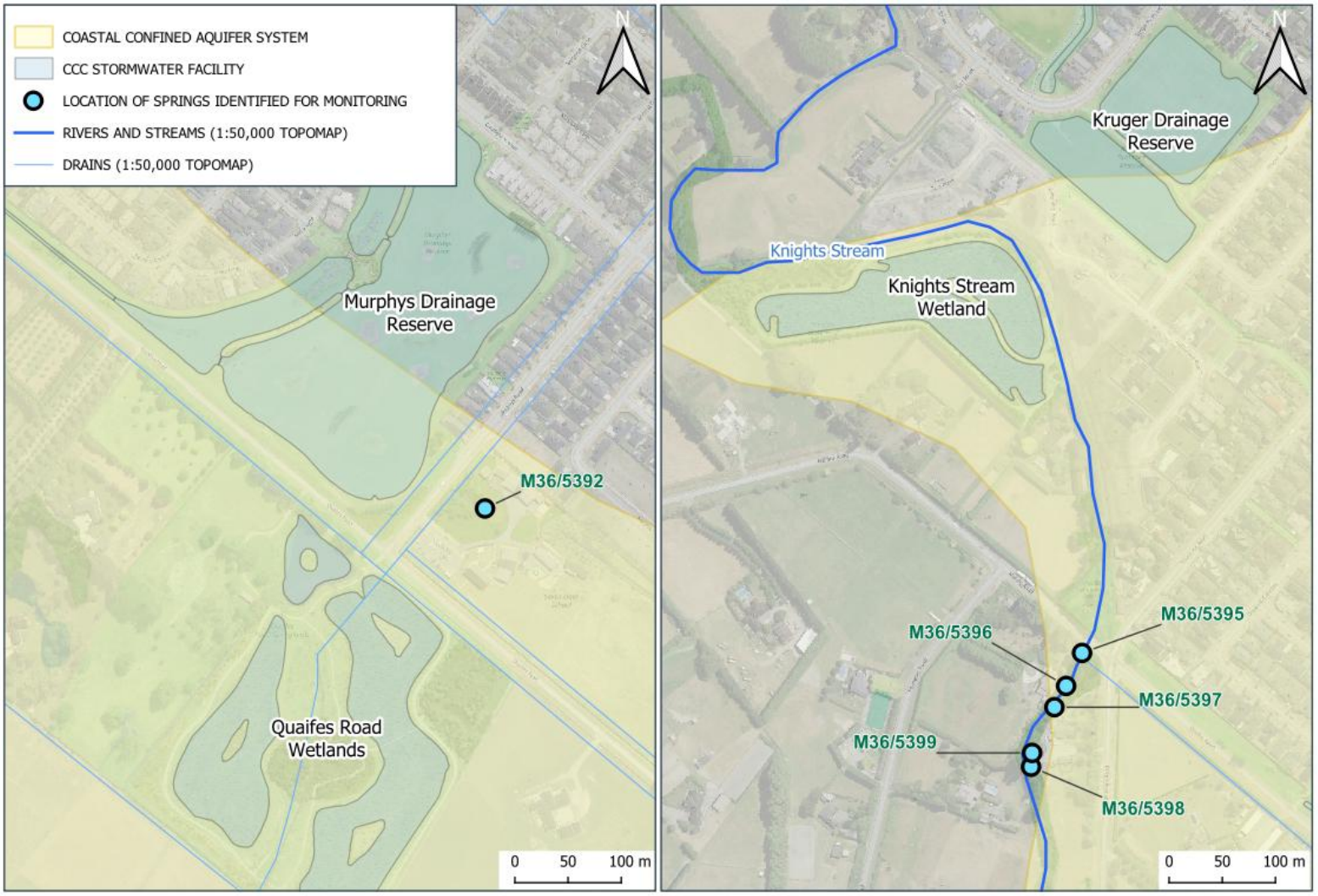

Figure 7. Locations of spring monitoring sites within the Halswell/Huritini Stormwater Management Plan Catchment

- The bottles should be firmly sealed to ensure water cannot leak out of the bottle and no water could ingress into the bottle. Samples shall be stored immediately in a chilled container (chilly bin with ice packs) before proceeding with further on-site assessments. During this process, exposure to direct sunlight must be avoided as far as practicable by the sampler. Samples should be delivered to the laboratory within 24 hours, and a completed chain of custody form should accompany all samples.
- Following sampling, a secure well-cap shall be placed on the bore to prevent infiltration of surface water or rainwater. Where possible, the bore should also be fitted with a lockable cover to minimise the risk of tampering or unauthorised access.

Surface Water Quality

Samples of water from the stormwater basins during wet-weather sampling shall be collected and analysed as per surface water sample collection practices as follows (based on NEMS, 2019b):

- A Survey123 form should be used to record site metadata on each sampling occasion. The following key parameters must be included:
    - The name of the water body/site location;
    - Date and time of field measurements;
    - The weather conditions at the time of measurements, including the intensity of rainfall at the time of sampling and within the 24-hours previous;
    - Approximate depth and coverage of water within the stormwater basin(s);
    - Location sample was obtained within the stormwater basin;
    - General sample colouration (clear/colourless, turbid, or brown) and if the water has any unusual smell;
    - The presence of any scums, foams or floatables; and
    - General notes of any other factors that may influence the data being collected; for example, potential waterfowl or stock influence, land-use changes, or channel alterations.
- Photos of the extent of stormwater present within the stormwater basins shall additionally be taken.
- Samples shall be collected by either wading into the water, with samples being collected from upstream of the sampler (if a current is present), or, samples may be collected from the bank, upstream from the sampler, using a telescopic water quality sampler. To reduce risk of injury, it is recommended that the latter method is followed if sampling is to be completed by a single sampler.
- The measurement of field water quality parameters (pH, specific conductance, temperature, dissolved oxygen (and turbidity, optional)) should be conducted and recorded prior to sampling by putting the measuring device directly into the water body.
- Water samples for laboratory testing should be collected directly into laboratory-prepared sample bottles. All unpreserved and nonsterile containers (as indicated on the container label) must be rinsed with the surface water to be collected before sample collection. Rinsing requires the container be plunged into the water, approximately 20 cm below the surface, and rotated so that the opening faces upstream and allows the container to fill. The contents of the container are then discarded on the stream bank. This process is repeated three times to complete the rinsing process. Following rinsing, the sample is taken by again filling the container following the same method. The purpose of obtaining the sample below the water surface is to avoid sampling any surface microlayer that is potentially present. Likewise, care should be taken not to disturb any sediment present at the base of the stormwater basin.
- Bottles pre-dosed with preservatives (e.g. acids for metal analysis) must not be rinsed, and care must be taken to avoid spillage or contamination of the preservative. In such cases, the sample should first be collected in a clean, unpreserved container that has been appropriately rinsed with the sample water, as per above, then transferred into the preserved bottle. For the analysis of dissolved metals, field filtration (using a 0.45 µm filter) is preferred over laboratory filtration, as it reduces the risk of changes to sample chemistry during transport and storage.
- Samples shall be stored immediately in a chilled container (chilly bin with ice packs) before proceeding with further on-site assessments. During this process, exposure to direct sunlight must be avoided as far as practicable by the sampler. Samples shall be

delivered to the laboratory within 24 hours, and a completed chain of custody form shall accompany all samples.

3.6 Reporting

The two-year monitoring report for the CSNDC shall include a report detailing the results of the groundwater and spring monitoring specified in this chapter, which was undertaken during the previous two calendar years. The report shall include:

- Groundwater level patterns in Council water level monitoring sites in relation to rainfall and stormwater infiltration;
- Visual observations of spring appearance, flow and location at the specified sites with reference to flow levels within the streams and periods of rainfall and stormwater infiltration;
- Statistical analysis of electrical conductivity records undertaken using Time Trends or other robust analysis, using a statistical level of significance of 5% (i.e. $p \leq 0.05$);
    - A minimum of three years is required before trends analysis can be undertaken (NIWA, 2014);
    - Trends analysis shall be conducted on data since the beginning of the dataset;
- For groundwater quality data statistical temporal trends analyses against historical data to determine whether water quality is remaining stable, improving or declining, using Time Trends or another robust method;
- An assessment as to whether the Receiving Environment Objectives and Attribute Target Levels specified in Schedule 9 (Groundwater and Springs) of the consent conditions are being met at each site for copper, lead and zinc; and
- A discussion as to how rainfall and stormwater management systems are affecting groundwater levels and quality.

4. Surface Water Levels and Flows, Sea Level and Rainfall Depth

4.1 Purpose for monitoring under this consent

Monitoring of surface water levels and flows, sea level and rainfall depth enables CCC to assess the accuracy of the water quantity models developed for the Pūharakekenui/ Styx, Ōtakaro/ Avon, Ōpāwaho/ Heathcote River and Huritini/ Halswell Rivers. This in turn allows CCC to confirm whether the conditions of consent are being met.

CCC intends to use monitoring data collected, along with surveyed flood extents during significant rainfall events, to validate and calibrate its stormwater quantity models for the Pūharakekenui/ Styx, Ōtākaro/ Avon, Ōpāwaho/ Heathcote and Huritini/ Halswell Rivers. Further, as new greenfields developments and their associated stormwater mitigation systems are completed and commissioned, the models will be updated as needed to ensure the expected progress is being made toward the Maximum Probable Development (MPD) flood mitigation targets set in Schedule 10 of the consent.

4.2 Sites

CCC has maintained and added to the hydrometric[2] network which was established by the Christchurch Drainage Board. This network consists of monitoring sites for surface water levels and flows, sea level, rainfall and groundwater levels (the latter discussed in the groundwater section of this document). The data collected from this network is used for the Council's management of the rivers and for the design of stormwater networks. Data is also used for emergency management purposes, particularly in time of flood. CCC engages a subcontractor to maintain the hydrometric network and collect the data. Quarterly and annual reports are produced that summarise the data, and make recommendations for maintenance and upgrades.

4.3 Surface Water Level and Flows

Continuous water level gauging data began in about 1980 and additional sites were added in 1989. CCC currently obtains data from 25 river level gauges (Figures 8 and 9). This includes 20 permanent and 5 project-based sites. The permanent river level gauges are telemetered and provide real time information at 15 minute (or less) intervals. Project-based gauges are typically connected to a data-logger which is downloaded monthly. River flow is calculated at eight rated sites (both permanent and project-based). Regular flow gaugings are undertaken to maintain accurate ratings. In addition to the automatically gauged sites, there are a number of locations with staff gauges. Levels at these sites can be recorded manually as needed.

[2] Hydrometry refers to the measurement of all elements in the hydrological cycle. In this context the hydrometric network refers to the measurement of rainfall, surface water levels and flows, and groundwater levels.

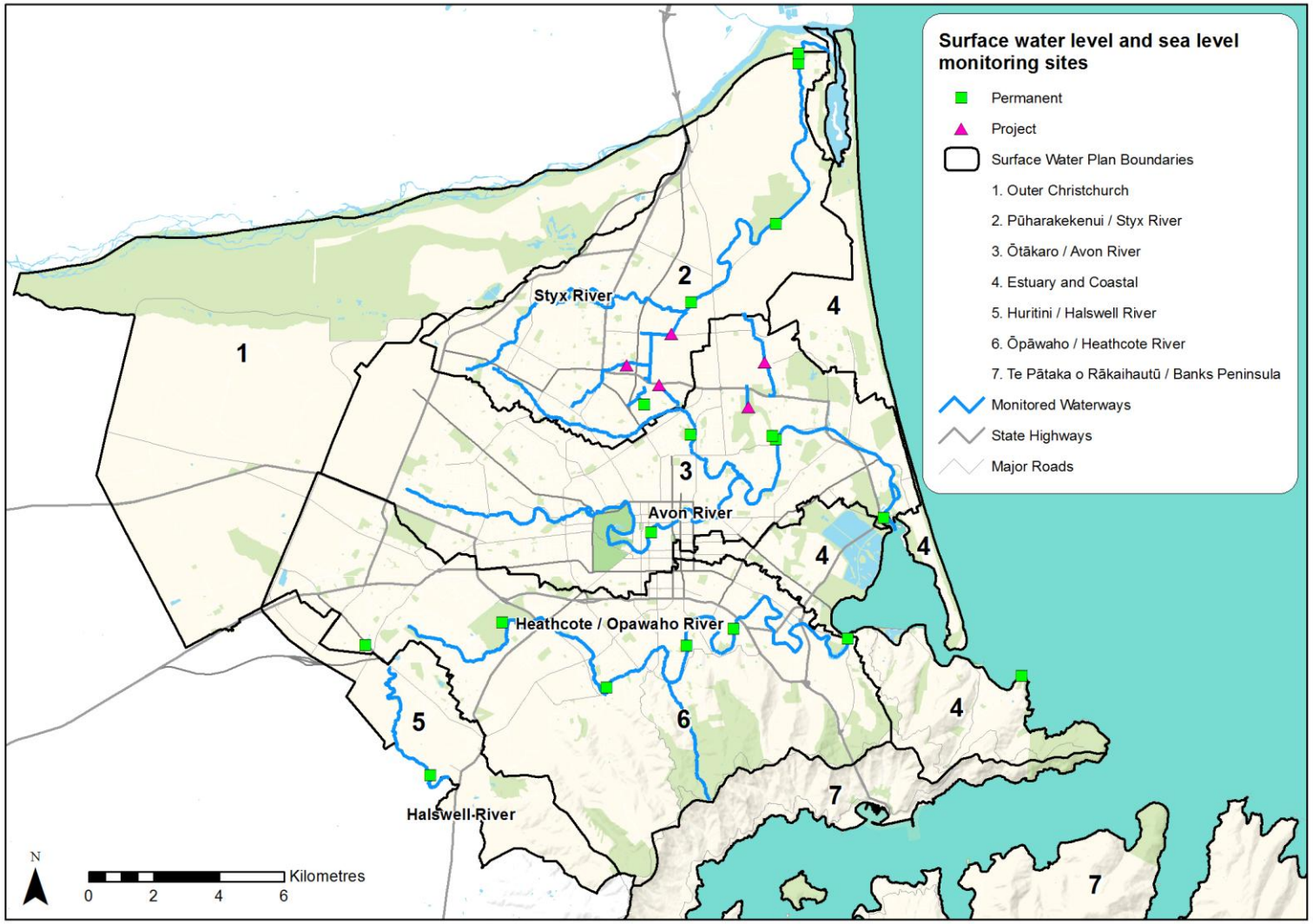

Figure 8. Location of water level sites (City)

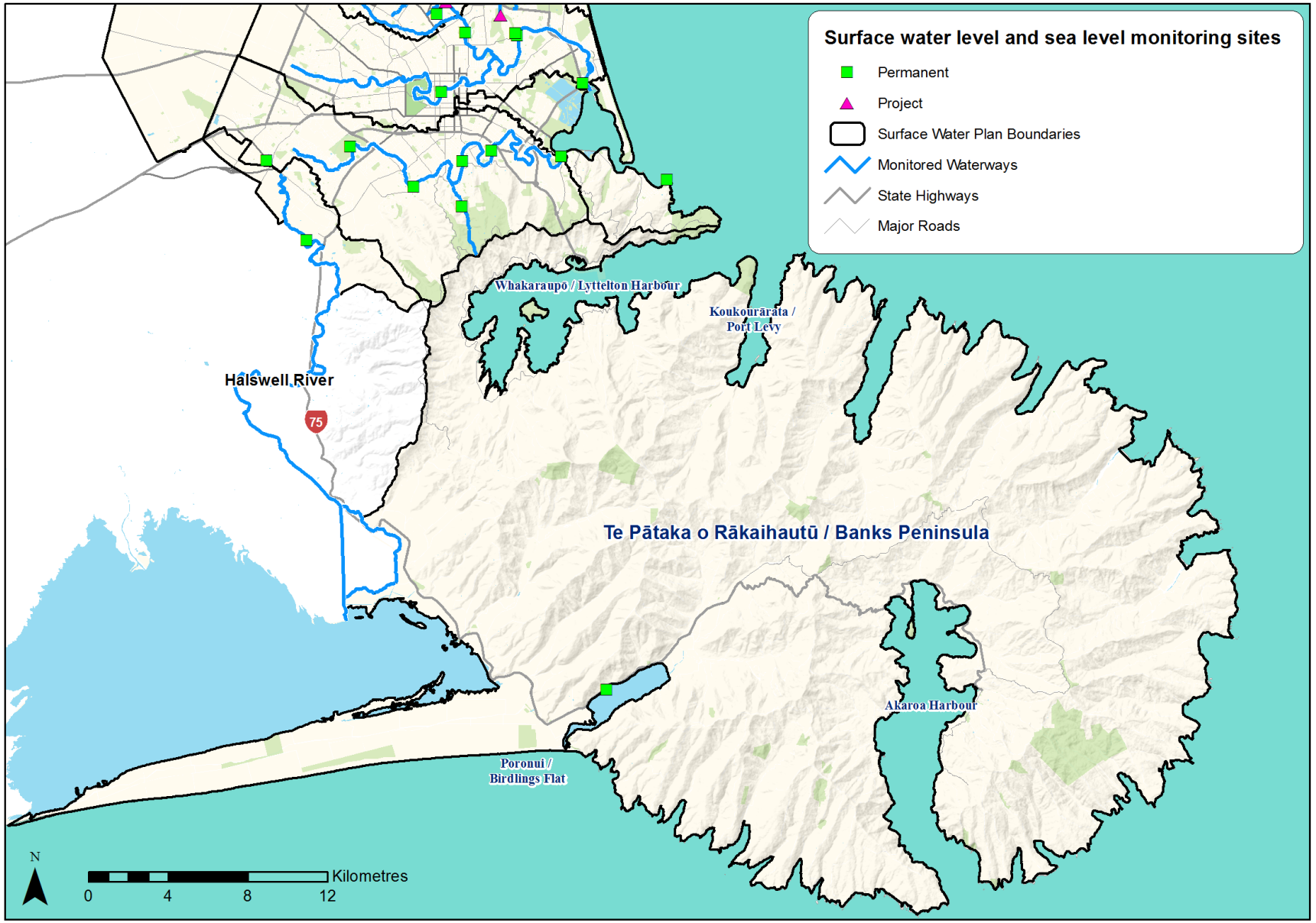

Figure 9. Location of water level sites (Banks Peninsula)

4.4 Sea Level

The National Institute of Water and Atmospheric Research (NIWA) maintains a CCC/ECan sea level monitoring site at Sumner Head in Scarborough (Figure 8). Tide levels have been analysed and statistics generated by NIWA based on recordings at the Pūharakekenui/ Styx River tide-gates, Sumner Head, Avon River at Bridge Street and Heathcote River at Ferrymead (Goring, 2008; Goring, 2011). This information is used to inform the downstream water levels which are critical to the functioning of the Ōtākaro/ Avon and Ōpāwaho/ Heathcote River models, and also inform long-term planning decisions.

4.5 Rainfall Depth

There is a network of 21 rain gauges which presently provide real time information at 15 minute (or less) intervals (Figures 10 and 11). The longest record is the almost continuous daily rainfall record for the Botanic Gardens dating back as far as 1873. However, it was not until 1962 that records of rainfall began at hourly intervals and this has progressively been reduced to sub-hourly recording. This provides Christchurch with a good basis for its rainfall statistics, which have been compiled by NIWA for use in stormwater design (Griffiths et al, 2009).

4.6 Reporting

CCC will report on the stormwater quantity models in the annual report on a 5-yearly basis, starting in the year 2021. Reporting will cover:

- Any significant changes made to the input parameters of the models;
- Any significant changes to development patterns (greenfield or brownfield);
- Any significant updates to model hydraulics (bridges, culverts, etc.);
- Any significant calibration or validation exercises undertaken;
- A discussion of progress toward meeting the flood mitigation targets set in Schedule 10 of the consent; and
- Any other relevant discussion involving changes to models or analysis of modelling results.

In addition, CCC maintains a database with all recorded data to be made available as needed for projects or updating of hydrological models. TIDEDA (a NIWA product for storing and analysing time dependent data) is used to allow detailed analysis of the data. Quarterly and annual reports are produced, with a summary of the data and a review of operational issues.

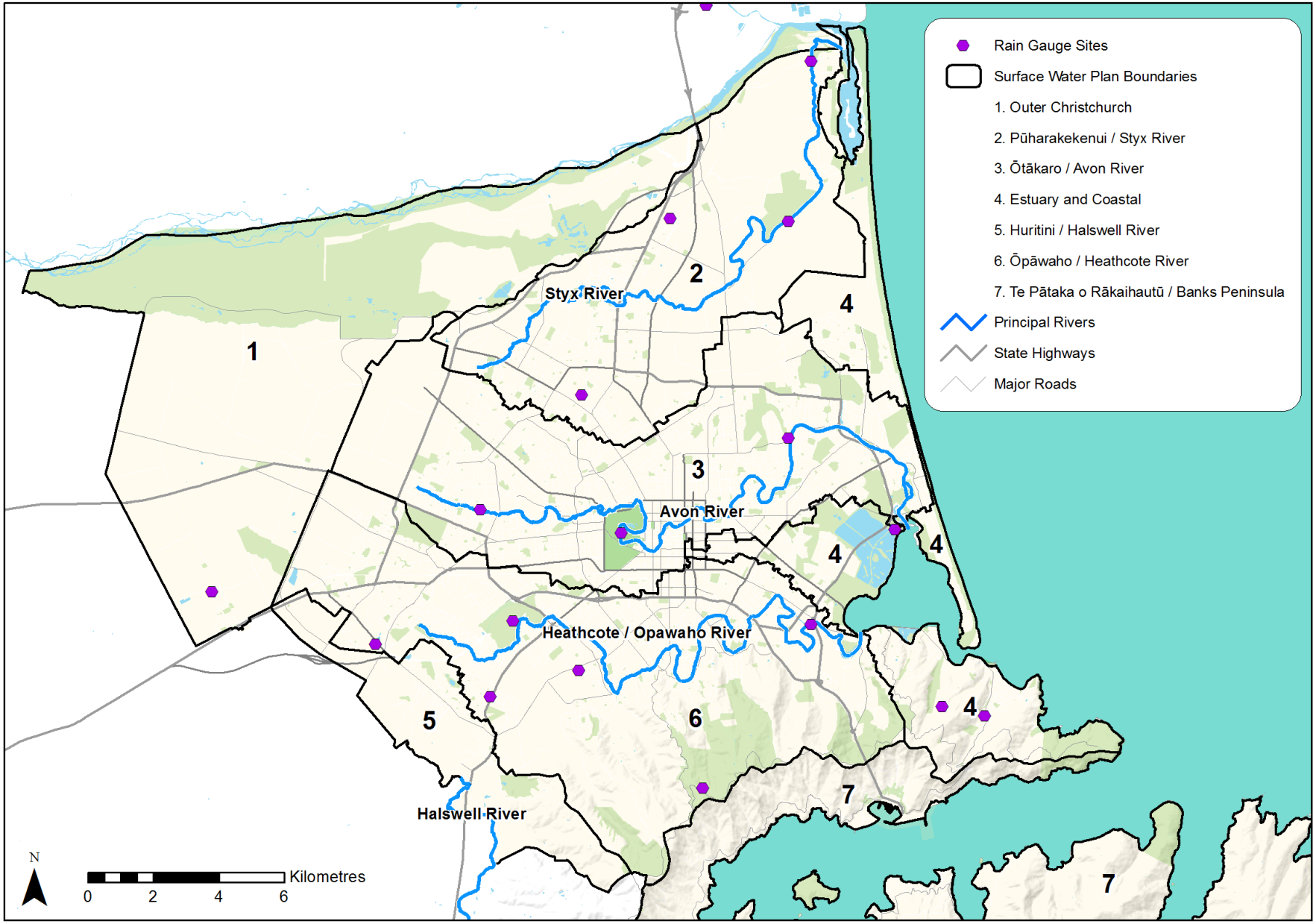

Figure 10. Location of rainfall depth sites (City)

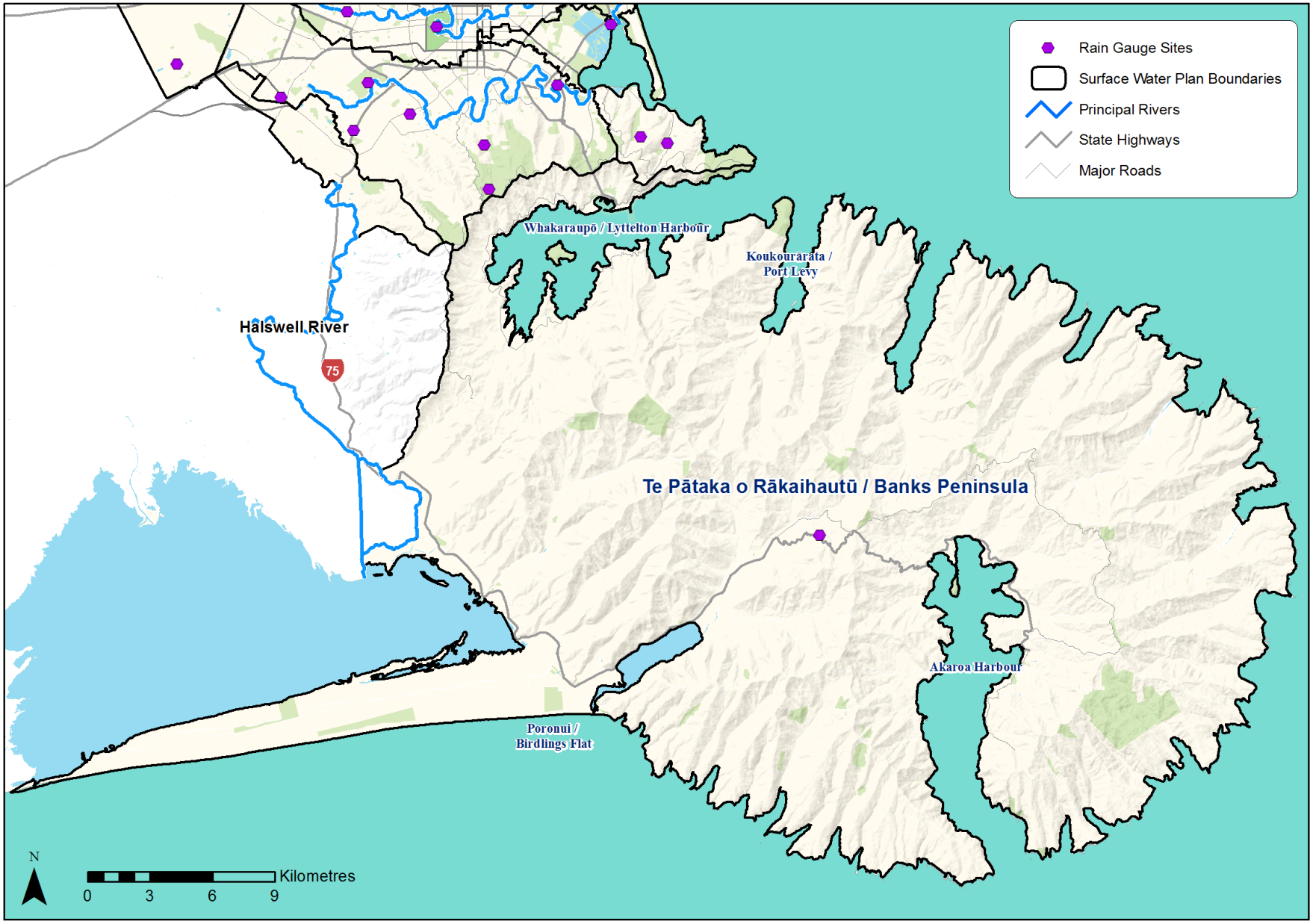

Figure 11. Location of rainfall depth sites (Banks Peninsula)

5. Surface Water Quality

5.1 Purpose for monitoring under this consent

The purpose of this monitoring is to (1) measure whether stormwater discharges are causing adverse effects on surface water quality, (2) determine compliance with the conditions of the consent, (3) inform stormwater mitigation and (4) inform management of waterway health. This monitoring is of a range of parameters present in stormwater (such as metals and sediment), but also additional parameters to give a better understanding of water quality overall. Monitoring includes baseline monitoring (to understand the typical quality of the water and because it is easier to undertake a widespread monitoring) and wet weather monitoring (to particularly focus on stormwater inputs).

5.2 Background

Water quality monitoring of waterways has been undertaken previously by the CCC for many decades, with regular monthly sampling being undertaken at numerous sites in Christchurch since 2007. This new monitoring programme builds on this past monitoring by including additional sites and receiving environments.

5.3 Sampling Sites and Frequency

5.3.1 Regular Monitoring

A total of 51 sites within the waterways and coastal areas of Christchurch and Banks Peninsula shall be monitored monthly (Figures 9 to 15; Appendix D). These sites predominantly include (a) waterways within the five main river catchments of Christchurch (Ōtākaro/ Avon River, Ōpāwaho/ Heathcote River, Pūharakekenui/ Styx River, Huritini/ Halswell River and Ōtūkaikino River), (b) waterways within Banks Peninsula settlement areas and (c) coastal areas (estuaries and ports, within Christchurch and Bank Peninsula). Following a review of the EMP in 2024, changes were made to the sampling sites, effective from January 2025.

5.4 Wet Weather Monitoring

Wet weather monitoring of waterways has previously been undertaken as part of stormwater discharge consents requirements. Previous EMP versions required two rounds of wet weather monitoring at 32 sites within the district, on a five-yearly rotation by catchment, resulting in an average of 13 wet weather samples collected per year. This new version of the EMP requires the same minimum of 13 wet weather samples collected per year, but the sampling is now focussed on targeted investigations (e.g., in rapidly urbanising catchments) and assessing stormwater treatment effectiveness. This new approach to wet weather sampling is better aligned with the consent outcome of identifying problem areas, proposing improvements, and monitoring the effectiveness of those improvements. It also aligns with the targeted wet weather monitoring requirement of Schedule 3 (k) attached to the CSNDC. (Figures 9 to 15; Appendix D). Wet weather sampling shall be carried out using the following criteria:

- By using grab sampling, or other method that results in more robust sampling, such as Nalgene bottles or autosamplers, as approved by Environment Canterbury (Regional Leader – Monitoring and Compliance).
- Dry period prior to sampling = minimum of 3 days (on advice from Ash O'Sullivan from PDP that even 24 hours is sufficient time for contaminants to accumulate);
- Rainfall depth = minimum of 3 mm total before sampling begins (based on modelling by Tom Parsons for Avon Stormwater Management Plan that this is sufficient to obtain the first flush (5-25 mm) of contaminants); and

- Sampling timeframe = where practicable3, sampling shall occur within 1-2 hours of the desired rainfall being achieved, as determined using MetConnect or equivalent forecasted and real-time rainfall, to ensure first flush is captured. Tide cycles needed to be taken into consideration for tidal sites. Field data shall be captured electronically in the field using a data collection application such as ArcGIS Survey123. This is to ensure consistency and accuracy in data collection.

[3] The term “where practicable” acknowledges that it may be impractical to sample within 2 hours of the desired rainfall depth being achieved, considering: a) spatial and temporal variations in rainfall timing and depth; and b) many events will fall outside normal work hours. However, sampling shall occur no more than 4-8 hours of the desired rainfall being achieved.

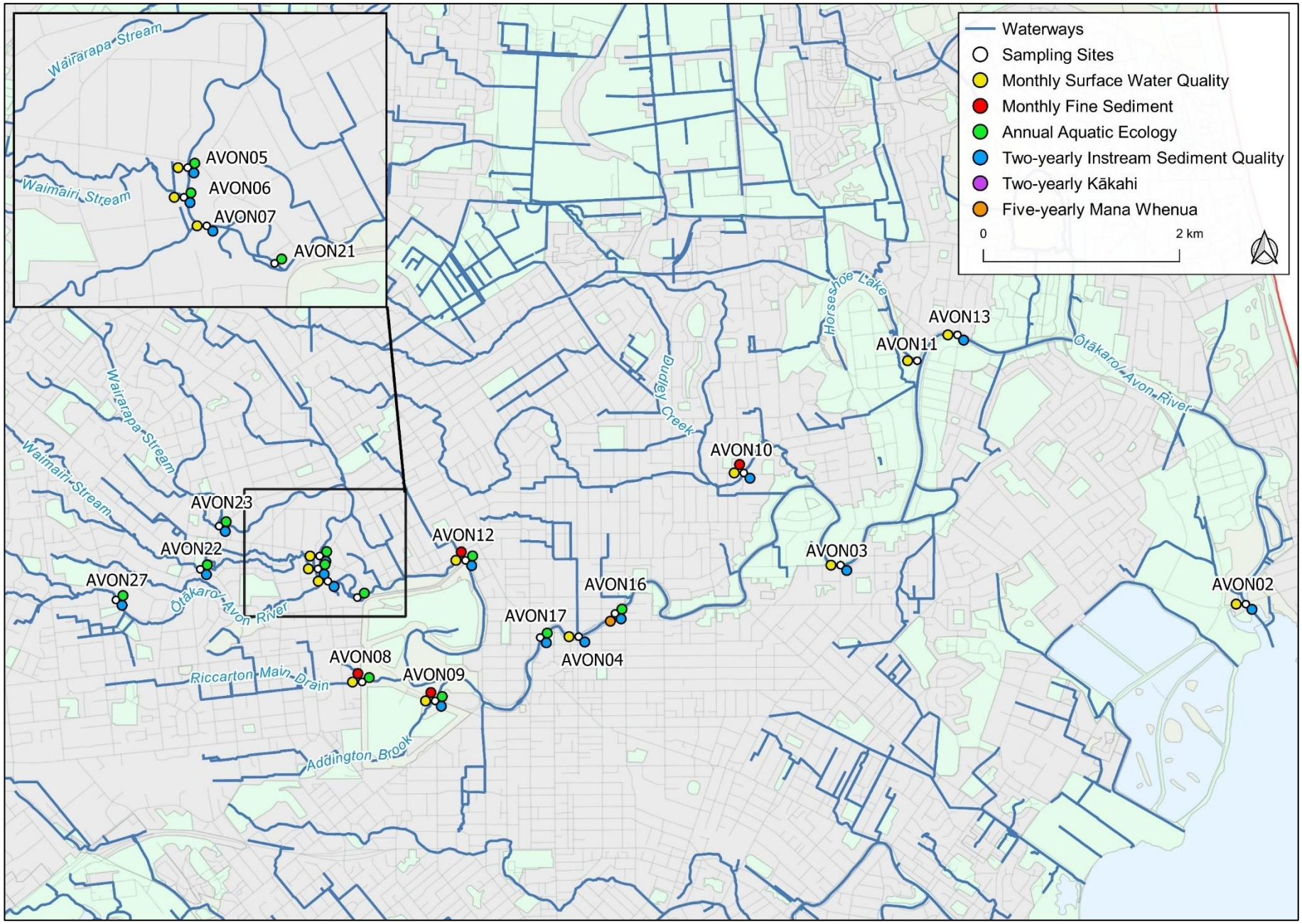

Figure 12. Location of surface water, instream sediment, aquatic ecology and mana whenua values monitoring sites in the Ōtākaro/ Avon River Stormwater Management area

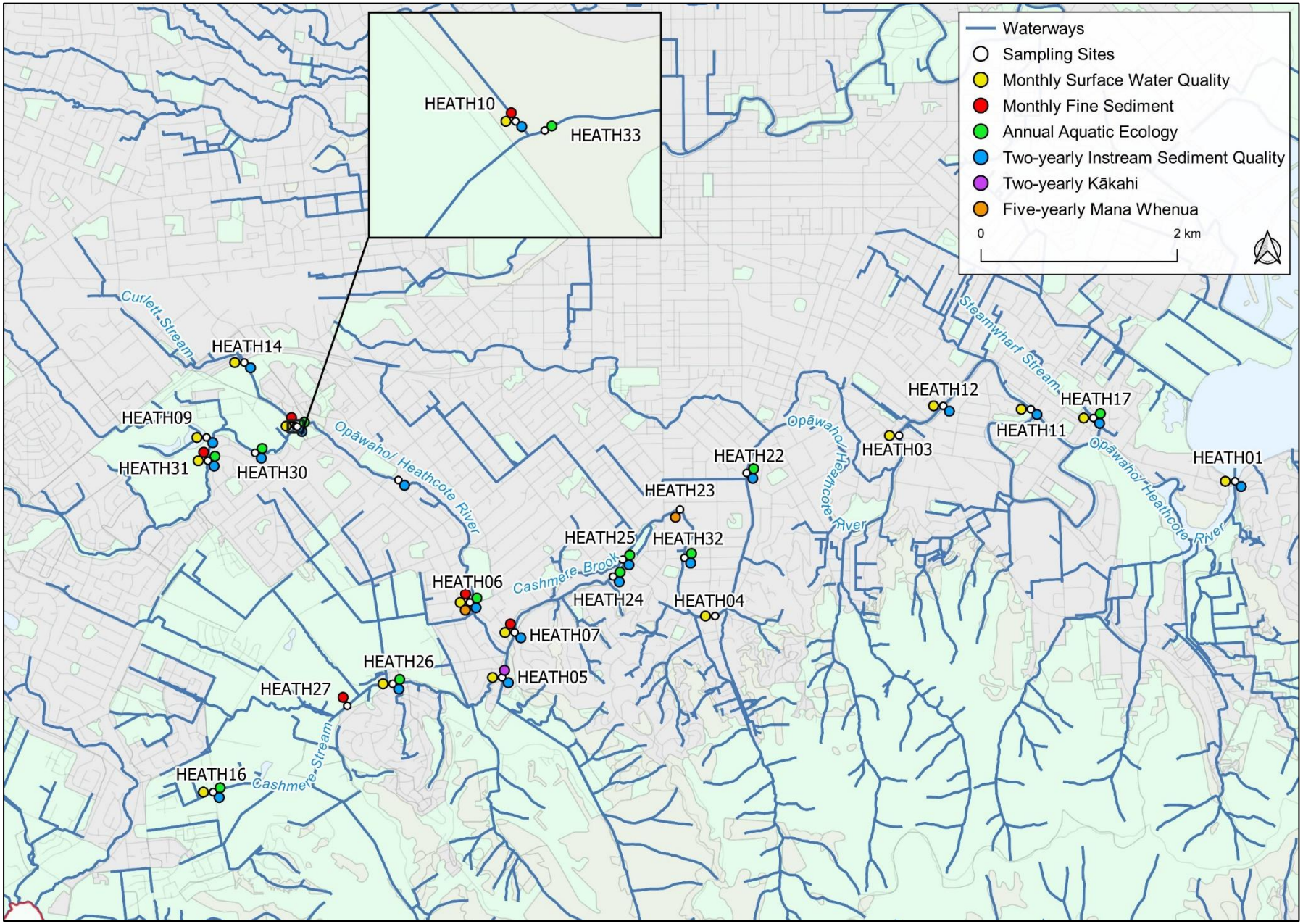

Figure 13. Location of surface water, instream sediment, aquatic ecology and mana whenua values monitoring sites in the Opāwaho/ Heathcote River Stormwater Management area

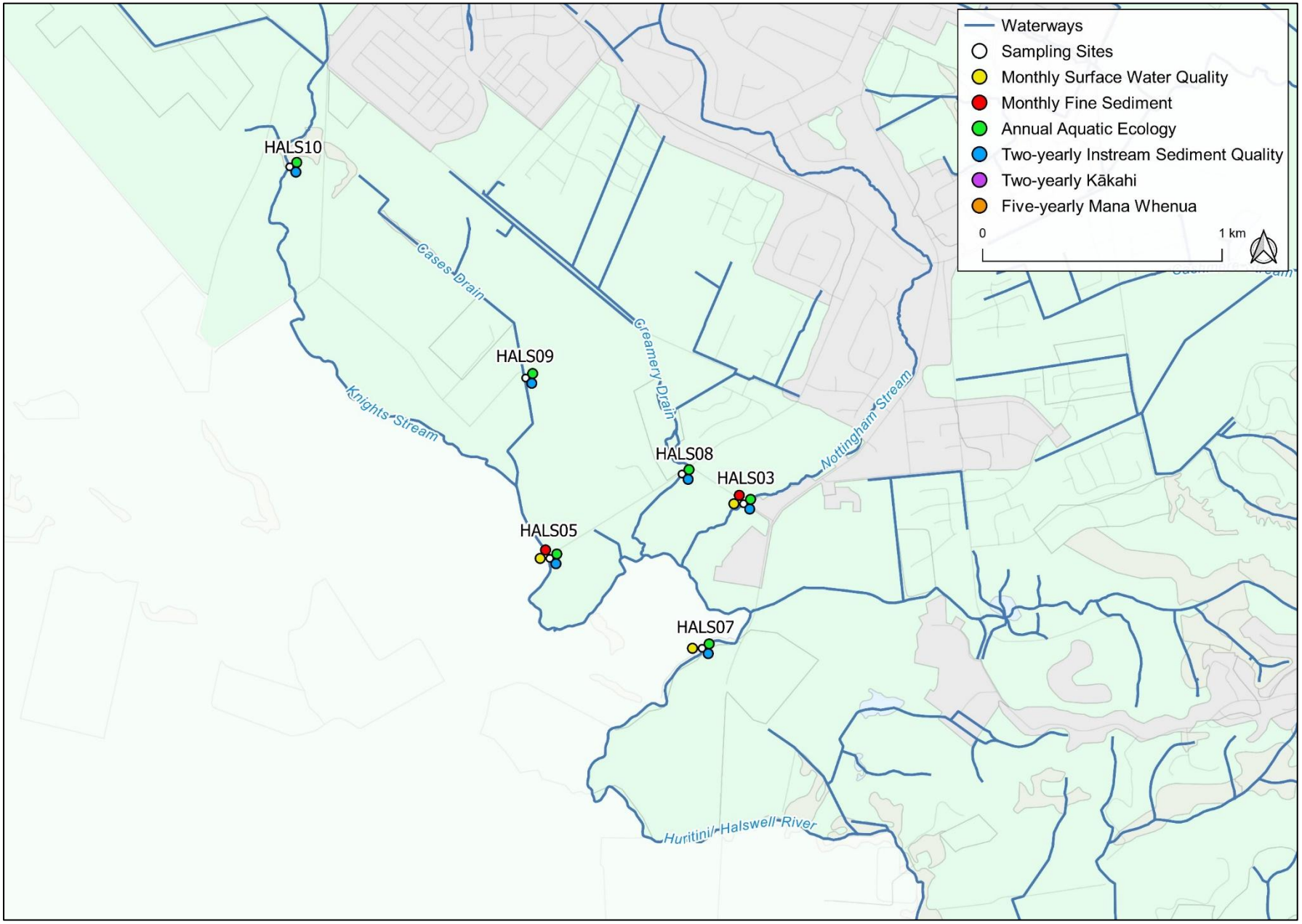

Figure 14. Location of surface water, instream sediment and aquatic ecology monitoring sites in the Huritini/ Halswell River Stormwater Management Plan area

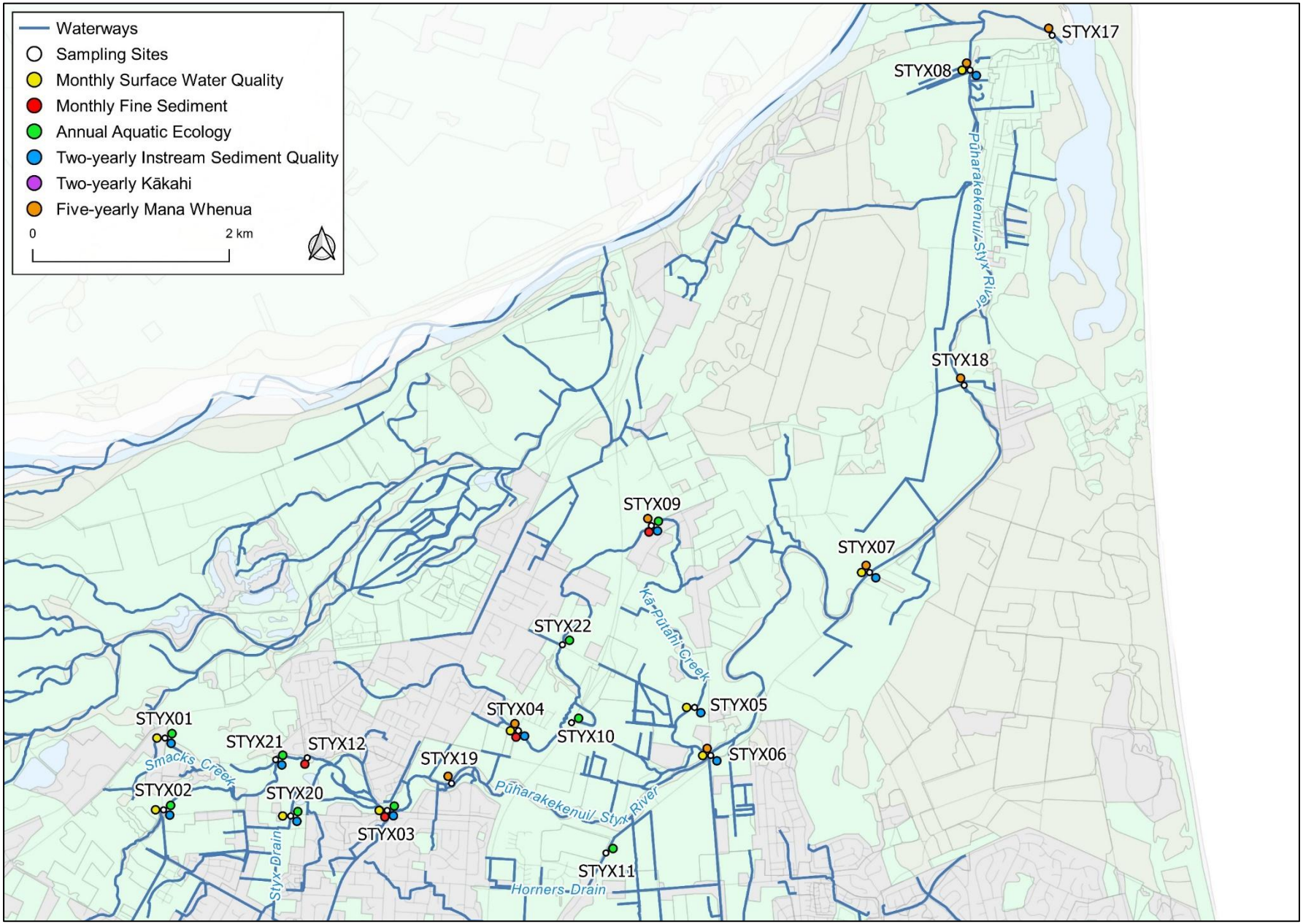

Figure 15. Location of surface water, instream sediment, aquatic ecology, and mana whenua values monitoring sites in the Pūharakekenui/ Styx River Stormwater Management Plan area

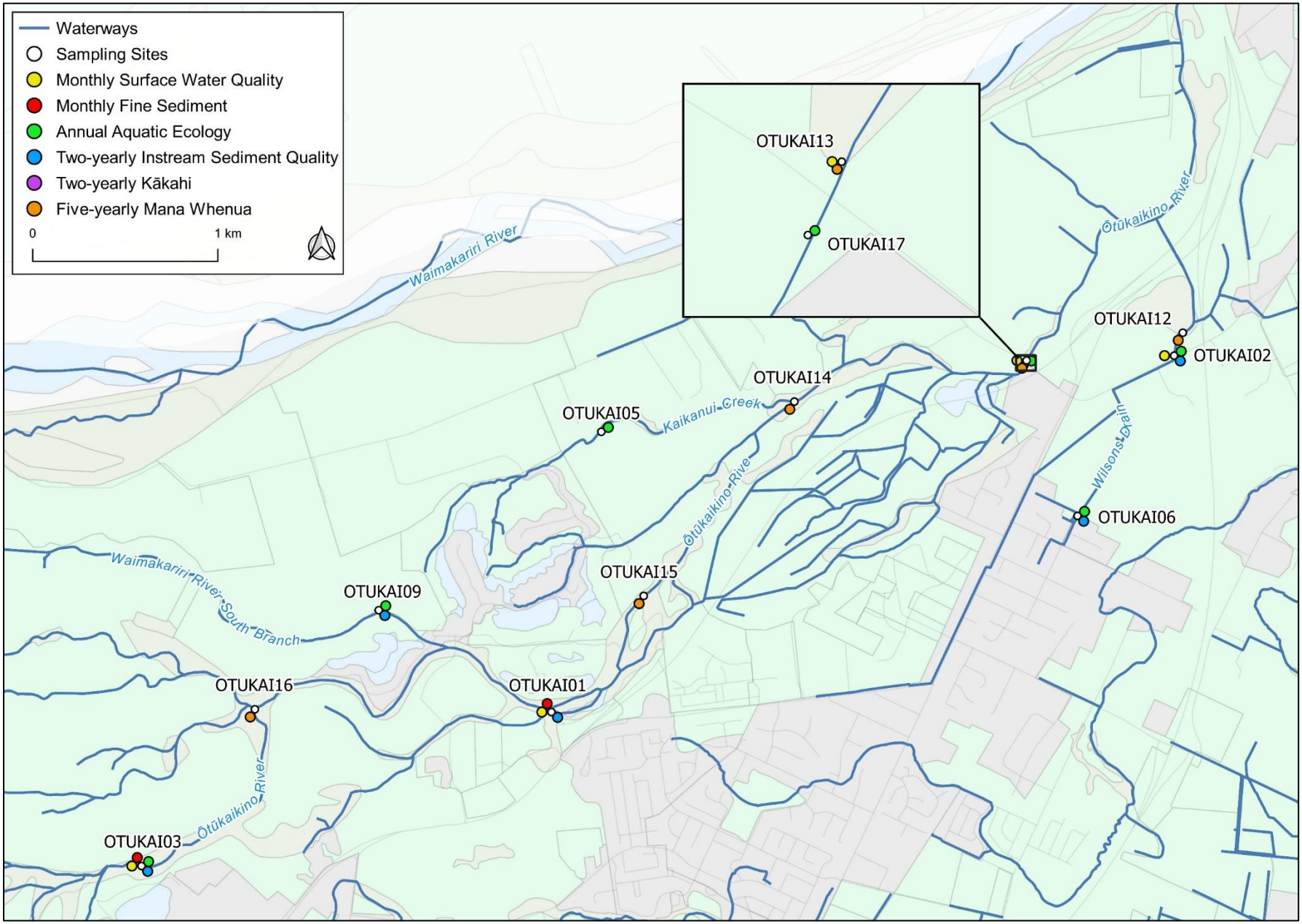

Figure 16. Location of surface water, instream sediment and aquatic ecology monitoring sites in the Ōtūkaikino River Stormwater

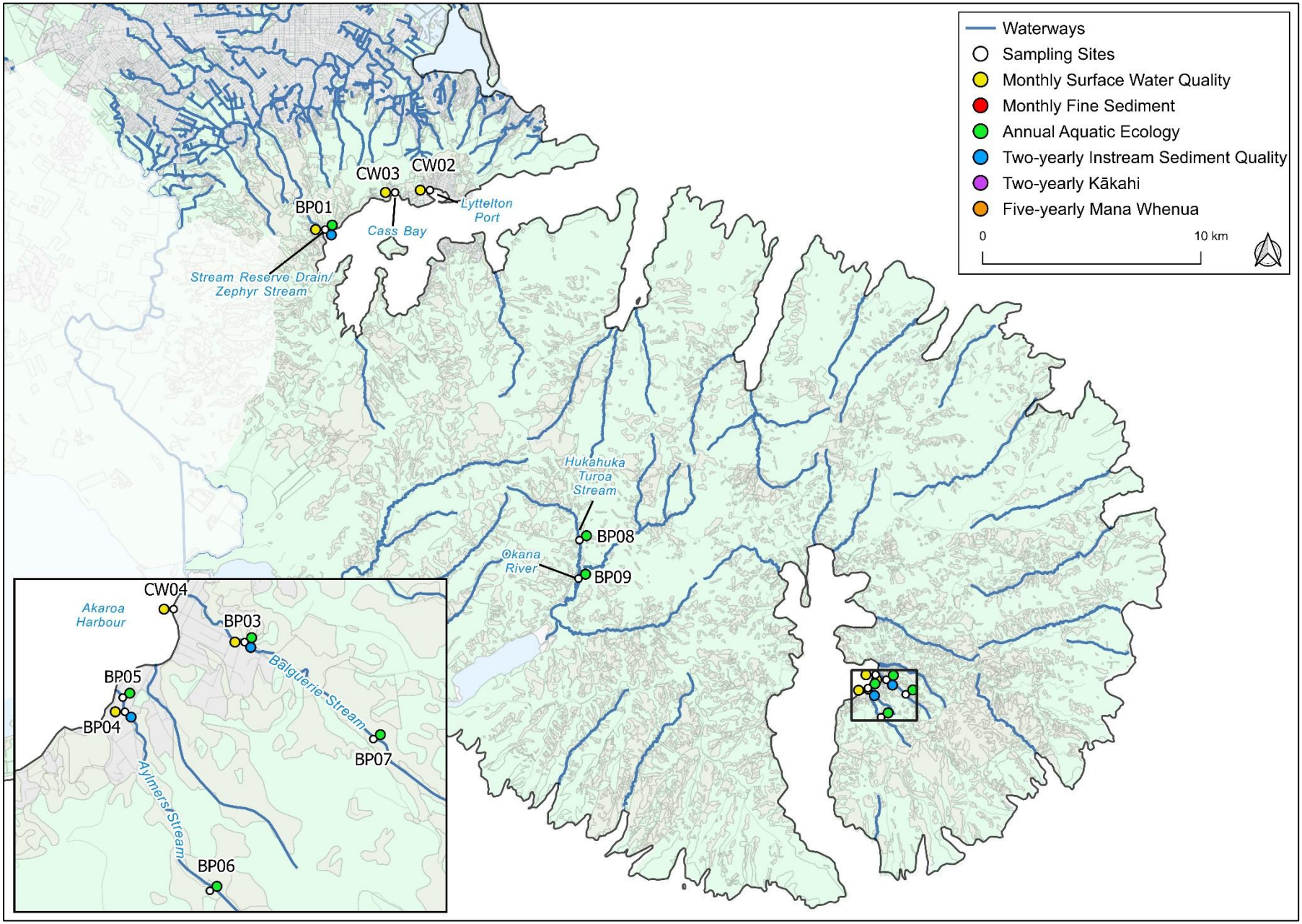

Figure 17. Location of surface water, instream sediment and aquatic ecology monitoring sites in the Banks Peninsula Stormwater

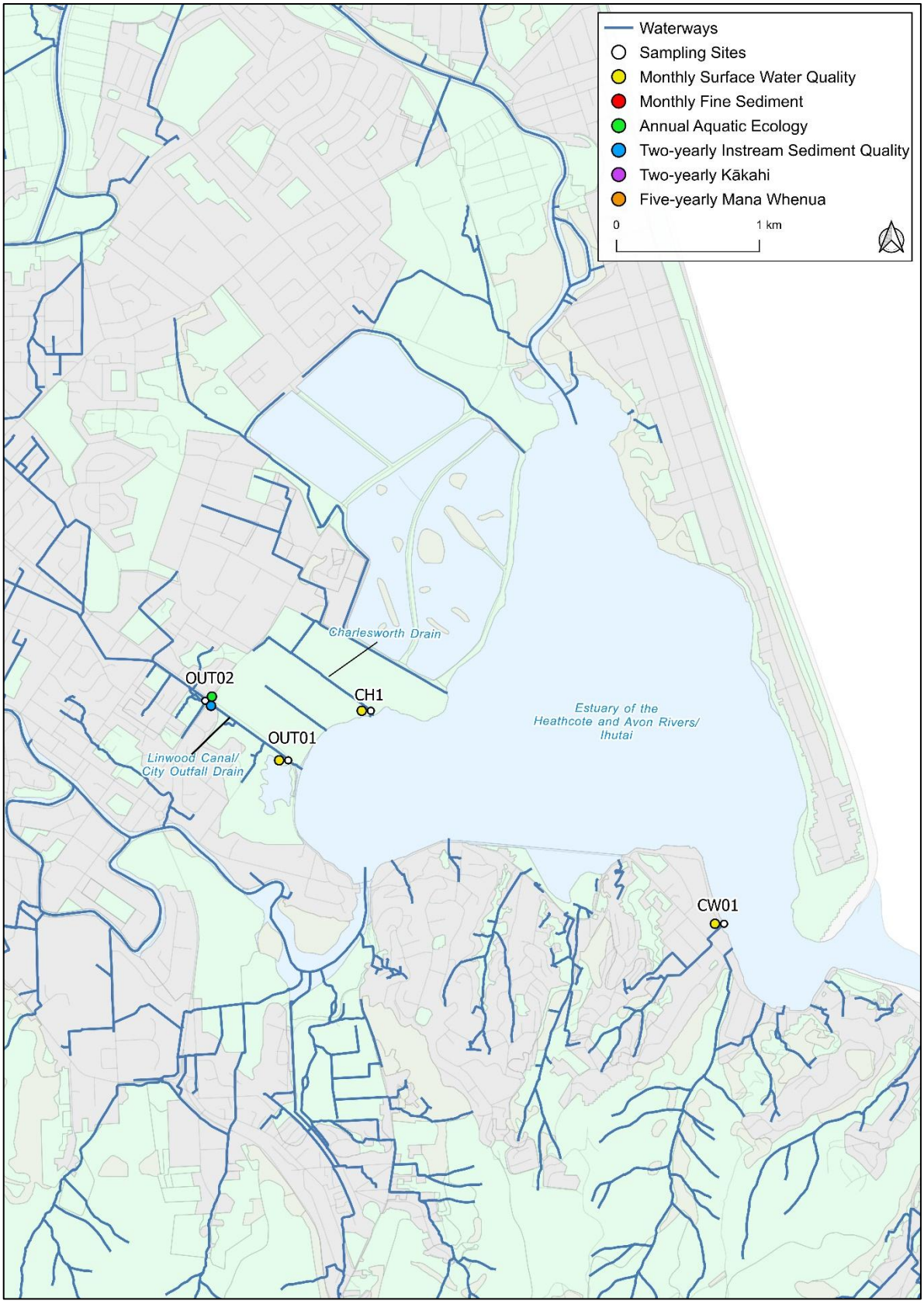

Figure 18. Location of surface water, instream sediment and aquatic ecology monitoring sites in the Estuary and Coastal Stormwater Management Plan area

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5.5 Methods

The sample collection and laboratory analysis methods detailed in this section are consistent with past sampling undertaken by the CCC (primarily for stormwater consenting requirements). Samples from tidal sites shall be taken during low tide, with sampling within catchments starting at the most downstream site. The exception to this is the Beachville Road Ihutai/ Avon-Heathcote Estuary and Cass Bay sites, which shall be sampled at high tide, due to high tide samples better representing outfall inputs. Tide times for Lyttelton and Akaroa sites shall be based on their respective harbour tide times, while tide times for the Ōtākaro/ Avon River, Opāwaho/ Heathcote River and the Ihutai/ Avon-Heathcote Estuary shall be considered to be one hour after the respective tide in Lyttelton Harbour. Monthly sampling will take place on a routine basis regardless of the weather, which will allow for some of those samples to be taken during rainfall events.

Samples of water from each site shall be collected and analysed as follows:

- Samples should be collected from an area most representative of the site and should be in approximately the same location each time sampling is undertaken;
- Samples may be collected in a bucket before transfer to an appropriate, correctly labelled bottle, provided the bucket is rinsed twice beforehand with water from the site;
- Bottles (and lids) that do not have preservative should be rinsed with a small amount of water from the site immediately prior to sample collection and the rinsate discarded away from the sampling site; any bottles with preservative in them must not be rinsed, nor filled to overflowing as the preservative will be lost;
- Never allow the inner surface of a sample container or lid to be contacted by any material other than the sample water;
- Samples shall be dispatched in bottles prepared by an International Accreditation New Zealand (IANZ) accredited laboratory4 and as such will follow a Quality Assurance Plan; samples shall be immediately stored on ice and delivered to the laboratory within 24 hours, and a completed chain of custody form shall accompany all samples;
- At each site, in situ measurements of conductivity/salinity, temperature and dissolved oxygen shall be recorded using a calibrated meter at the same representative location as water samples were taken;
- The occurrence of rainfall at the time of sampling and within the 24-hours previous should be recorded, with rain defined as stormwater being seen flowing along gutters or out of stormwater pipes; and
- Samples shall be analysed for the parameters in Table 5 by an IANZ accredited laboratory; detection limits for each parameter shall be suitable to enable comparison of the results with relevant guidelines for reporting purposes.

The parameters to be tested were chosen specifically due to the following potential effects on instream biota, determined by whether the following guidelines are being met, as detailed in Table 5:

- Metals commonly found in stormwater, in particular, copper, lead and zinc, can be toxic to aquatic organisms, negatively affecting such things as fecundity, maturation, respiration, physical structure and behaviour (Harding, 2005). The toxicity of copper, lead and zinc in freshwater, and therefore the risk of adverse biological effects, alters depending on several abiotic factors. These toxicity modifying factors (TMFs) include, but are not limited to, organic carbon, hardness, pH, temperature, alkalinity and inorganic ligands (Gadd et al., 2023; Warne et al., 2018). The LWRP refers to default ANZG (2022) guidelines for metals but current recommendations are to modify these default guideline levels by relevant TMFs (Gadd et al., 2023; ANZG, 2022; Warne et al., 2018). Prior to 2025, CCC used hardness modified guideline values for lead and zinc. These “bioavailability-adjusted” guidelines were based on catchment medians for hardness that were recalculated every five years. Following the recommendations of Gadd et al. (2023), from 2025 CCC will measure hardness, dissolved organic carbon

[4] The Christchurch City Council Laboratory is an IANZ accredited laboratory and currently undertakes the analyses

and pH at all the freshwater monitoring sites to calculate toxicity based on TMFs per sample. For coastal sites, the ANZG (2022) guidelines detail values of 0.0013 mg/L for copper, 0.0044 mg/L for lead, and 0.008 mg/L for zinc.

- *pH* is a measure of acidity or alkalinity, on a scale from 0 to 14; a pH value of seven is neutral, less than seven is acidic and greater than seven is alkaline. Appropriate pH levels are essential for the physiological functions of biota, such as respiration and excretion (Environment Canterbury, 2009). Aquatic species typically have tolerances for certain pH levels and alteration of pH can result in changes in the composition of fish and invertebrate communities, with generally a positive relationship between pH and the number of species present (Collier et al, 1990). The guidelines in the Land and Water Regional Plan (LWRP; Environment Canterbury, 2015) for all waterways are a lower limit of 6.5 and an upper limit of 8.5. The ANZECC (2000) guidelines have a guideline value for estuaries of 7.0 - 8.5.
- *Conductivity* is a measure of how well water conducts an electrical current. Pure water has very low conductivity, but dissolved ions in the water (e.g. contaminants such as metals and nutrients) increase conductivity. ANZG (2022) have a guideline value for Cool Dry Low-elevation rivers of 116 µS/cm. There are no New Zealand guidelines for conductivity in coastal environments and it is more relevant to measure salinity in any case. Salinity is naturally high in coastal water and salinity levels can provide an indication of the relative contribution of fresh and coastal waters within tidally influenced areas such as estuaries and the lower reaches of rivers.
- Elevated levels of suspended sediment (*Total Suspended Solids, TSS*) in the water column decrease the clarity of the water and can adversely affect aquatic plants, invertebrates and fish (Crowe & Hay, 2004; Ryan, 1991). For example, sediment can affect 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 (Crowe & Hay, 2004; Ryan, 1991). The LWRP details in Rule 5.95 standards for TSS in stormwater prior to discharge, but does not detail specifically a guideline value within waterways (Environment Canterbury, 2018). The WRRP also does not detail a guideline level. A guideline level of 25 mg/L is considered an appropriate threshold to indicate potential detrimental effects on biota (Hayward et al., 2009; Stevenson et al., 2010) and is therefore used in this report. Additional site-specfic guidelines have been developed for tidal waterway and coastal sites following consultation with ECan (Michele Stevenson and Melanie Burns, ECan, personal communication, June 2023). These are based on the 80th percentile data for each site, following the approach outlined in Dudley et al. (2019), as detailed in Table 5.
- *Turbidity* is a measure of the transmission of light through water. Suspended matter in the water column causes light to be scattered or absorbed as is travels through the water. As for TSS, turbidity decreases the clarity of the water and can negatively affect stream biota (Ryan, 1991). A guideline level for this parameter is not provided in the LWRP. ANZG (2022) provides a guideline of 1.3 Nephelometric Turbidity Units (NTU) for Cool Dry Low-elevation rivers and ANZECC (2000) provides a value of <10 NTU which has been applied to the Ihutai site. Additional site-specific guidelines have been developed for tidal waterway and coastal sites following consultation with ECan (Michele Stevenson and Melanie Burns, ECan, personal communication, June 2023). These are based on the 80th percentile data for each site following the approach outlined in Dudley et al. (2019), as detailed in Table 5. Turbidity has historically been analysed at the laboratory using NTU, but since December 2020 has been analysed using Formazin Nephelometric Units (FNU), in accordance with the requirements of the National Environmental Monitoring Standards (NEMS, 2019). Turbidity NTU values prior to December 2020 have been converted to FNU at the catchment scale, using a conversion factor calculated from 12 months of concurrent testing of both methods (NEMS, 2019). However, the NTU guideline values are still used for direct comparsion against this FNU data (Michele Stevenson, ECan, personal communication, May 2021).
- *Dissolved Oxygen (DO)* is the concentration of oxygen dissolved or freely available in water and is commonly expressed as percent saturation. Adequate DO levels are essential for aquatic animals, such as fish and invertebrates, and can be influenced by many factors, including temperature, velocity, decomposition of organic material, and the photosynthesis and respiration of aquatic plants. The LWRP details a minimum DO

level of 70% for 'spring-fed – plains' and 'spring-fed – plains – urban' waterways, and 90% for Banks Peninsula waterways. The RCEP (2012) guidelines are a minimum of 80 % DO for the selected coastal sample locations.

- High water temperature can affect aquatic biota, with some studies showing that the presence of sensitive macroinvertebrates decreases with increasing temperature (Wahl et al, 2013). The LWRP water quality standard for waterway temperatures is a maximum of 20°C; the RCEP (2012) details a maximum of 25°C for the coastal sites, with no more than a 3°C change as a result of discharge of contaminant or water.
- *Biochemical Oxygen Demand* (BOD5) is an indicator of the amount of biodegradable organic material in the water and the amount of oxygen required by bacteria to break down this material. High BOD5 values are due to plant matter, nitrogen and phosphorus, and indicate the potential for bacteria to deplete oxygen levels in the water. The LWRP does not have a guideline level for this parameter. The Ministry for the Environment (1992) and RCEP (2012) guideline level is 2 mg/L, although this is for filtered samples and samples are currently tested for total levels, so comparisions to the guideline will be conservative.
- *Total ammonia* (ammoniacal nitrogen) is typically a minor component of the nitrogen available for plant growth, but at high levels can have toxic effects on aquatic ecosystems. The toxicity of ammonia varies with pH (ANZECC, 2000). Therefore, the LWRP water quality standards also vary depending on pH, ranging from 2.57 mg/L at pH 6 to 0.18 mg/L at pH 9 (Environment Canterbury, 2015). The water quality standard for this monitoring shall be adjusted based on the median pH levels for the relevant catchments. The exception to this is for Banks Peninsula waterways which have a set guideline value regardless of pH (0.32 mg/L; Environment Canterbury, 2015). Ammonical nitrogen is not required to be sampled at coastal sites.
- *Nitrate* can also be toxic to stream biota and specific guidelines for this parameter have recently been developed to protect freshwater species (Hickey, 2013). Guidelines are available for different species protection levels: 99% (pristine environment with high biodiversity and conservation values), 95% (environments which are subject to a range of disturbances from human activities, but with minor effects), 90% (environments which have naturally seasonally elevated concentrations for significant periods of the year (1-3 months)), 80% (environments which are measurably degraded and which have seasonally elevated concentrations for significant periods of the year (1-3 months)), and acute (environments which are significantly degraded; probable chronic effects on multiple species). Based on these descriptions and the predominantly urban nature of the waterways monitored, most of the waterways would fall under the 80% to acute species description (i.e. Ōtākaro/ Avon, Opāwaho/ Heathcote and Huritini/ Halswell River catchments). However, the Pūharakekenui/ Styx and Ōtūkaikino River catchments (and Cashmere Stream) likely fall under the 90% species protection. To be conservative, the 90% species protection shall be used as the guideline level for all waterways. Within this 90% level of species protection there are two guideline values: the ‘grading’ guideline (3.8 mg/L) that provides for ecosystem protection for average long-term exposure (measured against medians) and the ‘surveillance’ guideline (5.6 mg/L) that assesses seasonal maximum concentrations (measured against annual 95% percentiles). Nitrate is not required to be sampled at coastal sites.
- *Dissolved Inorganic Nitrogen (DIN)*, which is the sum of ammonia, nitrite and nitrate, provides a measure of the risk of eutrophication and toxicity (Environment Canterbury, 2015). The LWRP details a value of 1.5 mg/L for 'spring-fed – plains' and 'spring-fed – plains – urban' waterways, and 0.09 mg/L for Banks Peninsula waterways. DIN is not required to be sampled at coastal sites.
- *Dissolved Reactive Phosphorus (DRP)* is a soluble form of phosphorus that is readily available for use by plants. Phosphorus is an essential nutrient for plant growth and can limit primary production at low levels, but can cause proliferation of algae and aquatic plants at high levels. The guideline levels in the LWRP for 'spring-fed - plains' and 'spring-fed – plains – urban' waterways are 0.016 mg/L, and 0.025 mg/L for Banks Peninsula waterways. DRP is not required to be sampled at coastal sites.
- *Escherichia coli* is a bacterium that is commonly used as an indicator of faecal contamination in freshwater and therefore health risk from contact recreation (Ministry for the Environment, 2003). The guideline level in the LWRP for 'spring-fed – plains',

'spring-fed – plains – urban' and Banks Peninsula waterways is 550 E. coli per 100ml (for 95% of samples). There are no New Zealand guidelines for coastal environments.

- *Enterococci* is a faecal streptococci bacterium that is used as an indicator of faecal contamination in saline environments and therefore health risk from contact recreation (Ministry for the Environment, 2003). This parameter is not relevant to non-tidal waterway sites, only tidal waterway and coastal sites. There are guideline levels for coastal sites in the RCEP, but these are considered difficult to measure, with the requirement for running medians not to exceed certain values, as well as maximum values for any given sample. These guidelines are also only in relation to some of the site classifications and only during the summer months. Instead, enterococci shall be compared against the Ministry for the Environment (2013) guidelines, with more stringent levels adopted for those sites where contact recreation is more likely to occur (Cass Bay and Akaroa Harbour; 200 CFU/100 ml), compared to those were contact recreation is less likely to occur (500 CFU/100 ml).
- *Faecal coliforms* are also to be monitored in surface water at the Akaroa coastal site, to allow comparisions to the Ministry for the Environment (2003) guidelines for shellfish consumption.

5.6 Reporting

The annual monitoring report for the consent shall include a report on the water quality monitoring undertaken during the previous calendar year . This report shall include:

- An assessment of parameter concentrations at each site against the most relevant guideline levels (Table 5), where available, to determine likely effects on the receiving environment due to water quality. For the monthly data this shall include;
    - A three-year rolling dataset for all parameters (to represent current state)
    - Additionally for TSS, copper, lead and zinc, data for the monitoring year alone, to allow an assessment of whether responses to monitoring will be triggered (i.e., the three-year rolling dataset will not be used for this compliance assessment)
- For the strongly salinity affected tidal waterway sites (Avon River at Bridge Street Bridge, Heathcote River at Tunnel Road, Heathcote River at Ferrymead Bridge and Linwood Canal), coastal guidelines shall be used instead of waterway guidelines;
- Spatial comparisons of concentrations within and across catchments;
- For the monthly data, Mann-Kendal trend analysis shall be used to statistically test whether water quality is remaining stable, improving or declining over time;
    - Analysis and interpretation will generally follow the recommendations of Snelder et al (2021), which is consistent with the approach used for national reporting of water quality on the Land and Water Aotearoa (LAWA) website5;
    - Trends will be reported in terms of direction (increasing, decreasing, or indeterminate), likelihood (likely and very likely), and the annual rate of change, as per Snelder et al (2021).
    - Trends analyses shall be conducted on data collected since the beginning of the dataset (typically 2007) and on more recent periods (e.g., the most recent 10 years), to understand long term and recent trends in water quality.
- An assessment as to whether the Receiving Environment Objectives and Attribute Target Levels relating to surface water quality (TSS, copper, lead and zinc), as specified in Schedules 7 (Waterways) and 8 (Coastal Waters) of the consent conditions, are being met. In accordance with Schedule 8 of the CSNDC, metals shall not be assessed against the Attribute Target Levels at the Lyttelton Port site;
- For the wet weather monitoring, a description of the purpose of the sampling (including, sites sampled and rationale), key results, and any recommendations for further sampling or mitigation;
- A discussion of likely reasons for any poor or declining water quality (i.e. whether there is the potential this could be due to stormwater inputs); A discussion of contaminants of concern and sites/catchments with poor values that should be considered as priority areas for stormwater management; and

[5] https://www.lawa.org.nz/learn/factsheets/calculating-water-quality-trends-in-rivers-and-lakes

- Sites not meeting the required Attribute Target Levels, that shall trigger the further investigations detailed in the consent conditions.

Table 5. Parameters to be analysed in surface water samples and the corresponding guideline levels.

Guidelines should be compared to median levels from one calendar year of monitoring, unless otherwise indicated. ANZG = Australian and New Zealand Guidelines for Fresh and Marine Water Quality; HMGV = Hardness Modified Guideline Value; RCEP = Regional Coastal Environment Plan; LWRP = Land and Water Regional Plan; ANZECC = Australia and New Zealand Environment and Conservation Council. From 2025, metal toxicity will be calculated on a per-sample basis, using guidance on Toxicity Modifying Factors in the ANZG. The levels of species protection (90%. 95%. 99%) will remain the same for each catchment. The first annual report using this updated approach will be in 2026.

Parameter	Non-Tidal Waterway Guideline Level	Coastal and Tidal Waterway Guideline Level
Dissolved copper	ANZG (2022) (95th percentile, not medians): Ōtākaro / Avon and Opāwaho/ Heathcote River catchments (90% species protection: ≤0.0018 mg/L Huritini/ Halswell, Pūharakekenui/ Styx and Ōtūkaikino River catchments (95% species protection): ≤0.0014 mg/L Cashmere Stream and Banks Peninsula waterways (99% species protection): ≤0.001 mg/L	ANZG (2022) (95th percentile, not medians): ≤0.0013 mg/L
Dissolved lead	ANZG (2022) HMGV (95th percentile, not medians): Ōtākaro/ Avon River catchment (90% species protection): ≤0.0154 mg/L Opāwaho/ Heathcote River catchment (90% species protection): ≤0.0239 mg/L Cashmere Stream (99% species protection): ≤0.0043 mg/L Huritini/ Halswell River catchment (95% species protection): ≤0.0109 mg/L Pūharakekenui/ Styx River catchment (95% species protection): ≤0.006 mg/L Ōtūkaikino River catchment (95% species protection): ≤0.0041 mg/L Stream Reserve Drain & Aylmers Stream (Banks Peninsula): ≤0.0014 mg/L Balguerie Stream (Banks Peninsula): ≤0.0011mg/L	ANZG (2022) (95th percentile, not medians): ≤0.0044 mg/L
Dissolved zinc	ANZG (2022) HMGV (95th percentile, not medians): Ōtākaro/ Avon River catchment (90% species protection): ≤0.0295 mg/L Opāwaho/ Heathcote River catchment (90% species protection): ≤0.0396 mg/L Cashmere Stream (99% species protection: ≤0.0063 mg/L Huritini/ Halswell River catchment (95% species protection): ≤0.0174 mg/L Pūharakekenui/ Styx River catchment (95% species protection): ≤0.0117 mg/L Ōtūkaikino River catchment (95% species protection): ≤0.0091 mg/L Stream Reserve Drain & Aylmers Stream (Banks Peninsula): ≤0.0029 mg/L Balguerie Stream (Banks Peninsula): ≤0.0025mg/L	ANZG (2022) (95th percentile, not medians): ≤0.008 mg/L
Total water hardness and Dissolved Organic Carbon (DOC)	No New Zealand guidelines currently exist; should they become available these will be used; this parameter is usually only relevant to determine the toxicity of other parameters such as metals	Not to be tested
pH	LWRP (Environment Canterbury, 2015): All waterways: 6.5 - 8.5	ANZECC (2000)6: 7.0 - 8.5
Conductivity	ANZG (2022) (Cool Dry Low-elevation rivers (medians)): 116 µS/cm	None applicable for naturally saline coastal and tidal waters in New Zealand.
Salinity7	Not relevant to waterway sites	None applicable for naturally saline coastal and tidal waters in New Zealand.

[6] These values are from the ANZECC (2000) guidelines for estuaries of South-East Australia; the guidelines recommend these values are used for New Zealand while no other guidelines are available, but they should be used with caution due to the differing ecosystems between countries and replaced with national guidelines should they become available

[7] Salinity and enterococci are to be tested at the four strongly tidal sites (Avon River at Bridge Street Bridge, Heathcote River at Tunnel Road, Heathcote River at Ferrymead Bridge, and Linwood Canal) and all coastal sites

Parameter	Non-Tidal Waterway Guideline Level	Coastal and Tidal Waterway Guideline Level
Total Suspended Solids (TSS)	Hayward et al., 2009; Stevenson et al., 2010: All waterways: ≤25 mg/L	Lyttelton Port: 29.7 mg/L (based on 80th percentile of all available data and SQ30680 80th percentile in Dudley et al. (2019) report (17.2 mg/L)) Akaroa Harbour: 13 mg/L (based on 80th percentile ofall available data and SQ35189 80th percentile in Dudley et al. (2019) report (12 mg/L)) Ihutai / Avon-Heathcote Estuary: 17.7 mg/L (based on 80th percentile of all available data) Cass Bay: 30.1 mg/L (based on 80th percentile of all available data (June 2023-Dec 2023)) Ōtākaro/ Avon River at Bridge Street: 23 mg/L (based on 80th percentile of all available data) Opāwaho/ Heathcote River at Ferrymead Bridge: 50 mg/L (based on 80th percentile of all available data) Linwood Canal/ City Outfall Drain: 13 mg/L (based on 80th percentile of all available data)
Turbidity	ANZECC (2000): All waterways: ≤1.3 NTU	Ihutai / Avon-Heathcote Estuary: 9.8 FNU (based on 80th percentile of all available data) Lyttleton Port: 22.3 FNU (based on 80th percentile of all available data) Akaroa Harbour: 5.5 FNU (based on 80th percentile of all available data) Cass Bay: 23.4 FNU (based on 80th percentile of all available data (June 2023-Dec 2023)) Ōtākaro/ Avon River at Bridge Street: 16.3 FNU (based on 80th percentile of all available data) Opāwaho/ Heathcote River at Ferrymead Bridge: 29.9 FNU (based on 80th percentile of all available data) Linwood Canal/ City Outfall Drain: 12.3 FNU (based on 80th percentile of all available data)
Dissolved Oxygen (DO)	LWRP (Environment Canterbury, 2015): 'Spring-fed – plains – urban' and 'spring-fed – plains waterways:' ≥70 % Banks Peninsula waterways: ≥90	RCEP (Environment Canterbury, 2012): ≥ 80 %
Water temperature	LWRP (Environment Canterbury, 2015): All waterways: ≤20ºC	RCEP (Environment Canterbury, 2012): ≤25°C
Biochemical Oxygen Demand (BOD5)	Ministry for the Environment (1992): All waterways: ≤2 mg/L	RCEP, excluding The Operational Area of the Port of Lyttelton (Environment Canterbury, 2012): ≤2 mg/L
Total ammonia (ammoniacal nitrogen)	LWRP (Environment Canterbury, 2015): Banks Peninsula waterways: ≤0.32 mg/L All other waterways: determined by median catchment pH, as per the LWRP	Not required to be sampled
Nitrate nitrogen	LWRP (Environment Canterbury, 2015): Banks Peninsula waterways: Median: ≤1.0 mg/L; 95th percentile: ≤1.5 mg/L NPS-FM (Ministry for the Environment, 2023): Median: ≤2.4 mg/L; 95th percentile: ≤3.5 mg/8	Not required to be sampled
Dissolved Inorganic Nitrogen (DIN)	LWRP (Environment Canterbury, 2015): 'Spring-fed – plains – urban' and 'spring-fed – plains' waterways: ≤1.5 mg/L Banks Peninsula waterways: ≤0.09 mg/L	Not required to be sampled
Nitrite nitrogen	No New Zealand guidelines currently exist; should they become available these will be used	Not required to be sampled
Dissolved Reactive Phosphorus (DRP)	LWRP (Environment Canterbury, 2015): 'Spring-fed – plains – urban' and 'spring-fed – plains' waterways: ≤0.016 mg/L Banks Peninsula waterways: ≤0.025 mg/L	Not required to be sampled
Escherichia coli9	LWRP (Environment Canterbury, 2015): All waterways: ≤550 CFU/100ml (95th percentile, not medians)	No New Zealand guidelines currently exist; only tested at Ihutai/ Avon-Heathcote Estuary, as enterococci more relevant at the other coastal sites
Enterococci4	Ministry for the Environment (2013): At all measured sites: ≤500 CFU/100 ml (95th percentile, not medians)	Ministry for the Environment (2013)10: Ihutai/ Avon-Heathcote Estuary, Cass Bay and Akaroa Harbour: 140 CFU/100 ml (Alert level – single sample) Lyttelton Harbour: ≤500 CFU/100 ml (95th percentile, not medians)

[8] National bottom line – to be used for all waterway sites, except those in Banks Peninsula

[9] Not to be tested in Lyttelton Harbour, Cass Bay or Akaroa Harbour, as enterococci is more relevant to these saline environments

[10] These values are more stringent for coastal areas where swimming is likely to occur

Parameter	Non-Tidal Waterway Guideline Level	Coastal and Tidal Waterway Guideline Level
Faecal coliforms	Not relevant to waterway sites	Ministry for the Environment (2013): Akaroa Harbour: 14/100 mL (median) and 43/100 mL (not exceeded in more than 10% of samples) This parameter is not required to be measured at the remaining coastal sites

6. Instream Sediment Quality

6.1 Purpose for monitoring under this consent

The purpose of this monitoring is to (1) measure whether stormwater discharges are causing adverse effects on instream sediment, (2) determine compliance with the conditions of the consent, (3) inform stormwater mitigation and (4) inform management of waterway health. This monitoring is of a range of parameters typically present in stormwater.

6.2 Background

The quality of sediment within Christchurch waterways has been analysed on one-off occasions a number of times since the inception of the CCC and the former Christchurch Drainage Board. An earlier version of this EMP involved five-yearly monitoring. This new monitoring programme again builds on this past monitoring, by increasing the monitoring frequency to every two years and increasing the number of monitoring sites

6.3 Sampling Sites and Frequency

Waterway sediments shall be sampled at 60 sites from across the district (Figures 9 to 15; Appendix D). Thirty sites will be sampled each year, such that sampling at a given site will occur every two years. Sampling sites include the core of sites monitored under a previous version of this EMP, with some previous sites removed for logistical reasons (e.g., if they lacked sufficient fine sediment to sample). Additional sites were selected to improve spatial coverage and include locations in rapidly developing catchments. After two rounds of monitoring at a site, the data will be reviewed to determine whether there is merit in continuing to monitor at that location, or if it would be better to change to another site to better target other areas of concern. Environment Canterbury will be consulted before making any changes to monitoring sites.

6.4 Methods

The methods detailed in this section are similar to those previously used in sediment surveys around Christchurch (e.g. Kingett Mitchell, 2005; Golder Associates, 2009; Golder Associates, 2012b; Gadd & Sykes 2014).

Samples are to be collected and analysed in the following manner:

- Samples should be collected following a period of at least three days of dry weather, to ensure that sediments are settled and fine surface sediments have not been removed by high flows;
- Sediment samples should be collected from the surface at a depth of no greater than 3 centimetres of sediment, which reflects the most recently accumulated sediment;
- Sampling methods should be employed with the aim of ensuring capture of sufficient fine material (< 2 millimetres) for laboratory analyses;
- A single composite sample shall be collected from each site;
- Samples are to be collected by making multiple sweeps with a container across the stream bed to collect at least 5 subsamples, which are then composited into one sample;
- Water shall be drained off directly from the sample container or using a mesh sieve of less than 2 µm in size;
- Following sample collection at each site, all equipment must be washed thoroughly with water to remove all visible sediment, then rinsed with acid (10% HCl) to remove any metals adsorbed to the sampler and then rinsed thoroughly to remove all acid (Burton & Pitt 2002);
- Samples shall be placed in a chilly bin containing pre-chilled ice-bricks;
- Samples shall be transported to an IANZ accredited laboratory within 24 hours; any samples stored overnight shall be chilled in a refrigerator;
- A completed chain of custody form shall accompany all samples;

- Samples shall be analysed for the parameters listed in Table 6, using the most relevant USEPA methods (< 2 millimetres fraction to be used for analysis); detection limits for each parameter shall be suitable to enable comparison of the results with relevant guidelines for reporting purposes; and
- Polycyclic Aromatic Hydrocarbons should be normalised by 1% Total Organic Carbon in accordance with the relevant guideline methodology.
- Monitoring requirements are to be detailed in office and field guides that are to be followed by all field staff.
- Field data shall be captured electronically in the field using a data collection application such as ArcGIS Survey123. This is to ensure consistency and accuracy in data collection.

Table 6. Parameters to be analysed in waterway sediment samples

Parameter	Units of Measurement
Particle size distribution	-
Total recoverable copper, lead and zinc	mg/kg dry weight
Total Organic Carbon (TOC)	mg/kg dry weight
Total Phosphorus	mg/kg dry weight
Total Polycyclic Aromatic Hydrocarbons (PAHs)	mg/kg dry weight
Total Petroleum Hydrocarbons (TPH)11	mg/kg dry weight

6.5 Reporting

The annual monitoring report for the consent shall include a report on the instream sediment quality monitoring undertaken during the previous calendar years. This report shall include:

- An assessment of parameter concentrations at each site against the most relevant available guideline levels, such as ANZG (2018) to determine likely effects on the receiving environment due to sediment quality;
- Spatial comparisons of concentrations within and across catchments;
- Comparisons to historical data (using statistics where possible) to determine whether sediment quality is remaining stable, improving or declining;
- An assessment as to whether the Receiving Environment Objectives and Attribute Target Levels relating to sediment quality, as specified in Schedule 7 (Waterways) of the consent conditions, are being met;
- A discussion of likely reasons for any poor or declining sediment quality (i.e. whether there is the potential this could be due to stormwater inputs); and
- A discussion of contaminants of concern and sites/catchments with poor values that should be considered as priority areas for stormwater management.

[11] TPH data will be reviewed after 2 rounds of sampling at each site. The purpose of the review will be to assess the merits of continued TPH measurement.

7. Aquatic Ecology

7.1 Purpose for monitoring under this consent

The purpose of this monitoring is to (1) measure aquatic ecology values, which in part can be affected by stormwater discharges, (2) determine compliance with the conditions of the consent, (3) inform stormwater mitigation and (4) inform management of waterway health.

7.2 Background

The aquatic ecology of Christchurch's five main river catchments (Ōtākaro/ Avon River, Opāwaho/ Heathcote River, Huritini/ Halswell River, Pūharakekenui/ Styx River and Ōtūkaikino River) have been assessed by the CCC/Christchurch Drainage Board on one-off occasions during a number of events historically, and more recently on a regular five-yearly catchment rotation basis. In 2024, Banks Peninsula sites were sampled to inform the development of the Banks Peninsula SMP This new monitoring programme includes many of these past sites, as well as additional sites and receiving environments. These sites are typically distributed throughout the catchment and are not focussed on sites of high or low ecological value specifically. Sites within Banks Peninsula are only located within the stormwater management areas being authorised by the comprehensive discharge consent (i.e. within settlement areas).

7.3 Sampling Sites and Frequency

7.3.1 Monthly Fine Sediment Monitoring

A total of 17 sites within the waterways and coastal areas of Christchurch shall be monitored monthly (Figures 9 to 15; Appendix D). These sites have been included because they are waterways within the five main river catchments of Christchurch (Ōtākaro/ Avon River, Opāwaho/ Heathcote River, Huritini/ Halswell River, Pūharakekenui/ Styx River and Ōtūkaikino River) that are considered to be sensitive and/or influenced by stormwater. The location of one site is yet to be determined (OTUKAI07). Non-wadeable sites have been excluded due to the difficulties in sampling this environment and because these sites can naturally be soft-bottomed; it is noted that this metric is excluded for non-wadeable sites in the LWRP.

7.3.2 Annual Aquatic Ecology Monitoring

The annual aquatic ecology monitoring programme includes a total of 52 locations across the district, with 37 sites monitored by CCC and data from 15 sites that are monitored by ECan as part of their State of the Environment network. , Most of the CCC sites were previously sampled on a five-yearly basis, with the last round of five-yearly monitoring occurring in the Ōtākaro/ Avon River catchment in 2024. The change to annual monitoring was done to provide data that is more consistent with national recommendations (e.g., NEMS, 2020) and to better detect and respond to changes in aquatic ecosystem health over time.

7.3.3 Two-Yearly Kākahi Monitoring

A kākahi survey at one site in Cashmere Stream shall be carried out every two years during March – April (Figure 10; Appendix D). The first survey was undertaken in 2021 (Instream Consulting Limited, 2021). This frequency of monitoring is due to the amount of development currently occurring in the catchment, to allow a relatively frequent check of the health of the population. The March – April timing is to be comparable to previous surveys and to avoid the sensitive reproductive period of development and release of juveniles (glochidia), which may extend into February.

7.3.4 Five-Yearly Kākahi Monitoring

A kākahi survey shall be carried out in each of the five main river catchments in the city on a five-yearly basis (Figures 9; Appendix E).

7.4 Methods

7.4.1 Monthly Fine Sediment Monitoring

Fine sediment cover (< 2 mm; i.e. silt/sand) of the streambed shall be estimated monthly at each site. The sampling method to be used is adapted from (a) methods used by ECan (Rachel Webster, ECan, personal communication, August 2015) and (b) Sediment Assessment Method 2 from Clapcott et al (2011). These methods have been adapted to allow a relatively semi-quantitative assessment of each reach, without having to undertake lengthy, and therefore costly, investigations.

Fine sediment cover shall be assessed using the following method:

- The reach to be assessed shall be 30 metres in length where available, with the reach starting at the downstream coordinate for the site and continuing upstream from that point;
- The upstream and downstream extents of each reach shall be marked to ensure consistency between monitoring events;
- The entire reach should be transversed and ten estimates taken of fine sediment (< 2 mm) percent cover, with these estimates taken at roughly equidistant points, where possible;
- A bathyscope shall be used to assess the percent cover of fine sediments;
- The ten estimates shall encompass all habitat types within the wetted margin of the reach (i.e. pools, runs, riffles, backwaters);
- Estimates shall consist of only visible cover, not assumed cover (e.g. not assumed sediment under macrophytes);
- Sediment that settles thickly on macrophytes and other substrates should be included in the estimate;
- Each estimate should be rounded to the nearest 5%, with 1% recorded if a small amount of sediment is present and 0% recorded if no sediment is present;
- The overall percent cover value for the site shall be the median of the ten assessments;
- Where possible, observations should be conducted by the same observer across each site and each month, to ensure consistency in the sometimes subjective percent cover assessments; and
- Should the visibility not be favourable at the time of the scheduled sampling, the site is not required to be revisited for that month.
- Field data shall be captured electronically in the field using a data collection application such as ArcGIS Survey123. This is to ensure consistency and accuracy in data collection.

7.4.2 Annual Aquatic Ecology Monitoring

Monitoring requirements described in the following sections are detailed in office and field guides, that are to be followed by all staff involved. Monitoring undertaken by CCC will occur in January/February, to align with historic CCC monitoring (typically in March) and ECan monitoring (typically in December/January. Surveys will include assessments of habitat, periphyton, macrophytes and macroinvertebrates. From 2024, sampling methods were amended, with the main differences being simplified habitat sampling that is more aligned with national protocols, and cessation of fish monitoring in favour of an annual review of fishing records for the district

Monitoring will be timed to avoid major disturbances that are unrelated to CSNDC discharges. Thus, a 14 day stand down period of no sampling shall follow either: a) floods that result in substantial movement of the stream bed; or b) widespread macrophyte removal by CCC or other contractors. The latter will require ecology field staff to coordinate with members of CCC's land drainage team, who oversee CCC's waterway maintenance and macrophyte removal programme.

7.4.3 Habitat, Periphyton and Macrophytes

At each site, sampling shall be carried out over a 50 m length of waterway, as detailed in Table 7. Monitoring requirements are to be detailed in office and field guides that are to be followed by all field staff. In addition, field data shall be captured electronically in the field using a data collection application such as ArcGIS Survey123. This is to ensure consistency and accuracy in data collection. To ensure data is recorded consistently over time, all monitoring data will be entered into a database.

Table 7. Summary of habitat, macrophyte and periphyton data to be collected at aquatic ecology monitoring sites

Parameter	Method	
Habitat quality	Rapid Habitat Assessment (Clapcott, 2015).	
Macrophytes ((single, reach-wide measure of macrophyte cover and composition)	Emergent macrophyte composition & % cover Total macrophyte composition & % cover Species present and relative abundance	
Periphyton (single, reach-wide measure of periphyton cover and composition)	Composition % cover (modified from Biggs & Kilroy, 2000) - Thin mat forming algae (<0.5 mm thick) - Medium mat forming algae (0.5 – 3 mm thick) - Thick mat forming algae (>3 mm thick) - Short filamentous algae (<20 mm long) - Long filamentous algae (>20 mm long)	
Width, depth and velocity (single transect)	In a representative section of run habitat (preferably the same location every year), measure: Wetted width; plus depth and water velocity at five points across the transect.	
Flow composition (%) (site-wide assessment)	Still Backwater Pool Run	Riffle Rapid Cascade
Water permanence (site-wide assessment)	Ephemeral Intermittent	Perennial
Site Photographs	As a minimum: One taken from the downstream end of the reach looking upstream; and One taken from the upstream end of the reach looking downstream; and A representative image of the bed.	
Water chemistry (site-wide assessment)	Dissolved oxygen (% and mg/L) Temperature (°C)	pH Conductivity (µS/cm) Time of measurement

7.4.4 Macroinvertebrates

The aquatic benthic invertebrate community shall be assessed using the following methodology:

- One kicknet sample shall be taken at each site);
- Samples shall be collected using the semi-quantitative C1 (hard-bottomed streams) or C2 (soft-bottomed streams) protocols from Stark et al (2001);
- The decision of whether to use soft-bottomed or hard-bottomed protocols and associated MCI scores shall follow the recommendations of Clapcott et al. (2017).
- Samples shall be processed using Protocol P2 (200 Individual Fixed Count with scan for rare taxa) from Stark et al (2001);
- Taxa shall be identified to the level of taxonomic resolution as defined in Table A1.1 in Clapcott et al. (2017); and
- The following invertebrate indices shall be calculated in accordance with Stark & Maxted (2007), Collier (2008), and Clapcott et al. (2017):
    - Taxa richness
    - Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa richness and percent composition (% EPT)
    - Macroinvertebrate Community Index (MCI) and Quantitative MCI (QMCI)
    - Average Score Per Metric (ASPM)
- To ensure data is recorded consistently over time, all monitoring data will be entered into a database.

7.4.5 Fish

Fish communities throughout the district shall be summarised using results from the New Zealand freshwater fish database.

7.4.6 Two-Yearly and Five-Yearly Kākahi Monitoring

Quantitative sampling shall be carried out at the two-yearly monitoring site, using the following methods (Instream Consulting Limited, 2021; Instream Consulting Limited, 2023):

- Undertake the survey in March- April during baseflow
- Record any factors that may impact sampling efficiency;
- Use systematic sampling with multiple random starts using 0.25 m² quadrats placed at predetermined locations;
- The locations of the first three quadrats shall be selected at random from within a small starting area, using a random number generator. Each of these quadrats represents the beginning of a sampling unit called a ‘chain’, with each chain located three metres apart;
- Quadrats shall then be sampled at set intervals from the initial three quadrats, in all directions, filling the entirety of the sampling area;
- At least 200 quadrats shall be sampled over a stream length of approximately 100 metres;
- These predetermined quadrat locations shall be found in the field by running a tape along the full length of the survey area and a tape across the waterway;
- All kākahi observed on the bed of each quadrat shall be placed in a 5 millimetre mesh sieve – if the bed consists of fines (< 2 mm, sediment shall be extracted by hand to a depth of approximately 10 centimetre and put through the sieve;
- The total number of live kākahi and dead/empty kākahi shells shall be recorded per quadrat;
- At least the first 300 live kākahi per site shall have their lengths measured using Vernier callipers. Once 300 have been measured, all kākahi shall be measured for the remainder of the transect, to avoid sampling bias;
- Kākahi shall be returned to the bed hinge down at the quadrat location in which they were found; and
- Habitat measurements shall be carried out over the sampling reach, including, but not limited to:
    - Wetted width: at ten equidistant transects

- Depth and velocity: at five points across the waterway at five equidistant transects
- Velocity: measured at 40% of the water depth
- Percent shade (using a spherical densiometer), macrophyte cover and composition, and fine sediment cover: at five equidistant transects
- Substrate composition: 10 particles measured at each of five equidistant transects, giving a total of 50 particles

Qualitative rapid sampling shall be carried out at the CCC and ECan annual ecology monitoring sites, using the following methods (Instream Consulting Limited, 2021):

- Undertaking of survey during baseflow in March-April and, when possible, shortly after macrophyte removal, to enhance search efficiency;
- A single 30 minute timed search at each site, visually observing the full width of stream bed through bathyscopes, moving in an upstream direction;
- Recording of any factors that may impact search efficiency;
- Once a kākahi is located, its GPS location and the elapsed search time shall be recorded and then searches resumed for any remaining time;
- All kākahi observed during the 30 minute search shall be counted; and
- A rapid habitat assessment shall also be carried out (Clapcott, 2015).
- Data will be reviewed following the 2025 round of rapid sampling. All sites with kākahi will be subsequently monitored on a five-yearly basis, using the above rapid sampling method.

Reporting

A monitoring report shall be prepared that considers data collected within the district at the Sites listed in Appendix D by CCC and ECan. The annual monitoring report shall include:

- Methods, including a site map, site coordinates, and sampling dates;
- An assessment at each site against the most relevant indices and guideline levels (i.e. macroinvertebrate indices), where available, to determine habitat quality and ecological values;
- Spatial comparisons of habitat quality and ecological values within and across catchments;
- Comparisons to historical data (using statistics where possible) to determine whether habitat quality and ecological values are remaining stable, improving or declining;
- Analysis of spatial patterns and temporal trends in freshwater fish communities across the district;
- An assessment as to whether the Receiving Environment Objectives and Attribute Target Levels relating to aquatic ecology (QMCI, fine sediment cover, and total macrophyte and filamentous algae cover), as specified in Schedule 7 (Waterways) of the consent conditions, are being met, using the following approach;
    - LWRP classifications ('spring-fed – plains – urban', 'spring-fed – plains' and ‘Banks Peninsula’) for each site, and therefore the relevant Attribute Target Level, shall be in accordance with that detailed in Appendix D
    - The current state of macroinvertebrate communities shall be calculated as the five-year median score of the QMCI, MCI, and ASPM. The five-year median QMCI score will also be used for comparison against the QMCI Attribute Target level.
    - The five-year median for fine sediment cover, total macrophyte cover, and filamentous algae cover will be compared against their relative Attribute Target Levels.
    - Time trends in fine sediment cover and macroinvertebrate QMCI, MCI, and ASPM shall be assessed statistically, using the same approach for water quality described in Section 5.5.

- A discussion of likely reasons for any poor or declining habitat quality and ecological values (i.e. whether there is the potential this could be due to stormwater inputs); and

- A discussion of contaminants of concern and sites/catchments with poor values that should be considered as priority areas for stormwater management.

8. Mana Whenua Values

8.1 Purpose for monitoring under this consent

The purpose of this monitoring is to (1) measure mana whenua values, which in part can be affected by stormwater discharges, (2) determine compliance with the conditions of the consent, (3) inform stormwater mitigation and (4) inform management of waterway health. This monitoring covers general state of environment monitoring, so it is not possible to deduce specific effects of stormwater discharges.

8.2 Background

Cultural monitoring under this consent is based on the methodology and sites of the State of the Takiwā. 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). The major objective of State of the Takiwā is to enable tangata whenua to generate robust and defensible information on the health of the environment for a variety of purposes, including to inform recommendations for management (Pauling, 2004). The approach to data collection is a combination of field assessments measured against cultural criteria, and collection of supporting information on culturally relevant features of monitoring sites, including traditional use. The range of assessments attempts to capture key mana whenua values and indicators of environmental health, especially those important to mahinga kai (food gathering) and other cultural activities.

The following State of the Takiwā programmes have been undertaken within the Christchurch City Council jurisdiction:

- Ōtākaro and Ōpāwaho catchments in 2007 by Te Rūnanga o Ngāi Tahu, in-conjunction with members of Ngāi Tūāhuriri and Ngāti Wheke, for Environment Canterbury as part of the Healthy Estuary & Rivers of the City Monitoring Programme (Pauling et al, 2007);
- Ōtākaro and Ōpāwaho catchments in 2012 by Te Ngāi Tūāhuriri Rūnanga and Mahaanui Kurataiao Limited (MKT) (Lang et al, 2012); and
- Pūharakekenui in 2012 by Rūnanga roopu (monitoring team) in conjunction with MKT (Orchard & Lobb, 2013).

8.3 Sampling Sites and Frequency

Approximately 35 sites are to be sampled five-yearly in conjunction with the monitoring of surface water quality, instream sediment quality and aquatic ecology (Appendix D). The sites to be monitored are based on previous State of the Takiwā sites (Appendix D, Figures 9-10 and 12 and Table 8). Some of these sites overlap with other monitoring sites (e.g. instream sediment and aquatic ecology).

It is proposed to include an additional five sites each in waterways in the Huritini/ Halswell River, Ōtūkaikino River and Banks Peninsula, as well as a total of five coastal sites within Christchurch and Banks Peninsula. However, as State of the Takiwā assessments have predominantly not previously been undertaken in these catchments, these sites are yet to be confirmed. Two additional sites in the Heathcore will also be included, with the locations yet to be confirmed. The opportunity to overlap these additional sites with current ecological sites should be investigated, to ensure maximum collection of data, but it is acknowledged that none may overlap with areas of cultural importance and therefore new sites may be more appropriate. Site selection will be guided by MKT (sites located on Banks Peninsula) and Whitiora Centre Ltd (WCL) (for sites located in all other areas of the district) and local Papatipu Rūnanga, and sites will be selected prior to the first scheduled monitoring of the relevant catchments.

Monitoring will be undertaken concurrently with the aquatic ecology surveys, during March, to ensure no biases due to sampling during different seasons and this being the preferred time for ecological monitoring generally.

Table 8. Summary of the sites to be monitored for mana whenua values

And the reason It is proposed to include two additional sites within the Opāwaho/ Heathcote River catchment, and five sites each in the Huritini/ Halswell River and Banks Peninsula waterways, and five sites in total within coastal areas in Christchurch and Banks Peninsula. Site selection will be guided by Mahaanui Kurataiao Limited(sites located on Banks Peninsula) and Whitiora Centre Ltd (sites located in all other areas of the district) and local Papatipu Rūnanga, and sites will be selected prior to the first scheduled monitoring of the relevant catchments. Sites are to be located in areas subjected to stormwater discharges from the reticulated network.

Site ID	Location Description	Cultural Importance
AVON14	Ōruapaeroa/Travis Wetland	Traditional settlement and food gathering site, significant urban/rural drainage sink and native/natural wetland remnant
AVON15	Te Oranga/Horseshoe Lake	Traditional settlement and food gathering site, significant urban drainage sink and native/natural wetland/spring remnant
AVON16	Ōtākaro/Avon River downstream of Kilmore Street	Traditional settlement and food gathering site
AVON20	Ōtākaro/Avon River at Waipapa/Little Hagley Park	Traditional settlement and food gathering site, upper most main channel site
AVON24	Pūtarikamotu/Ilam Stream at Deans Bush	Traditional settlement and food gathering site, remaining native forest remnant, protected reserve
HEATH18	Ōpāwaho/Heathcote River at Garlands Road Bridge	Traditional settlement and food gathering site
HEATH23	Ōpāwaho/Heathcote River downstream of Colombo Street	Mid-catchment reference
HEATH06	Ōpāwaho/Heathcote River at Rose Street	Significant recreational area – public pool, soccer and cricket, as well as site of Kura Kaupapa Māori
STYX17	Styx River near the mouth of Te Riu O Te Aika Kawa/Brooklands Lagoon	Traditional mahinga kai site
STYX08	Pūharakekenui/Styx River at Kainga Road/Harbour Road Bridge	Mahinga kai, indigenous species
STYX18	Styx River at Spencerville Road	Traditional mahinga kai site
STYX07	Pūharakekenui/Styx River at Richards Bridge/Teapes Road	Mahinga kai, indigenous species
STYX06	Pūharakekenui/Styx River at Marshland Road Bridge	Mahinga kai, kanakana-lamprey spawning habitat, indigenous species
STYX09	Kā Pūtahi Creek at Ouruhia Reserve	Spring fed water (pure), mahinga kai, indigenous species
STYX04	Kā Pūtahi Creek at Blakes Road	Spring fed water (pure), mahinga kai,indigenous species

Site ID	Location Description	Cultural Importance
STYX19	Styx River at Styx River Conservation Reserve (portion between railway line and SH74)	Traditional mahinga kai site and reserve
OTUKAI12	Wilsons Drain at Ōtūkaikino wetland	Wāhi tapu site, remnant wetland
OTUKAI13	Ōtūkaikino River Downtream of Dickeys Road	Downstream site
OTUKAI14	Ōtūkaikino River downstream of Groynes Dog Park	Wai kōura previously found at this site
OTUKAI15	Ōtūkaikino River at Groynes Picnic Area 2a	Downstream of groynes weir
OTUKAI16	Ōtūkaikino River at Isaccs Conservation Park Walkway	Confluence of streams downstream of the Isaac conservation park. Significant riparian planting has been undertaken here.

8.4 Methods

A key part of this cultural monitoring is the involvement of tangata whenua in fieldwork and data collection. Monitoring will be carried out in conjunction with MKT and WCL, and will involve Papatipu Rūnanga representatives in field work and data collection. Monitoring teams need to be mandated/selected by the appropriate Papatipu Rūnanga, and can be made up of representatives from multiple rūnanga, particularly where a shared boundary is involved. It may also involve the contracting of relevant expertise to assist in the monitoring. Monitoring team members will normally discuss the key features and issues of each monitoring site collectively, before filling out the relevant forms individually.

Monitoring will include three State of the Takiwā monitoring methods: (1) takiwā general site assessment (waterway and coastal sites), (2) Cultural Health Index (CHI) assessment (waterway sites only), and (3) Marine Cultural Health Index (MCHI) assessment (coastal sites only) (Tipa & Tierney, 2003; Pauling, 2004; Pauling et al, 2007; Lang et al, 2012; Schweikert et al, 2012; McCarthy et al, 2013). The details of these methods are outlined below. The fishing component of the waterway monitoring will be undertaken by the ecologists involved in the aquatic ecology surveys. Fishing will be undertaken at a time when the cultural assessments are being undertaken, so the cultural assessors can be involved in the process. Where sites do not overlap with ecological monitoring, fishing only will be undertaken and not the full suite of monitoring typically undertaken at the ecology sites. The results of the ecological monitoring for all sites within the catchment being surveyed will also be made available to the cultural assessors as soon as practicable after completion, as this information may also be useful and complimentary to their assessments. No fishing is proposed to be undertaken at the coastal sites, given the difficulties in obtaining a representative survey in these environments and that this does not appear to be a requirement for the MCHI.

Where previous monitoring has been undertaken (e.g., Ōtākaro, Ōpāwaho and Pūharakekenui) information on cultural association and historical state/species is not necessary to repeat. However, where this has not been done, monitoring will involve an initial step of working with rūnanga to complete this ahead of undertaking assessments.

Cultural monitoring will be undertaken on a five-yearly catchment rotation basis, as per the surface water, instream sediment and aquatic ecology monitoring. The timeframe for this is detailed in Appendix E.

8.4.1 Takiwā General Site Assessment

The Takiwā general site assessment consists of three forms. The Site Definition Form records the site name, locality, traditional significance and traditional condition of the site amongst other details. The Site Visit Form records information on aspects of the monitoring visit, including the date, time, weather conditions, heritage/archaeological details, land use and other relevant information. The General Site Assessment Form includes questions addressing the health of the site in relation to the following categories:

- The amount of pressure from external factors;
- Levels of modification/change at the site;
- Suitability for harvesting of mahinga kai;
- Access issues;
- Willingness to return to the site;
- Overall state/health of the site; and
- Presence and abundance of culturally relevant species.

The information gathered from these forms is entered into the Takiwā 2.0 database and the index score for overall site health calculated. This index reflects the average score from nine individual assessments, all of which are a score on a one to five scale (Table 9).

8.4.2 Cultural Health Index Waterway Assessment

The Cultural Health Index (CHI) waterway assessment involves three aspects (Tipa & Tierney, 2003; Tipa & Tierney, 2006):

- Determination of whether site is of traditional or contemporary significance to Māori, assessed by the roopu based on feedback from whānau and kaumātua in particular;
- A mahinga kai assessment; and
- A cultural stream health assessment.

The mahinga kai and cultural stream health assessment consist of a series of questions to which scores of between 1 (poor quality/low values) and 5 (high quality/values) are assigned, and averaged to reflect the current condition of the site for these cultural aspects (Table 9).

8.4.3 Marine Cultural Health Index Assessment

The Marine Cultural Health Index was developed by Te Rūnanga o Ngāi Tahu in conjunction with the University of Otago (Schweikert et al, 2012) and provides an assessment tool that can be used in coastal sites to understand the ecological health of customary fishing areas and management. The MCHI toolkit is divided into four sections: (a) Key Cultural Indicators, (b) Habitat Threats & Quality Indicators, (c) Benchmark Questions and (d) Survey Results (Schweikert et al, 2012; McCarthy et al, 2013). The Key Cultural Indicators are scored on a 0 – 4 scale and include assessments of site contamination, the ability to get a feed, taste and condition of kai species, and replacement of kai (surveyors undertake this assessment on their most highly prized kai species). Assessments for Habitat Threats and Quality Indicators include water clarity, sedimentation, invasive species and presence of provision species. At the completion of the survey, data can be sent to Toitū Te Whenua for entry into the Ngāi Tahu State of the Takiwā database, where overall site assessments are archived and analysed.

Table 9. Summary of assessment parameters under the two cultural monitoring methods

Method	Assessment	Criteria scored from 1- 5
Takiwā General Site Assessment		➢ Site human pressure ➢ Site modification ➢ Harvest access ➢ Willingness to harvest ➢ Willingness to return for cultural use ➢ Overall health of the site ➢ % cover of indigenous plants ➢ Current versus traditional number of species ➢ A score based on the Takiwā Abundance Index, which assesses all introduced and native species present (e.g. plants, birds and fish)
Cultural Health Waterway Assessment	Mahinga kai assessment	➢ Abundance of mahinga kai species present at the site in relation to traditional abundance ➢ Ease of access ➢ Whether or not Maori would return to use the site in the future
	Cultural stream health assessment	➢ Water clarity ➢ Flow ➢ Catchment land use ➢ Marginal vegetation ➢ Riverbed sediments ➢ Water quality ➢ Variety of habitats ➢ Impression of overall health

8.5 Reporting

The annual monitoring report for the consent shall include a report on the mana whenua values monitoring undertaken during the previous calendar year. This report shall include:

- A summary of the assessment scores and observations;
- Spatial comparisons within and across catchments;
- Temporal comparisons against previous studies, where available, to determine if values are remaining stable, improving or declining;
- An assessment of whether the Receiving Environment Objectives and Attribute Target Levels relating to mana whenua values (Waterway Cultural Health Index, Marine Cultural Health Index, and State of Takiwā scores), as specified in Schedules 7 (Waterways) and 8 (Coastal Waters) of the consent conditions, are being met. This shall be established by averaging Waterway Cultural Health Index/Marine Cultural Health Index and State of Takiwā scores and comparing this to an Attribute Target Level of 5 for all sites
- A discussion of likely reasons for any poor or declining values (i.e. whether there is the potential this could be due to stormwater inputs); and
- A discussion of contaminants of concern and sites/catchments with poor values that should be considered as priority areas for stormwater management.

9. EMP Reporting

In accordance with the conditions of the consent, a monitoring report is required to be submitted to the Canterbury Regional Council and stakeholders by the 30th of June each year. This report shall include the following:

- Detailed monitoring reports for each of the following aspects, which incorporate the reporting requirements detailed in the respective sections of this monitoring report:
    - Groundwater
    - Surface water levels and flows, sea level and rainfall depth
    - Surface water quality
    - Instream sediment quality
    - Aquatic ecology
    - Mana whenua values
- An holistic assessment of surface water quality, instream sediment quality, aquatic ecology and mana whenua values monitoring, to determine causes, relationships and trends, as far as is possible;
- A discussion of likely reasons for any poor results or declining trends (i.e. whether there is the potential this could be due to stormwater inputs);
- A discussion of contaminants of concern and sites/catchments with poor values that should be considered as priority areas for stormwater management;
- A summary of whether the Receiving Environment Objectives and Attribute Target Levels of the consent were met. With regards to the TSS water quality guidelines for tidal waterway and coastal sites detailed in Table 5, these guidelines are not official regional or national guidelines. They have instead been developed between ECan and CCC scientists to allow the calculation of a Water Quality Index to compare water quality between sites. As such, these guidelines shall not be used to assess against Attribute Target Levels for compliance purposes; and
- Responses to monitoring (in accordance with the conditions of the consent).

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Appendix A: Soil Quality Monitoring Sites

Table i. Soil sampling monitoring of stormwater devices. Cu = total recoverable copper; Zn = total recoverable zinc; Pb = total recoverable lead; As = total recoverable arsenic; Cd = total recoverable cadmium; Cr = total recoverable chromium; Ni = total recoverable nickel; PAH = Polycyclic Aromatic Hydrocarbons; SVOC = Semi-Volatile Organic Compounds.

Site	Type of System	Land Use	Year System Constructed	Metals	PAHs	SVOCs	Previous Sampling	Easting	Northing
Denton Park	Soakage basin	Residential	1997	✓ Cu, Zn, Pb	✓		2010 (IGSC)	2471174	5740565
Beckenham Library	Detention swale	Car park	2005	✓ Cu, Zn, Pb	✓		2010 (IGSC)	2480757	5738373
Tumara Park	Infiltration and detention	Large residential	2003	✓ Cu, Zn, Pb	✓		2010 (IGSC)	2484754	5747875
Hornby Industrial Park	Infiltration basin	Residential	1995	✓ Cu, Zn, Pb, As, Cd, Cr, Ni	✓	✓	2010 (IGSC)	2470426	5739650
Richmond Housing Complex	Swale and first flush basin	High density housing	2007	✓ Cu, Zn, Pb	✓		2010 (IGSC)	2482302	5743028
Grove Road	Rain garden	Commercial	TBA	✓ Cu, Zn, Pb	✓		None	2479132	5740733

Appendix B : Groundwater level station details

Station details		
Number	Name	Start of record
3245014	Roydvale Ave	06-Oct-77
3245015	Fairford St (opp Oldwood)	19-Dec-88
3246004	PS62, Tyrone Street	05-Jun-84
3246005	Dartford St, Brooklands	21-Jul-81
3246006	Lower Styx Track Burwood Forest	11-Mar-91
3246007	Mairehau Rd, near Greenhaven	07-Mar-97
3246016	Marshland Domain	07-Mar-97
3246018	QEII Drive (away) #2 Drain	24-May-99
3247004	No.134 Inwoods Road	12-Nov-84
3255007	Kirkwood Intermediate School	06-Jan-67
3255009	Halswell Ret.Basin, Halswell Jnt	11-Oct-77
3255011	Cashmere/Kennedys Road	11-Sep-00
3255012	Cashmere Road	11-Sep-00
3255013	Halswell Road PS	05-Jun-84
3255015	Hendersons Road	11-Sep-00
3255016	Milns/Sparks Road	13-Apr-92
3255017	Whincops Road	13-Apr-92
3255018	Hodgens Road	13-Apr-92
3255019	Quarry Carpark No.2	16-Jun-98
3255042	Wigram Road near Haytons	10-Dec-13
3256014	Fisher Ave/Norwood Street	20-Apr-92
3256016	Gould Crescent, Woolston	07-Aug-78
3256017	PS42, Sparks Road	07-Jul-69
3256018	PS20, Locarno Street	03-Jun-59
3256034	PS1, Woodham Road	03-Jun-59
3257024	Ruru Road, Bexley	10-Mar-86
3257031	Cnr Wakefield and Nayland, Sumner	08-Aug-19

Appendix C : Stormwater Basin Monitoring Requirements

Catchment	Site	Water level and electrical conductivity	Quarterly water quality	Wet-weather monitoring	Easting (NZTM)	Northing (NZTM)	Monitoring bore
Styx/ Pūharakekenui	Englefield Basin	Yes	Yes*	Yes*	1569308	5187649	Monitoring bore needs to be installed.
Ōtukaikino	Outlook Basins	Yes	Yes*	Yes*	1565835	5187649	Bore missing , new bore needed
Heathcote/ Ōpāwaho	Kakapo Basin	Yes	Yes*	Yes*	1562815	5180116	Bore 5#
Heathcote/ Ōpāwaho	Awatea South Basin	Yes	Yes*	Yes*	1562985	5177067	Bore 1#
Halswell/ Huritini	Shands Road/ Establishment Drive Basin	Yes	Yes*	Yes*	1562985	5177359	Monitoring bore needs to be installed.
Halswell/ Huritini	Carrs Road Basin	Yes	Yes*	Yes*	1563697	5176577	Monitoring bore needs to be installed.
* Shall be undertaken at the six basins each year# No ECan well number, for bore location refer to AECOM (2022) Stormwater Basin Environmental Investigation (Comprehensive Stormwater Network Discharge Consent (CRC190445)). Report prepared for Christchurch City Council.							

Appendix D: Surface Water, Instream Sediment, Aquatic Ecology and Mana Whenua Values Monitoring Sites

Table i. Water quality, deposited sediment, sediment quality, aquatic ecology, kākahi, and mana whenua monitoring sites. Waterway classifications are as per the Canterbury Land and Water Regional Plan:SFP = Spring-fed plains; SFP-U = Spring-fed plains – urban; BP = Banks Peninsula. Coastal environment classifications are as per the Canterbury Regional Coastal Environment Plan.TBC = To Be Confirmed. ECan = sites monitored by Environment Canterbury.

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Ōtākaro/Avon River	AVON02	Avon River at Bridge Street	Yes		Yes				1577691	5180813	SFP-U
Waterway	Ōtākaro/Avon River	AVON03	Avon River at Dallington Terrace/Gayhurst Road	Yes		Yes				1573560	5181210	SFP-U
Waterway	Ōtākaro/Avon River	AVON04	Avon River at Manchester Street	Yes		Yes				1570890	5180481	SFP-U
Waterway	Ōtākaro/Avon River	AVON05	Wairarapa Stream downstream of Fendalton Road	Yes		Yes	Yes			1568250	5181303	SFP-U
Waterway	Ōtākaro/Avon River	AVON06	Waimairi Stream downstream of railway bridge	Yes		Yes	Yes			1568233	5181172	SFP-U
Waterway	Ōtākaro/Avon River	AVON07	Avon River at Mona Vale	Yes		Yes				1568334	5181046	SFP-U
Waterway	Ōtākaro/Avon River	AVON08	Riccarton Main Drain	Yes	Yes		Yes			1568683	5180019	SFP-U
Waterway	Ōtākaro/Avon River	AVON09	Addington Brook	Yes	Yes	Yes	Yes			1569427	5179826	SFP-U

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Ōtākaro/Avon River	AVON10	Dudley Creek	Yes	Yes	Yes				1572574	5182150	SFP-U
Waterway	Ōtākaro/Avon River	AVON28 / SQ00063	Dudley Creek at Banks Ave and North Parade Road				ECan			1572819	5182465	SFP-U
Waterway	Ōtākaro/Avon River	AVON11	Horseshoe Lake Discharge	Yes						1574342	5183294	SFP-U
Waterway	Ōtākaro/Avon River	AVON12	Avon River at Carlton Mill Corner	Yes	Yes	Yes	Yes			1569737	5181259	SFP-U
Waterway	Ōtākaro/Avon River	AVON13	Avon River at Avondale Road	Yes		Yes				1574752	5183557	SFP-U
Waterway	Ōtākaro/Avon River	AVON14	Ōruapaeroa/Travis Wetland						Yes	1575535	5185269	SFP-U
Waterway	Ōtākaro/Avon River	AVON15	Te Oranga/Horseshoe Lake						Yes	1574035	5183994	SFP-U
Waterway	Ōtākaro/Avon River	AVON16	Avon River downstream of Kilmore Street			Yes	Yes		Yes	1571260	5180717	SFP-U
Waterway	Ōtākaro/Avon River	AVON17 / SQ00128	Avon River at Victoria Square near Armagh Street			Yes	ECan			1570498	5180473	SFP-U
Waterway	Ōtākaro/Avon River	AVON20	Avon River at Waipapa/Little Hagley Park						Yes	1571109	5180591	SFP-U
Waterway	Ōtākaro/Avon River	AVON21	Avon River downstream of Mona Vale Loop				Yes			1568634	5180880	SFP-U
Waterway	Ōtākaro/Avon River	AVON22 / SQ00130	Waimairi Stream at Fendalton Park			Yes	ECan			1567033	5181168	SFP-U
Waterway	Ōtākaro/Avon River	AVON23	Wairarapa Stream Upstream of Glandovey Road			Yes	Yes			1567225	5181608	SFP-U
Waterway	Ōtākaro/Avon River	AVON24	Pūtarikamotu/Ilam Stream at Deans Bush						Yes	1567428	5180681	SFP-U
Waterway	Ōtākaro/Avon River	AVON27 / SQ00129	Avon River at UCSA			Yes	ECan			1566173	5180855	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH01	Heathcote River at Ferrymead Bridge	Yes		Yes				1576491	5177150	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH03	Heathcote River at Opawa Road/Clarendon Terrace	Yes						1573071	5177615	SFP-U

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Ōpāwaho/Heathcote River	HEATH04	Heathcote River at Bowenvale Ave	Yes						1571198	5175780	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH05	Cashmere Stream at Worsleys Road	Yes		Yes		Yes		1569030	5175155	BP
Waterway	Ōpāwaho/Heathcote River	HEATH06	Heathcote River at Rose Street	Yes	Yes	Yes	Yes		Yes	1568701	5175918	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH07	Heathcote River at Ferniehurst Street	Yes	Yes	Yes				1569157	5175612	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH09	Hayton Stream at Retention Basin	Yes		Yes				1566020	5177596	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH10	Curletts Road Stream upstream of Heathcote River confluence	Yes	Yes	Yes				1566928	5177711	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH11	Heathcote River at Catherine Street	Yes		Yes				1574413	5177883	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH12	Heathcote River at Mackenzie Avenue Footbridge	Yes		Yes				1573520	5177917	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH14	Curletts Road Stream at Southern Motorway	Yes		Yes				1566405	5178358	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH16	Cashmere Stream at Sutherlands Road	Yes		Yes	Yes			1566086	5173988	BP
Waterway	Ōpāwaho/Heathcote River	HEATH17	Steamwharf Stream upstream of Dyers Road	Yes		Yes	Yes			1575049	5177794	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH18	Ōpāwaho/Heathcote River at Garlands Road Bridge						Yes	TBC	TBC	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH22	Heathcote River downstream of Tennyson Street			Yes	Yes			1571519	5177234	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH23	Heathcote River downstream of Colombo Street						Yes	1570841	5176863	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH24	Heathcote River downstream of Barrington Street			Yes	Yes			1570159	5176181	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH25	Cashmere Brook at Ashgrove Terrace			Yes	Yes			1570258	5176354	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH26	Cashmere Stream at Penruddock Rise	Yes		Yes	Yes			1567915	5175090	BP

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Ōpāwaho/Heathcote River	HEATH27	Cashmere Stream, Behind 406 Cashmere Road (downstream of stormwater discharge)		Yes					1567453	5174866	BP
Waterway	Ōpāwaho/Heathcote River	HEATH29	Heathcote River downstream of Spreydon Domain			Yes				1567973	5177163	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH30	Heathcote River at Canterbury Park/Showgrounds			Yes	Yes			1566515	5177439	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH31	Heathcote River at Warren Crescent	Yes	Yes	Yes	Yes			1566034	5177359	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH32 / SQ00647	Heathcote River at Waimea Terrace			Yes	ECan			1570886	5176371	SFP-U
Waterway	Ōpāwaho/Heathcote River	HEATH33 / SQ00141	Heathcote River at Curletts Road				ECan			1566944	5177706	SFP-U
Waterway	Pūharakekenui/Styx River	STYX01	Smacks Creek at Gardiners Road near Styx Mill Road	Yes		Yes	Yes			1566804	5187956	SFP-U
Waterway	Pūharakekenui/Styx River	STYX02	Styx River at Gardiners Road	Yes		Yes	Yes			1566790	5187226	SFP-U
Waterway	Pūharakekenui/Styx River	STYX03	Styx River at Main North Road	Yes	Yes	Yes	Yes			1569066	5187219	SFP-U
Waterway	Pūharakekenui/Styx River	STYX04	Ka Putahi Creek at Blakes Road	Yes	Yes	Yes			Yes	1570401	5188030	SFP-U
Waterway	Pūharakekenui/Styx River	STYX05	Ka Putahi Creek at Belfast Road	Yes		Yes				1572194	5188267	SFP
Waterway	Pūharakekenui/Styx River	STYX22 / SQ30305	Ka Putahi Creek at Belfast Road (ECan)				ECan			1570849	5188905	SFP-U
Waterway	Pūharakekenui/Styx River	STYX06	Styx River at Marshland Road Bridge	Yes		Yes			Yes	1572358	5187778	SFP
Waterway	Pūharakekenui/Styx River	STYX07	Styx River at Richards Bridge/Teapes Road	Yes		Yes			Yes	1573975	5189640	SFP
Waterway	Pūharakekenui/Styx River	STYX08	Styx River at Kainga Road/Harbour Road Bridge	Yes		Yes			Yes	1574998	5194749	SFP
Waterway	Pūharakekenui/Styx River	STYX09	Ka Putahi Creek at Ouruhia Reserve		Yes	Yes	Yes		Yes	1571754	5190116	SFP
Waterway	Pūharakekenui/Styx River	STYX10	Ka Putahi Creek between Blakes and Belfast Roads				Yes			1570942	5188112	SFP-U

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Pūharakekenui/Styx River	STYX11	Horners Drain at Hawkins Road				Yes			1571292	5186787	SFP
Waterway	Pūharakekenui/Styx River	STYX12	Styx River at Styx Mill Conservation Reserve		Yes					1568252	5187755	SFP-U
Waterway	Pūharakekenui/Styx River	STYX17	Styx River near the mouth of Te Riu O Te Aika Kawa/Brooklands Lagoon						Yes	1575833	5195103	SFP
Waterway	Pūharakekenui/Styx River	STYX18	Styx River at Spencerville Road						Yes	1574937	5191544	SFP
Waterway	Pūharakekenui/Styx River	STYX19	Styx River at Styx River Conservation Reserve						Yes	1569721	5187495	SFP
Waterway	Pūharakekenui/Styx River	STYX20	Styx Drain upstream of Styx Mill Road	Yes		Yes	Yes			1568084	5187163	SFP-U
Waterway	Pūharakekenui/Styx River	STYX21 / SQ00035	Styx River at Styx Mill Reserve			Yes	ECan			1567931	5187736	SFP-U
Waterway	Huritini/Halswell River	HALS03	Nottingham Stream at Candys Road	Yes	Yes	Yes	Yes			1564532	5173080	SFP-U
Waterway	Huritini/Halswell River	HALS05	Knights Stream at Sabys Road	Yes	Yes	Yes	Yes			1563723	5172852	SFP-U
Waterway	Huritini/Halswell River	HALS07	Halswell River at Wroots/Halswell Roads	Yes		Yes	Yes			1564359	5172477	SFP-U
Waterway	Huritini/Halswell River	HALS08	Creamery Stream downstream of Sabys Road			Yes	Yes			1564275	5173204	SFP-U
Waterway	Huritini/Halswell River	HALS09	Cases Drain upstream of Downies Road			Yes	Yes			1563622	5173605	SFP-U
Waterway	Huritini/Halswell River	HALS10	Knights Stream upstream of Whincops Road			Yes	Yes			1562637	5174486	SFP-U
Waterway	Ōtūkaikino River	OTUKAI01	Otukaikino River at Groynes Inlet	Yes	Yes	Yes				1567878	5188869	SFP
Waterway	Ōtūkaikino River	OTUKAI02	Wilsons Drain at Main North Road	Yes		Yes	Yes			1571241	5190793	SFP
Waterway	Ōtūkaikino River	OTUKAI03	Otukaikino Creek at Omaka Scout Camp	Yes	Yes	Yes	Yes			1565664	5188038	SFP
Waterway	Ōtūkaikino River	OTUKAI17 / SQ30445	Otukaikino River upstream of Dickeys Road (ECan)				ECan			1570432	5190741	SFP

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Ōtūkaikino River	OTUKAI05	Kaikanui Creek downstream of Clearwater Resort				Yes			1568147	5190382	SFP
Waterway	Ōtūkaikino River	OTUKAI06	Wilsons Drain at Tyrone Street			Yes	Yes			1570719	5189928	SFP
Waterway	Ōtūkaikino River	OTUKAI09	Otukaikino River at Clearwater Resort			Yes	Yes			1566945	5189419	SFP
Waterway	Ōtūkaikino River	OTUKAI12	Wilsons Drain at Otukaikino Wetland						Yes	1571288	5190917	SFP
Waterway	Ōtūkaikino River	OTUKAI13	Otukaikino River downstream of Dickeys Road	Yes					Yes	1570444	5190767	SFP
Waterway	Ōtūkaikino River	OTUKAI14	Otukaikino River downstream of Groynes Dog Park						Yes	1569190	5190545	SFP
Waterway	Ōtūkaikino River	OTUKAI15	Otukaikino River at Groynes Picnic Area 2a						Yes	1568376	5189496	SFP
Waterway	Ōtūkaikino River	OTUKAI16	Otukaikino River at Isaacs Conservation Park Walkway						Yes	1566276	5188884	SFP
Waterway	Linwood Canal/City Outfall Drain	OUT01	Linwood Canal/City Outfall Drain at Humphreys Drive	Yes						1575952	5178026	SFP-U
Waterway	Linwood Canal/City Outfall Drain	OUT02	Linwood Canal/City Outfall Drain at Dyers Road			Yes	Yes			1575371	5178443	SFP-U
Waterway	Charlesworth Drain	CH1	Charlesworth Drain near mouth	Yes						1576530	5178373	SFP-U
Waterway	Stream Reserve Drain/Zephyr Stream (Governors Bay)	BP01	Stream Reserve Drain above Outfall to Governors Bay	Yes		Yes	Yes			1572035	5170197	BP
Waterway	Balguerie Stream (Akaroa)	BP03 / SQ00170	Balguerie Stream downstream of Settlers Hill (Road)	Yes		Yes	ECan			1597748	5149578	BP
Waterway	Balguerie Stream (Akaroa)	BP07 / SQ00684	Balguerie Stream at Stoney Bay Road				ECan			1598639	5148907	BP
Waterway	Aylmers Stream (Akaroa)	BP04	Aylmers Stream downstream of Rue Jolie, next to Bruce Terrace	Yes		Yes				1596920	5149096	BP
Waterway	Aylmers Stream (Akaroa)	BP05 / SQ30707	Aylmers Stream opposite Aubrey St				ECan			1596905	5149194	BP
Waterway	Aylmers Stream (Akaroa)	BP06 / SQ00491	Aylmers Stream at Aylmers Valley Road				ECan			1597508	5147858	BP

Environment	Catchment	Site ID	Location	Monthly Water Quality	Monthly Deposited Sediment	Two-yearly Sediment Quality	Annual Ecology	Two-yearly Kakahi	Five-yearly Mana Whenua	Easting (NZTM)	Northing (NZTM)	Classification
Waterway	Okana River	BP08 / SQ00137	Hukahuka Turoa Stream at Port Levy Road				ECan			1583686	5155972	BP
Waterway	Okana River	BP09 / SQ33056	Okana River upstream of SH75				ECan			1583644	5154210	BP
Coastal	Ihutai/Avon-Heathcote Estuary	CW01	Estuary of the Heathcote and Avon Rivers/Ihutai at the eastern tip by Beachville Road	Yes						1579001	5176882	Coastal Contact Recreation Water
Coastal	The operational area of the Port of Lyttelton	CW02	Lyttelton Port at the small wharf opposite Voelas Road	Yes						1576834	5172004	Coastal Aquatic Ecology Water
Coastal	Cass Bay	CW03	Eastern side of Cass Bay off the Cass Bay Walkway	Yes						1575236	5171897	Coastal Contact Recreation Water
Coastal	Akaroa Harbour	CW04	Akaroa Harbour at the termination of Rue Balguerie	Yes						1597257	5149806	Coastal Shellfish Gathering Water

Appendix E: Kākahi and Mana Whenua Values Monitoring Schedule

Table i. Five-yearly rotational monitoring schedule kākahi and mana whenua values) for waterway and coastal sites, within Christchurch and Banks Peninsula

Catchment	Next Survey Due
Opāwaho/ Heathcote River Linwood Canal Banks Peninsula	2025
Huritini/ Halswell River	2026
Ōtūkaikino River Coastal Waters	2027
Pūharakekenui/ Styx River	2028
Ōtākaro/ Avon River	2029