Integrated Catchment Management Plan

for South-West Christchurch

May 2008

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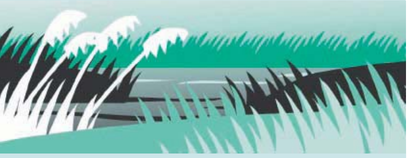

Integrated Catchment Management Plan for South-West Christchurch

On behalf of

Christchurch City Council

Prepared by

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Executive Summary

The Integrated Catchment Management Plan (ICMP) is a foundation document to the South-West Area Plan (SWAP), which is being developed concurrently. The SWAP will assess and make recommendations regarding any future urban development of South-West Christchurch, and will form the basis for any zone changes to the City Plan. The ICMP will not determine future land use; rather, it will address how surface water management will respond to any future land use changes.

Existing surface water and groundwater quantity has been assessed, and has been identified as a major issue within South-West Christchurch due to existing flood issues in both the Heathcote and Halswell rivers. The sensitivities and effects of inundation of Henderson's Basin on private land owners is also a key concern.

The preliminary surface water management scheme provides a conservative level of mitigation, and is predicted to reduce flood levels to below 2002 levels. Past adverse effects relating to the period from 1991 to 2002 are addressed by either retro-fitting mitigation to some existing areas, or using compensatory storage in one area to mitigate effects from other areas. Overall, it is considered that a significant amount of existing development has been mitigated by the proposed preliminary surface water management scheme.

The present Christchurch City Council design standards for rainfall intensity provide a margin of safety for increases due to climate change. However, the final design of structures and any review of this plan should review the impact of climate change using the latest available information.

The assessment of groundwater predicts a net increase in groundwater recharge of four percent across the entire study site as a result of the infiltration and soakage systems identified in the preliminary surface water management scheme. No adverse effects on springs and baseflow are predicted. The changes in groundwater levels (i.e. mounding) as a result of the installation of infiltration basins has been determined to be localised around the immediate extent of the infiltration basins.

Receiving environment waterways have been identified and classified in terms of their importance and ability to be protected. Each class of receiving environment and non-receiving environment waterways have had a number of water quality (and ecological) objectives identified. Groundwater has also had a number of water quality objectives identified.

A comprehensive assessment of treatment systems and mitigation options has been carried out. The recommended option (Option 8) to be adopted as part of the mitigation strategy involves the use of soakage basins, where suitable soakage conditions exist, and sedimentation basins followed by wetlands (or wet ponds). Option 8 also provides for other values, such as recreation, ecology, landscape, and culture, and is more consistent with the Christchurch City Council's Natural Asset Management Strategy and other policies. Option 8 is predicted to meet the United States Environmental Protection Agency (USEPA) criteria at key receiving environment waterways. The mitigation strategy is also recommended to include the provision of flexibility to allow for additional measures or systems to be inserted into the treatment train to cater for any unexpected water quality results, and in particular for high risk industrial sites. The option of using filtration systems capable of removing high levels of metals (dissolved and total fractions) is recommended in these circumstances.

Predicted changes in groundwater quality following the proposed mitigation are limited to shallow localised areas immediately around soil adsorption basins. The overall changes to groundwater quality are considered no more than minor and are not expected to impact the community drinking water wells. Therefore, the water quality of springs contributing to surface waterway base and low flows is not expected to change significantly.

The performance of the proposed mitigation will be measured against the receiving environment objectives by monitoring water quality and ecology within Class 1 receiving environment waterways. The strategy will also include a review provision to keep up to date with science and to respond to monitoring results.

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Document Quality Assurance

This report has been prepared in accordance with Kingett Mitchell quality assurance procedures. All relevant quality control information in relation to biological and/or environmental data is identified within the document. The report has been reviewed and is approved for release as set out below.

	Name	Signature
Project Manager	**Paul May**	
Project Reviewer	**Mike Fitzpatrick**	
Director approval for release	**Roger Cudmore**	

Christchurch City Council Adoption

This Integrated Catchment Management Plan has been adopted in accordance with Christchurch City Council approval procedures. The adoption of the Integrated Catchment Management Plan by Christchurch City council is an endorsement and commitment to managing the South-West Christchurch catchments as outlined in this plan, including the implementation of mitigation and long term monitoring.

	Name	Signature
Programme Manager	**Jenny Ridgen**	

1. Introduction

1.1 Purpose

This Integrated Catchment Management Plan (ICMP) has been prepared by Golder Associates (NZ) Limited, in association with the Christchurch City Council. The purpose of the ICMP is to outline the integrated management of stormwater in South-West Christchurch. The ICMP will accompany an assessment of environmental effects (AEE) report which will be submitted as part of a resource consent application for the discharges of stormwater in South-West Christchurch.

The ICMP is one of the foundation documents to the South-West Christchurch Area Plan (SWAP). The SWAP takes a very broad and long term (35 years) view of urban development possibilities in the south-west area and will provide a framework for managing the effects of land use change.

Prior to this report, Christchurch City Council and contracted consultants have carried out a large number of comprehensive investigations. These investigations have been summarised and incorporated into this ICMP. Table 1.1 identifies the investigations carried out and acknowledges the organisations involved.

Table 1.1: Background documents relating to South-West Christchurch.

Report	Organisation
Pilot Study Stage One, South-West Christchurch ICMP Technical Report No. 1	Kingett Mitchell Limited and Pattle Delamore Partners Limited (Groundwater Appendix)
Sediment Quality Survey, South-West Christchurch ICMP Technical Report No. 2	Kingett Mitchell Limited
Aquatic Values and Management, South-West Christchurch ICMP Technical Report No. 3	Aquatic Ecology Ltd, EOS Ecology Ltd and Kingett Mitchell Limited
Water Quantity Assessment and Management, South-West Christchurch ICMP Technical Report No. 4	Kingett Mitchell Limited, Christchurch City Council, Pattle Delamore Partners Limited (Groundwater Appendices) and NIWA (Surface Water Modelling Appendices)
Water Quality Assessment and Management, South-West Christchurch ICMP Technical Report No. 5	Kingett Mitchell Limited, Pattle Delamore Partners Limited (Groundwater Appendices)
Phase 1 Ground and Surface Water Management	Christchurch City Council
Phase 1 Land Use	Christchurch City Council
Phase 1 Natural Values	Christchurch City Council
Phase 1 Economic Issues, Constraints, Culture & Heritage	Christchurch City Council
Phase 1 Recreational Open Space	Christchurch City Council
Phase 1 Water Supply and Wastewater	Christchurch City Council
Phase 1 Transportation	Christchurch City Council

1.2 Waterway Management in Christchurch City

Christchurch is characterised by more than 360 km of open waterways and over 50 wetlands. In recent years, the Christchurch City Council has changed the philosophy for managing these waterways and wetlands. Today's philosophy focuses on incorporating knowledge from a wide range of disciplines to restore and maintain the values that communities place on waterways. These values have been identified as ecology, landscape, recreation, heritage, culture, and drainage.

The change in management philosophy involves a major shift away from the former single-focus approach of drainage utility, to one that demands a much greater knowledge and awareness of the inter-relationship between land and water. Christchurch City Council is also working closely Environment Canterbury (ECan), and with Tangata Whenua.

The Waterways and Wetlands Natural Asset Management Strategy (CCC 1999) divided the city into 14 project areas according to land use, community characteristics, and the relationship between land and water environments to help achieve integrated planning. Long term visions were developed for each area in consultation with local communities, and the anticipated cost of these visions determined the budgets required to protect, restore, and maintain waterways and wetlands for the next 40 years.

ICMP represents the response to changes in legislation increasing consent requirements and greater environmental awareness. The introduction of ICMP represents a significant raising of the bar in terms of understanding of key environment values and issues within catchments. The ICMP is one of the foundation documents of the Area Plan, which is being prepared for South-West Christchurch to provide a framework for managing urban growth. The ICMP is intended to precede and advise (or direct) any further urban re-zonings.

1.3 What is an Integrated Catchment Management Plan?

The purpose of an ICMP is to demonstrate how a catchment will be managed and protected, and how possible degraded waterways could be enhanced in response to past and potential future effects of land use change (such as urban development). Human activities and developments can impact on surface water resources through changing drainage patterns, confinement of waterway corridors, and the introduction of contaminants. This can, in turn, increase the risks of flooding, reduce the aquatic value of a waterway, pose threats to human health, and even change the appearance of a waterway.

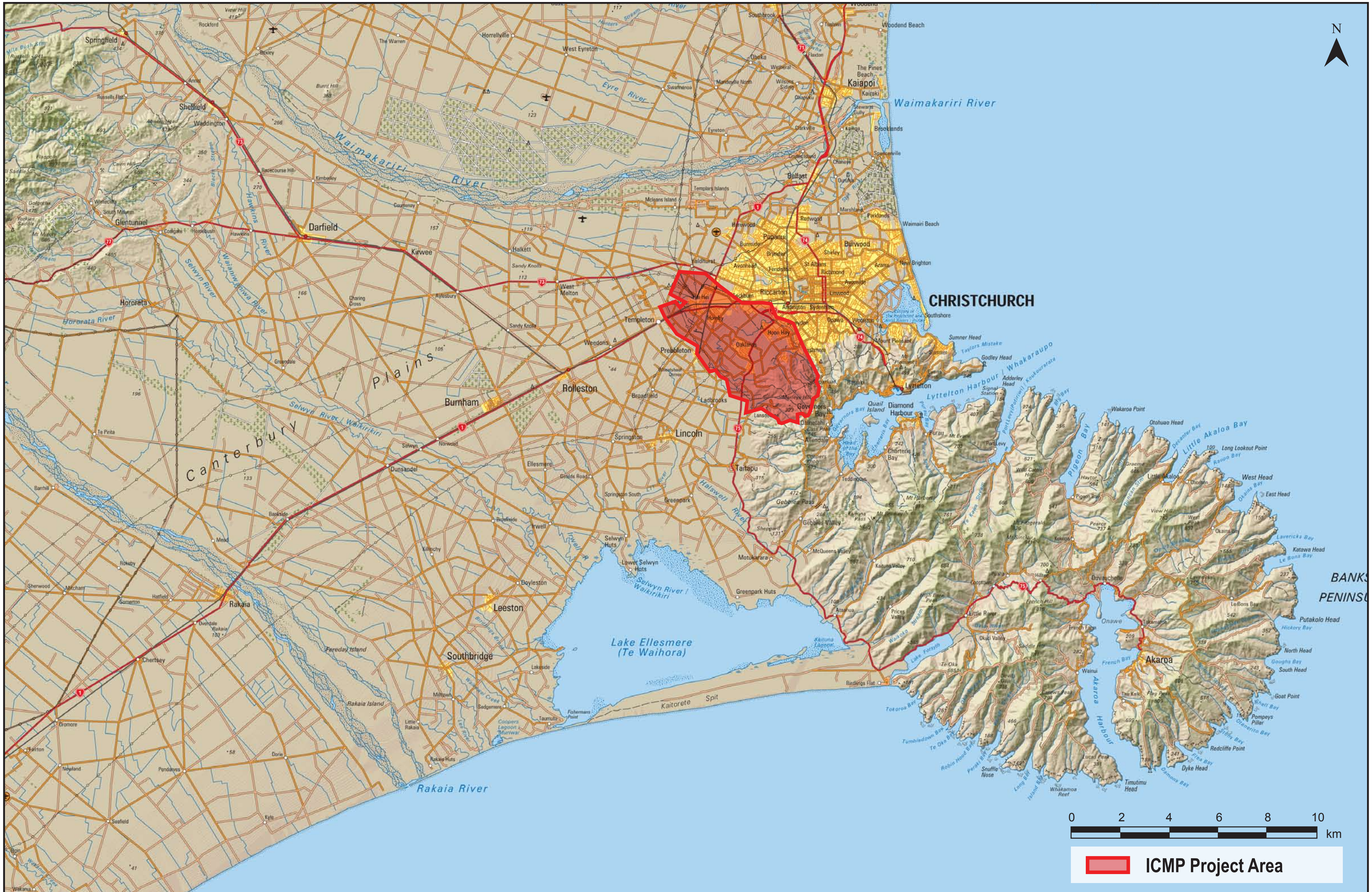
The term **'integrated'** is used because an ICMP integrates the available knowledge of catchment hydrology, engineering, ecology, and public health with community knowledge and expectations. The ICMP gives consideration not only to surface and groundwater management, but also to other natural and physical resource issues including ecology, recreation and open space, landscape, heritage, and cultural values.

A **'catchment'** approach ensures that the cumulative effects arising from all activities located within the catchment are considered. In the past, such discharges have not been adequately managed, with the focus instead on point source discharges. This has resulted in significant adverse effects through the accumulation of what were considered relatively minor discharges, and inadequate assessment of the interactions of the effects of the discharges.

Many discharges into waterways in Christchurch are managed through resource consents. This includes overflows from the city's sewer system and some discharges from industrial sites. Other discharges, including most of the city's stormwater, are not covered by resource consents. This ICMP is particularly relevant to the latter, and will support an application for the area wide discharge consent for stormwater from South-West Christchurch. Any such consent granted by ECan would result in Christchurch City Council's management of stormwater within the catchment as outlined in this plan.

1.4 South-West Christchurch

The south-western area of Christchurch, known as "South-West Christchurch" (refer to Fig. 1.1), is on the fringe of the urban area and consists of a total area of 7,975 ha. Whilst the area is partially urbanised (a mix of business and residential), some 4,165 ha (52%) remains zoned as rural land use (predominantly agricultural). However, rural areas are under pressure to be re-zoned to allow urban development.



SOURCE: MEMORY MAP NAVIGATOR LTD

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TITLE SOUTH-WEST CHRISTCHURH LOCATION PLAN.

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South-West Christchurch has a particularly varied and sensitive water environment, characterised by the upper reaches of two major rivers (the Heathcote and Halswell Rivers) and their tributaries, a number of man-made drains, natural springs, and ponding areas. The area includes the upper reaches of the Heathcote River (including Cashmere Stream) and the Halswell River (including Nottingham and Knights Streams), and the suburbs of Wigram, Halswell, Cashmere, and Hornby.

Understanding the water and soil system in South-West Christchurch is an important first step toward the sustainable management of the natural and physical resources of the area. There is a strong interrelationship between surface water and groundwater in Christchurch, particularly in South-West Christchurch, where groundwater flows from north-west of the city towards the Port Hills to emerge as the headwaters of the Heathcote and Halswell Rivers.

The Area Planning Protocol (CCC 2003) has been developed to ensure effective coordination and consideration of all relevant issues. In conjunction with the Area Planning Process, a further overall Planning and Consents Protocol for Surface Water Management (Kingett Mitchell 2006) has been adopted by Christchurch City Council and ECan. The Planning and Consents Protocol provides guidance in assessing and managing the surface water issues on a catchment-wide basis.

1.5 Sewer Overflows

Christchurch City Council currently holds resource consents that permit untreated wastewater overflows to discharge to surface waterways during infrequent events, at locations where the conveyance network capacity is exceeded. The consent was granted on the basis that Christchurch City Council is currently investing in significant network upgrades, in part to reduce the frequency of overflow events. No water quality or ecological investigations have been carried out to determine the effects, if any, of these overflows. However, the overflows generally occur outside of the South-West Christchurch area, and the network upgrades have been designed to accommodate any potential development within South-West Christchurch.

1.6 Outline of this Report

This document addresses the integrated management of stormwater in South-West Christchurch with the following structure.

Section 2 – Policy framework outlines the legislation, statutory, and non-statutory documents which must be considered in the development of the ICMP. This includes a wide range of documents, such as government legislation and local government policies, plans, and strategies.

Section 3 – Description of the catchment summarises the various technical reports that have been prepared for South-West Christchurch ICMP. These include the reports identified in Table 1.1

Section 4 – Receiving environment objectives sets out the objectives that have been developed to guide the future management of the waterways in South-West Christchurch. Any future development will be undertaken in such a way that the receiving environment objectives are achieved.

Section 5 – Proposed catchment management describes how the objectives detailed in Section 4 will be achieved. Section 5 addresses all facets of the proposed catchment management, including the management of surface water, sediment control during construction, design, education, management practices at industrial sites, sewer overflows, and industrial discharges.

Section 6 – Monitoring describes the proposed monitoring that will measure the level to which the objectives set out in Section 4 are being achieved.

Section 7 – Institutional Capacity describes the Christchurch City Council's capacity to implement the ICMP for South-West Christchurch. ECan's role is also discussed.

Section 8 – Review provides details on the provisions for reviewing the ICMP in response to updated knowledge or monitoring results.

1.7 Consultation

Christchurch City Council has undertaken regular and on-going consultation with ECan while preparing the ICMP. Christchurch City Council will seek discharge and other related consents from ECan as part of the integrated catchment management process, and the ICMP will form the basis of the consent application. The consent application and Assessment of Environmental Effects are provided as separate documents; however, the ICMP will accompany the consent application as part of the supporting documentation. Consultation with residents, iwi and interest groups has also been carried out as part of the investigative process to date.

2. Policy Framework

The development of South-West Christchurch must be consistent with the national, regional, and local legal and planning framework. There are many policy and planning documents that influence catchment management in South-West Christchurch. These include national legislation and regional and local government policies, plans and strategies, as identified below:

Statutory Documents and Legislation

- Resource Management Act (1991).
- Local Government Act (2002) including the Long Term Council Community Plan (LTCCP).
- Building Act (1991).
- Health Act (1956).
- Regional Policy Statement (RPS).
- Transitional Regional Plan (TRP) for Canterbury.
- Proposed Natural Resources Regional Plan (NRRP) for Canterbury.
- Proposed Land and Vegetation Management Regional Plan for the Port Hills.
- Christchurch City District Plan (the “City Plan”).

Non Statutory Documents

- Area Planning Protocol (CCC 2003a).
- Surface Water Planning and Consents Protocol (Kingett Mitchell 2006).
- Waterways and Wetlands Natural Asset Management Strategy (CCC 1999).
- Heathcote River Floodplain Management Strategy (CCC 1998).
- Ngai Tahu Freshwater Policy.
- Infrastructure Design Standard (in development).
- Waterways, Wetlands and Drainage guide (CCC 2003b).
- Greater Christchurch Urban Development Strategy

The relevant content of these statutory and non-statutory documents is provided in the Assessment of Environmental Effects for the South-West Christchurch ICMP and the Phase 1 Report – Ground and surface water management report (being a technical report supporting SWAP).

3. Catchment Description

3.1 Overview

The South-West Christchurch ICMP area is approximately 8,000 ha, and includes the headwaters and upper mainstem reaches of the Heathcote and Halswell river catchments. The South-West Christchurch project area boundaries are identified in Fig. 3.1.

The study area extends from the upper reaches of Haytons Drain and Paparua Main Drain (Heathcote River catchment) north at Hei Hei, southwards to the Halswell River at Lansdowne Valley. The western boundary of South-West Christchurch is Pound Road, where Paparua water races (of Waimakariri River origin) enter the study area. The eastern boundary is the Heathcote River at Cashmere. The study area also extends to ephemeral waterways draining the north and west-facing slopes of the Port Hills.

3.2 Project Areas and Catchments

The South-West Christchurch ICMP area is divided into two main river catchments (upper Heathcote and Halswell catchments) and 37 sub catchments, as shown in Fig. 3.1. The main relevance of identifying the two river catchments is to illustrate which river system each individual stormwater system discharges to within the project area. The sub-catchments shown are based on desktop reviews of LIDAR surveys carried out prior to 2003.

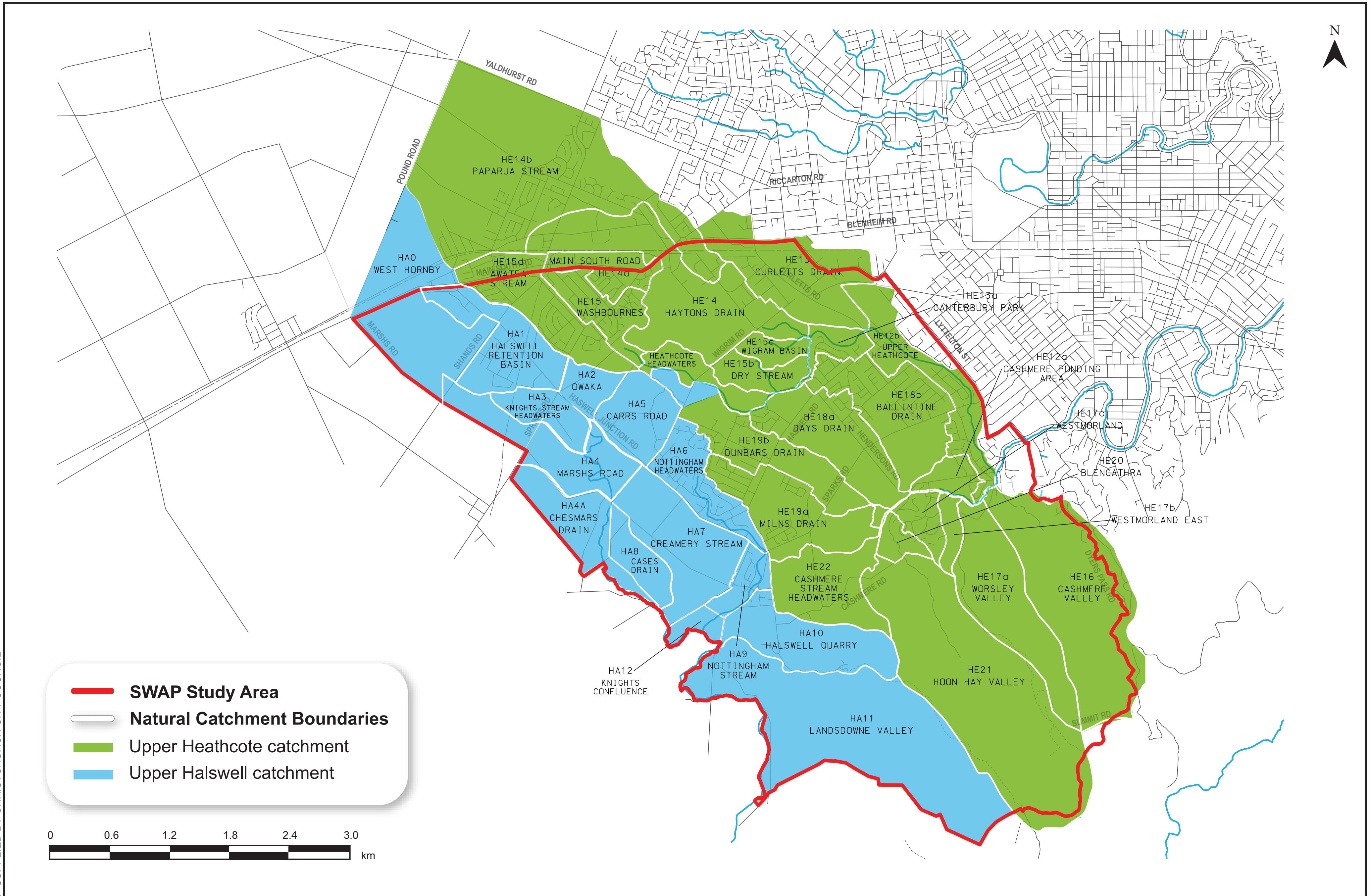
In terms of future surface water management, and for the purpose of SWAP assessment and development, the project area has been divided into nine surface water management areas (SWMAs), as shown in Fig. 3.2. These surface water management areas identify areas that will ultimately be managed individually and, in some cases, have different management approaches proposed.

3.3 Existing Land Use

The upper Heathcote catchment consists of 5,271 ha with the predominant existing land use (based on current City Plan zonings) being rural with 2,197 ha (~42%), followed by 1,212 ha (~23%) of residential land, 862 ha (~16%) of open space, 586 ha (~11%) of business zoned land, and 414 ha (~8%) of roads. The upper Halswell catchment consists of 2,704 ha with the predominant existing land use being rural with 1,967 ha (~72%), followed by 267 ha (~10%) of business zoned land, 244 ha (~9%) residential, 128 ha (~5%) of roads, and 98 ha (~4%) of open space. The urban and rural areas are identified in Fig. 3.3, and rural land use is further classified in Fig. 3.4.

An additional classification of land use has been conducted to assist in identifying higher priority business sites in terms of environmental risks. The survey information has been categorised using the Hazardous Activities and Industries List (HAIL). The HAIL is a compilation of activities and industries which typically use or store hazardous substances that could cause contamination if these substances escaped from safe storage, were disposed of on the site, or were lost to the environment through their use. HAIL is a revision of the list of industrial activities first published in the ANZECC (1992) Guidelines. The HAIL is intended to identify most situations in New Zealand where hazardous substances could cause, and in many cases have caused, land contamination. The HAIL classifications were modified slightly to allow all sites to be classified rather than having no classification (refer to Water Quality Assessment, South-West Christchurch ICMP Technical Series – Report Number 5 for detailed classifications).

The fact that an activity or industry appears on the list does not mean that hazardous substances were used or stored on all sites occupied by that activity or industry, nor that a site of this sort will have hazardous substances present in the land. The list merely indicates that such activities and industries are more likely to use or store hazardous substances, and therefore there is a greater probability of site contamination occurring than with other uses or activities.



BASE MAP SUPPLIED BY CHRISTCHURCH CITY COUNCIL

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TITLE SOUTH-WEST CHRISTCHURCH STUDY AREA, CATCHMENTS AND SUB-CATCHMENTS.

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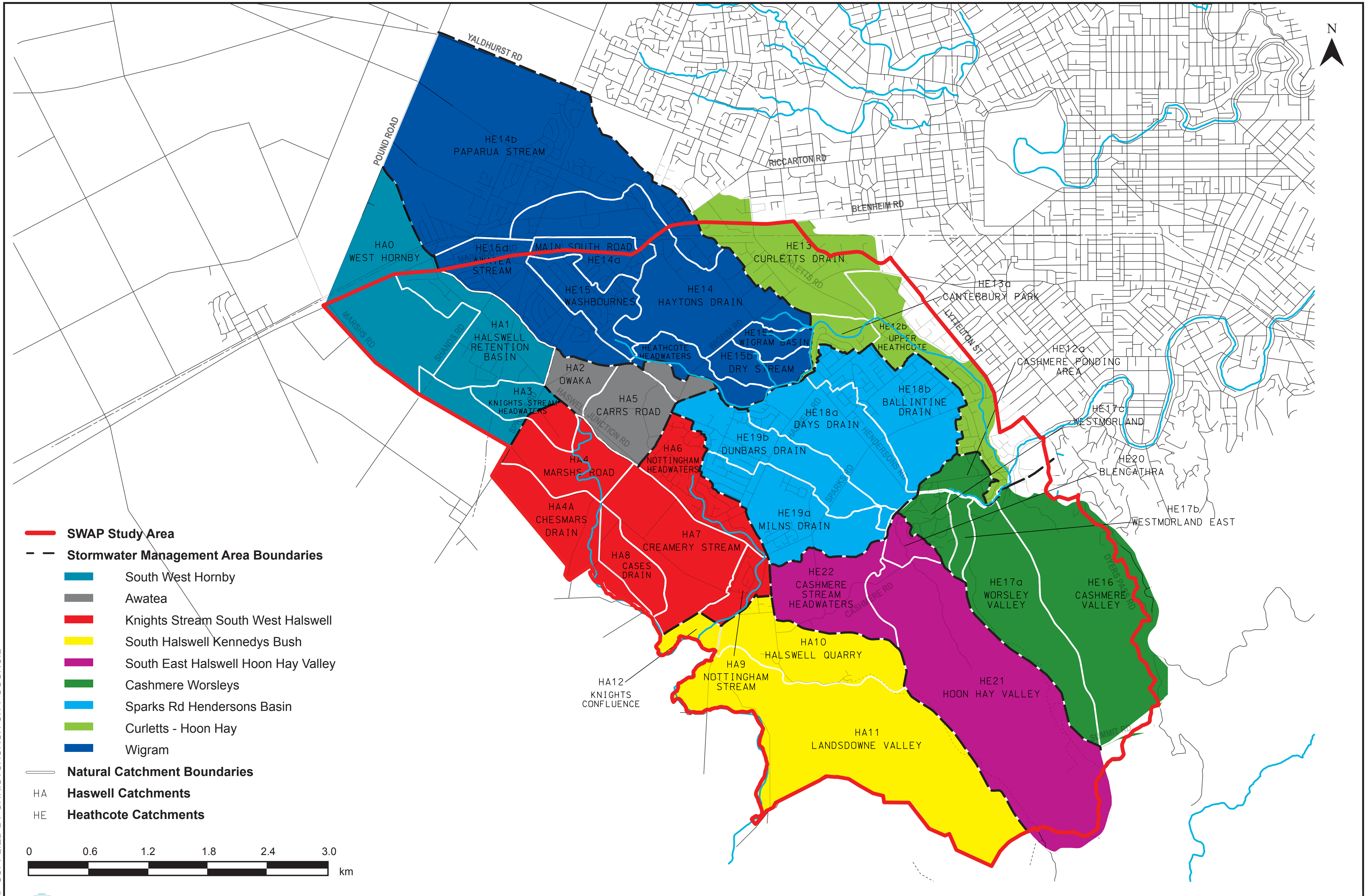

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TITLE SWMs AND THEIR RELATIONSHIP TO SUB-CATCHMENTS IN SOUTH-WEST CHRISTCHURCH

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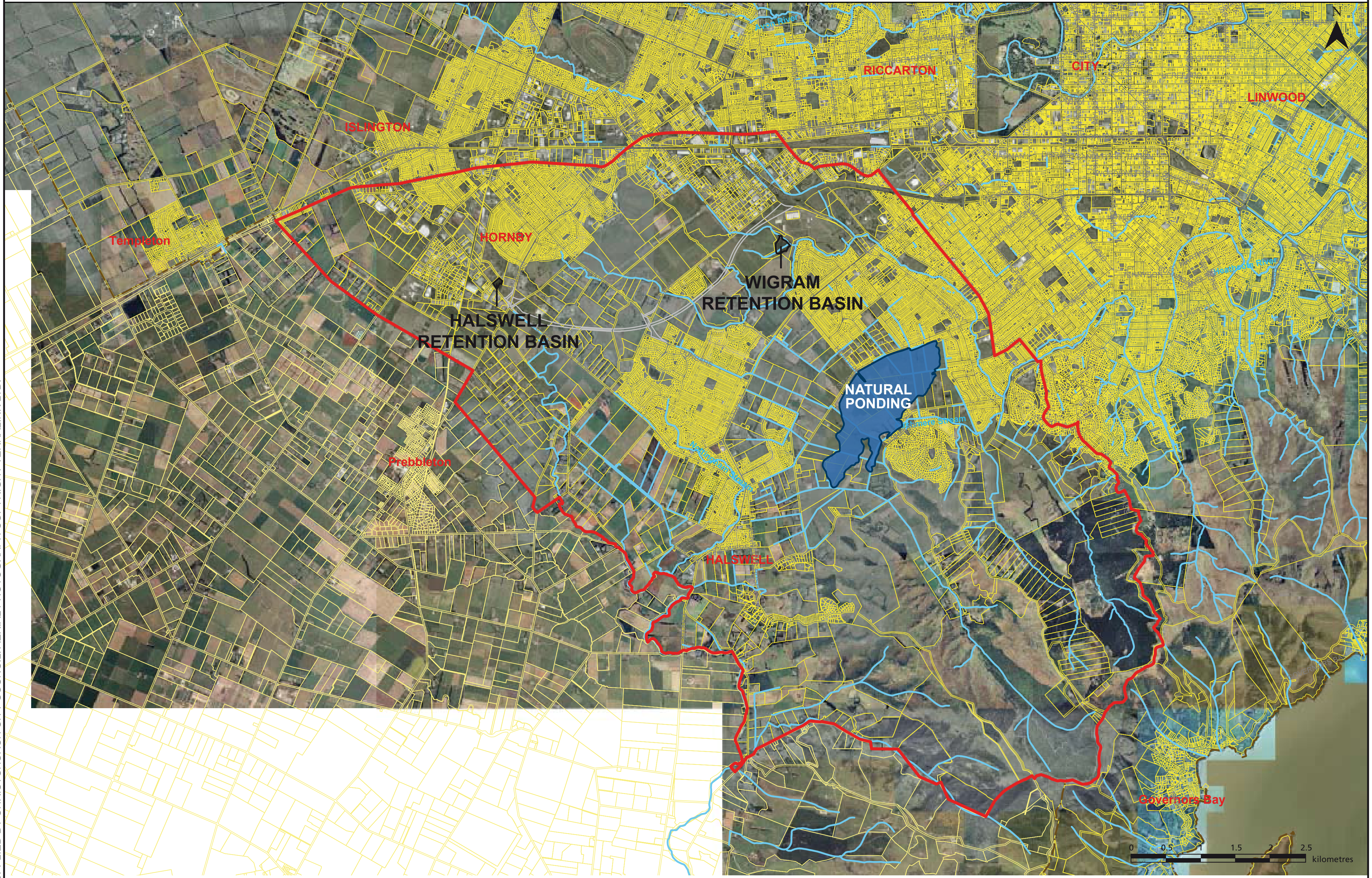

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TITLE SOUTH-WEST CHRISTCHURCH AERIAL PHOTOGRAPH.

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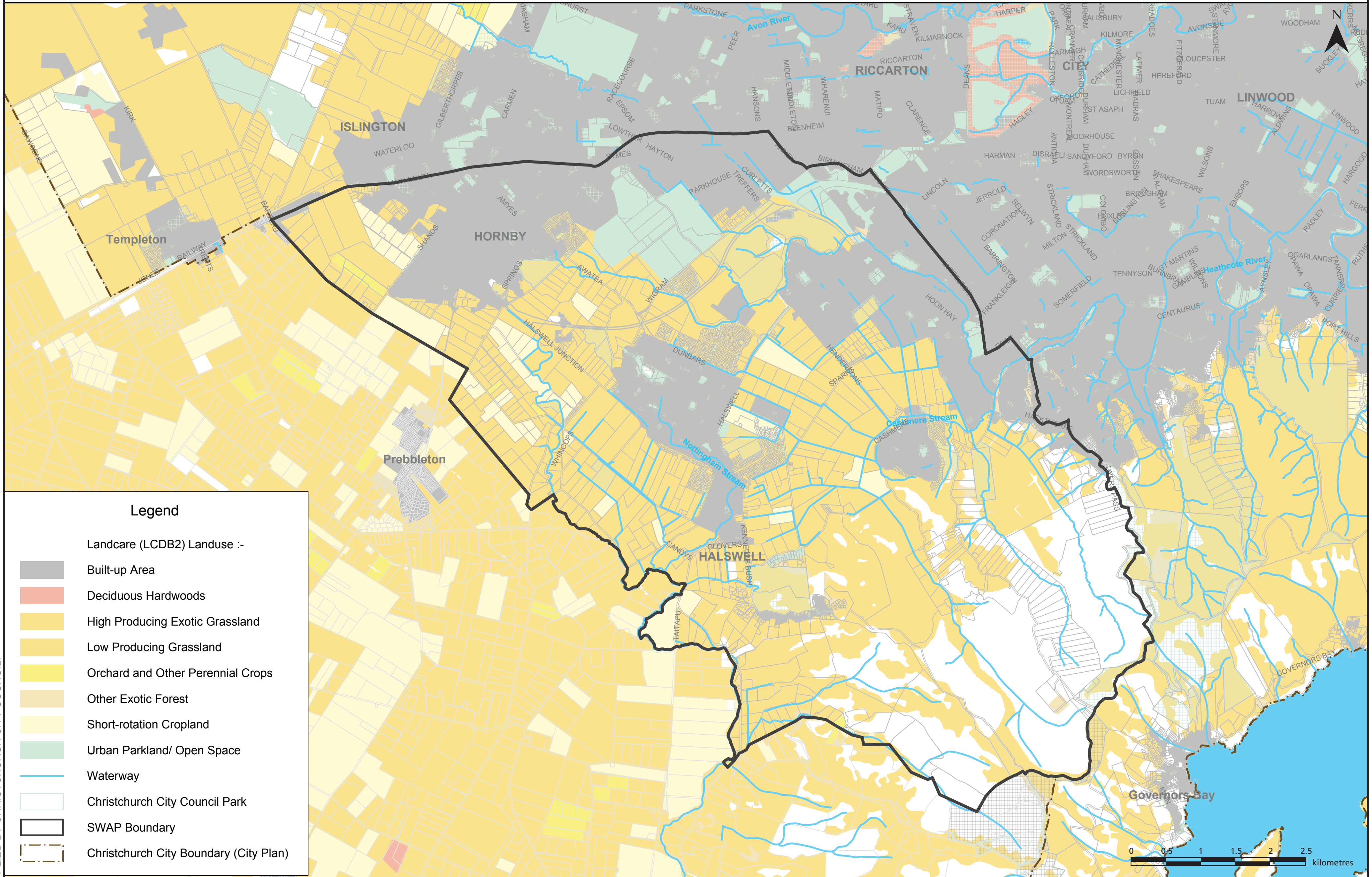

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TITLE SOUTH-WEST CHRISTCHURCH RURAL LAND USE CLASSIFICATIONS.

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Conversely, if an activity or industry does not appear on the list, it does not guarantee that such a site will not be contaminated. Each case must be considered on its merits by reviewing the information at hand. In applying the list, it must be remembered that the activity may only have occupied a small part of the site, and therefore the possibility of contamination will also be for a small part of the site.

South-West Christchurch has large industrial and commercial areas, with 687 individual sites. The land use survey results have been used to allocate a HAIL classification to each site. This process has identified a number of issues with regard to the level of information available on site activities and the HAIL categories. Modified HAIL categories have therefore been used to help classify the 687 sites.

Class O industries contribute to almost 30% of the industrial land use in South-West Christchurch. Class O includes 18 schools, five hospitals, and four swimming pool complexes, as well as a number of eating establishments and clothing manufacturers.

The second most dominant industrial land use is motor vehicle workshops, which comprise more than 11%. South-West Christchurch has 76 motor vehicle workshops, which are likely to be sources of oil, grease, and petroleum products with the potential to enter the stormwater system if not managed appropriately.

Industries which individually comprise between 5-10% of industrial land use include building material manufacturers (HAIL class 48), refrigeration industries, and transport depots. These industries collectively comprise more than 20% of industrial land use in South-West Christchurch.

A large number of the industry categories (16 in total) comprise between 1-5% of the total industrial land use, on an individual basis. However, collectively these industries comprise approximately 30% of total industrial land use, and therefore should not be considered as minor contributors of contaminants to the stormwater system.

All other industries contributed less than 1% individually to the total area of industrial land use. However, it should be noted that some of these industries, such as hazardous chemical depots, pesticide manufacturers, and petroleum depots, have the potential to pose a significant threat to the environment if contaminants are not managed in an appropriate manner.

In summary, South-West Christchurch has a large number and wide variety of industries, all of which are potential sources of stormwater and groundwater contaminants.

3.4 Topography

The topography of the catchment is characterised by the steep north facing slopes of the Port Hills (to the South-east) and the relatively flat Canterbury Plains. A detailed topographic survey (LIDAR) has been completed in recent years which provided valuable information for determining natural sub-catchment boundaries, low lying areas, and information for general engineering design of surface water management systems.

3.5 Geology

The geology of South-West Christchurch has been summarised in PDP (2003, 2005a and 2005b). The north-facing slopes of the Port Hills are generally composed of basaltic flows, ash deposits, and intrusive rocks that dip to the north-west. The basalt and ash deposits are derived from twin volcanoes that formed Banks Peninsula some 6 to 12 million years ago (PDP 2003). The limited interconnection of fractures within the basalt permits a minor amount of water movement. However, water emanating from the volcanic strata is reportedly often of poor quality due to high concentrations of dissolved solids (PDP 2003).

Surface geology of the Canterbury plains and the majority of the river catchments is dominated by unconsolidated gravel, sand, and silt. Gravel strata occur in sinuous zones extending across the western half of the city. The gravels were deposited by river channels, dating before European settlement times, and represent the most permeable surface strata in Christchurch. Alluvial silt and sand occur throughout much of the central city and to the west, between the gravel channels. They represent overbank deposits of river channels, and tend to be finer grained, with a greater portion of silt and an absence of gravel.

A number of permeable gravel units exist below the surface deposits. The gravels represent regional scale meandering rivers and the confined artesian aquifers of Christchurch. In the east the gravels are overlain by marine and alluvial sands and silts, which are thickest near the coastal margin and thin in a westerly direction. The sands and silts form confining layers to two aquifers. The uppermost confining layer occurs at the surface and is up to 10 m thick in the east, while a second confining layer between the upper and lower aquifers is located between 30 m and 50 m below the surface. The two confining layers dip eastwards and thin westwards (PDP 2003).

The presence of a confining layer can act to protect the underlying groundwater resource. The thickness and lithological continuity of the confining layer defines three aquifer vulnerability zones within South-West Christchurch (refer Fig. 3.5). These include:

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

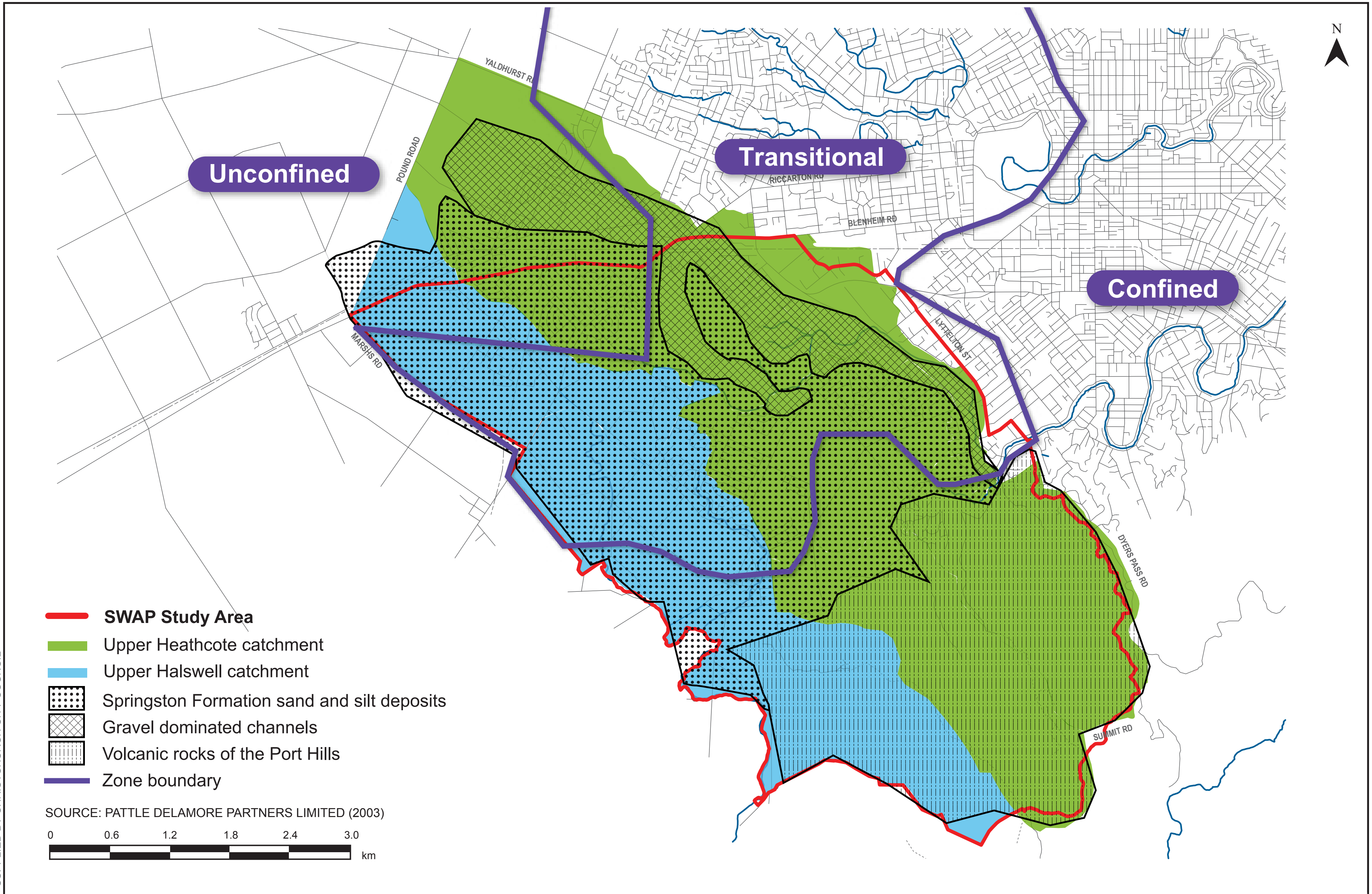
The confining layer also controls artesian groundwater pressures and limits the potential for infiltration of stormwater.

3.6 Soils

The soils of South-West Christchurch have been summarised in PDP (2003, 2005a and 2005b). There are five main types of soil in the South-West Christchurch catchment, including Waimakariri, Kaiapoi, Taitapu, Selwyn, and Horotane soils (refer Table 3.1 & Fig. 3.5). All of the soils, except for Taitapu, are recognised as suitable for urban development. Those soils classified as being unsuitable for urban use may be modified so that they are suitable (through the application of fill or by engineering techniques).

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

Soils on the volcanic rocks of the Port Hills are dominated by loess (a wind-blown silt) or colluvium (a transported soil). Loess is typically clay rich and has a very low permeability; however, during summer it is prone to dehydration, which causes fissures. The fissures extend both laterally and vertically, and can cause considerable slope instability and construction issues.



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TITLE GEOLOGICAL UNITS AND DISTRIBUTION OF UNCONFINED, CONFINED, AND TRANSITIONAL ZONES.

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Table 3.1: Soil types in South-West Christchurch and their suitability for urban use.

Soil	Location	Suitability for urban use
Waimakariri	Low terraces – north and east of the area, and along sinuous 'channels'. Generally follows the Heathcote & Halswell River.	Suitable (A1) but Wa0 has high horticultural value.
Kaiapoi	Low terraces – much of the eastern portion of the area.	Suitable (A1) but Ka0 has high horticultural value (A2).
Selwyn	Flood plains – long sinuous channels, extending north-west in the Halswell catchment	Suitable (A1), but Sl0 and Sl1 have high horticultural value (A2).
Taitapu	Low lying areas such as Henderson's Basin, middle reaches of Heathcote River, west of Knights Stream. Limited low lying areas in the Halswell catchment.	All unsuitable (C1).
Horotane	Cashmere Stream valley floor, southern part of catchment.	Suitable (A1).

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

3.7 Drainage System

3.7.1 Streams and drainage channels

The Heathcote River is classified under the proposed NRRP as a lowland stream in the upper reaches, and an urban stream in the lower reaches. Along its length the Heathcote River is joined by several waterways, including Dry Stream, Haytons Drain, and Curletts Drain, before its confluence with the Cashmere Stream in the eastern part of the South-West Christchurch study area. The Heathcote River catchment waterways are shown in Fig. 3.6, including original alignments as shown on the 1856 "Black Maps".

The headwaters of the Heathcote River are fed by Christchurch City Council utility piped drains from the Awatea Stream and Washbournes sub-catchments. The land use within this area is predominantly residential, and encompasses part of Hornby. The upper Heathcote River drains rural and semi-rural land to Templetons Road then Haytons Drain. Further downstream the river flows through the established residential suburbs of Spreydon and Hoon Hay. Haytons Drain is a significant tributary of the Heathcote, and it joins the main river through the Wigram Retention basin, upstream of Curletts Road. Cashmere Stream is another major tributary of the Heathcote River, and rises from an area between Halswell Road and Sutherlands Road, with the source close (ca. 100 m) to the Halswell River. The Halswell River catchment waterways are shown in Fig. 3.6, including their original alignment as shown on the 1856 "Black Maps".

The Halswell River is classified as a lowland stream under the proposed NRRP. The Halswell River receives appreciable flow from Knights Stream, a largely spring-fed tributary fed from rural land around Prebbleton, and Templeton, but also from the suburb of Halswell. From the Knights Stream confluence, until the course re-curves back to SH 75 (Taitapu Rd), the channel is quite uniform in profile. Land use varies between cropping, grazing, and road reserve land. Downstream of SH75 (Taitapu Road) the channel becomes shallower and generally more heterogeneous. After the confluence with Knights Stream, the Halswell River meanders south for approximately 5km to Lansdowne Valley, where the river reaches the study area boundary.

3.7.2 Stormwater system

The existing stormwater system is extremely varied. Stormwater is generally reticulated via small pipes to open drains and waterways. The current Christchurch City Council approach is to develop a drainage network based on waterways along green corridors, and to limit the amount of piping as much as possible.

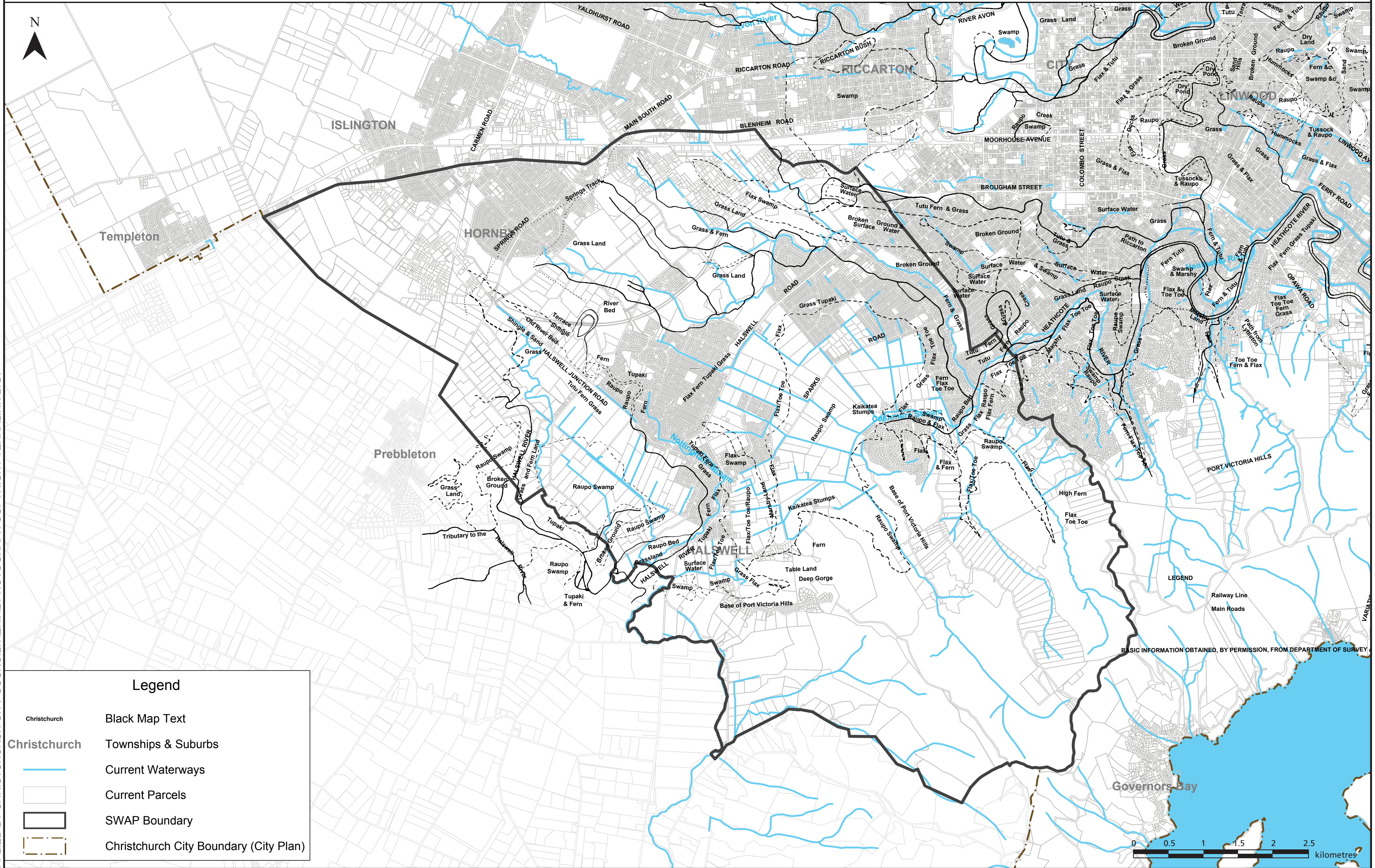

FIGURE SUPPLIED BY CHRISTCHURCH CITY COUNCIL. AERIAL PHOTOGRAPH COPYRIGHT TERRALINK LTD.

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TITLE SOUTH-WEST CHRISTCHURCH WATERWAYS AND BLACK MAP (1856).

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The older urban parts of the Heathcote and Halswell catchments typically do not have any form of water quantity or quality mitigation. The areas serviced by the Wigram Retention Basin and the Halswell Retention Basin are two exceptions. The more recent subdivisions were required to provide mitigation of water quantity and quality of stormwater discharges. Stormwater mitigation has been based on grassed soil adsorption basins (retention basins) that discharge to ground where suitable hydrogeological conditions exist, and dry detention basins discharging slowly to surface waterways elsewhere. In general, the water quality mitigation is based on capturing and treating the first 25 mm of each rainfall event, although some earlier systems are based on 15 mm capture. Mitigation of water quantity effects varies greatly, although more recent systems are based on detention or retention of a 2% Annual Exceedance Probability (AEP) event, which is equivalent to a 50 year return period event.

A number of natural ponding areas also exist within South-West Christchurch, and these ponding areas provide a vital role in the management of peak flood events in the Heathcote River. Hendersons basin is the largest of these ponding areas, and provides detention of stormwater and rural runoff from the Sparks Road-Hendersons Basin SWMA (refer to Fig. 3.2). Much of Hendersons Basin is in private ownership and the basin is a passive system. Active management of the basin could reduce flooding in the Heathcote River downstream of South-West Christchurch. However, this may require Christchurch City Council to purchase the entire basin to allow more frequent ponding in the basin, greater ponding depths (by providing bunding of parts of the basin), and longer ponding durations. The Cashmere-Worsley and Hoon Hay Valley basins are independent of Hendersons Basin and provide detention of flood flows from the hill catchments and discharge directly into Cashmere Stream.

3.8 Riparian Ecology

3.8.1 Heathcote River catchment

The Pilot Study Stage One, Report Number 1 of the South-West Christchurch ICMP Technical Series (Kingett Mitchell 2005a) provides a review of existing information, and identifies several reports containing information relating to riparian vegetation and habitat in the Heathcote River system of South-West Christchurch. Overall, the riparian habitat within the study area is recognised as being of poor quality, with the majority of vegetation being composed of planted exotic trees and grasses. There is no indication of any original habitat remaining, and only a few areas with predominantly native vegetation are known.

The Christchurch City Council has undertaken some riparian enhancement work in the lower Heathcote River. Although the vegetation is still quite young, its presence has increased the habitat value for the area. There is one ecological heritage site (EHS 15.21 - City Plan map 45) along upper heathcote from Curletts Road to Wigram Road that consists of riparian willow woodland with native trees, shrubs, ferns and sedges.

3.8.2 Halswell River catchment

Information summarised in Pilot Study Stage One, Report Number 1 of the South-West Christchurch ICMP Technical Series (Kingett Mitchell 2005a) identified no information on the vegetation surrounding the Halswell River. However, there was some information relating to riparian vegetation in the main tributaries of the Halswell River. After reviewing information in various reports, we can conclude that riparian vegetation throughout the study area appears to have been reduced and highly modified, with little native vegetation remaining. Overall, the riparian habitat within the study area is of a poor quality, since the majority of vegetation present is composed of planted gardens, and exotic trees and grasses. There is only one area (Kennedy's Bush) of 87 ha where original habitat is still remaining, and only a few more areas with predominantly native vegetation are known. There is only one RAP site (EHS 15.06 – City Plan map 44), identified at Halswell Junction, Springs Road, that consists of danthonia grass land.

3.9 Freshwater Ecology

3.9.1 Introduction

An ecological investigation of waterways in South-West Christchurch is presented in the Aquatic Values and Management Report, Report Number 3 of the ICMP Technical Series (EOS Ecology Ltd et al. 2005). This investigation assessed the ecology of the Heathcote and Halswell catchments, with detailed sampling undertaken in the river's mainstems, as well as several contributing tributaries. This work included an initial visual survey of all waterways along their entire length, followed by the selection of 27 sites for closer ecological assessment. Detailed descriptions of the ecological sample locations can be found in EOS Ecology Ltd et al. (2005).

The following section summarises the in-stream habitat, macroinvertebrate communities, and fish fauna of the two waterways and their associated tributaries.

3.9.2 Heathcote River catchment

The Heathcote mainstem was surveyed from Templeton's Road (its approximate upstream limit of permanent flow) downstream to its confluence with Cashmere Stream.

Physical Properties of Surveyed Sites

Most of the sites were slow-flowing aquatic habitats, with substrates dominated by fine particulates, although there were also five riffle habitats and four run habitats which had coarse substrates. Most sites with a coarse substrate (coarse gravel and cobbles) were moderately embedded in finer substrate. Boulders were only present at two sites along Cashmere Stream (Sites 4 and 25), with the flow at Site 4 approaching that of a rapid during times of moderate flow.

Macroinvertebrates

A total of 35 invertebrate taxa were recorded from the 15 sites in the Heathcote catchment, with the number of taxa at each individual site showing moderate to high taxa richness (i.e. 10 or more taxa; Fig. 3.7). The most diverse invertebrate group was two-winged flies, followed by caddisflies and snails. Other groups were represented by one to two taxa.

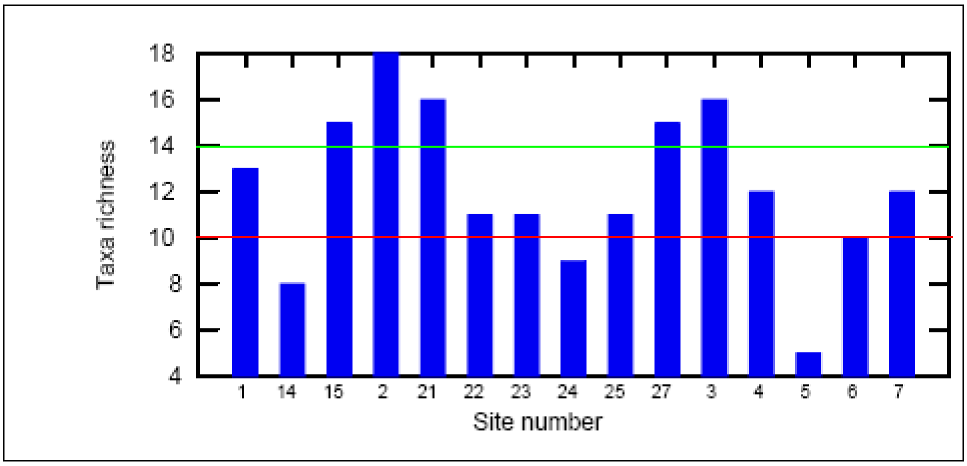


Fig. 3.7: Taxa richness at 15 sites in the Heathcote catchment (values below the red bar are regarded as low taxa richness and values above the green bar as high taxa richness for the study area).

The most abundant and widespread taxa in the survey area were the hydrobiid snail, amphipods, and ostracod microcrustaceans. The abundance of all other taxa was less than 10%. Six taxa were widespread and occurred at more than three-quarters of sites. These included the snail (*P. antipodarum)* (14 sites), amphipod (*P. fluviatilis)* (13 sites), orthoclad midges and worms (12 sites), and ostracods and *Physella* snails (11 sites).

The ecological value of an area is typically determined using one or a combination of measures of biodiversity. In streams, invertebrate richness is a common measure of biodiversity. One such measure is the % EPT taxa richness (Ephemeroptera (mayflies) + Plecoptera (stoneflies) + Trichoptera (caddisflies)). EPT taxa are typically relatively pollution sensitive, and therefore provide a useful measure of water and habitat quality; generally an EPT abundance of greater than 10% is considered high abundance. Of the EPT taxa, caddisflies were the only EPT group found in the Heathcote catchment. Three sites in the catchment had high EPT abundance and taxa richness; these included two sites from the Cashmere Stream headwater network, and one from the upper Paparoa Main Drain (Fig. 3.8). At all other sites EPT taxa were absent or in very low abundance. However, despite the low abundance of EPT taxa, some sites did support high taxa richness (15–16 taxa) (Fig. 3.7).

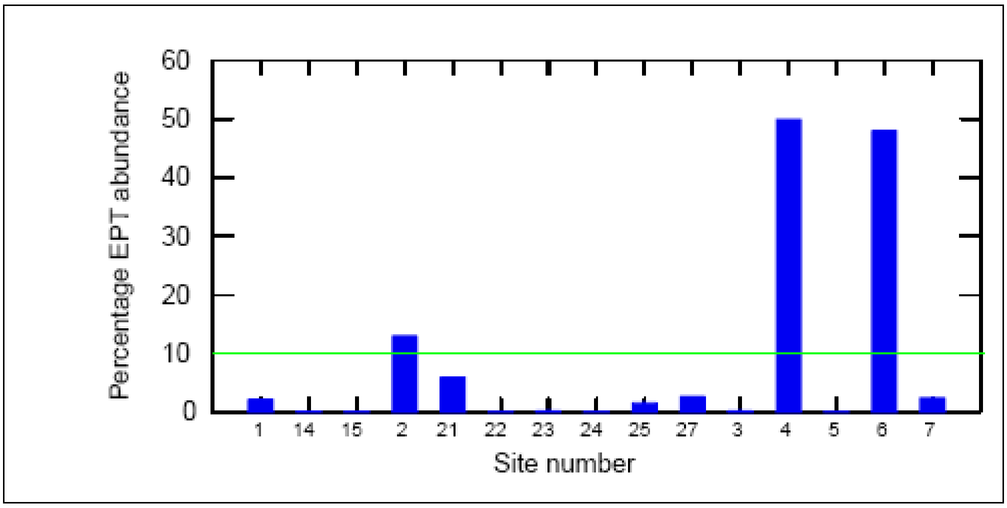


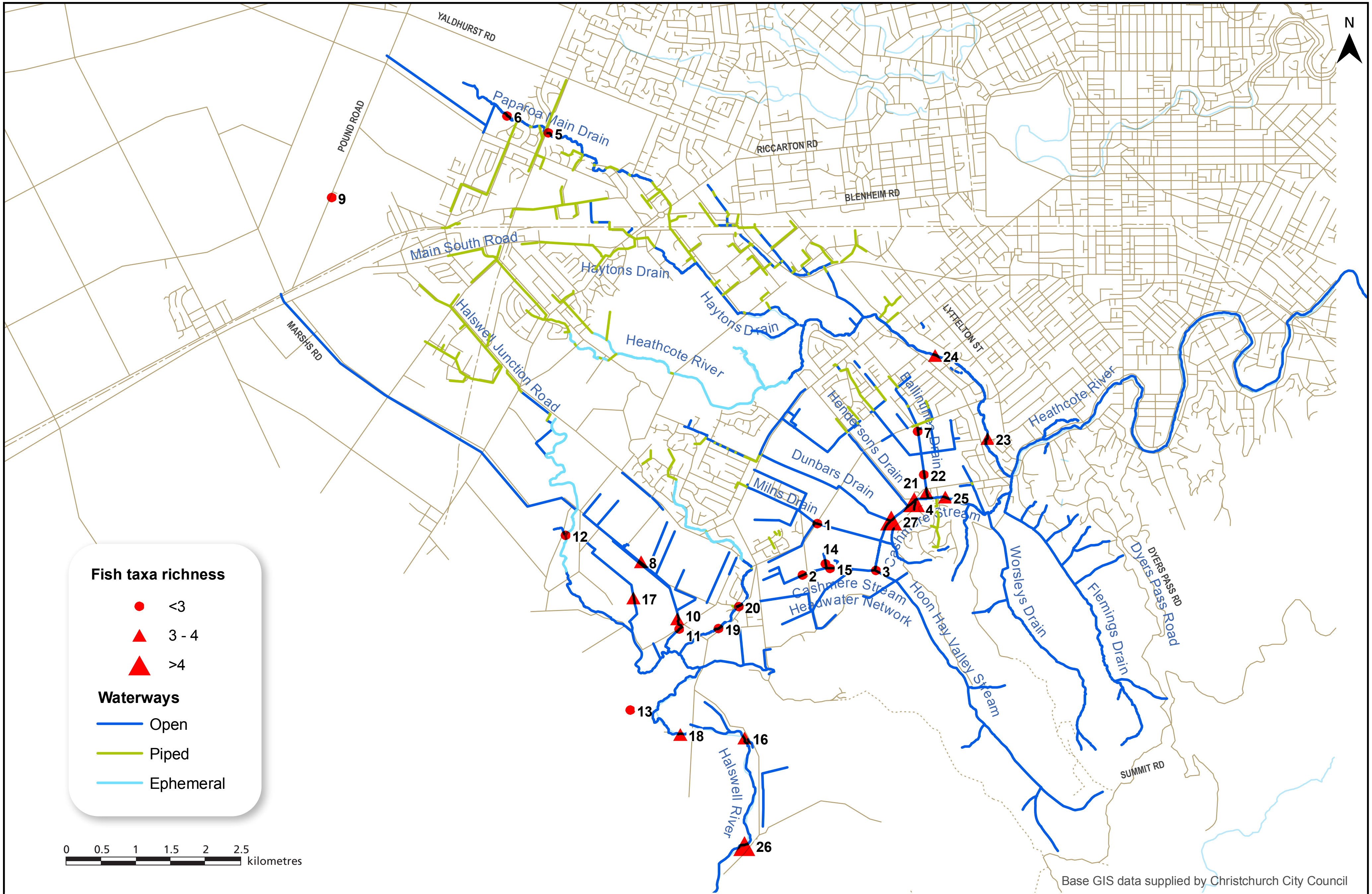
Fig. 3.8: Percentage abundance of EPT taxa from 15 sites in the Heathcote catchment (values above the green bar show high percentage abundance for the study area).

Freshwater crayfish (koura) were caught while electric fishing at two sites in Cashmere Stream and at one site in its headwater network. Freshwater shrimps were also caught within the Cashmere Stream area. In addition, large numbers (up to 70 in a 7m reach) of live freshwater mussels were found in the lower reaches of Cashmere Stream mainstem during subsequent visits (S. McMurtrie, pers. obs.).

Overall, sites with shallow water depths, high water velocities and coarse substrates had more EPT taxa, hydrobiid snails, and riffle beetles. Sites with greater cover, depth of silt and sand, slower flowing deep water, and greater macrophyte cover had more amphipods and chironomid midge larvae. This is the case for lowland streams in Canterbury in general, where homogeneous flow and substrate, coupled with higher cover of fine sediment, macrophytes, and periphyton favour an invertebrate fauna that is tolerant of relatively poor quality habitat (Meredith et al. 2003).

Fish Fauna

Seven freshwater fish taxa were identified from the Heathcote catchment (Fig. 3.9). Most of these fish were native and about a half were diadromous (sea-migrants). In order of observed abundance these were the upland bully, shortfin eel, common bully, longfin eel, bluegill bully, inanga, and brown trout.



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TITLE NUMBER OF FISH TAXA COLLECTED FROM ECOLOGY SAMPLING SITES IN THE SOUTH WEST AREA.

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The most abundant and widespread fish species in the Heathcote catchment were upland bullies and shortfin eels; they were found at all sites except the two most upstream sites. All other taxa were relatively uncommon. More diverse fish communities were in, or close to, waterways with natural water courses in Cashmere Stream and the Heathcote River mainstem.

Sites 4 and 27, both on Cashmere Stream, had the highest fish diversity in the Heathcote catchment, with five species recorded. Typical of many catchments in New Zealand with a diadromous fish fauna, fish species richness declined significantly with upstream distance from the sea, with only the non-migratory upland bully found at the most upstream sampling sites.

Longfin eels were the only native fish species collected that are uncommon or rare on a regional or national basis. Although relatively common, longfin eels are regarded as being chronically threatened with extinction (Hitchmough 2002) as their numbers are in gradual decline nationally.

Summary of Aquatic Ecological Values

All waterways in the project area are modified and affected to some degree by rural or urban land use. Overall, stream biota is similar to that of other modified lowland streams in Canterbury and New Zealand, and has limited ecological value on a regional or national scale. However, a number of localities were assessed as having high ecological values relative to waterways within the modified environment (EOS Ecology Ltd et al. 2005). These sites are shown in Fig. 3.10 and include:

1. Cashmere Stream mainstream (Heathcote Catchment) and some of its springhead tributaries have high values for both fish and invertebrates in some areas.
2. Lower reaches of Ballantines Drain (Heathcote Catchment) have moderate value for invertebrates downstream of Cashmere Road, and improvement of fish densities.
3. Uppermost reaches of Paparua Main Drain (Heathcote Catchment) have high value for invertebrates in Broomfield Common, upstream of Carmen Road.

Two waterways of low ecological value were considered to have been severely compromised by adjacent land use. These drains were Milns Drain (Site 1) and the middle reaches of Ballantines Drain (Sites 7 and 22) (EOS Ecology Ltd et al. 2005). The main cause of the problem is stock damage to stream banks and resultant turbidity and sedimentation, as well as land development construction activity upstream of Site 1. Ballantines Drain is believed to have good potential for ecological recovery if the source of the problem is removed.

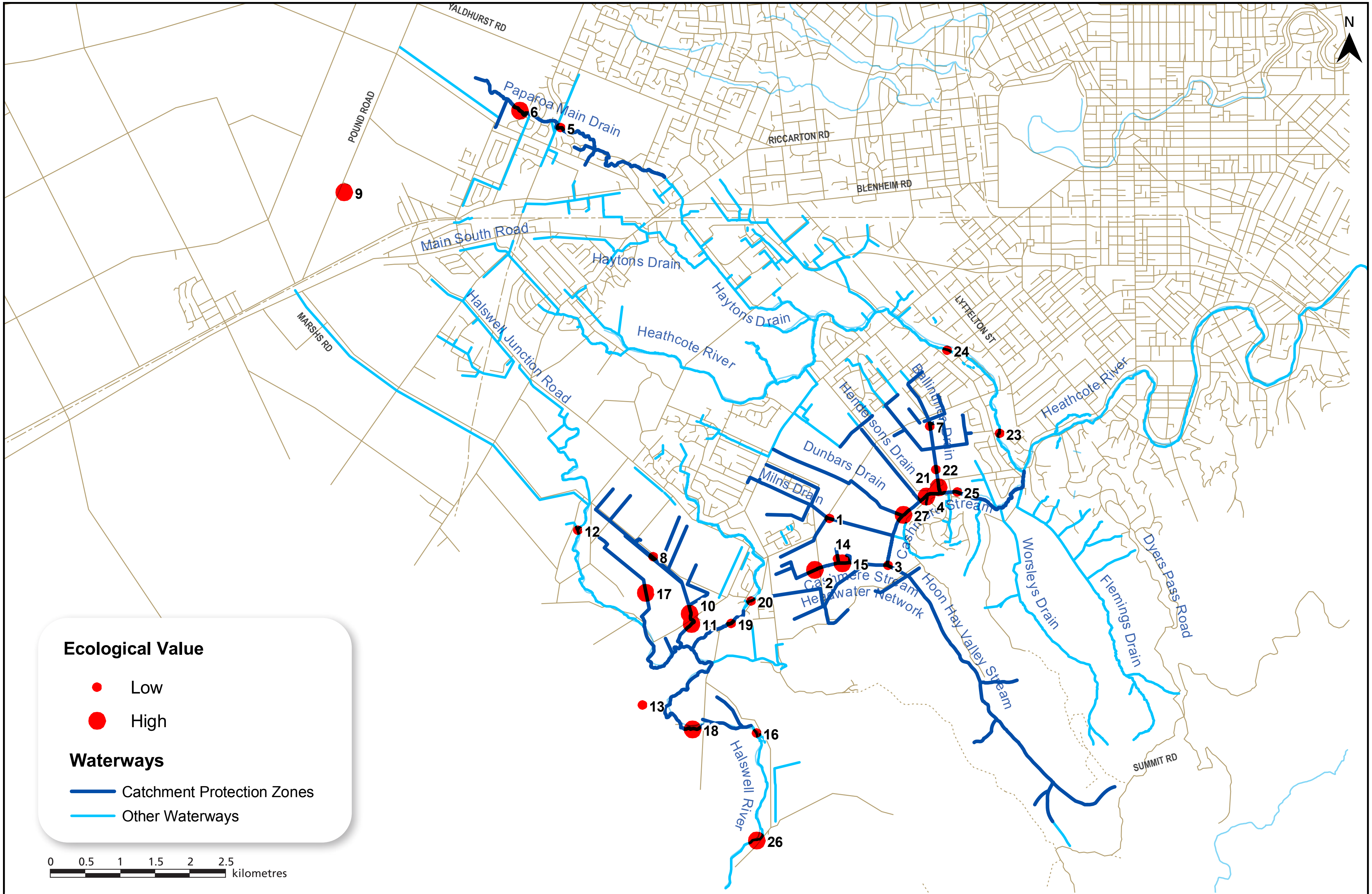
3.9.3 Halswell River catchment

Physical Properties of Survey Sites

As with the Heathcote catchment, survey sites in the Halswell River catchment were dominated by slow-flowing stream habitat, although the mean depth and width of habitats was greater than the Heathcote River. Mean substrate composition was finer and the degree of embeddedness was slightly greater for the Halswell River sites than the Heathcote sites; this reflects the greater prevalence of slow-flowing stream habitat in the Halswell. The shallow upper reaches of Nottingham Stream and Knights Stream had somewhat faster flows and coarser substrates.

Macroinvertebrates

A total of 37 invertebrate taxa were recorded from the 11 sites in the Halswell catchment. The most diverse invertebrate group was two-winged flies and caddisflies, followed by snails and beetles. Other groups were represented by one or two taxa. The most abundant and widespread taxa in the survey area were the amphipod (*P fluviatilis)*, the ubiquitous snail (*P. antipodarum)*, and ostracod micro-crustaceans (11%). The abundance of all other taxa was less than 10%.



Golder Associates

TITLE LOCATION OF SITES WITH HIGH ECOLOGICAL VALUE AND CATCHMENT PROTECTION AREAS.

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The EPT taxa found in the Halswell catchment consisted only of caddisfly species. Site 11, from the Quaifes Road Drain network of spring-fed streams, was the only site with EPT taxa abundance greater than 10% (Fig. 3.11). EPT taxa were absent or in very low abundance at all other sites. Several sites supported only a moderate abundance of EPT taxa, but had high taxa richness (Fig. 3.12).

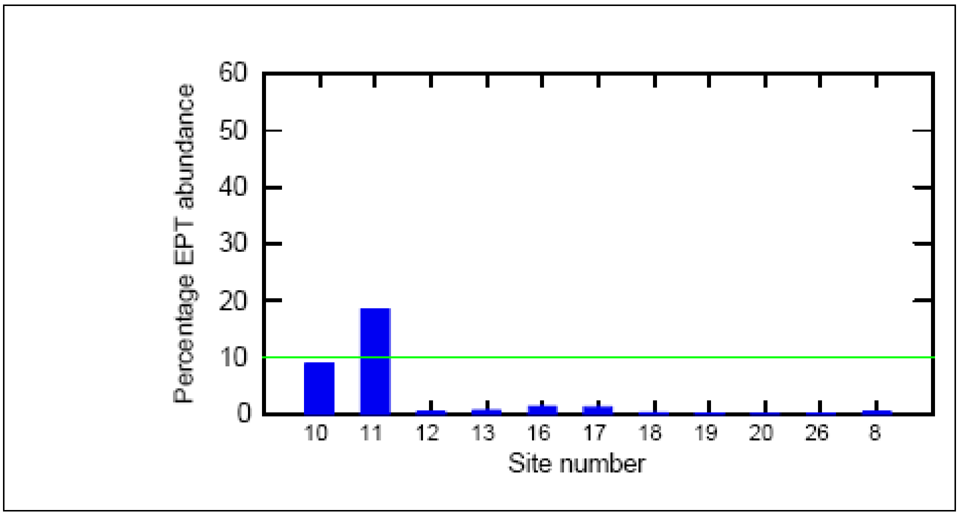


Fig. 3.11: Percentage abundance of EPT taxa from 11 sites in the Halswell catchment (values above the green horizontal line show high percentage abundance for the study area).

Freshwater crayfish were caught while electric-fishing at a site in Dawsons Creek Diversion, two sites in the Quaifes Road Drain network, and two sites in the Halswell River. One site in the Quaifes Road Drain network supported a particularly large number of crayfish, including 20 young-of-the-year. The largest crayfish caught (carapace length of 55 mm) in both the Heathcote and Halswell catchments was from a site in Dawsons Creek Diversion. No freshwater shrimp were caught from the Halswell catchment. Freshwater mussels were observed in the lower reaches of the Halswell River (i.e., downstream of Taitapu Road) during the 1st tier survey, although all observed specimens were empty shells, with no living specimens found.

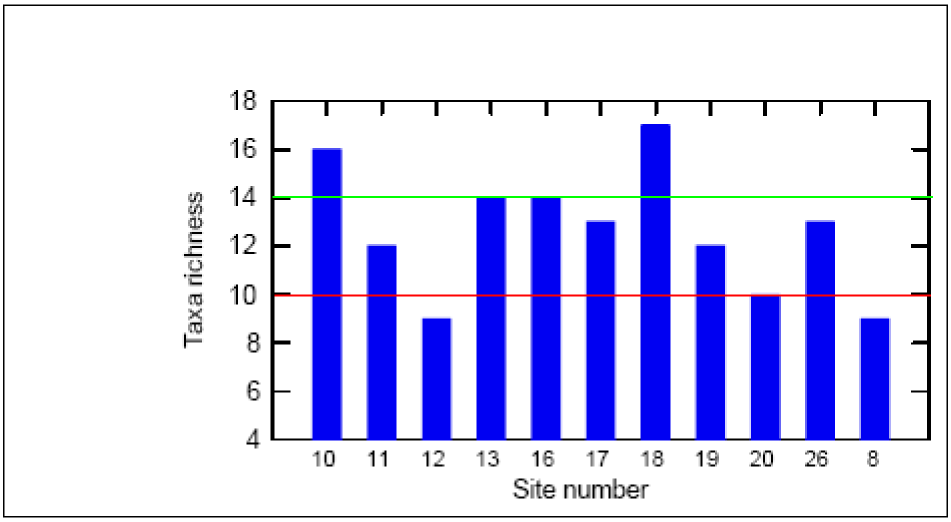


Fig. 3.12: Taxa richness at 11 sites in the Halswell catchment (values below the red bar are regarded as low taxa richness and values above the green bar as high taxa richness for the study area).

Fish Fauna

Seven fish species were identified from the Halswell catchment: upland bully, shortfin eel, longfin eel, perch, common bully, inanga, and brown trout. In contrast with the Heathcote catchment, no bluegill bullies were identified from the Halswell catchment. Perch were occasionally identified from the Quaifes Road drains which flow into Knights Stream.

The most abundant and widespread fish species in the Halswell catchment were upland bullies and shortfin eels; however, all sites had a greater abundance of upland bullies than shortfin eels. All other taxa were relatively uncommon.

The site with the greatest number of fish species was located on the lower Halswell at Lansdowne. Four fish species were recorded from two sites located further upstream, and from the excavated ponds in the Quaifes Drain network, which discharges into Knights Stream. As with the Heathcote catchment, Halswell catchment fish species diversity declined significantly with distance upstream from Lake Ellesmere.

Summary of Aquatic Ecological Value

Two sites in the Halswell catchment, both in the Quaifes Road spring-fed drain network, were regarded as being of high ecological value in regards to aquatic invertebrate fauna, due to a high abundance of EPT taxa and good taxa diversity. The Quaifes Road spring-fed drain network also supported a reasonable freshwater crayfish population. One site also supported a particularly high density of crayfish, and was the only site with a breeding population.

The Halswell River supports an important perch fishery, and waterways in the Quaifes Drain spring-fed drain network provide highly suitable rearing habitat for this species. Perch prefer sluggishly-flowing or lake waters with aquatic macrophytes upon which to spawn (McDowall 1990), and the excavated ponds on Christchurch City Council land upstream of Sabys Road are particularly suited for this species. Perch are known to become piscivorous at a larger size. A diet study indicated that in the Selwyn River, native common bullies made up almost the entirety of the perch diet (Griffiths 1976). Smaller perch could also compete for food and space with native fish.

The upper reaches of rural Knights Stream were regarded as low value for both fish and invertebrates. During the current study, it became apparent that the waterway has become greatly modified and the removal of riparian vegetation along a 50 m section had greatly decreased bank stability, resulting in bank erosion and large sediment inputs into the waterway. Anecdotal evidence also indicates a loss of some springheads in the vicinity of Marshs Road, and lower flows and siltation in the middle-upper reaches of Knights Stream (upstream of Sabys Road).

3.9.4 Te Waihora/Lake Ellesmere

Te Waihora/Lake Ellesmere is the receiving environment for the Halswell River. Although recognised for having high cultural and recreational values, the ecology of Te Waihora/Lake Ellesmere is not well researched (Gough & Ward 1996). Although Te Waihora/Lake Ellesmere is an organically enriched environment due to runoff from the surrounding agricultural area, the lake supports a diverse assemblage of fish and birdlife. It is unusual in that it has variably brackish water rather than being purely estuarine or freshwater.

Because Te Waihora/Lake Ellesmere is closed to the sea for a significant part of the year, this can interfere with the passage of migratory fish, including whitebait species and eels (NIWA 1996). This has implications not only for the fishery in the lake, but also for contributing rivers, including the Halswell. Therefore, seasonal management of the Te Waihora/Ellesmere lake opening is crucial to native fisheries in the upper Halswell catchment. Te Waihora/Lake Ellesmere is recognised as a wetland of international significance.

3.9.5 Summary

Overall, stream biota was similar to other modified lowland streams in Canterbury and elsewhere in New Zealand. However, there were a number of localities within the South-West area that had relatively high ecological values for the modified environment, and these values may be sensitive to hydrological, habitat, and water quality effects associated with urban development. Key findings include:

- Most sampling sites had moderate to high invertebrate taxa richness (10 taxa or more).
- The species found were generally of a high pollution tolerance.
- Freshwater crayfish are a significant find among the invertebrate taxa, and are most common in the Quaifes Drain network. This find is of particular ecological and local conservation interest. Freshwater crayfish have been recently considered a threatened species.
- Several sites showed high fish taxa richness.
- The findings included the first record of bluegill bullies from the Heathcote River catchment.
- None of the native fish fauna are uncommon or rare on a regional or national basis except longfin eels.

3.10 Marine Ecology

Overview

The marine environment of the Avon-Heathcote Estuary is discussed in Pilot Study Stage One, Report Number 1 of the South-West Christchurch ICMP Technical Series, and a summary is provided in the following section.

The Heathcote River ultimately discharges into the south-west corner of the Avon-Heathcote Estuary. The estuary is linked to Pegasus Bay through a narrow neck in the south-east corner. While the Avon-Heathcote Estuary is not within the limits of the study area, the consent process will require an assessment of environmental effects, which will require consideration of the Avon-Heathcote Estuary, as it is the receiving environment for the Heathcote River.

There have been a considerable number of studies undertaken on the ecology of the Avon-Heathcote Estuary. The most comprehensive ecological study is generally considered to be Knox & Kilner (1973). Subsequently, Knox (1992) and Owen (1992) have provided overviews of the ecology of the estuary. The 1973 estuary study undertaken by the Department of Zoology at the University of Canterbury was the first comprehensive examination of an estuarine system in New Zealand. In this section information on the three main areas of ecology within the estuary are reviewed. These main areas are invertebrates, algae, and fish.

Benthic Invertebrates

Sagar & Weatherhead (1999) carried out a review of changes in the benthic macro-invertebrate abundance in the Avon-Heathcote Estuary. They noted that the estuary supports a “rich fauna of benthic invertebrates dominated by typical, estuarine species of molluscs, polychaetes and crustaceans”. The composition of the benthic invertebrate community of the tidal flats is known to vary according to the environmental gradients in the estuary. On this basis, three main groups are identified:

- River deposition zones: sediments near the mouths of the two rivers contain high densities of deposit-feeding mud-snail and comparatively small numbers of polychaetes.
- Oxidation pond zones: sites immediately adjacent to the oxidation pond discharges contain fine, muddy sediments with a high organic content. They are dominated by large densities of organic enrichment-tolerant polychaetes and moderate densities of cockles and other bivalve molluscs.

- Mid-estuary, bivalve-dominated zones: sites in the mid-reaches of the estuary with sandier sediments contained a very large biomass of cockles and the small wedge shell, Tellina liliana.

Algae

The dense micro and macro algae populations have been a feature of the Avon-Heathcote estuary. Historically the estuary was subject to industrial discharges containing nutrients and organic matter that contributed to the eutrophic status of the estuary. The discharge from the Bromley oxidation ponds currently contributes the bulk of the nitrogen and phosphorus entering the estuary (URS 2000). Nuisance growths of micro (e.g., Euglena) and macroalgae (e.g., Ulva (sea lettuce), Gracilaria and Enteromorpha) are still common in the estuary, and sediments near the oxidation pond outlets contain elevated concentrations of nutrients and support dense growths of macroalgae. At times, algae such as sea lettuce detach and drift with the tide and winds to areas such as tidal flats between the ponds and the Heathcote River. The drifts of macroalgae settle and decompose, resulting in local patches of anaerobic sediments. The discharge from the Bromley oxidation ponds will soon be removed from the estuary and a significant reduction in nitrogen and phosphorus entering the estuary is expected.

Fish

The Avon-Heathcote estuary is used by a large number of fish species. It provides habitat for many fish species and for some species it provides breeding sites, feeding, and passage during migration. The importance of the Heathcote River estuary lies in providing passage for native fish species that utilise the upper reaches of the freshwater part of the river for the adult part of their life cycle.

James (1999) reviewed the fish resources of the Avon-Heathcote River as part of the technical studies for the renewal of the resource consents for the Bromley oxidation pond discharge to the Avon-Heathcote River. James (1999) noted that 34 species of fish have been recorded in the estuary. Many of the fish are not permanent residents, spending only part of their life cycle in the estuary. These species include seasonal species (e.g., whitebait); permanent species (e.g., triplefins, cockabullies, spotties and rockfish); species that spend their juvenile stages in the estuary but migrate freely between the estuary and the sea as adults (e.g., flounder and mullet); transitory marine species (e.g., kahawai, red cod, barracuda, red gurnard) and migratory species (e.g., eel, trout, lamprey).

3.11 Freshwater Quality

3.11.1 Introduction

The majority of water quality data available for the Heathcote and Halswell Rivers and their tributaries were collected under the Christchurch City Council water quality monitoring program between 1989 and 2002. Overall there are 16 Christchurch City Council water quality monitoring sites located within the Heathcote River catchment and 10 water quality monitoring sites located within the Halswell River catchment. This monitoring program provided detailed information about the majority of water quality parameters in these catchments; however, there were limited water quality data available for metals. The following section provides a brief summary of water quality in each catchment.

3.11.2 Heathcote River catchment

Table 3.2 summarises the water quality data collected by Christchurch City Council at each of the sampling sites in the Heathcote River catchment. Water quality data was compared to typical stormwater event mean concentrations (ECM) reported by Williamson (1993) and relevant guidelines, in order to assess potential effects (Table 3.2). This comparison shows that pH was typically near neutral (median: 7.3) and within the USEPA criteria. Conductivity and suspended solids concentrations were typically low, but varied greatly between the sample sites within the catchment; the sites closest to the estuary recorded the highest conductivity and suspended solids concentrations, reflecting the influence of tidal water on these parameters.

Dissolved oxygen was generally above the ANZECC (1992) trigger value; however, dissolved oxygen (DO) was found to be suppressed at some sites in the upper catchment (i.e. < 5 g/m^3). It is noted that DO values below 5 g/m^3 can threaten the survival of native freshwater fish (Dean & Richardson, 1999). Median biochemical oxygen demand (BOD) concentrations were generally low (1.2 g/m^3). However, elevated BOD (>10 g/m^3) was detected at two sites in the catchment, which drained predominantly industrial areas.

Measurements of total ammoniacal-nitrogen in the Heathcote Rivers were generally below the threshold for long-term toxicity (USEPA, 1999), except in the vicinity of Haytons Drain (a major industrial area draining to the Heathcote River), where ammonia levels were high enough to be toxic given the right temperature and pH conditions. Nitrate-nitrogen levels were also elevated, the main source of which was found to be groundwater springs.

Table 3.2: Comparison of water quality in Heathcote and Halswell catchments to stormwater EMCs and relevant guidelines.

Parameters	Heathcote[a] River	Halswell[a] River	Stormwater EMCs[b] Low	Average	High	Guideline
pH	7.3 (6.4 - 8.6)	7.6 (6.5 – 9.6)	-	-	-	6.5 - 9[c]
Conductivity (µS/cm)	275 (60 – 21,900)	228 (55 – 520)	-	-	-	-
Suspended solids g/m^3	9 (<0.1 – 1,120)	25 (<1 – 687)	50	170	470	-
Dissolved oxygen g/m^3	8.1 (0.6 – 14)	8.9 (2 – 250)	-	-	-	> 6[d]
BOD g/m^3	1.2 (0.1 – 20)	1.4 (0.2 – 29)	5	8	13	-
Ammoniacal-N g/m^3	0.09 (<0.01 – 63)	0.05 (<0.01 – 2.4)	0.025	0.1	0.25	3.6[e]; 2.8[f]
Nitrate-N g/m^3	1.65 (0.01 – 6.4)	1.5 (<0.01 – 6.7)	0.375	0.8	1.5	-
Nitrite-N (mg/m^3)	27 (1.5 – 1,010)	17 (<1 – 173)	-	-	-	-
DRP (mg/m^3)	52 (<1 – 7,200)	25 (1.5 – 970)	13	40	70	10[g]
Enterococci (cfu/100 ml)	170 (3 – 8,800)	-	-	-	-	140[h]; 280[i]
Faecal coliforms (cfu/100 ml)	420 (<1 – 48,000)	300 (<10 – 21,600)	-	8,000[j]	-	-
E.coli (cfu/100 ml)	570 (<1 – 215,000)	-	-	-	-	260[h], 550[i]
Copper (mg/m^3)[k]	4.6 (1.1 – 210)	-	15	40	110	3.2[l]
Lead (mg/m^3)[k]	2.8 (0.4 – 15)	-	-	-	-	0.66[l]
Zinc (mg/m^3)[k]	30 (10 – 240)	-	90	260	800	42.6[l]

Notes: [a] Median values (range); [b] Taken from Williamson 1993. Note that the lead EMC data in Williamson (1993) is not presented as this data was tabulated prior to lead being removed from petrol in New Zealand; [c] USEPA (2004); [d] ANZECC (1992) guideline; [e] USEPA (1999) freshwater ammonia criteria calculated for a temperature of 20°C and median pH value for the Heathcote River; [f] USEPA (1999) freshwater ammonia criteria calculated for a temperature of 20°C and median pH value for the Halswell River; [g] ANZECC (2000); [h] MfE (2003) alert level; [i] MfE (2003) action level; [j] overall median concentration from data collected in NZ, Australia, Canada and USA; [k] EOS Ecology (2006); [l] USEPA (2004) water quality criteria based on a hardness of 30 g/m^3.

Dissolved reactive phosphorous concentrations in the river were typically low in the upper catchment (Cashmere Stream: median 3.8 mg/m^3), but increased downstream of Hayton's Drain (median: 200 mg/m^3). The effect of the phosphorus from Haytons Drain has been seen along the length of the river.

Low faecal coliform and *E. coli* numbers were measured in the Cashmere Stream site at the top of the catchment. However, all other sites along the river showed fluctuating faecal coliform and *E. coli* numbers, with Enterococci and *E.coli* above the MfE/MoH (1999) alert level.

Copper, lead, and zinc concentrations were found to be elevated, especially in the utility waterways draining industrial areas (e.g., Haytons Drain, Curletts Road Drain). Metal concentrations exceeded USEPA criteria at most sites.

3.11.3 Halswell River catchment

As for the Heathcote catchment, water quality data was compared to typical stormwater EMCs reported by Williamson (1993) and relevant guidelines, in order to assess potential effects (Table 3.2). This comparison showed that pH was typically near neutral (median: 7.6) and within USEPA criteria. Conductivity and suspended solids concentrations were typically low. Dissolved oxygen concentrations were generally above the ANZECC (1992) trigger value, and were similar across the sites, except for the Knights Stream, Saby's Bridge site in the upper catchment, which showed consistently elevated DO concentrations (210 – 250 g/m^3). Median BOD concentrations were generally low; however, elevated BOD was recorded at the Knights Stream, Saby's Bridge site (median: 9.6 g/m^3), and at the inlet and outlet of the retention basin (median: 5; 8.7 g/m^3).

Total ammoniacal nitrogen concentrations in the River were low and consistently below USEPA (2002) chronic toxicity values for the temperature and pH ranges detected in the Creek. Nitrate-nitrogen levels were elevated at several sites. The main source of nitrate-nitrogen was a groundwater spring, located somewhere between the two sample sites on the Knights Stream in the upper part of the catchment. Nitrate-nitrogen levels were shown to decrease with distance from this area. Dissolved reactive phosphorous concentrations were typically elevated and often exceeded the New Zealand periphyton guidelines (Biggs, 2000). Faecal coliform numbers were typically elevated. Faecal coliform numbers were highest at the Nottingham Stream site (median: 1,500), but all sites showed a wide variation in count number.

Limited water quality data clearly indicate that heavy metals are likely to be at significant levels (KML 2005b), particularly within network waterways servicing industrial catchments.

3.11.4 Summary

Overall, these studies show that while some sites show reasonable water quality, a significant number of others do not, especially sites receiving runoff from industrial areas. Results to date suggest that relevant guidelines are being exceeded for a number of parameters and at a number of sites. Concerns relate particularly to elevated nutrient concentrations and elevated bacterial indicators (Enterococci/*E.coli*). Metal concentrations are in the lower end of the range reported in the literature for urban stormwater; however, they exceed relevant guidelines.

3.12 Sediment Quality

3.12.1 Introduction

Stream sediment quality is discussed in Pilot Study Stage One (Kingett Mitchell 2005a) and Sediment Quality Survey (Kingett Mitchell 2005b), which are report numbers 1 and 2 of the South-West Christchurch ICMP Technical Series. A summary of the two reports is provided in the following section.

Stream sediments provide an historical indication of water quality (Kingett Mitchell 2005a and 2005b). Polluted stream sediments inhibit the presence and health of benthic biota that would otherwise inhabit these sediments. The physical and chemical characteristics of stream sediments are influenced by soils and rocks within the catchment, local flow conditions (e.g., fast versus slow), and contributions from manmade sources, i.e. land use within the catchment.

A recent survey of sediment quality of waterways in South-West Christchurch is presented in Sediment Quality Survey, Report Number 2 of the ICMP Technical Series (Kingett Mitchell 2005b). This survey involved the collection of samples from 27 sites in the Heathcote River and 19 sites in the Halswell River (refer to Kingett Mitchell (2005b) for sample locations). This survey assessed the physical characteristics of the sediments, along with metal and PAH concentrations.

The following sections summarise sediment quality in the Heathcote and Halswell River catchments, as well as any known information about sediment quality in the Avon-Heathcote Estuary and Lake Ellesmere, the receiving environments of the two rivers.

3.12.2 Heathcote River catchment

Physical characteristics of sediments are known to influence the level of natural or anthropogenic contaminants detected. Variations in texture have two primary influences. The first is that very fine particles with high surface areas relative to their size can adsorb and concentrate contaminants, and the second is that coarse sands can dilute contaminant concentrations through their poor sorption characteristics as well as the low concentration of many elements in minerals such as quartz. The physical characteristics of the sediments collected in the Heathcote catchment showed variable texture within the tributaries, and typically fine sediment within the upper and lower sections of the Heathcote River. The middle section of the Heathcote River contained coarse sediments.

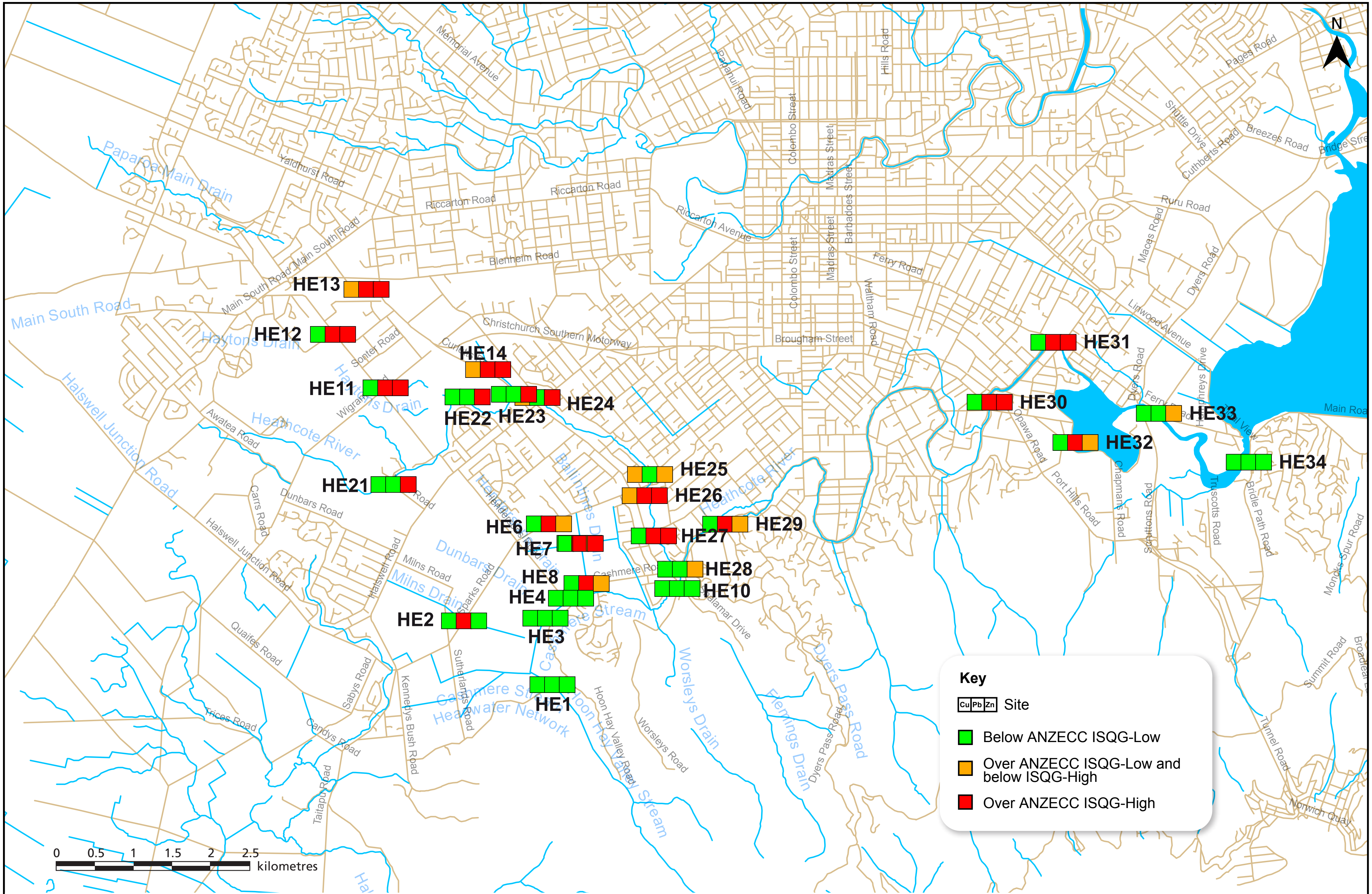
ANZECC (2000) provide sediment quality guidelines for metals and PAHs (and other contaminants) in both marine and freshwater environments. These are provided as two values, the ISQG-low (interim sediment quality guideline) and ISQG-high. The guidelines are trigger values that, if exceeded, prompt further action such as evaluation of bioavailability and background concentrations. Where the sediment concentration is below the ISQG-low, it is considered that there is low risk of adverse effects to aquatic species inhabiting the stream sediments.

Sediment quality data was compared to ANZECC (2000) guidelines, and is presented in Fig. 3.13. Any location where concentrations exceed the ANZECC (2000) ISQG-high is shaded red. Any location where any sediment sample exceeds the ISQG-low but does not exceed the ISQG-high is shaded amber. Those locations where concentrations are lower than the ISQG-low are shaded green.

Sediment samples from the Heathcote catchment of South-West Christchurch displayed elevated concentrations of copper, lead, and zinc. Different land uses within the catchment can be expected to generate different contaminant loads that may enter the stream systems. In the Heathcote catchment metal concentrations in the stream sediments generally increased from rural land use in the upper Cashmere Stream and its tributaries; to residential land use around the Cashmere Stream and the main Heathcote River; to mixed urban and industrial land use in Hornby and around Blenheim Road, where metal concentrations were highest.

Outside the South-West Christchurch catchment, metal concentrations generally decreased with proximity to the estuary. Copper concentrations were below ANZECC (2000) trigger values at all downstream sites. Lead and zinc were above the ISQG-high around Woolston, but decreased to below the ISQG-low at Ferrymead Bridge.

Of all the metals zinc is the parameter of most biological concern, with ~80% of samples exceeding the ISQG-low and ~50% exceeding the ISQG-high. Six of these were from sites in the main Heathcote River and five from tributaries. Overall, the metal concentrations indicate the potential for adverse effects to aquatic organisms.



TITLE COMPARISON OF COPPER, LEAD AND ZINC IN THE HEATHCOTE CATCHMENT TO ANZECC (2000) SEDIMENT QUALITY GUIDELINES.

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Polycyclic aromatic hydrocarbon (PAH) concentrations in the Heathcote River catchment varied significantly between urbanised catchments (Fig. 3.14). Within the Heathcote catchment, the background sites contained generally lower total PAH concentrations. The mixed and residential sites appeared to have the highest concentrations of total PAHs. PAHs exceeded the ISQG-low in Dunbars, Ballantines, Sherrings, and Stillwells Drains. Concentrations are sufficiently high in some parts of the Heathcote River catchment that PAHs may be contributing to potential adverse environmental effects.

3.12.3 Avon-Heathcote estuary

The quality of sediments in the Avon-Heathcote estuary has been extensively studied. These studies have included sediments in the estuary of the Heathcote River and the tidal flats in the areas adjacent to where the river enters the main Avon-Heathcote estuary.

The most recent large survey was undertaken by Christchurch City Council in 1998 (Milne 1998). As with the earlier surveys, the study showed that the concentrations of metals in the sediments of the main estuary are not high. This arises in part because the sediments over much of the main body of the estuary are sandy. Comparison of the median concentrations from Milne's 1998 study with the ANZECC (2000) sediment quality guidelines shows that none exceeded the ISQG-low.

Mills & Williamson (1999) reviewed available information on organic compounds in sediments in the Avon-Heathcote estuary. They identified higher concentrations of contaminants in sediments which were located adjacent to the Avon and Heathcote Rivers; however, the average concentrations of compounds such as DDTs and PCBs in the Heathcote sediments were shown to be slightly lower than in a number of other urbanised estuaries in New Zealand. PAH, dieldrin, and chlordane concentrations were similar to those found in other urbanised estuaries in New Zealand.

3.12.4 Halswell River catchment

The physical characteristics of the sediments collected in the Halswell catchment showed that the tributaries of the Halswell typically contained coarser sediments than the Heathcote River. The sediments of the Halswell River were dominated by fine sand and mud.

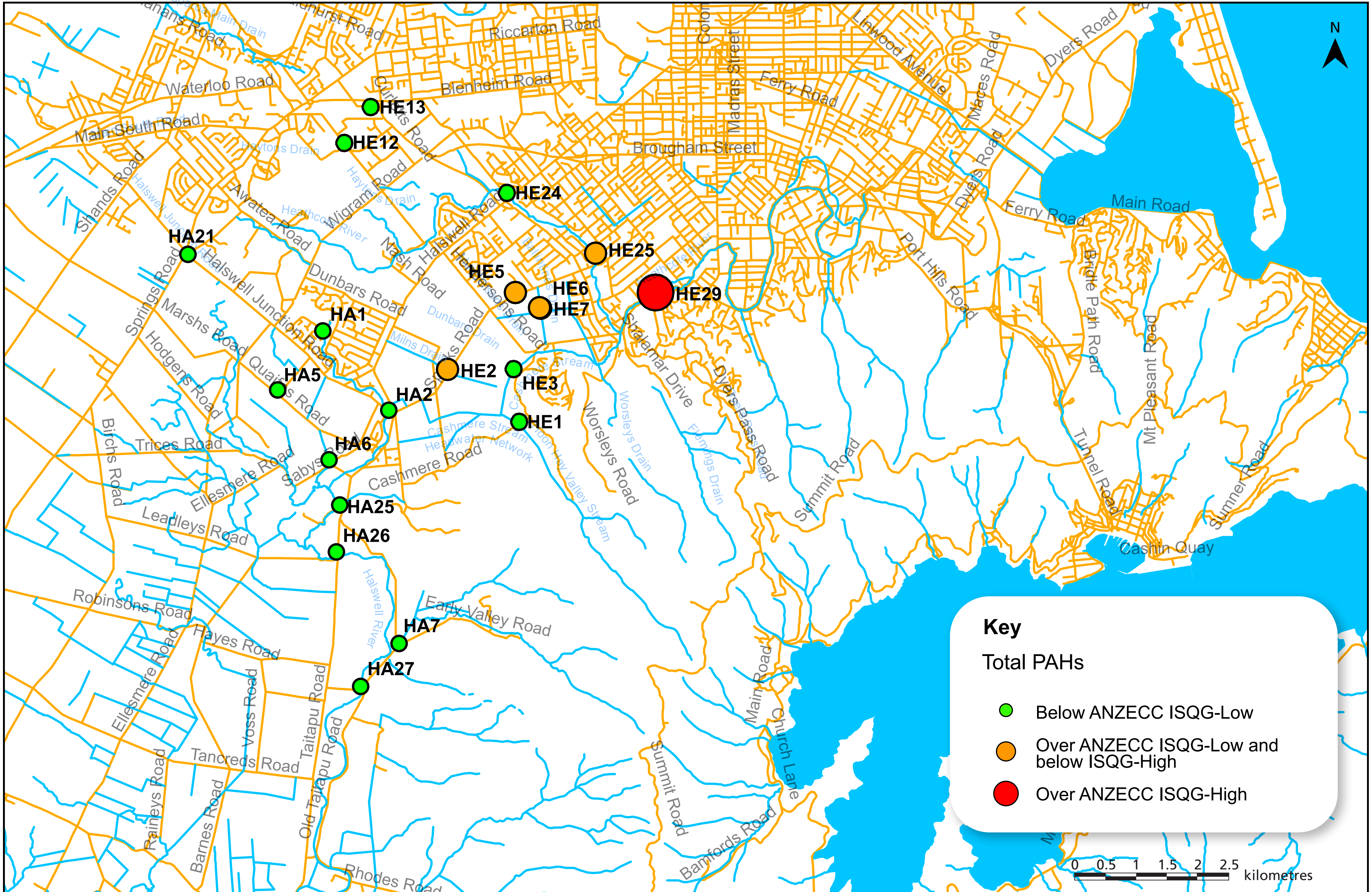
For the Halswell catchment, sediments from urban catchments had higher concentrations of metals than the mixed and background (rural) catchments (Fig. 3.15). The mixed land use sites were all in the main stem of the Halswell River, and the catchment was predominantly rural, with some upstream urban influences.

The samples with exceedences were collected from tributaries of the Halswell River, Nottingham Stream, Greens Drain, and Knights Stream. Samples collected from the main stem of the Halswell River did not exceed ANZECC (2000) sediment quality guidelines. This indicates that there is low risk of adverse effects to aquatic organisms in the Halswell River from the presence of copper, lead, or zinc.

The concentrations of PAHs in the Halswell catchment, in all three land uses, were typically lower than those in the Heathcote catchment. At all sites the concentration of PAHs were below the ISQG-low (refer to Fig. 3.14).

3.12.5 Lake Ellesmere

The quality of sediments in Lake Ellesmere has not been extensively studied like the Avon-Heathcote Estuary. Although there is an industrial zone located in the upper reaches of the Halswell River catchment (i.e., west of Springs Road), the majority of the catchment is rural in nature. Sediments are therefore expected to reflect those of a receiving environment with mostly rural catchment areas, with some industrial and urban influences.



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TITLE COMPARISON OF TOTAL PAHs IN THE HEATHCOTE AND HALSWELL CATCHMENTS TO ANZECC (2000) SEDIMENT QUALITY GUIDELINES.

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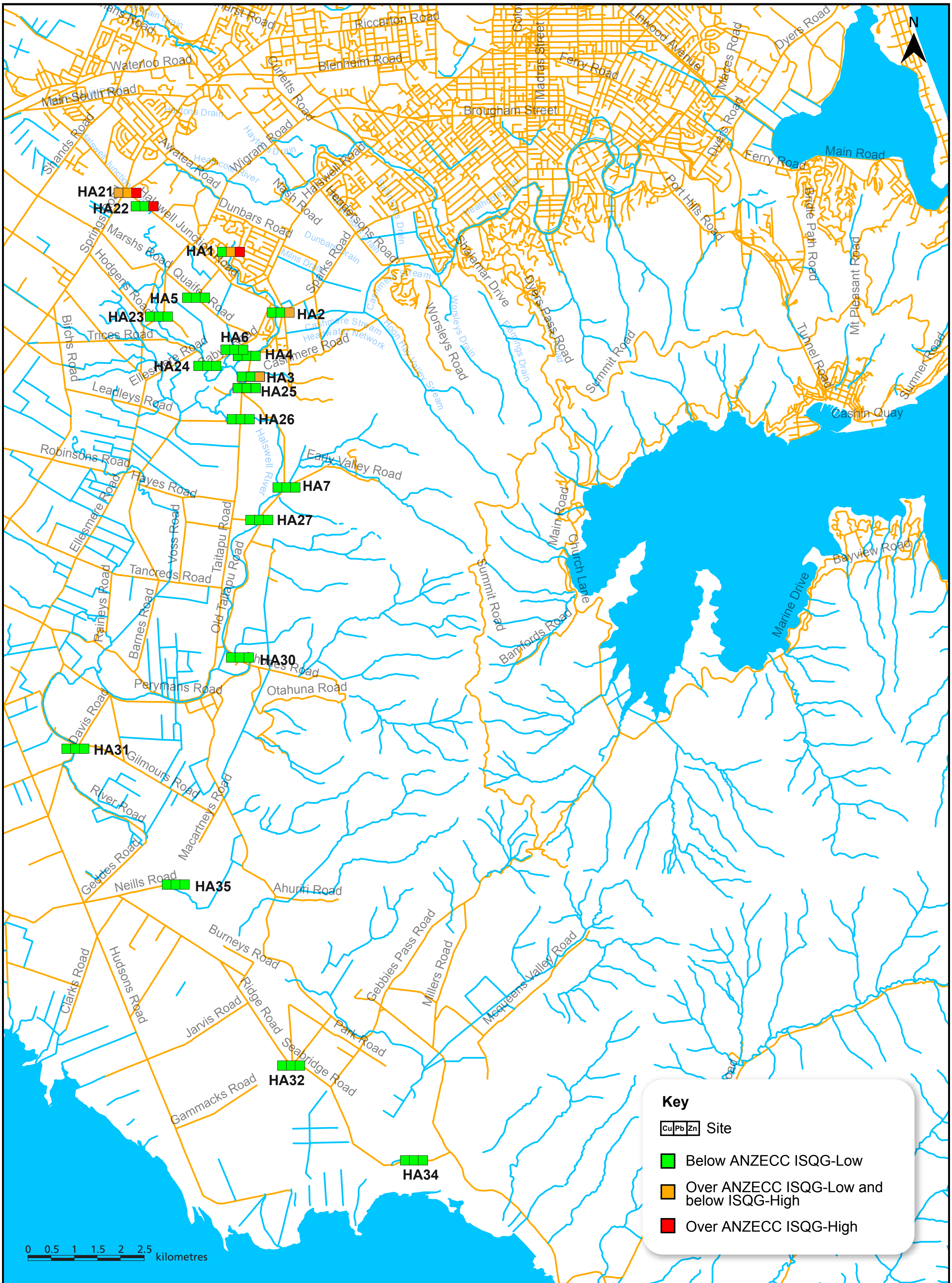

TITLE COMPARISON OF COPPER, LEAD AND ZINC IN THE HALSWELL CATCHMENT TO ANZECC (2000) SEDIMENT QUALITY GUIDELINES.

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3.12.6 Summary

Overall, the upper reaches of the Heathcote River (predominantly residential and industrial) are significantly degraded with regard to metal contamination in stream sediments. Zinc is the key concern, with approximately 50% of sites in the Heathcote River, and a smaller number in the Halswell, exceeding the ANZECC (2000) guidelines. The upper reaches of the Halswell River (predominantly rural land use) are in better condition than the Heathcote, but still have a number of sites (within industrial areas) where ANZECC (2000) guidelines are exceeded.

PAHs have also been detected at significant levels at a number of sites in the Heathcote River, while no sediments sampled from the Halswell River exceeded the ANZECC (2000) guidelines. The results generally show higher levels of PAHs in residential areas, whereas levels are low to moderate in industrial areas, and low in rural areas. The results suggest the source of PAHs may be predominantly associated with residential areas. Management of stormwater quality, starting with reducing contaminant loads at their source, is an important method of reducing the potential for adverse effects on stream sediments as a result of development (KML 2005a).

3.13 Groundwater

3.13.1 Characteristics

The South-West Christchurch project area is located within the Christchurch-West Melton groundwater zone. In the southern part of the catchment the base of the Port Hills contributes groundwater to the surrounding sedimentary strata. The rate of recharge is not known, but a lack of high yielding wells in the volcanic rock and an apparent lack of influence on groundwater quality suggests that it is small (PDP 2003 and 2005b).

Available groundwater data indicates that there is considerable variation in groundwater levels throughout the area, with the depth to groundwater on the Canterbury Plains generally increasing to the north-west. Groundwater flow in the northern part of the Heathcote catchment is towards the east, with the flow direction shifting to the south and south-east in the southern part of the catchment. This change in flow direction, forming a groundwater divide, is reportedly induced by the relatively low permeability of the Port Hills volcanic rocks (PDP 2003). Groundwater flow in the Halswell catchment is generally to the south.

Generally, groundwater within the northern and central parts of the catchment is likely to flow east, and at shallow depths emerges as surface flow in the Heathcote, Cashmere, and Knights waterways. Deeper groundwater will either be consumed by abstraction, or will flow to the sea via offshore submarine springs (PDP 2003). Flow patterns at a smaller scale will be more complex, being influenced by hydraulic conductivity, lithological character, pumping, and infiltration.

3.13.2 Springs and Baseflow Contributions

There are a large number of springs in the project area. Artesian pressure forces groundwater up through confining layers until it emerges as a spring. Springs contribute significantly to baseflows within Cashmere Stream, and within tributaries of the Halswell and Heathcote Rivers. Springs in Hendersons Basin have been proven to be sensitive to groundwater pressures; this relationship is expected to exist for other springs as well.

The distribution of springs is controlled by the distribution and characteristics of the confining layer over the aquifer that is the source of the springs. Essentially, this means that springs are found where there is a moderate thickness of confining layer and the groundwater pressures created are sufficient to cause springs to ‘break through’. The majority of springs are located between Knights Stream, Cashmere Stream, and the Heathcote River. A large number of springs associated with the Halswell River are located outside the bounds of the South-West project area.

Fourteen springs contribute to permanent flow in the Cashmere Stream and Hendersons Basin in the Heathcote catchment. The Cashmere Stream at the Heathcote River confluence has a baseflow of approximately 300 L/s, and the Heathcote River at that point has a baseflow of 600 L/s. Nine springs also occur on the boundary of the Heathcote and Halswell catchments, within paddocks to the east of Knights Stream (in the area to the south-west of the intersection of Quaifes Road and Murphys Road).

Given that the springs are a significant contribution to Cashmere Stream and Heathcote River baseflow, it is recommended that future land development does not cause a lowering of groundwater pressures, i.e., during urban development rainwater infiltration must continue to occur in areas where it recharges the groundwater resource.

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

Seven springs occur within or to the west of the headwaters of the Halswell River. The baseflow of the Halswell River at Old Tai Tapu Road Bridge is about 1,000 L/s. Urban development should be carried out in a way that maintains groundwater levels so that these spring flows are not lost, as they are the most important contributors to baseflow. Groundwater in the Halswell catchment could also be consumed by abstraction, or will seep into Te Waihora (Lake Ellesmere), or further to the southeast to the sea (PDP 2004).

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

3.13.3 Use

Groundwater within South-West Christchurch is used mainly as a reticulated drinking water supply. It is also used for commercial, industrial, and irrigation purposes. Four major pumping stations are located in the Heathcote catchment, consisting of 18 public drinking water supply wells. Only two of the 18 wells, located at Hillmorton and Spreydon, are in the most vulnerable upper aquifer. Public drinking water wells are identified in Fig. 3.16.

The protection of groundwater resources is a significant issue for Christchurch, given that the City's drinking water is obtained from groundwater and, to date, has required no treatment.

3.13.4 Stormwater management

The potential distribution of urban development is constrained to a certain extent by the ability to deal with surface water shed during rain storms. Ideally, stormwater runoff would be managed so that it is released to the natural environment in a manner that is similar to the pre-urbanised flow pattern.

In areas where surface water infiltration into the ground is not possible, detention mechanisms are required, which will include the controlled release of water to the natural surface waterway system at a time that allows safe and efficient discharge. In areas underlain by permeable gravel (for example, in part of South-West Christchurch), stormwater can infiltrate directly to groundwater.

Stormwater infiltration is restricted by two major factors: high groundwater levels, and areas where the surface strata have low permeability.

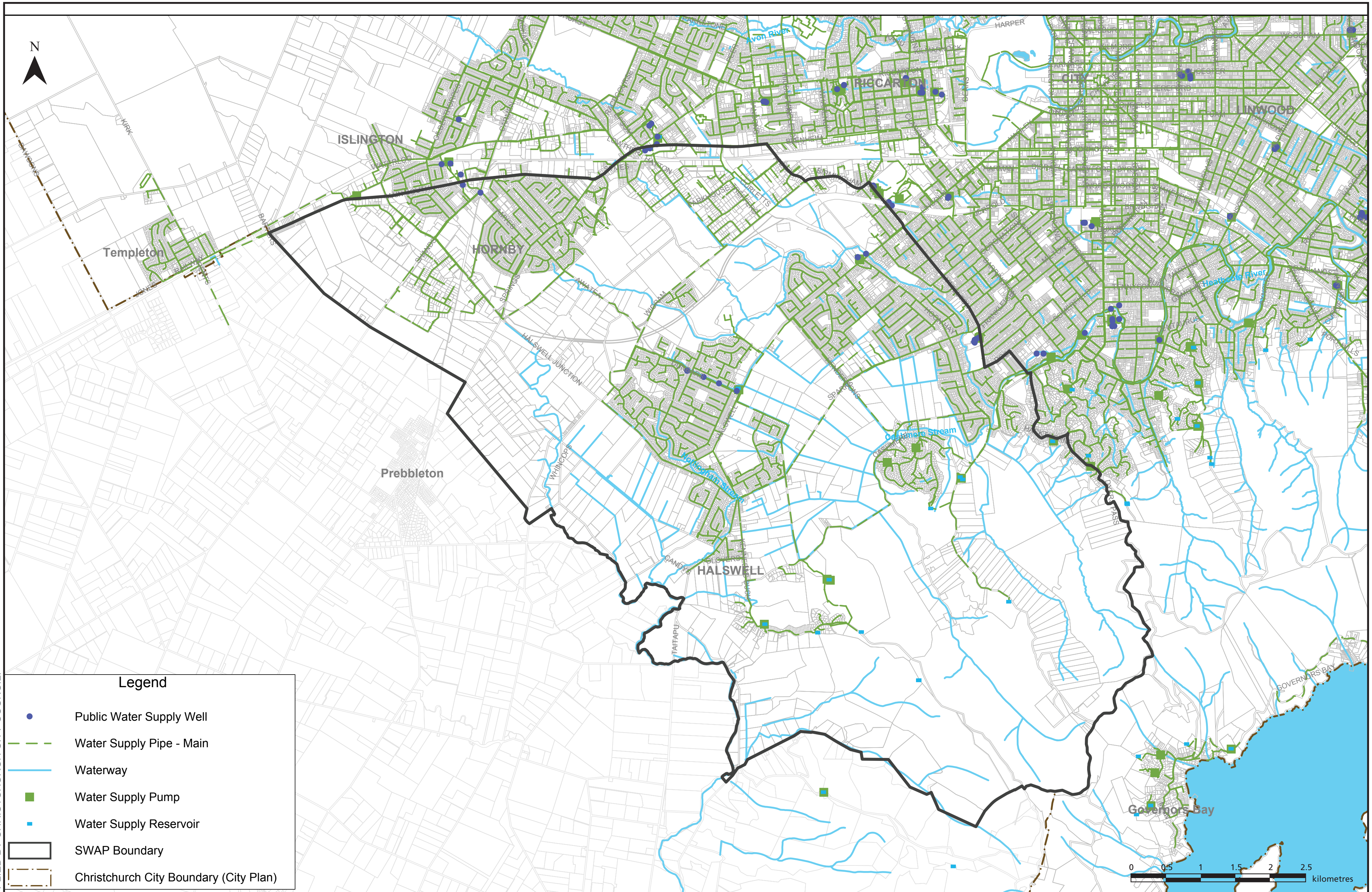

FIGURE SUPPLIED BY CHRISTCHURCH CITY COUNCIL.

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TITLE SOUTH-WEST CHRISTCHURCH PUBLIC DRINKING WATER WELLS.

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Three broad zones of groundwater level and geology are a useful tool in assessing zones of potential infiltration:

- Groundwater depths of greater than 3 m indicate that infiltration of surface water is unlikely to cause problems, provided that the soil is sufficiently permeable; this applies to the region west of the confining layers 3 m contour and the central and south-eastern parts of the two catchments. High infiltration rates (>50 mm/hour) will occur where there is alluvial gravel strata, and lower infiltration rates (<5 mm/hour) will occur in Springston silt and sand.
- Depths of less than 2.5 m indicate that infiltration of surface water is unlikely under high groundwater conditions, regardless of soil conductivity, i.e., predominantly in the north-western part of the project area.
- At groundwater levels between 2.5 m and 3 m, infiltration of surface water may be possible provided that soil conductivities are sufficient. High infiltration rates occur in alluvial gravels (>50 mm/hour), and lower infiltration rates occur in Springston sands and silts (<5 mm/hour).

Generally, stormwater infiltration is considered likely to be governed by the distribution of gravels and silts. Areas underlain by gravels at shallow depth are suitable for infiltration, and areas underlain by the overbank silts and sandy silts are suitable for detention. To determine the infiltration potential, information contained on geological maps should be confirmed with field based investigations (PDP 2004).

3.14 Transport

Transport is an important factor to consider when providing integrated catchment management. Roads with high traffic volumes can produce significant contaminant loads without appropriate mitigation. No water quality and quantity mitigation is typically provided for existing stormwater discharges from roads within South-West Christchurch. The transportation network is shown in Fig. 3.17.

3.15 Land-use

The development of new residential and business areas will occur within the network of stormwater management facilities and the Greenprint. This will ensure the built environment does not compromise the natural environment, and that connections between open space areas (including stormwater management facilities) can be achieved.

The spatial structuring of medium and low density residential areas will be a critical factor in achieving urban consolidation objectives. Higher density areas could potentially be perceived to provide a lower amenity if not balanced with high quality and accessible open space. The stormwater management scheme and Greenprint provide guidance to where medium density areas may be successful.

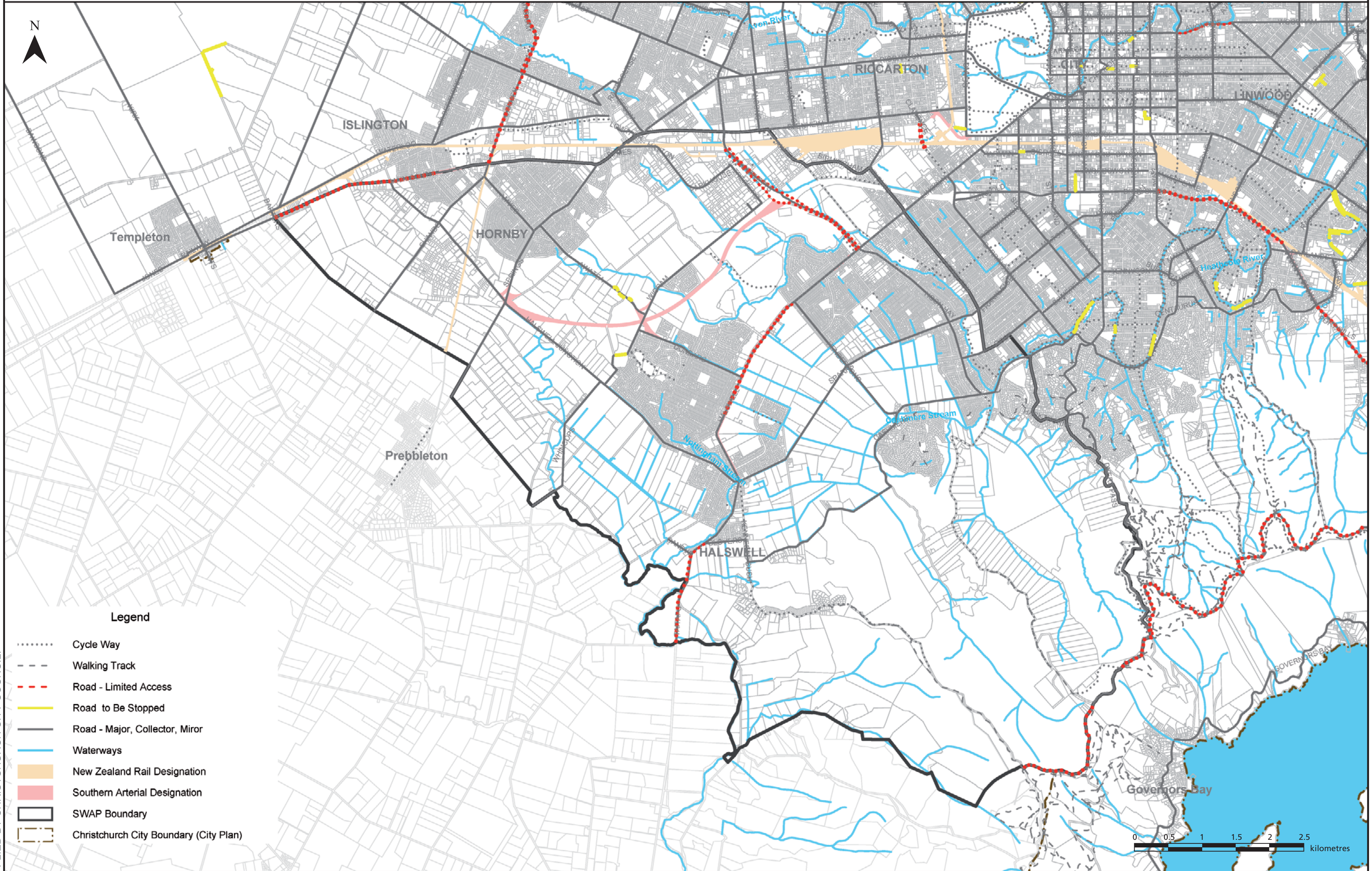

FIGURE SUPPLIED BY CHRISTCHURCH CITY COUNCIL.

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TITLE SOUTH-WEST CHRISTCHURCH TRANSPORTATION NETWORK.

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4. Receiving Environment Objectives

4.1 Background

The adopted approach for defining a receiving environment within South-West Christchurch has been developed based on legislation, statutory documents (City Plan and NRRP), and non-statutory documents (Planning and Consents Protocol for Surface Water Management, Heathcote River Floodplain Management Strategy). A significant amount of information has been collected, including stream sediment and water quality data, measurement of baseflows and identification of springs, hydrological and hydraulic modelling, and ecological surveys. Investigation and assessment of infiltration rates of surface and subsurface soil and groundwater have also been conducted. The knowledge obtained from these assessments has been used to further build an understanding of the receiving environments. Future investigation can be used to build on what has already been gathered, and assess trends within the receiving environments.

Investigations have identified the South-West Christchurch environment as being highly modified as a result of urbanisation. Surface water and groundwater quality has been degraded by urban expansion and historic industrial site practices. The objectives have been developed to prevent further degradation of surface water quality and ecological values in the short term and to improve water quality and ecological values over the life of this ICMP. The objectives with respect to ecological values are based on providing improved habitat and water quality and remove barriers for the enhancement or return of ecological systems. However it is recognised that re-colonisation of historically degraded waterways is a complex process and the objectives cannot guarantee re-colonisation and restoration of historical ecological values. The objectives with respect to groundwater quality is to maintain a high quality groundwater resource which will require improving industrial site management and ensure soakage system provide sufficient treatment prior to mixing with groundwater. The groundwater objectives also seek to protect the water quality of springs that contribute to baseflow in waterways.

Receiving environment objectives relating to water quantity controls are based on the recommendations of the Heathcote Floodplain Management Strategy which requires no increase and where possible reduce flood levels in Heathcote River from that predicted for 1991 land use and catchment development levels. The same recommendations for the Heathcote River have been adopted for the Halswell River.

The following objectives are statements of intent for which action plans and time frames have yet to be defined. The objectives have been developed through recommendations in the water quantity assessment (South-West Christchurch ICMP Technical Series Report Number 4) and water quality assessment (South-West Christchurch ICMP Technical Series Report Number 5) reports and a series of workshops between Christchurch City Council and ECan. The ICMP is a living document and the objectives may change over time. ECan and Christchurch City Council will work together in relation to these objectives.

4.2 Groundwater Objectives

The groundwater beneath South-West Christchurch is defined as one interconnected receiving environment. The recommended receiving environment objectives relating to groundwater quality and quantity have been developed over a series of workshops and meetings, and are based on the knowledge of the South-West Christchurch receiving environments. The objectives for the groundwater receiving environment are:

- Meet proposed NRRP groundwater quality standards (i.e., maintain 2002 groundwater quality) at public drinking wells and springs.
- Maintain a high quality groundwater resource.
- Design soil absorption basins and soakage systems to avoid contamination of deep confined aquifers.
- Protect the water quality of springs that contribute to waterway baseflows.

4.3 Surface Water and Ecological Objectives

The recommended receiving environment objectives relating to water quality and aquatic ecology have also been developed over a series of workshops and meetings, and are based on the current knowledge of the South-West Christchurch receiving environments. Waterways have been given classifications, and objectives have been set based on those classifications. The classifications of the waterways are shown in Fig. 4.1. The adopted objectives are:

Class 1 Receiving Waterways

- Protect existing and otherwise enhance ecological values.
- Meet USEPA criteria for copper, zinc, and lead.
- Reduce nutrient levels.
- No ecological impacts from construction activities.
- Reduce existing flood levels (Heathcote Floodplain Management Strategy)
- Protect springs that provide baseflow.
- Protect and enhance existing baseflow conditions.

Class 2 Receiving Waterways

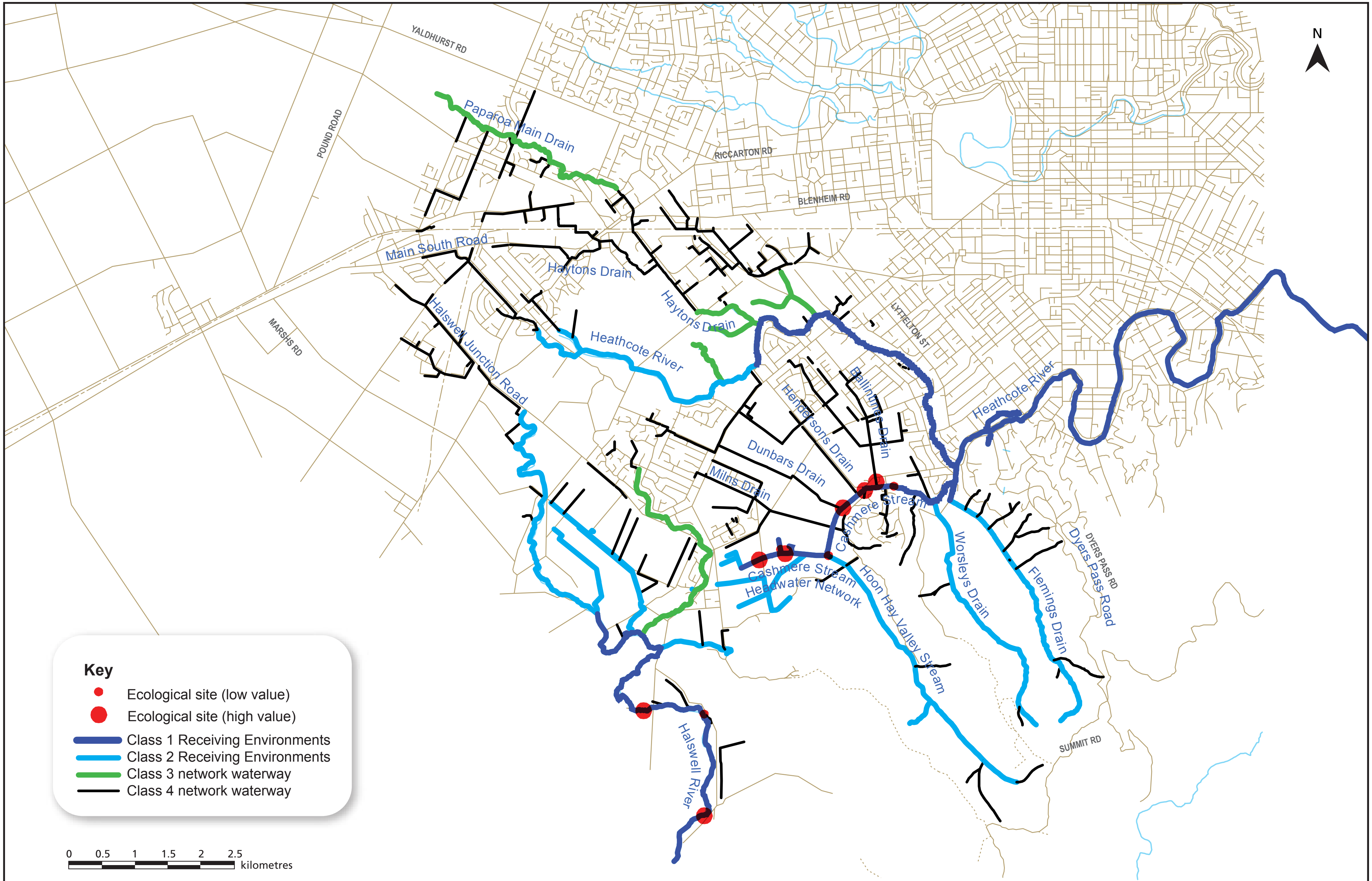
- Enhance ecological values.
- Meet USEPA criteria for copper, zinc, and lead where possible.
- Reduce nutrient levels.
- No ecological impacts from construction activities.
- Reduce existing flood levels (Heathcote Floodplain Management Strategy).
- Protect springs that provide baseflow.
- Protect existing baseflow conditions.

Class 3 Network Waterways

- Enhance ecological values.
- Ensure Class 1 and 2 waterways downstream are not compromised.
- Maintain level of service.

Class 4 Network Waterways

- Ensure Class 1 and 2 waterways downstream are not compromised.
- Maintain level of service.



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TITLE WATERWAY AND RECEIVING ENVIRONMENT CLASSIFICATIONS.

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5. Proposed Integrated Catchment Management

5.1 Introduction

The South-West Christchurch ICMP has been developed to enable structural mitigation measures (Surface Water Management Scheme) to be implemented in a progressive manner based on final land use for the project area following the Area Planning and City Plan processes. Structural mitigation for water quality and quantity effects will be implemented in advance of any development. Alternative structural measures will be implemented on a reactive basis following monitoring and reporting on ICMP performance against receiving environment objectives. The non-structural mitigation measures will be proactively implemented as programmes are developed and resources obtained. These measures will include environmental and targeted education (building materials and industrial sites), source control, low impact design, and promotion and enforcement of better environmental management practices at industrial sites.

The management approach includes the following methods to meet the objectives identified in Section 4:

- Level of service (design capacity of conveyance systems) and infrastructure design (Infrastructure Design Standards and Waterways, Wetlands and Drainage Guide).
- Environmental education (awareness of environmental effects of building materials, effects of poor industrial practices and general environmental and waterway awareness).
- Industrial stormwater and site management (ECan Pollution Prevention Guide, source control and individual site permitting).
- Stormwater quality and quantity mitigation (Surface Water Management Scheme and contingency mitigation measures).
- Sediment and erosion control for construction of new subdivisions and other developments (develop and implementation of plans).
- Low impact design and source control.
- Waterway enhancement programmes.
- Green Print initiatives and land use controls.
- Monitoring and reporting (refer to Section 6).
- Further investigations (refer to Section 6).
- Sub-Project Area reports (refer to Section 8).
- Operation and Maintenance (develop and implement plans) of stormwater systems (refer to Section 8).
- ICMP Reviews (refer to Section 9).

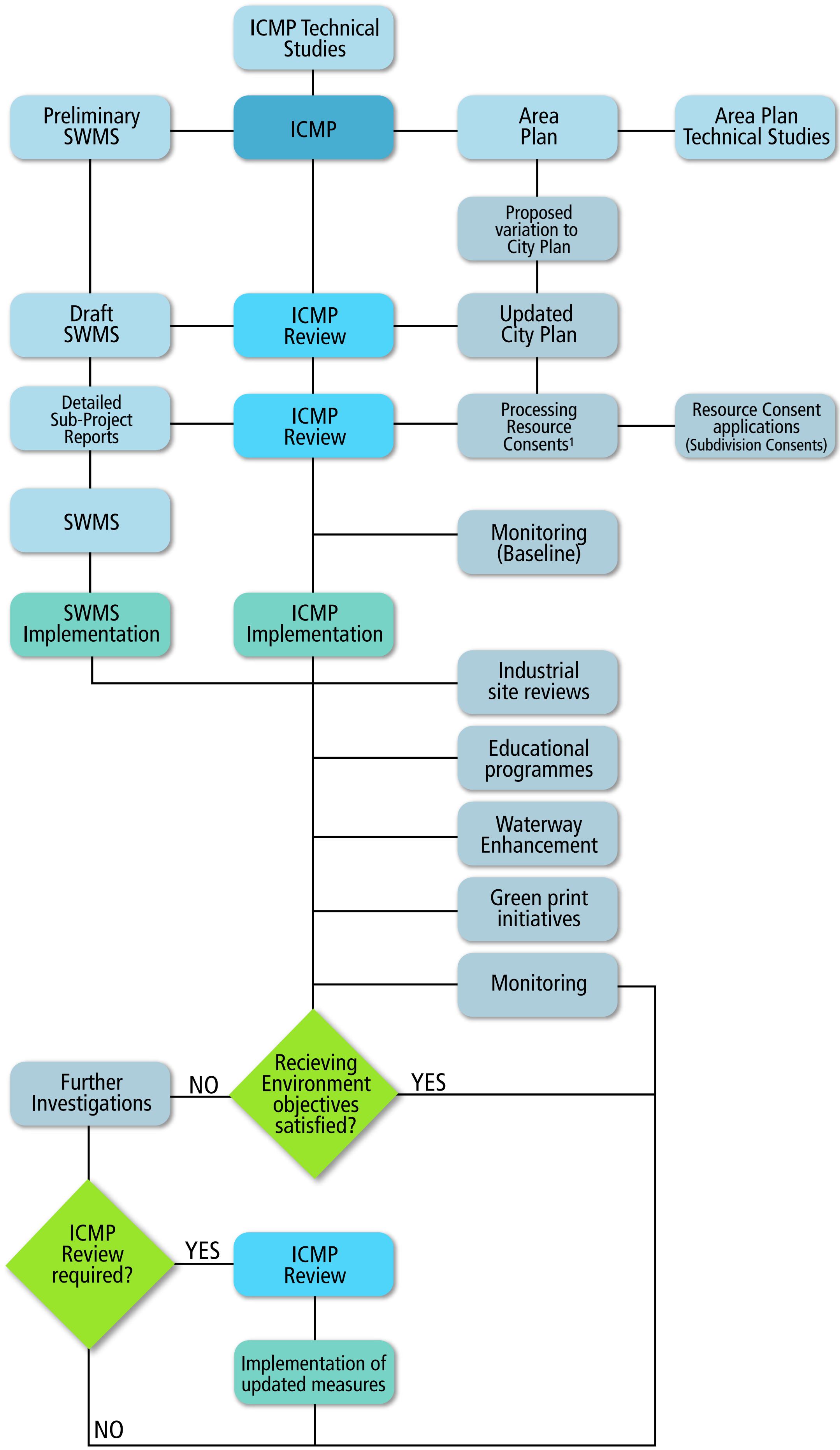
The linkage between mitigation and management measures and the receiving objectives is summarised in Table 5.1. The linkages identified in Table 5.1 clearly show a wide range of integrated catchment management measures are proposed to meet receiving environment objectives. The decision process for providing integrated catchment management measures within South-West Christchurch is summarised in Fig. 5.1.

The following sections describe the methods proposed to meet the receiving environment objectives.

Table 5.1: Linkage between management tools and objectives.

	SWMS	SECMP	SPAR	O & M Plans	Green Print	W\W Enhancement	IDS & WWDG	Subdivision Consents	Source Control (BM)	Source Control (Ind)	Lu Controls (AP)	Lu controls (CP)	Education (BM)	Education (G)	Education (Ind)	Monitoring	Further Investigations	ICMP Reviews
Class 1 Receiving Waterways																		
Protect existing and otherwise enhance ecological values.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Meet USEPA criteria for copper, zinc, and lead.	■		■	■			■	■	■	■	■	■	■	■	■	■	■	■
Reduce nutrient levels.										■	■	■		■	■	■	■	■
No ecological impacts from construction activities.		■	■				■	■			■	■		■		■	■	■
Reduce existing flood levels (HFMS).	■		■	■		■	■	■			■	■				■	■	■
Protect springs that provide baseflow	■		■		■	■	■	■			■	■		■			■	■
Protect and enhance existing baseflow conditions.	■		■			■	■	■			■	■		■			■	■
Class 2 Receiving Waterways																		
Enhance ecological values	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Meet USEPA criteria for copper, zinc, and lead where possible.	■		■	■			■	■	■	■	■	■	■	■	■	■	■	■
Reduce nutrient levels										■	■	■		■	■	■	■	■
No ecological impacts from construction activities.		■	■				■	■			■	■		■		■	■	■
Reduce existing flood levels (HFMS).	■		■	■		■	■	■			■	■				■	■	■
Protect springs that provide baseflow.	■		■		■	■	■	■			■	■		■			■	■
Protect existing baseflow conditions.	■		■			■	■	■			■	■		■			■	■
Class 3 Network Waterways																		
Enhance ecological values.	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Ensure Class 1 & 2 w\w downstream are not compromised.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Maintain level of service.	■		■	■		■	■	■			■	■						■
Class 4 Network Waterways																		
Ensure Class 1 & 2 w\w downstream are not compromised.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Maintain level of service.	■		■	■		■	■	■			■	■						■
Groundwater																		
Meet NRRP quality standards at public drinking wells & springs.	■		■	■			■	■	■	■	■	■	■	■	■	■	■	■
Maintain a high quality groundwater resource.	■		■	■			■	■	■	■	■	■	■	■	■	■	■	■
Design SABs to avoid contamination of deep confined aquifers.	■		■					■							■		■	
Protect the water quality of springs and baseflow.	■		■	■			■	■	■	■	■	■	■	■	■	■	■	■

Notes: SWMS = Surface Water Managemnt Scheme; SECMP = Sediment and Erosion control Management Plans; SPAR = Sub-Project Area Reports; O & M Plans = Operation and Maintenance Plans; w\w = waterway; IDS = Infrastructure Design Standards; WWDG = Waterways, Wetlands and Drainage Guide; BM = Building Materials; Ind = Industrial Sites; LU = Land Use; AP = Area Plan; CP = City Plan; G = General; HFMS = Heathcote Floodplain Management Strategy.



[1] Commencement of construction following SWMS implementation.

5.2 Level of Service

The level of service for surface water management that Christchurch City Council provides is determined through the Long Term Council Community Plan consultation process. The level of service provided by Christchurch City Council is outlined in the Infrastructure Design Standard and the Waterways, Wetlands and Drainage Guide. The Infrastructure Design Standard and the Waterways, Wetlands and Drainage Guide also outline the standards and design methods to be used when designing infrastructure on behalf of Christchurch City Council.

The Infrastructure Design Standard and the Waterways, Wetlands and Drainage Guide are important documents in ensuring the level of service is provided and infrastructure is designed to standards approved by Christchurch City Council. This will ensure that infrastructure and developments within South-West Christchurch will be implemented such that secondary overflows paths are maintained or provided, correct reticulation capacity is provided, properties are protected from flooding and developments will be compatible with the surface water management scheme (based on six values approach) proposed by Christchurch City Council.

5.3 Environmental Education

Christchurch City Council recognises the importance of environmental education on achieving longer term environmental objectives. The Christchurch City Council currently has a number of environmental education programmes (i.e., drains to waterways and community waterway enhancement projects). Christchurch City Council is committed to continuing such programmes and developing new programme where possible. In addition to current environmental education programmes Christchurch City Council will work with Environment Canterbury on the following programmes:

- Building Materials - Raising awareness of the effect of building materials on stormwater quality (i.e., zinc roofing products and copper spouting and down-pipes) and providing information on more environmentally sustainable choices is considered the most effective way of reducing the effects of building materials.
- Erosion and Sediment Control for Guidelines for small have been recently developed by ECan. Christchurch City Council contributed to these guidelines and will require these guidelines to be implemented for all building consents for small properties (i.e., residential houses). This will help mitigate effects from sediment discharges during construction of individual houses which normally occurs after subdivision construction when the erosion and sediment control plans for the subdivision are no longer in place.
- Industrial site management. ECan has recently developed a Pollution Prevention Programme that promotes self auditing of industrial sites, and helps site occupiers develop appropriate and best practice environment management practices on site. The programme has been very successful given the large number of industrial sites within Canterbury and the relatively limited resources. Christchurch City Council recognise this programme as being strategically important in reducing surface water and groundwater effects from industrial sites. Christchurch City Council will work with ECan to implement this programme throughout South-West Christchurch.

5.4 Industrial Stormwater and Site Management Controls

The environmental management practices at existing and new industrial sites within South-West Christchurch are a key issue in relation to protecting groundwater and surface water quality. Historical site practices are well recognised as a significant contribution to environmental effects observed in both surface waterways and groundwater.

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

The improvement of site and environmental practices of existing industrial sites, in particular the older sites, are well recognised as a significant opportunity to improve environmental quality within South-West Christchurch. As such, Christchurch City Council are interested in working closely with ECan in identifying key sites that both organisations can further promote and enforce appropriate practices and source control where required. This can be achieved through Christchurch City Council supporting ECan's existing Pollution Prevention Guide programme by providing additional resources. In additional Christchurch City Council will work with ECan to identify higher risk industrial sites which both councils will enforce an agreed individual permitting system for industrial stormwater discharges into the Christchurch City Council stormwater network.

A land use survey has been conducted by Christchurch City Council to assist in identifying higher priority sites. The survey information has been categorised using the Hazardous Activities and Industries List (HAIL), as described in Section 3 of this ICMP.

5.5 Stormwater Quality and Quantity Mitigation

5.5.1 Introduction

A surface water management scheme will be developed to provide a high level of water quality mitigation and limit flooding in the receiving environment waterways to levels not exceeding those identified in the Heathcote Floodplain Management Strategy (CRC 1998). The surface water management scheme is also intended to provide for other values (i.e., landscape, recreation, culture, heritage and ecology), and be robust enough to accommodate for possible 'future' needs (climate change, higher water quality requirements, etc.).

For South-West Christchurch the guiding document for stormwater disposal options for new systems is the Heathcote River Floodplain Management Strategy, which advocates soakage to ground in the upper Heathcote catchment for new developments where possible, and the preservation and possible enhancement of natural ponding areas such as Hendersons Basin. The objective in this strategy is to limit flooding in the middle and lower reaches of the Heathcote River to levels not exceeding that experienced at the time of the strategy. Similar flooding issues exist for the Halswell River. The water quantity and quality assessments (Report Numbers 4 and 5 of the South-West Christchurch ICMP Technical Series) further support the objectives and recommendations of the Heathcote Floodplain Management Strategy.

The adopted mitigation strategy for water quantity is based on the option of providing detention capacity for 2% annual exceedance probability (AEP) critical duration events with slow release to surface water, rapid soakage chambers, or soakage trenches where site conditions are suitable.

Following an assessment of water quality mitigation options Christchurch City Council has adopted the option of providing water quality mitigation for South-West Christchurch via providing soil adsorption basins where suitable soakage conditions exist, and sedimentation basins followed by wetlands (or wet ponds) where soakage is not feasible. The adopted mitigation option for water quality will be integrated with water quantity mitigation to form the surface water management scheme.

The choice of mitigation facilities within the different sub-catchments has been strongly influenced by the following factors:

- Water quantity mitigation requires large detention and retention basins to be constructed and therefore water quality mitigation can be located within the land purchased for water quantity.
- The adopted option must have regard to strategies for other values for the South-West Christchurch Area Plan such as recreation, landscape, cultural, heritage, and ecology (aquatic and terrestrial). In recognising these important inter-relationships and the Christchurch City Council's desire to provide an integrated approach to planning for the long term future of South-West Christchurch, it is clear that

while other mitigation options (i.e. filtration systems) may exist that can meet the sole requirements for water quality, they cannot meet these other important values that Christchurch City Council must consider to better ensure high ecological and amenity outcomes for South-West Christchurch.

- Christchurch City Council has significant experience in design and maintaining soil adsorption basins, sedimentation basins, wetlands and wet ponds.

The mitigation strategy also includes the provision of contingency measures or systems to be inserted into the treatment train to cater for any unexpected water quality results. The mitigation strategy is also designed to be flexible, so it can respond to a variety of land use changes and land use types, as well as site restraints (e.g., that may prevent ponds and wetlands from being constructed), and still achieve the receiving environment objectives outlined in Sections 4.2 and 4.3.

5.5.2 Design principles

The key design principles for the development of a surface water management scheme and the Christchurch City Council philosophy are:

- It is fundamentally a 'natural' system, avoiding the over-use of pipes, concrete channels, and pumping stations. As such it will require significant maintenance but not replacement. This approach is consistent with the sustainability principles of the Resource Management Act.
- Significant land areas are required for the water management facilities, approximately 7% to 10% of the developed land area for quality and quantity combined. This is much greater than what has been required previously for management of waterways (approximately 1%), where waterway corridors made no provision for stormwater treatment or for storage. Maximum possible integration of land use with other needs, such as recreational open space, will help to reduce the land cost associated with water quantity and quality treatment. Much of the scheme's water quantity mitigation area could be used for other purposes, such as recreational areas, because ponding would only occur during infrequent, more severe rain events.
- The proposed facilities are typically large and designed to serve large areas, rather than having a proliferation of smaller facilities. Generally, the facilities are clear of the waterway channels, although often adjacent to these channels.
- The proposed facilities include several that treat the adverse effects of earlier developments.
- There is a continuous network of swales and waterways connecting all facilities. These provide for trickle discharge from soakage facilities, slow release from detention basins, and secondary emergency overflow paths. This drainage network should also provide the basis for 'green corridors' that satisfy other values.
- Some of the standards being used and solutions being proposed will represent a significant 'raising of the bar' in terms of the level of mitigation being provided and the resulting cost.

5.5.3 Design Approach

A surface water management scheme will consist of water quality (stormwater treatment) and quantity (flood mitigation) components. Wherever possible the surface water management scheme will included retrofitting of existing urban areas on the flat. The retrofitting of mitigation for existing urban areas is considered a significant part of the surface water management scheme. The proposed retrofitting of mitigation will be achieved by diverting existing urban areas into facilities constructed to mitigate new urban areas identified in Development Scenario 2. Where retrofitting mitigation into existing areas is possible, the mitigation will be built to the same standard as proposed for new areas. However, it is important to recognize that retrofitting existing areas is dependent on new development occurring.

Hydrological and hydraulic modelling has predicted that the adopted approach will reduce existing flood levels in the Heathcote River, and the assumption has been made that the same outcome can be expected for the Halswell River. The soil adsorption basins or sedimentation basins and associated wetlands (or wet ponds) are constructed as part of a treatment train with detention basins downstream. There are, however, three options within the preliminary surface water scheme for achieving the water management objectives in the sub-catchments that feed into Hendersons Basin. These options pertain to the management of water quantity effects of any new development. The options are:

- Option A - Deal with water quality and quantity effects in each local sub-catchment.
- Option B - Rely upon Hendersons Basin to deal with the water quantity effects and provide land for the wetlands (or wet ponds).
- Option C - Manage the water quantity effects in a compensatory way by creating a storage facility in Hoon Hay Valley.

These options differ significantly from each other, especially in terms of the land requirement. It is important that one or more of the options are adopted so strategic land protection can proceed. The main difference between the options with specific regard for water quality is the waterways between the possible new development and Hendersons Basin would have lower water quality for Option B. This is unlikely to be a significant issue, as none of these waterways are defined as receiving environments in Section 4 (refer to Fig. 4.1), and no industrial land is proposed in any of the development scenarios within the catchments. The main difference between the options with specific regard for water quantity is that the flood mitigation facilities would be located at different locations (i.e., locally or combined at Hendersons Basin, or mitigation achieved via compensatory storage at Hoon Hay Valley).

The surface water management scheme will be based on key design approaches:

- The water quality mitigation facilities will provide treatment of the Water Quality Volume (WQV), by either filtration through soil adsorption basins and disposal to ground, or sedimentation within sedimentation basins followed by wetlands (or wet ponds) and surface water discharge.
- The water quantity mitigation facilities that will provide flood management for sub-catchments on the flat are, where possible, based on the conservative concept of Total Storm Detention (TSD) of 2% AEP events for the critical duration of the Heathcote River, Hendersons Basin and the Halswell River, depending on the location of the facility. On the hillside developments, however, the detention basins are sized on an extra-over basis, requiring the detention of the volume of water in excess of that of a 2% AEP event prior to development.

The design of the sedimentation basins and wetlands (or wet ponds) has been conservatively based on the WQV approach defined in TP 10 (ARC 2003) and the Christchurch City Council (CCC 2003b) guideline. This suggests that providing treatment for 80% of the average annual stormwater volume should achieve 75% removal (for sedimentation basins) of the total suspended sediment load. This approach also provides treatment of all stormwater for a significant amount of the time (i.e., significantly greater than 80%), as 20% of the annual volume is generated during a smaller number of infrequent events. The WQV approach is equivalent to providing treatment of the runoff from the first 25 mm of rainfall for Christchurch.

Soil adsorption basins will also be designed based on the water quality volume approach as this will ensure 80% of the average annual stormwater volume will be treated by filtration (slow infiltration through the soil media bed) prior to disposal to ground. The remaining 20% of the average annual stormwater volume receives some treatment via sedimentation prior to disposal to ground via rapid soakage.

In general, the soil adsorption basins are designed to discharge the WQV to ground via infiltration over 48 hours, while discharge over four days from sedimentation basins to wetlands has been adopted to reduce the land area occupied by wetlands. The minimum residence time in a wetland prior to discharge to surface water is 2 days. However, the duration of the discharge to ground or surface water varies depending on a number of factors, including site limitations. Stormwater above the WQV flows into rapid soakage chambers or soakage trenches for the soil adsorption basins. Some detention basin capacity will also need to be provided. For sedimentation basins, stormwater above the WQV flows into the detention basins. Detention basins will be designed to empty in seven days or less.

The WQV has been calculated in accordance with Christchurch City Council (CCC 2003b), which specifies, in a recently revised table, impervious surface values of 36% for residential areas and 81% for industrial areas. The soil adsorption and sedimentation basins are typically designed to be 1 m deep; however, this varies depending on topographic conditions. The wetland is also typically designed to be 0.15 m deep and to provide a volume reduction of 25% to account for wetland vegetation (CCC 2003b).

The TSD standard for development on the flat consists of sizing the detention basins such that they can contain the volume of the 2% AEP event for the critical duration of the Heathcote River, Hendersons Basin or the Halswell River, depending on the location of the facility. The extra-over standard for development on the hills only requires the detention of the volume of water in excess of the critical duration 2% AEP event prior to development. The TSD and extra-over detention basins are designed using a runoff coefficient of 0.25 for undeveloped land on the flat, 0.65 for developed residential land on the flat, 0.80 for undeveloped land on the hill, and 0.90 for developed residential land on the hills. In flat developed business zones (for example within Awatea) the coefficient used is generally 0.90. However, South West Hornby industrial area is an exception to this. A coefficient of 0.45 has been adopted on the assumption that all roof runoff will drain directly to ground. The 2% AEP events are based on critical durations of 36 hours (169 mm) for the Heathcote River catchment, including Hendersons Basin, and 60 hours (193 mm) for the Halswell River catchment.

5.5.4 Existing Stormwater Systems

There are no plans to modify or upgrade the existing stormwater systems other than the retro-fitting discussed in Section 5.5.7. Monitoring of ICMP performance against receiving objectives may result in a ICMP review which may require a review of existing systems in the event more mitigation is required to meet objectives.

5.5.5 Roads and Southern Arterial

Water quality and quantity mitigation for road runoff will be incorporated within the surface water management scheme. Mitigation facilities for the Southern Arterial may have to be provided separately to the facilities proposed in the preliminary surface water management scheme (refer to Section 5.5.6). However, the mitigation provided for the Southern Arterial will be to the same standards as those of the preliminary surface water management scheme.

5.5.6 Contingency Mitigation

The adopted mitigation strategy includes the provision for alternative mitigation measures where the proposed approach in Section 5.2 is not technically feasible or, in the case of industrial areas, is not sufficient to meet the receiving environment objectives discussed in Section 4. The purpose of this provision of an alternative option is to ensure sufficient flexibility in the adopted strategy to overcome unexpected situations, as well as water quality that does not meet the receiving environment objectives discussed in Section 4.

The alternative option for water quality mitigation is the use of filtration systems. The filtration systems used shall be capable of performing at equivalent removal rates for TSS and metals (total and dissolved fractions to that of the StormFilter®). The systems used could include sand filters, other propriety media filtration systems, and custom built systems (i.e., filtration trenches and sand filters). The filtration systems are envisaged to be used in the event that additional retro-fitting of treatment into existing urban areas is needed, or if the approach outlined in Section 5.2 is not technically feasible for a sub-catchment or a small subdivision.

The other situation where the use of filtration is envisaged is in the event that, after sufficient water quality monitoring has been completed, receiving objectives cannot be met. This could be specifically for industrial areas, or where unexpected water quality is detected over a sufficient period of monitoring. The filtration systems could be located at source onsite or downstream of the surface water management facilities discussed in Section 5.2 (downstream of sedimentation basins and upstream of wetlands).

5.5.7 Preliminary Surface Water Management Scheme

Introduction

A preliminary surface water management scheme has been developed based on hypothetical Development Scenario 2 (refer to Water Quality Assessment, Report Number 5 for the South-West Christchurch ICMP Technical Series and Water Quantity Assessment, Report Number 4 of the South-West Christchurch ICMP Technical Series). The preliminary surface water management scheme has been developed to cover all sub-catchments in the project area where possible land use change may occur. The preliminary surface water management scheme has also been developed in conjunction with other values, such as landscape and recreation, in an integrated fashion through a series of workshops.

It is important to recognise that the final location of facilities is subject to change following the design process, and in particular the land zoning process. The number of facilities may also increase or decrease following these processes. The size of each of the identified facilities will also change depending on how much land is zoned for urban development within its sub-catchment; in some cases, no facility will be required. The preliminary surface water management scheme will be finalised for each of the nine SWMAs in South-West Christchurch (refer to Fig. 3.2) following the completion of the Area Plan and City Plan processes at which time the extent of development will be confirmed. The facilities will only be constructed in the event that development occurs, including any retrofitting of existing areas.

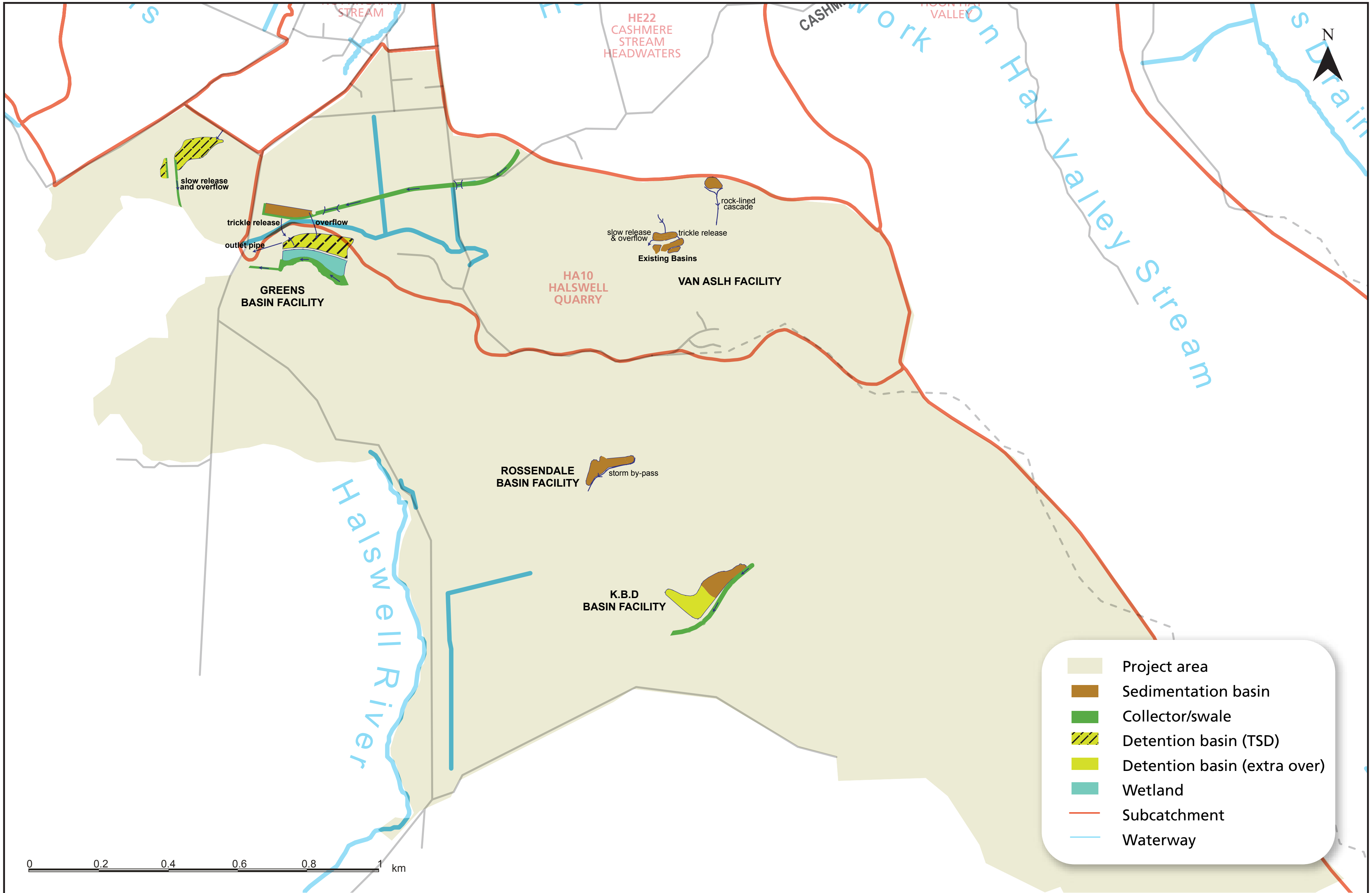
The preliminary surface water management scheme has been developed to provide an example of how the proposed mitigated approach responds to development, provide preliminary indications of facility locations and outline how facilities are sized for the level of development in each project area. The final size of facilities will be based on actual development levels and hence the facilities could be larger, smaller or not required. However the method for calculating facility size will not be changed from that outlined in Sections 5.5.3 unless future investigation or monitoring identifies further mitigation is required in which case a review of the ICMP will be undertaken.

South Halswell-Kennedys Bush

The South Halswell-Kennedys Bush SWMA comprises Knights Confluence, Halswell Quarry, and Lansdowne Valley sub-catchments, and is located in the south east corner of South-West Christchurch. Development is mainly limited to the Halswell Quarry sub-catchment, which is currently partly developed on the northern side. The Knights Confluence and Lansdowne Valley sub-catchments are largely undeveloped rural land.

Drainage of the undeveloped rural land is predominantly by soakage to ground, with runoff occurring through ephemeral waterways which discharge to the Halswell River. Wetlands within the Halswell Quarry Reserve remain wet during low rainfall periods, probably as a consequence of shallow groundwater in this area. Recent development of 6 ha on the hill side of the Halswell Quarry sub-catchment has been mitigated with the use of ‘Oderings Pond’ at the base of the hill.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of detention basins, sedimentation basins, and wetlands (Table 5.1). The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach discussed (water quantity) in Section 5.2.2, as summarised in Tables 5.2 and 5.3. The possible location and layout of each facility is illustrated in Fig. 5.2.



Golder Associates

TITLE SOUTH HALSWELL-KENNEDYS BUSH SWMA

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Table 5.2: Summary of water quality facilities for South Halswell-Kennedy's Bush.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Basin Volume[1] m^3	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
	Res	Hill						
Greens Basin	39.0	-	39.0	SB	3,510	0.91	1,756	1.56
Van Asch Hill	33.4	-	33.4	SB	3,340	0.38	1,670	1.48
Van Asch Valley	2.8	-	2.8	SB	280	0.04	140	0.12
Rossendale Basin	40	16	56	SB	4,000	0.46	-[2]	-[2]
KBD Basin	20	146	166	SB	12,450	2.80	12,450	11.07

Note: [1] Based on WQV; [2]No Wetland provided, SB = sedimentation basin, KBD = Kennedy's Bush Development.

Table 5.3: Summary of water quantity facilities for South Halswell-Kennedy's Bush.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Mitigation Volume (m^3)	Basin Area (ha)
	Res	Hill				
Greens Basin	39.0	-	39.0	SL	48,930[1]	2.8
Van Asch Combined	33.4	-	33.4	SL	3,367[2]	0.29
Rossendale Basin	40	16	56	SL	7,720[2]	-[3]
KBD Basin	20	146	166	SL	3,860[2 & 4]	-[3]

Note: SL = slow release to surface water; [1]Volume based on TSD of 2% AEP event of 193 mm; [2]Volume based on extra-over of 2% AEP event of 193 mm; [3]Detention provided in KBD water quality facility; [4] Detention volume not required given high water quality volume..

It is intended that water management facilities will be used to mitigate the additional 75.2 ha (or total of 81.1 ha) of development in the Halswell Quarry sub-catchment, and future development in the other sub-catchments. This will be achieved by the following two facilities:

- The Greens Basin facility is proposed to serve a total of 39 ha of new development in the Knights Confluence, Halswell Quarry, and a small part of Cashmere Stream Headwaters sub-catchments. The basin is located just east of Halswell Road, either side of Greens Drain. A sedimentation basin and wetland will provide water quality management. A detention basin sized to the TSD standard and slow trickle release to Halswell River will manage water quantity.
- The Van Asch facilities are assumed to be based on and around the existing detention basins. The facilities will serve 33.4 ha of proposed new development on the hill areas up valley from the Halswell Quarry. Most of the development area is in the Halswell Quarry sub-catchment, although small amounts are in the Cashmere Stream Headwaters and Hoon Hay Valley sub-catchments. The facility comprises a sedimentation basin on the ridge line near the western end of the hill area, which is designed to catch runoff from most of the 33.4 ha area. On the valley floor there is a detention basin designed on an extra-over basis. Further treatment takes place as surface water makes its way to the wetlands at the top of Greens Drain.

Two water management facilities, Rossendale and Kennedys Bush Development, will be installed in the Lansdowne Valley Catchment. These facilities will service 60 ha of new development and are summarised below:

- Rossendale facility services a 56 ha area with 40 ha of new development just south of Kennedy's Bush Road, south-east of Halswell Quarry Reserve. The facility consists of a sedimentation basin located in a natural gully to the west of the catchment area. Discharge from the sedimentation basin is by slow trickle release, but if it overflows then excess runoff water will flow directly to the Halswell River and bypass the basin.
- KBD facility, at the foot of the hills in the Lansdowne Valley, services 166 ha of flat and hill land. The facility is required to mitigate the effects of 20 ha of new development on flat land south of the

Rossendale Basin, but will capture runoff from the whole area. Runoff is captured by a combination sedimentation basin and detention basin. The volume of water detained by the basin is so large it exceeds the design requirement and the basin may, therefore, be used to compensate for the effects of other areas of development.

South East Halswell-Hoon Hay Valley

The South East Halswell-Hoon Hay Valley SWMA comprises three sub-catchments, of which the largest (Hoon Hay Valley) makes up over half the area. Most of the catchment is undeveloped rural land, with the only significant area of development being where part of the Westmorland subdivision is covered by the Blencathra sub-catchment.

By the existing drainage layout, the three sub-catchments contribute flow to the Cashmere Stream, which originates from the Cashmere Stream Headwaters sub-catchment. The stream is fed by runoff and a number of springs which rise to the south of Sutherland Road and which maintain a permanent flow in a number of waterways which make up the catchment.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of sedimentation basins, wetlands (or wet ponds), and detention basins. The detention basins are designed to a TSD standard (flat) or to an extra/over standard when runoff from hill catchments is intercepted. The size of each facility, based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2, is summarised in Tables 5.4 and 5.5. The possible location and layout of each facility is still to be determined.

The Hoon Hay Valley provides a possible option for the storage of stormwater, providing compensatory mitigation for developments in other sub-catchments that flow into Hendersons Basin. When developed, the Hoon Hay Valley area is expected to include water quantity management for the effects of a 2% AEP event on an extra/over basis. Full mitigation of the Cashmere Stream Headwaters water quantity effects to the TSD standard is intended. The options for doing so are by either local facilities (option A), relying upon Hendersons Basin being to absorb water quantity effects of development (Option B), or by using Hoon Hay Valley to provide compensatory storage (Option C).

Table 5.4: Summary of water quality facilities for South East Halswell-Hoon Hay Valley.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Basin Volume[1] (m^3)	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
	Res	Rural						
Blencathra	9.8	58.0	9.8	SB	980	0.13	490	0.44[2]
Hoon Hay Valley	56.0	-	56.0	SB	5,600	0.63	2,800	2.49[2]
Cashmere headwaters	85.3	-	85.3	SB	8,080	0.88	4,040	3.59

Note: SB = Sedimentation basin. [1] Based on WQV; [2] Wetland is likely to be located in Hendersons Basin.

Table 5.5: Summary of water quantity facilities for South East Halswell-Hoon Hay Valley.

Facility	Land Use			Mitigation Area (ha)	Facility Type	Mitigation Volume (m^3)	Basin Area (ha)
	Res Flat	Res Hill	Rural Hill				
Blencathra	-	9.8	58.0	67.8	SL	103,130[2]	-[3]
Hoon Hay Valley	-	56.0	-	56.0	SL	85,180[2]	-[3]
Cashmere headwaters (flat)	44.7	-	-	44.7	SL	49,100[1]	2.38
Cashmere headwaters (hill)	-	40.6	-	40.6	SL	2,800[2]	0.23

Note: SL = slow release to surface water; [1]Volume based on TSD (flat) of 2% AEP event of 169 mm; [2] Volume based on extra-over (hill) of 2% AEP event of 169 mm; [3] Storage provided in Hendersons Basin.

Cashmere-Worsleys

The Cashmere-Worsleys surface water management area comprises five sub-catchments, including the two large areas of Worsley Valley and Cashmere Valley. Development of the hill land in both of these valleys is not extensive at present, with a significant portion in each being zoned Rural H. The lower hill sites and flat land of the Westmorland, Westmorland East, Blencathra, and Cashmere Ponding Area sub-catchments are more developed, predominantly as residential subdivisions.

Current drainage is by runoff through a series of ephemeral waterways along the valley floors to Cashmere Stream. The lower sub-catchments are drained by pipework and utility drains to Cashmere Stream.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use identified in Development Scenario 2. The preliminary surface water management scheme is, however, subject to Environment Court hearings and an interim decision for Cashmere-Worsleys. The current proposal for facilities at Cashmere-Worsleys involves the use of sedimentation basins, wetlands (or wet ponds), and stormwater detention in one large basin located in the proposed environmental compensation area in the floor of Cashmere-Worsleys Valleys. The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2 is summarised in Tables 5.6 and 5.7. The possible location and layout of each facility is still to be determined.

There are no plans for further water management facilities in the Westmorland sub-catchment, due to a lack of land availability. A sand trap is currently used which discharges to the Cashmere Stream. If greater capacity is required in the future, it is possible for runoff from the top of the sub-catchment to be directed into the neighbouring Blencathra sub-catchment for treatment. Westmorland East is presently less developed, but there is an intention to mitigate the effects of all new development up to an extra/over standard for water quantity. The Cashmere Ponding Area will also be fully mitigated, but to a full TSD standard, with wetlands (or wet ponds) to maintain water quality.

Table 5.6: Summary of water quality facilities for Cashmere-Worsleys.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Basin Volume[1] m^3	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
	Res	Bus						
Cashmere Ponding	10.0	-	10.0	SB	900	0.10	450	0.40
Cashmere Valley	14.9	-	14.9	SB	1,390	0.17	700	0.62
Worsleys Valley	29.3	-	29.3	SB	2,910	0.34	1,410	1.29
Westmorland East	13.3	-	13.3	SB	1,330	0.17	670	0.59

Note: SB = sedimentation basin. [1] Based on WQV.

Table 5.7: Summary of water quantity facilities for Cashmere-Worsleys.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Mitigation Volume (m^3)	Basin Area (ha)
	Res Flat	Res Hill				
Cashmere Ponding	10.0	-	10.0	SL	10,990[1]	0.57
Cashmere Valley	9.6	-	9.6	SL	10,546[1]	0.54
	-	5.3	5.3	SL	370[2]	0.04
Worsleys Valley	2.0	-	2.0	SL	2,200	0.13
	-	27.3	27.3	SL	1,880[2]	0.16
Westmorland East	-	13.3	13.3	SL	920	0.08

Note: SL = slow release to surface water; [1]Volume based on TSD (flat) of 2% AEP event of 169 mm; [2] Volume based on extra-over (hill) of 2% AEP event of 169 mm.

Parts of the Cashmere and Worsley Valleys are regarded as being mitigated locally by individual and local facilities. Beyond that, it is intended to mitigate quality effects of all development within sedimentation basins and wetlands, and water quantity effects within detentions basins sized to an extra/over standard. A number of facilities may be required to be located in places which suit the topography and existing waterways.

Knights Stream South-West Halswell

The Knights Stream South-West Halswell SWMA comprises Creamery Stream, Cases Drain, Nottingham Stream, Nottingham Headwaters, and Chesmars Drain sub-catchments, as well as parts of the Knights Stream Headwaters and Marshs Road sub-catchments. Development of the catchment is almost complete on the eastern side (Nottingham Headwaters, Nottingham Stream sub-catchments) compared to the rural and completely undeveloped land on the south-western side of the catchment (Chesmars Drain and Cases Drain sub-catchments).

The Quaifes Road spring discharges perennial flows into the Creamery Stream and Cases Drain sub-catchments. Christchurch City Council has taken steps to protect the spring and has purchased the land where it rises.

Existing drainage in the rural areas is predominantly through Knights Stream or Marshs Road Drain and other tributaries to Halswell River. Some of the waterways are ephemeral, while others are permanent. Current drainage in the developed Nottingham Stream and Nottingham Headwaters sub-catchments is by pipework to Nottingham Stream. An area of 15 ha to the north-west of Nottingham Headwaters is piped to a soil adsorption basin in the corner of Westlake Reserve, for soakage to ground. This facility was installed in 2005.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of sedimentation basins and detention basins. The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2, as summarised in Tables 5.8 and 5.9. The possible location and layout of each facility is illustrated in Fig. 5.3.

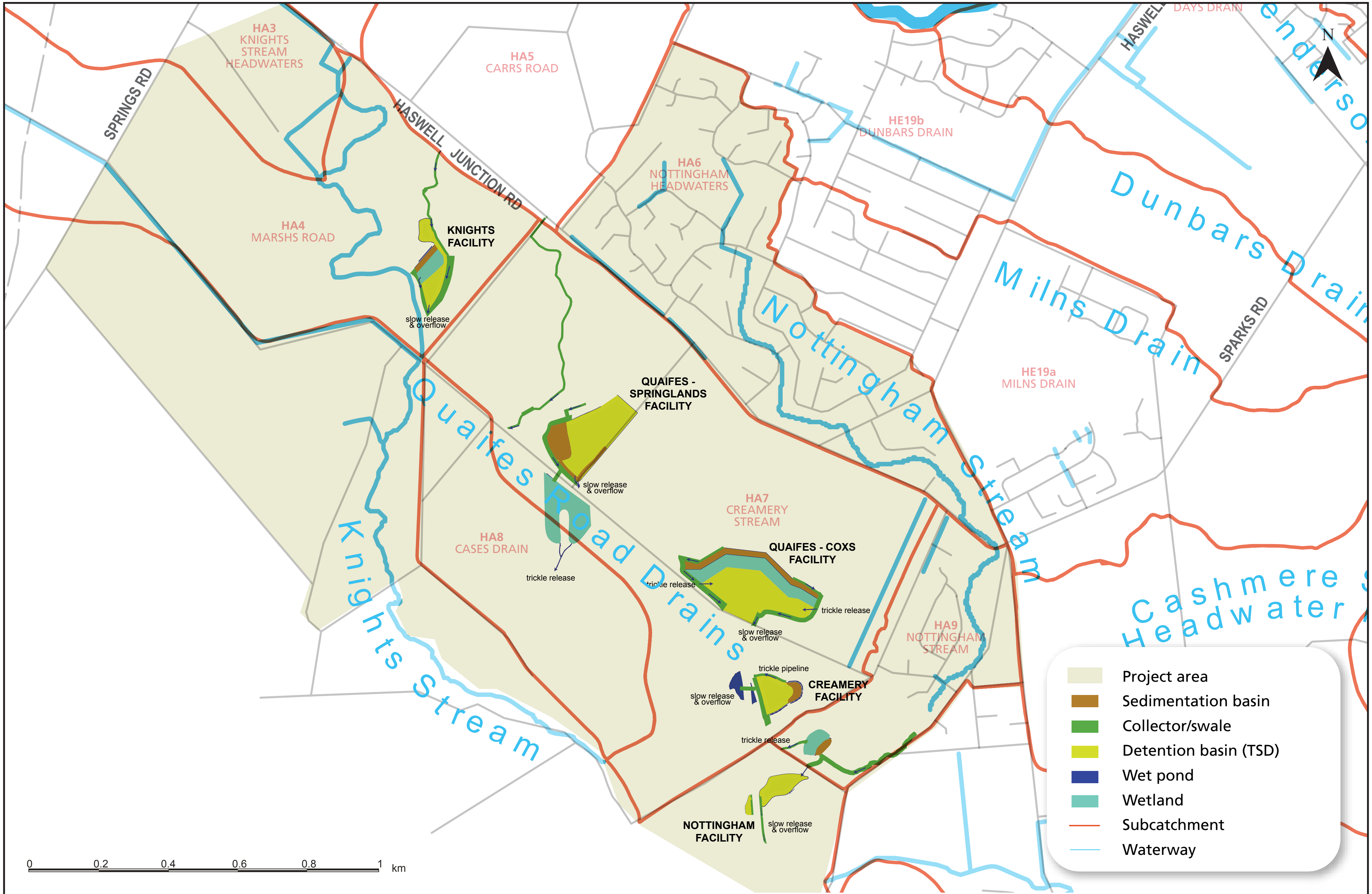

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Table 5.8: Summary of water quality facilities for Knights Stream South-West Halswell.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Basin Volume[1] m^3	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
	Res	Bus						
Knights	31.9	-	31.9	SB	2,871	0.45	1,436	1.28
Quaifes - Springlands	94.5	-	94.5	SB	8,505	1.48	4,252	3.78
Quaifes - Coxs	92.9	-	92.9	SB	8,361	1.73	4,180	3.72
Creamery	20.5	-	20.5	SB	1,809	0.39	1,800[2]	0.60
Nottingham	15.7	-	15.7	SB	1,413	0.31	1,414[2]	0.63

Note: SB = sedimentation basin. [1]Based on WQV; [2]Wet pond.

Table 5.9: Summary of water quantity facilities for Knights Stream South-West Halswell.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Mitigation Volume m^3	Basin Area m^3
	Res	Bus				
Knights	31.9	-	31.9	SL	40,020[1]	2.38
Quaifes - Springlands	94.5	-	94.5	SL	118,550[1]	7.63
Quaifes – Coxs	92.9	-	92.9	SL	116,550[1]	8.41
Creamery	20.5	-	20.5	SL	25,220[1]	2.13
Nottingham	15.7	-	15.7	SL	19,700[1]	1.66

Note: SL = slow release to surface water; [1] Volume based on TSD (flat) of 2% AEP event of 193 mm.

The proposed water management facilities consist of five basins in the Knights Stream South-West Halswell catchment. The facilities are:

- The proposed Knights facilities service an area of 31.9 ha, mostly from Marsh's Road sub-catchment, and about 5 ha from the Carr's Road sub-catchment. They comprise a sedimentation basin, wetland, and a detention basin sized to the TSD standard.
- The Quaifes-Springlands facilities service an area of 94.5 ha of the Creamery Stream sub-catchment. They consist of a sedimentation basin and a detention basin located north-east of Murphys Quaifes Road corner, and a wetland on the opposite side of Quaifes Road, among the Quaifes Road Springlands. Engineered bunds are required to prevent water being treated from interfering with water flow from the springs. The detention basin is sized to the TSD standard.
- The Quaifes-Coxs facilities, which service a further 92.9 ha of the Creamery Stream sub-catchment, are also comprised of a sedimentation basin, a wetland, and a detention basin. The detention basin is sized to the TSD standard. They are located east of Quaifes Road about 700 metres up from the Sabys Road intersection.
- The Creamery facilities service 20.5 ha and are located adjacent to and around the Stoothoff Ponds on Creamery Drain. They include a sedimentation basin and a wet pond. The Stoothoff Ponds can be upgraded to provide TSD for this part of the sub-catchment, including slow release to Creamery Drain and to Knights Stream.
- Nottingham facilities service 15.7 ha at the southern end of the Knights Stream South-West Halswell catchment. They are comprised of a sedimentation basin, a wetland, and a detention basin located either side of Candys Road. The detention basin is sized to the TSD standard.

Sparks Road-Hendersons Basin

The Sparks Road-Hendersons Basin surface water management area covers 1,215 ha, including Halswell Road and the proposed Southern Motorway at the northern boundary to the mainly residential neighbourhoods of Halswell, and the new Aidanfield subdivision. The residential zoned land is almost fully developed south of the Heathcote River, with most runoff draining to Hendersons Basin via a system of largely open drains. The remainder is zoned Rural 2. Much of the land is low lying within Hendersons Basin flood management area, and much of it will not be developed further.

The Ballantines Drain sub-catchment to the north-west delivers runoff through a combination of pipes and open waterways leading into Hendersons Basin. Dunbars Drain, Days Drain, and Milns Drain are all open waterways that convey runoff to Hendersons Basin. Adequate surface water systems are important in the area, as groundwater levels are relatively shallow, often less than 2.5 m, resulting in limited soakage to ground.

The Ballantines Drain sub-catchment has no new development proposed under Development Scenario 2. Days Drain, Milns Drain, and Dunbars Drain sub-catchments all have some further development proposed under Development Scenario 2.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of sedimentation basins, wetlands (or wet ponds), and detention basins. The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2, as summarised in Tables 5.10 and 5.11. The possible location and layout of each facility is illustrated in Fig. 5.4.

Table 5.10: Summary of water quality facilities for Sparks Road-Hendersons Basin.

Facility	Land Use			Mitigation Area (ha)	Facility Type	Basin Volume[1] (m^3)	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
	Res	Bus	Major Parks						
Milns Drain									
Lower Milns	46.9	2.6	-	49.5	SB	4,750	0.55		
Sutherlands/Milns	30.5	-	-	30.5	SB	2,750	0.46		
Dunbars Drain									
Bishop's Green/ Douglass-Clifford	84.5	-	6.4	90.9	SB	7,610	1.00		
Douglass-Clifford	9.2	5.0	1.5	15.7	SB	1,840	0.80		
Sparks Road	46.5	-	7.9	54.4	SB	4,190	0.88		
Hendersons	7.6	-	-	7.6	SB	680	0.15		
Dunbars Drain Subtotal				248.6				10,910	9.70
Days Drain									
North	42.5	-	6.4	48.9	SB	3,830	0.52		
South	60.3	4.6	-	64.9	SB	5,427	0.81		
Days Drain Subtotal				113.8				-[2]	-[2]

Note: SB = sedimentation basin; [1] Based on WQV; [2] Wet Pond provided in conjunction with detention basin (refer to Table 5.10).

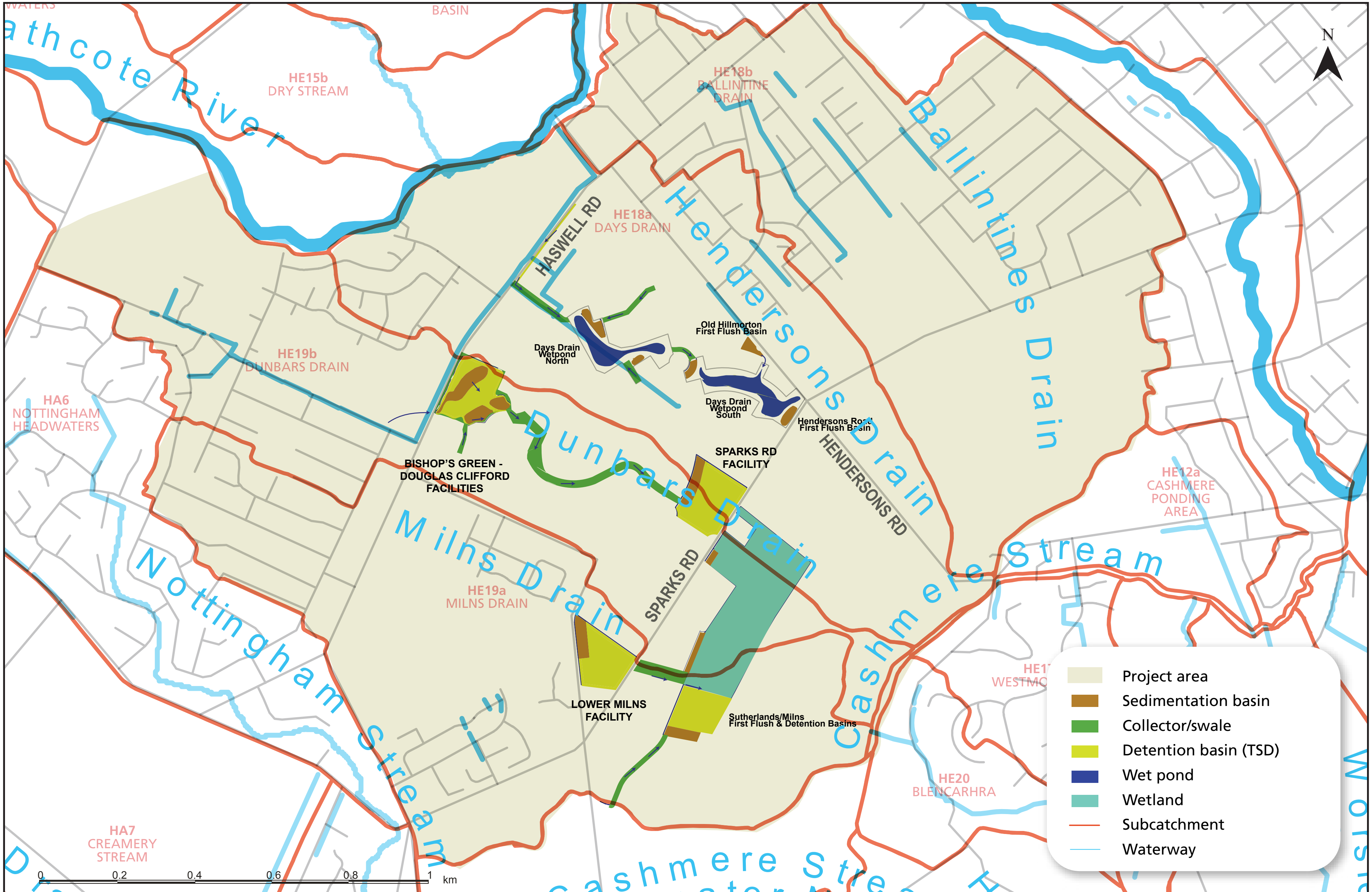

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Table 5.11: Summary of water quantity facilities for Sparks Road-Hendersons Basin.

Facility	Land Use			Mitigation Area (ha)	Facility Type	Mitigation Volume[1] (m^3)	Basin Area (ha)
	Res	Bus	Major Parks				
Milns Drain							
Lower Milns	46.9	2.6	-	49.5	SL	63,870	3.2
Sutherlands/Milns	30.5	-	-	30.5	SL	41,900	2.8
Dunbars Drain							
Bishop's Green / Douglass-Clifford	84.5	-	6.4	90.9	SL	11,3872	6
Douglass-Clifford	9.2	5.0	1.5	15.7	SL	-[2]	-[2]
Sparks Road	46.5	-	7.9	54.4	SL	54,418	3.3
Hendersons	7.6	-	-	7.6	SL	-[3]	-[3]
Dunbars Drain Subtotal				248.6			
Days Drain							
North	42.5	-	6.4	48.9	EWP	59,140	3.3
South	60.3	4.6	-	64.9	EWP	72,460	4.27
Days Drain Subtotal				113.8			

Note: SL = slow release to surface water; EWP = extended wet period; [1] Volume based on TSD (flat) of 2% AEP event of 169 mm; [2] Detention volume included in Bishop's Green basin; [3]Detention volume included in Sparks Road basin.

The Sparks Road-Hendersons Basin SWMA has a number of sub-options relating to where the mitigation occurs, as discussed in Section 5.2.2 (refer to sub-options A, B and C). The first option (Option A) to be considered would provide for the mitigation of water locally within each sub-catchment, as preferred for the Days Drain sub-catchment (refer to Fig. 5.4). The sedimentation basins will discharge to wet ponds (as shown in Fig. 5.4), or alternatively, wetlands could be constructed if groundwater investigations confirm their feasibility. The wet ponds (or wetlands) will discharge to Hendersons Basin via Days Drain.

The second option (Option B) only provides primary water quality management via sedimentation basins (basins) at each sub-catchment. Hendersons Basin would then be relied upon to mitigate the water quantity effects and provide secondary polishing via wetlands, as preferred for the Milns Drain and Dunbars Drain sub-catchments (refer to Fig. 5.4). The Lower Milns facilities are proposed to mitigate 49.5 ha of old development and 10.9 ha of new development in Halswell. A neighbouring system in the Milns Drain sub-catchment is proposed to mitigate 30.5 ha of future development in Halswell in the Milns Sutherlands water management facilities. The Douglas-Clifford, Bishops Green, and Sparks Road facilities service a combined area of 152.8 ha, and are serviced by one combined wetland.

The third option (Option C) would use special provisions constructed in Hoon Hay Valley to reduce inflows into Hendersons Basin, which would provide a compensatory approach to mitigating water quantity aspects of new development in the Sparks Road-Hendersons Basin surface water management area. However, this sub-option would still require water quality mitigation as per sub-options A and B.

Curletts-Hoon Hay

The Curletts-Hoon Hay surface water management area comprises three sub-catchments bounded by the Heathcote River on their southern side. The land within the catchment is almost fully developed for residential and industrial purposes, but it also includes the Canterbury Agricultural Park.

Drainage of the three sub-catchments is predominantly via pipework to the upper stretches of the Heathcote River. Runoff from the Curletts Drain sub-catchment enters the Heathcote River via the Curletts Road Drain, which is an urban stream in its lower reaches.

Development is near complete in the Upper Heathcote and Canterbury Park sub-catchments. Within the Curletts Drain sub-catchment it is expected that further development will be mitigated on site, although there has been a proposal to use vacant C1 land south-east of the Curletts Road/Motorway corner to provide water quality treatment for existing developments. Otherwise, no mitigation of past effects is proposed.

South-West Hornby

The South-West Hornby surface water management area is comprised of two sub-catchments (Halswell Retention Basin and West Hornby), and parts of two further sub-catchments (Knights Stream Headwaters and Marshs Road). Development of the area is mainly industrial, with the proposed motorway alignment planned to pass through the Knights Stream Headwaters sub-catchment.

In addition to natural ground soakage, the South-West Hornby sub-catchment has engineered ground soakage facilities for individual sites. Stormwater runoff is conveyed through pipework to the existing Halswell Junction Retention Basin from all sub-catchments except for Marshs Road sub-catchment, which drains excess runoff into the Marshs Road Drain. The retention basin, built in 1990, was designed to fill and overflow in an extreme event into the headwaters of Knights Stream. There has been an on-going issue with leakage from the pond above a certain reduced level.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of soil adsorption basins (with or without under-drains) and detention basins sized to the TSD standard. The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2, as summarised in Tables 5.12 and 5.13. The possible location and layout of each facility is illustrated in Fig 5.5.

The direct discharge of rainfall from roofs to ground soakage through a sealed system has been assumed. A storm surface runoff volume coefficient of 0.45 has been adopted.

A series of four possible additional facilities to the Halswell Junction Retention Basin are proposed to mitigate the effects of future development in the area. The facilities are:

- The Meadowlands facility will service the north western part of the South-West Hornby sub-catchment. Management of water quantity will be by slow release and overflow to surface water via a swale within the green corridor down to Springs Road and finally across to Marshs Road Drain at Marshs Road.
- Shands facility, proposed for the south-eastern part of the South-West Hornby sub-catchment, will also slowly release overflow water by open channel to Marshs Road Drain.
- Colombia facility is to be located in the old gravel pit area south-west of the Springs Junction/Halswell Junction Road corner. The facility will receive stormwater runoff from the Knight's Stream Headwaters sub-catchment north of the proposed motorway corridor. Water from the basin will be managed by rapid soakage to ground.
- The Racetrack facility will be located adjacent to Springs Road south of the motorway corridor, and will service parts of the Knights Stream Headwaters and Marshs Road sub-catchments Ha3 and Ha4. If the area south of the motorway is not developed the facility may be unnecessary.

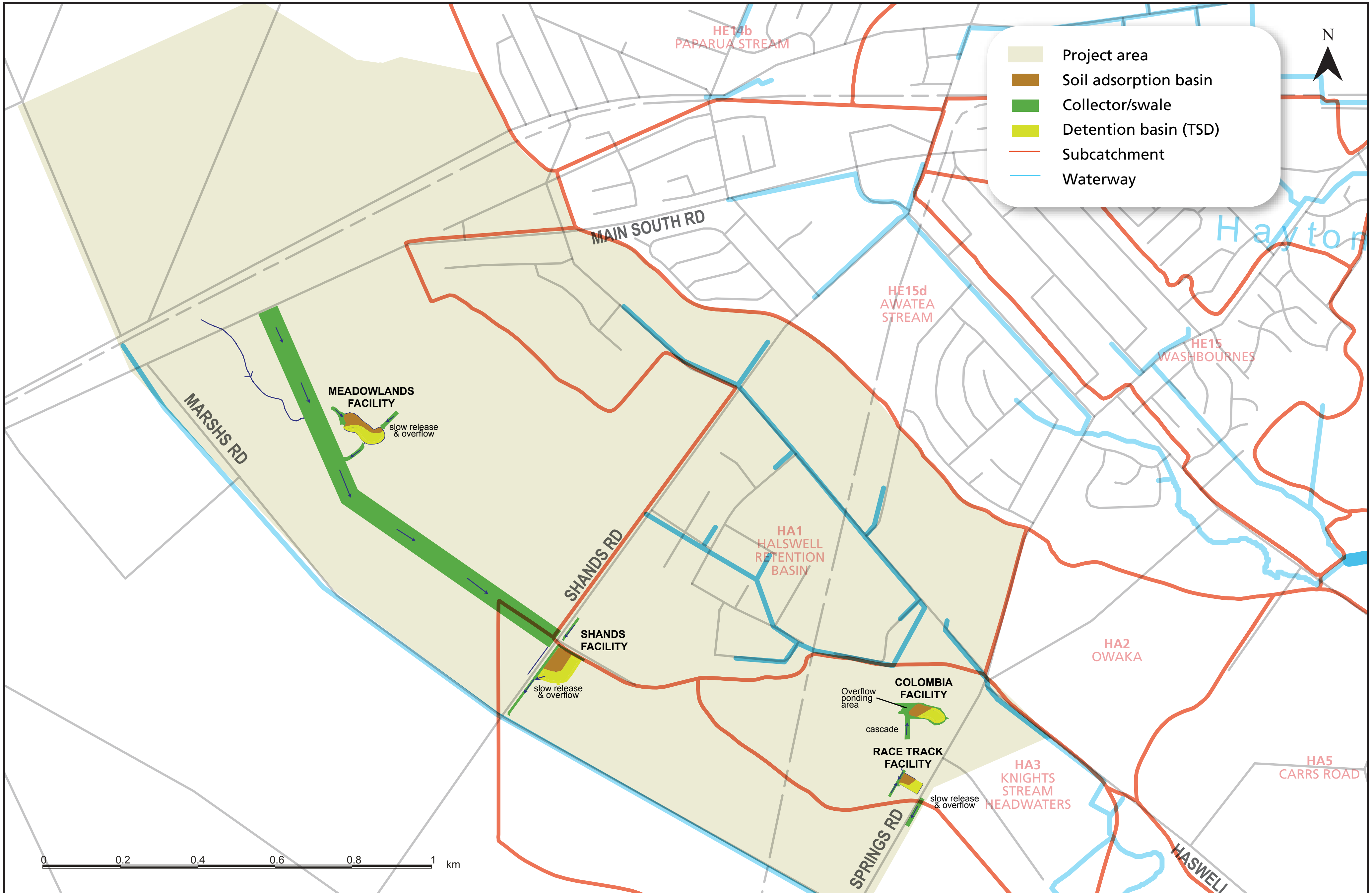

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Table 5.12: Summary of water quality facilities for South-West Hornby.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Basin Volume[1] m^3	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
	Res	Bus						
Meadowlands	-	33.3	33.3	SAB(u)	3,750	0.43	N/A	N/A
Shands	-	45.9	45.9	SAB(u)	5,160	0.58	N/A	N/A
Columbia	-	20.5	20.5	SAB	2,310	0.27	N/A	N/A
Racetrack	-	11.9	11.9	SAB(u)	1,340	0.17	N/A	N/A

Note: SAB = Soil Adsorption Basin; SAB(u) = Soil Adsorption Basin with under-drains; [1] Based on WQV.

Table 5.13: Summary of water quantity facilities for South-West Hornby.

Facility	Land Use		Mitigation Area (ha)	Facility Type	Mitigation Volume (m^3)	Basin Area (ha)
	Res	Bus				
Meadowlands	-	33.3	33.3	SL	28,920[1]	1.03
Shands	-	45.9	45.9	SL	39,860[1]	1.40
Columbia	-	20.5	20.5	s/i	17,800[1]	0.66
Racetrack	-	11.9	11.9	SL	10,335[1]	0.40

Note: SL = slow release to surface water; s/i = soakage and/or infiltration to ground. [1]Volume based on TSD (flat) of 2% AEP event of 193 mm with 45% runoff.

Awatea

The Awatea surface water management area comprises a small part of the Dunbars Drain sub-catchment of the Heathcote River and two sub-catchments, Owaka and Carrs Road, which feed into the Halswell River. Much of the catchment is undeveloped, and there are particular limitations for future development in the Carrs Road and Owaka areas from historical land uses such as landfill, hard fill, and the use of persistent agricultural chemicals.

Natural soakage in the area is good, so most rain water soaks away rapidly. All waterways in the Carrs Road sub-catchment are ephemeral, only flowing when there is an excess of runoff water to the Halswell River. The part of Dunbars Drain sub-catchment within this area is believed to drain by natural migration to the south-east.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of soil adsorption basins (with or without under-drains) and detention basins sized to the TSD standard relying primarily on stormwater disposal by soakage. The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2, as summarised in Tables 5.14 and 5.15. The possible location and layout of each facility is illustrated in Fig. 5.6.

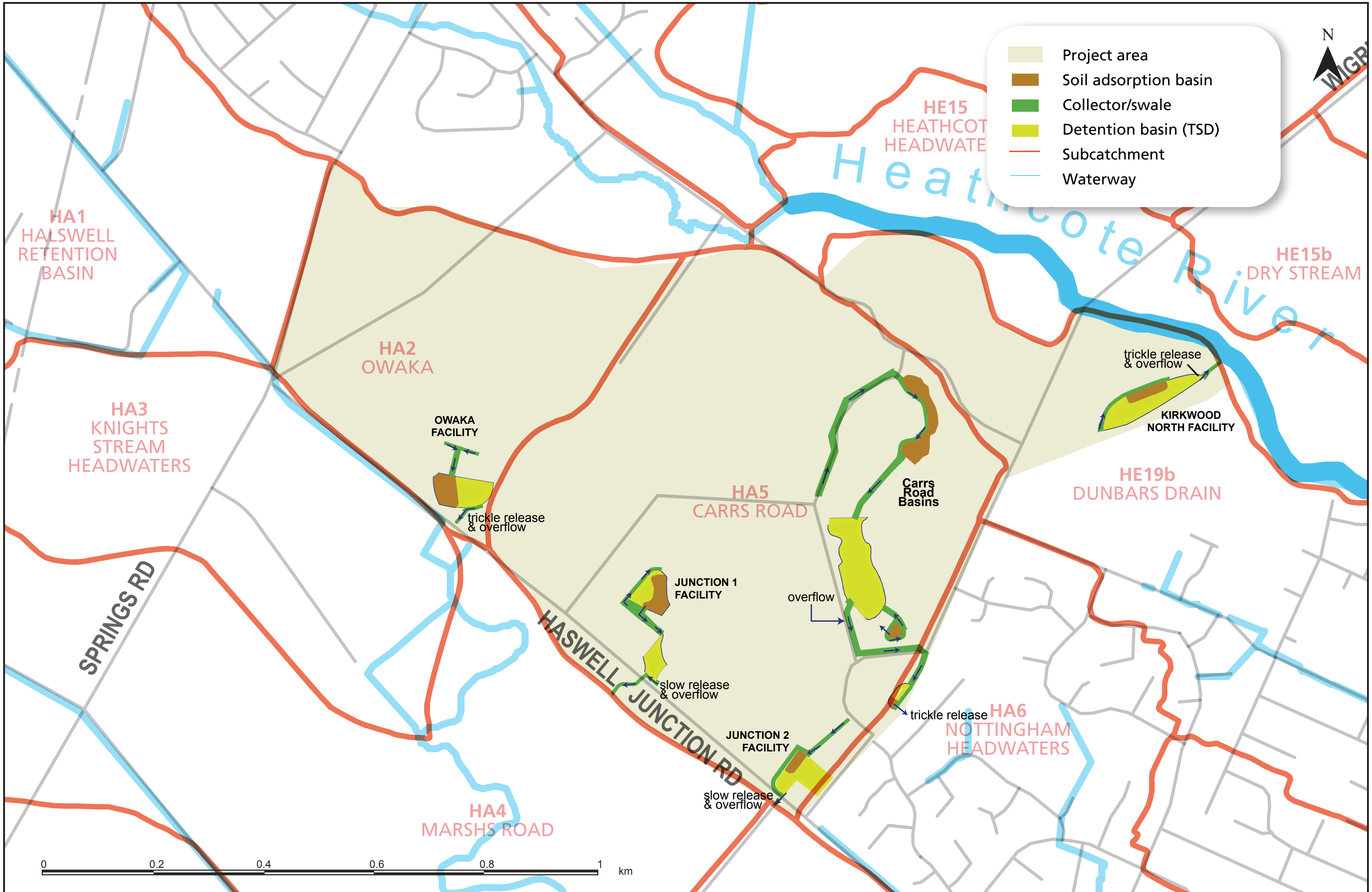

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Table 5.14: Summary of water quality facilities for Awatea.

Facility	Land Use Res	Land Use Bus	Mitigation Area (ha)	Facility Type	Basin Volume[1] m^3	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha)
Kirkwood North	32.0	-	32.0	SAB(u)	2,880	0.34	N/A	N/A
Carrs Rd 1	52.8	23.2	76.0	SAB	9,450	1.03	N/A	N/A
Carrs Rd 2	10.7	-	10.7	SAB(u)	960	0.12	N/A	N/A
Marquess	2.9	-	2.9	SAB(u)	260	0.04	N/A	N/A
Owaka	-	19.8	19.8	SAB(u)	4,010	0.46	N/A	N/A
Junction 1	10.7	14.6	25.3	SAB(u)	3,920	0.45	N/A	N/A
Junction 2	19.4	-	19.4	SAB(u)	1,750	0.21	N/A	N/A

Note: SAB = Soil Adsorption Basin; SAB(u) = Soil Adsorption Basin with under-drains. [1] Based on WQV.

Table 5.15: Summary of water quantity facilities for Awatea.

Facility	Land Use Res	Land Use Bus	Land Use Other	Mitigation Area (ha)	Facility type	Mitigation Volume (m^3)	Basin Area (ha)
Kirkwood North	32.0	-	-	32.0	s/i	35,150[1]	1.55
Carrs Rd 1	52.8	23.2	12.1	88.1	s/i	98,400[1]	4.11
Carrs Rd 2	10.7	-	-	10.7	s/i	11,754[1]	-[3]
Marquess	2.9	-	-	2.9	s/i	3,190[1]	0.18
Owaka	-	19.8	-	19.8	s/i	34,400[2]	1.04
Junction 1	10.7	14.6	2.0	27.3	SL	38,750[2]	1.21
Junction 2	19.4	-	2.9	22.3	SL	25,740[2]	0.83

Note: SL = slow release to surface water; s/i = soakage and/or infiltration to ground; [1] Volume based on TSD (flat) of 2% AEP event of 169 mm. [2] TSD volume based on 2% AEP event of 193 mm. [3] Included in Carrs Road 1.

Six facilities are to be used for the mitigation of surface water from the Awatea catchment. The facilities are:

- The Kirkwood North facility services part of the Wigram Basin and Dunbars Drain sub-catchments, and manages water by soakage to ground. However, provision has been made for slow release to the Heathcote River should this be necessary.
- The Carrs Road 1 and 2 facilities will consist of two soil adsorption basins either side of the proposed motorway corridor, and a detention basin sized to the TSD standard. Overflow from the retention basin will be by swale and then pipeline to the soil adsorption basin in the west of Westlake Reserve.
- The Marquess Basin, which services 2.9 ha of the Carrs Road sub-catchment south-east of Carrs Road and west of Wigram Road, is located south of the Carrs Road Basin, and overflow releases to the Westlake Reserve adsorption basin.
- The Owaka facility, located on the southern side of the proposed motorway, will service an area north east of the motorway via swales and a culvert which direct runoff to the basin. Water is released by soakage to ground and trickle released to surface water (Halswell Junction Road Outfall Drain and then the headwaters of Knights Stream).
- Junction 1 and 2 facilities service similar areas in the south-western and southern parts of the Carrs Road sub-catchment. The basins are located on Halswell Junction Road, fitting around an anticipated new road junction. The WQV is expected to be treated in a soil adsorption basin draining to a detention basin. Water is released to surface water in Knights Stream and an un-named waterway that crosses Whincops Road respectively.

Wigram

The Wigram surface water management area comprises eight sub-catchments (refer to Fig. 3.2) which range from the completely undeveloped Wigram Basin sub-catchment to the almost fully developed Main South Road sub-catchment. Soakage to ground is the dominant form of drainage on the undeveloped land, with excess run-off making its way to the Upper Heathcote River via small waterways and pipe drains. The fully developed land, much of which is industrial, is drained by piping or boxed drains to the Heathcote River. The origin of the Heathcote River is from drains in the Wigram catchment area, where it is ephemeral to the limit of permanent flow in the Templeton Road area.

The largest sub-catchment within the Wigram surface water management area is Paparua Stream sub-catchment. Approximately half of the 852 ha of flat land is undeveloped at present. The developed land is a mix of approximately one third industrial and two thirds residential. The developed land is drained by pipework to the upper Paparua Main Drain and Haytons Drain into the Wigram Retention Basin. Runoff from the lower sub-catchment drains directly to the Heathcote River.

Surface runoff is currently managed in the Wigram surface water management area by the Wigram Retention Basin, a wet pond which has been operational since 1993 and is regarded to be mitigating the effects of land zoned urban at that time. Slow release to the upper Heathcote River headwaters controls the rate at which water moves through the basin. In addition to its catchment area, the basin has a permanent water supply from Haytons Drain, which in turn comes from a baseflow of Waimakariri River water through the Paparua Water Race.

The preliminary surface water management scheme proposes to develop further facilities to mitigate surface water quality and quantity effects from the proposed land use changes identified in Development Scenario 2. The proposed facilities consist of soil adsorption basins with under-drains and detention basins sized to the TSD standard, relying primarily on stormwater disposal by soakage. The size of each facility is based on the WQV approach (water quality) and the standard Christchurch City Council design approach (water quantity) discussed in Section 5.2.2, as summarised in Tables 5.16 and 5.17. The possible location and layout of each facility is illustrated in Fig. 5.7.

The Wigram Aerodrome basins serve the Haytons Drain sub-catchment and part of the Wigram Basin sub-catchment, with catchment areas of 95 ha and 13.5 ha respectively. The northern basin overflows to Haytons Drain, while the southern basin overflows to the Heathcote River directly.

The Awatea Road Basins are comprised of three soil adsorption basins and one detention basin sized to the TSD standard, serving a total area of 398.3 ha over the Awatea Stream and Washbournes sub-catchments. Discharges from the detention basin are via a combination of slow soakage through the basin floor and slow release (of approximately 500 L/s), and the overflow (during events greater than 2% AEP) will be to the Heathcote River headwaters.

Table 5.16: Summary of water quality facilities for Wigram.

Facility	Land Use			Mitigation Area (ha)	Facility Type	Basin Volume [1] m^3	Basin Area (ha)	Wetland Treated Volume (m^3)	Wetland Area (ha^2)
	Res	Bus	Major Parks						
Aerodrome									
North basin	59.0	36.0	-	95.0	SAB(u)	8,550	0.94	N/A	N/A
South basin	13.5	-	-	13.5	SAB(u)	1,220	0.15	N/A	N/A
Awatea Road									
North facility	187.3	-	-	187.3	SAB(u)	16,860	1.80	N/A	N/A
South facility	100.0	99.5	11.5	211.0	SAB(u)	29,150	3.06	N/A	N/A

Note: SAB = Soil Adsorption Basin; SAB(u) = Soil Adsorption Basin with under-drains. [1] Based on WQV.

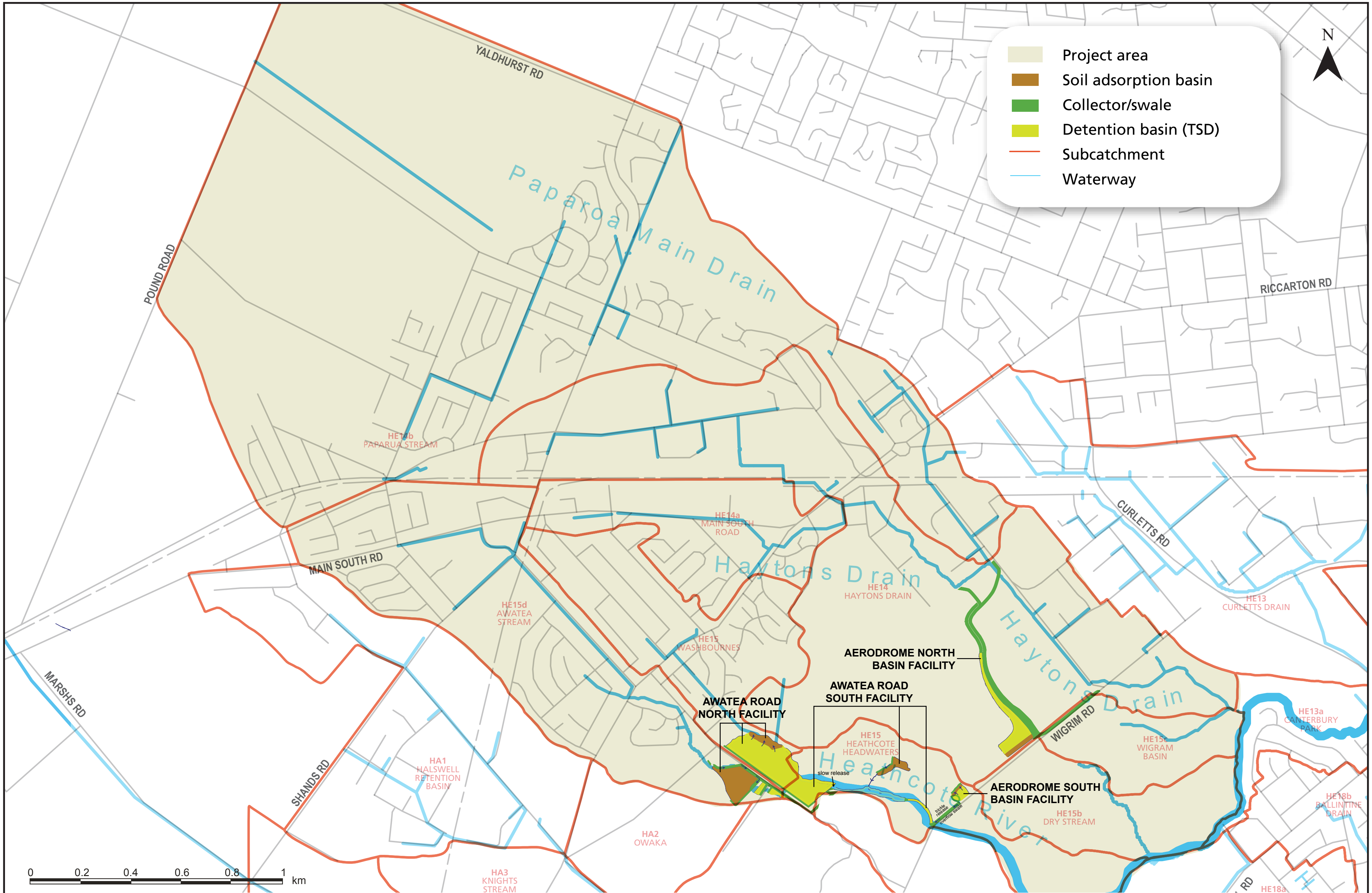

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Table 5.17: Summary of water quantity facilities for Wigram.

Facility	Land Use			Mitigation Area (ha)	Facility Type	Mitigation Volume (m^3)	Basin Area (ha)
	Res	Bus	Major Parks				
Aerodrome							
North basin	59.0	36.0	-	95.0	s/i	86,710[1]	3.62
South basin	13.5	-	-	13.5	s/i	14,830[1]	0.69
Awatea Road							
North facility	187.3	-	-	187.3	s/i	205,750[1]	14.61
South facility	100.0	99.5	11.5	211.0	s/i	266,050[1]	-[2]

Note: s/i = soakage and/or infiltration to ground; [1] TSD volume based on 2% AEP event of 169 mm. [2] Included in North Facility.

5.6 Sediment and Erosion Control during Construction

Sediment and erosion control is extremely important because sediment discharges to waterways during relatively short duration construction periods can have long terms impacts. South-West Christchurch could involve at any one time significant amounts of land stripped of vegetation, areas of filling left bare, or large open excavations for the construction of subdivisions, roads and other developments. Without protection measures, the development of this land can result in accelerated onsite erosion and greatly increase sedimentation of waterways. The adverse ecological effects caused by sediment in waterways result from smothering and abrading of fauna and flora, which modifies or destroys in-stream values and changes food sources and interrupts life cycles.

Sediment and erosion control during general construction projects, and in particular subdivisions, has not always been successful in the past, and Environment Canterbury has recently released their own guidelines. Christchurch City Council fully endorses the need to improve existing practises, and proposes that all construction activities within South-West Christchurch follow the Environment Canterbury guidelines. The receiving environment objectives have also adopted the turbidity requirements of the proposed NRRP for ensuring that stormwater discharges during construction have no more than minor impacts of waterways.

The key principles to successful sediment and erosion control that will be employed during construction activities within South-West Christchurch are:

- Sediment and erosion plans – a well developed plan is key to the success of sediment and erosion control. Contract engineers and contractors must be involved in the development of any plan to ensure a strong understanding of what is required and to ensure the plan is feasible and practically possible.
- Training – qualified professionals and contractors are vital to successful sediment and erosion control.
- Minimise disturbance – design land development to suit land sensitivity of the site. Minimise the amount of disturbance required to the least possible given practical restraints, and avoid sensitive parts of sites where possible.
- Stage construction – staging works in smaller quantity of earthwork with progressive stabilisation and/or vegetation reduces the time and area that soil is exposed and at risk to erosion and sediment generation.
- Protect steep slopes – steep slopes should be avoided where possible and where earthworks on steep slopes are required, diversion of runoff above the earthwork is vital, along with minimising the amount of earthworks carried out at any one time (refer to Stage Construction) and rapid stabilisation (vegetation or special measures).

- Protect waterways - extra care is required when earthworks are carried out adjacent to waterways or where waterways run through a site. Mitigation measures need to ensure direct discharges to waterways are avoided.
- Stabilise exposed area rapidly – the ultimate objective is to fully stabilise disturbed soils with vegetation after each stage and at specific milestones within stages. Rapid stabilisation should be provided for more sensitive sites using methods such as mulching.
- Install perimeter controls – a critical factor in sediment and erosion control is to divert clean water away from the site and to prevent sediment laden runoff within the site.
- Employ sediment removal devices – even with the best sediment and erosion control practices earthworks will discharge sediment laden runoff. Retention or detention systems are therefore required to avoid discharge or remove sediments via sedimentation prior to discharge or by filtration. The fine grained nature of some of Christchurch's soils needs to be considered when selecting and/or designing systems, and the option of using chemical dosing to improve sediment removal rates may need to be considered. Maintenance of sediment removal devices is vital and must be carried out regularly.
- Up to date plans – construction plans change and evolve during the duration of the project and the sediment and erosion control plans must be modified and updated prior (and obtain appropriate approvals where relevant) to any variation to the original plan.
- Assess and adjust – sediment and erosion control is only successful when careful monitoring of the performance of the plan and mitigation measures is carried out. The measures should be adjusted where monitoring identifies potential issues. Inspection of measures should be regularly carried out, in particular after significant rainfall events. Any repairs or maintenance requirements identified should be carried out as soon as practically possible.

5.7 Low Impact Development and Source Control

Low impact design and development, in particular source control, continues to receive considerable attention by both regional and city (or district) councils. Whilst such initiatives are recognised as key measures to ensure satisfactory environmental outcomes, they also raise a number of issues relating to implementation.

The South-West Christchurch ICMP provides a conservative approach to mitigating potential environmental effects and represents a strong change in direction towards low impact development. The following initiatives demonstrate how low impact development is to be achieved in South-West Christchurch:

- Greater mitigation of water quantity.
- Maintenance of existing groundwater recharge.
- Greater emphasis on mitigating water quality to enhance ecological (aquatic) values.
- Treatment of stormwater prior to discharge to ground (except roof runoff in certain areas).
- Location of stormwater mitigation measures in natural basins where practicable, and to support the creation of a linked network of parks and open space, including the ecological enhancement of aquatic, terrestrial and riparian habitat.
- More integrated sub-divisional design and linkage (addressing accumulative effects).
- Improved industrial management of stormwater (i.e. moving towards individual consents for higher risk and problematic sites, improved onsite mitigation and improving environmental management as required by HSNO Act).

At this stage the ICMP does not restrict the type of building materials used within South-West Christchurch, rather it promotes the use of building products that have lower environmental impacts. The matter of more stringent controls is to be investigated further by Christchurch City Council jointly with

Environment Canterbury prior to the implementation phase of the ICMP. Further improvements can be made at source over time with improved education and commitment to low impact building materials.

Removal of zinc and copper building products (roofing materials and gutters and down-pipes) is one example of removing the contaminants at source. Restricting building materials, however, has economic consequences to the building industry and is likely to give rise to strong opposition from the steel industry. These products currently meet relevant standards and are therefore entitled to be sold within New Zealand. Restrictions have been included in a number of smaller sub-divisional consents, but none of significance in South-West Christchurch. One argument on this issue is that it should be addressed by central government, as was the case with the removal of lead from petrol. However Christchurch City Council will work with ECan use education tools to promote more environmental sustainable products to developers, trades and the public as discussed in Section 5.3.

5.8 Waterway Enhancement

Christchurch City Council has a well established programme of enhancing waterways. The programme was originally developed to promote the six values approach and reduce maintenance costs through replace timber lined drains and piped systems with naturalised open waterways.

The waterway enhancement programme is an important management measure that Christchurch City Council is implementing throughout Christchurch. Waterways within South-West Christchurch will be prioritised along other waterways outside of South-West Christchurch for enhancement within the existing budgets.

Waterway enhancement can also be achieved during development through promotion of the advantages of higher section prices as well as improved living environments. Promoting and implementing waterway enhancement is also addressed as part of the Green Print process and the approach works well with the green corridor approach being promoted for South-West Christchurch which meets other values as well as ecological benefits.

5.9 Integration with other disciplines and the Greenprint

The development of the surface and groundwater management scheme has been prepared with consideration to other disciplines and achieving a values-based approach to land development. The scheme provides the foundation to achieve the protection and enhancement of natural, cultural, heritage, landscape, open space and recreational values, and ultimately a quality environment to live, work, and play within.

A 'Greenprint' has been prepared in conjunction with the Integrated Catchment Management Plan as part of the South-West Christchurch Area Plan. The Greenprint provides direction for the protection and enhancement of areas valued for natural, open space and recreation, cultural, and historical reasons. It provides the setting within which new development is to be designed, and opportunities for existing and future residents to connect with nature and recreate.

1. **A high quality water environment that is protected from contamination, designed to reduce flood risk, and enhanced to provide amenity and habitats for flora and fauna.**

South-West Christchurch has a rich and diverse range of water resources which provide the City with an opportunity to create a unique living environment. As already evident in the area, stormwater management facilities can improve the amenity and character of an area, soften the visual impact of the built environment, and connect the community with nature.

2. **A connected network of habitats which protect and restore natural ecosystems and result in improved species population and diversity.**

Prior to human settlement the South-West area consisted of flat, swampy land drained by various waterways, with the bush-clad Port Hills forming the southern boundary. Aquifers sit beneath the area and continue to discharge as springs. The South-West wetland habitat would have supported abundant birdlife, including waterfowl and swamp-birds such as Grey Duck, Brown Teal, New Zealand Scaup, and black stilt. During the settlement of Christchurch wetlands were drained, streams were straightened, and native bush was removed. The original riparian vegetation was largely replaced with a mix of exotic species, so that the remaining waterways and hills bear little resemblance to the natural environment prior to human settlement. The ecological repercussions have been extensive. Nonetheless, there are still areas which have ecological value including bird habitat, fishing sites, patches of forest, and ecological heritage sites. The Greenprint seeks to build on these existing values through providing new and enhanced core habitats (large areas providing a variety of habitats) and habitat nodes (smaller patches). These will be linked by ecological corridors that allow movement of species between areas of shelter, food, and space.

3. **A strong community identity through the active protection and restoration of values significant to tangata whenua, both historical and contemporary.**

South-West Christchurch is an area of cultural and historical significance to Tangata Whenua. Ngāi Tahu, and before them Ngati Mamoe and Waitaha, maintained both permanent and temporary habitation sites gathering natural resources from the network of springs, waterways, swamps, grasslands, and lowland podocarp forests that once made up the wider Christchurch area. The future management and development of the area offers an opportunity to recognise and provide for these relationships and connections through the protection, enhancement, and interpretation of traditional sites, mahinga kai species, place names, and other cultural values.

Several sites of particular significance have been identified, including Otumatua (landmark, wahi tapu), Oteikateana (landmark, wahi tapu), Owaka (historical passage), Hurutini (mahinga kai), Tauawaamaka (mahinga kai), Opawaho (mahinga kai), and Teurumanuka (mahinga kai). Recognition and protection of these areas will be achieved through a range of initiatives from the use of Maori names on all land development and management plans, restoring habitat, and telling the story of Maori occupation when developing reserve land (i.e. through interpretation boards and use of local materials such as flax).

4. **A strong community identity through the active protection and recognition of European heritage.**

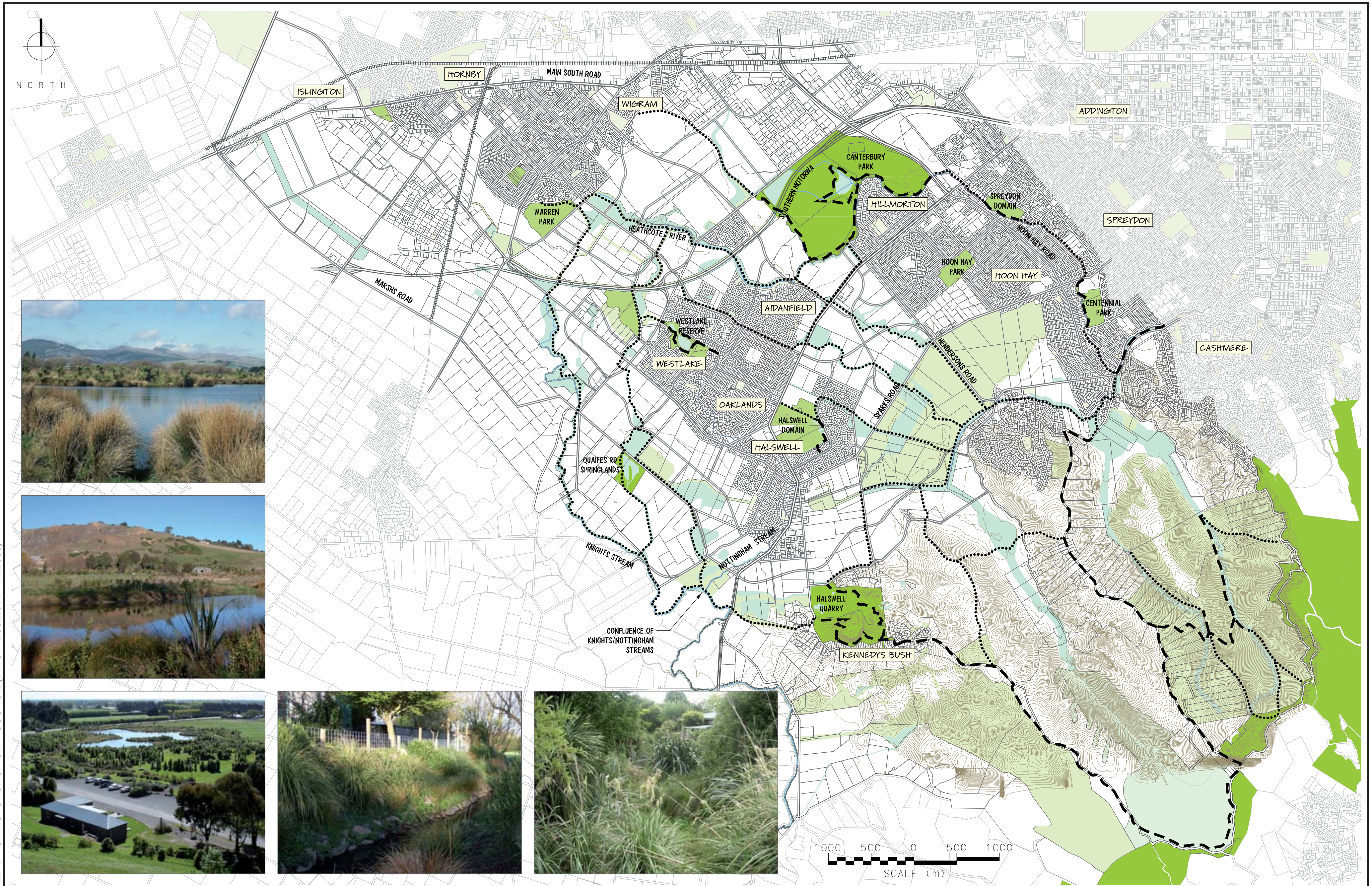
The European history of the area is dominated by farming, the extraction and manufacture of primary products, and industrial activity. There are also some large properties with interesting histories and unique land-uses: for example, the former Wigram Aerodrome site, Halswell Quarry, Canterbury Agricultural Park, and the St. John of God site. Archaeological and historical studies, raising community awareness, and protecting and enhancing heritage sites, are some of the mechanisms which will be used to achieve this objective.

5. **The protection and incorporation of landscape features into urban developments and public open space.**

The existing landscape of the South-West reflects a complex interplay of both natural and cultural processes. Public access to important landscape features will be retained and improved, view shafts (particularly of the Port Hills) will be incorporated into future urban design considerations, themed street planting will be used to promote local character, and important landscape features will be protected. Waterways and wetlands will become more prominent features in the landscape by exposing and restoring their special qualities. The use of native vegetation will be required in all public open spaces (including roadways) and encouraged on private land.

6. **A connected and diverse network of public open space to serve a broad range of community needs.**

Open spaces are important for a community's quality of life. South-West Christchurch currently has a range of public open space. Urban development will put increasing pressure on these areas, and population changes will lead to changes in the number, type, and range of open space required. In the future providing public open space will become increasingly important as private open space decreases with denser housing. The Greenprint signals a change in focus from providing numerous small local parks, to providing larger, connected open spaces with a variety of uses, based on the area's unique waterway network. Cycle and walking tracks will be provided alongside waterway corridors and public linkages created between major parks and reserves and key activity centres. District parks will be co-located where possible, adjacent to key waterways and stormwater management facilities to maximise the scale, versatility, and amenity of public areas.



PLAN SUPPLIED BY CHRISTCHURCH CITY COUNCIL (DWG IP208116 APRIL 2008)

Golder Associates

TITLE SOUTH-WEST CHRISTCHURCH GREENPRINT

MAY 2008

PROJECT CHCCC-CHC-015

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6. Monitoring

6.1 Introduction

Two types of monitoring will be carried out for South-West Christchurch. The first type of monitoring (management monitoring) is for continually improving the knowledge of the catchments, while the second (receiving environment monitoring) relates to measuring receiving environment conditions and ICMP performance against receiving environment objectives.

Monitoring is a key aspect of the proposed mitigation strategy, and is required to ensure that the approach is meeting the receiving environment objectives. The proposed monitoring is outlined in the following section.

6.2 Receiving Environment Monitoring

6.2.1 Groundwater

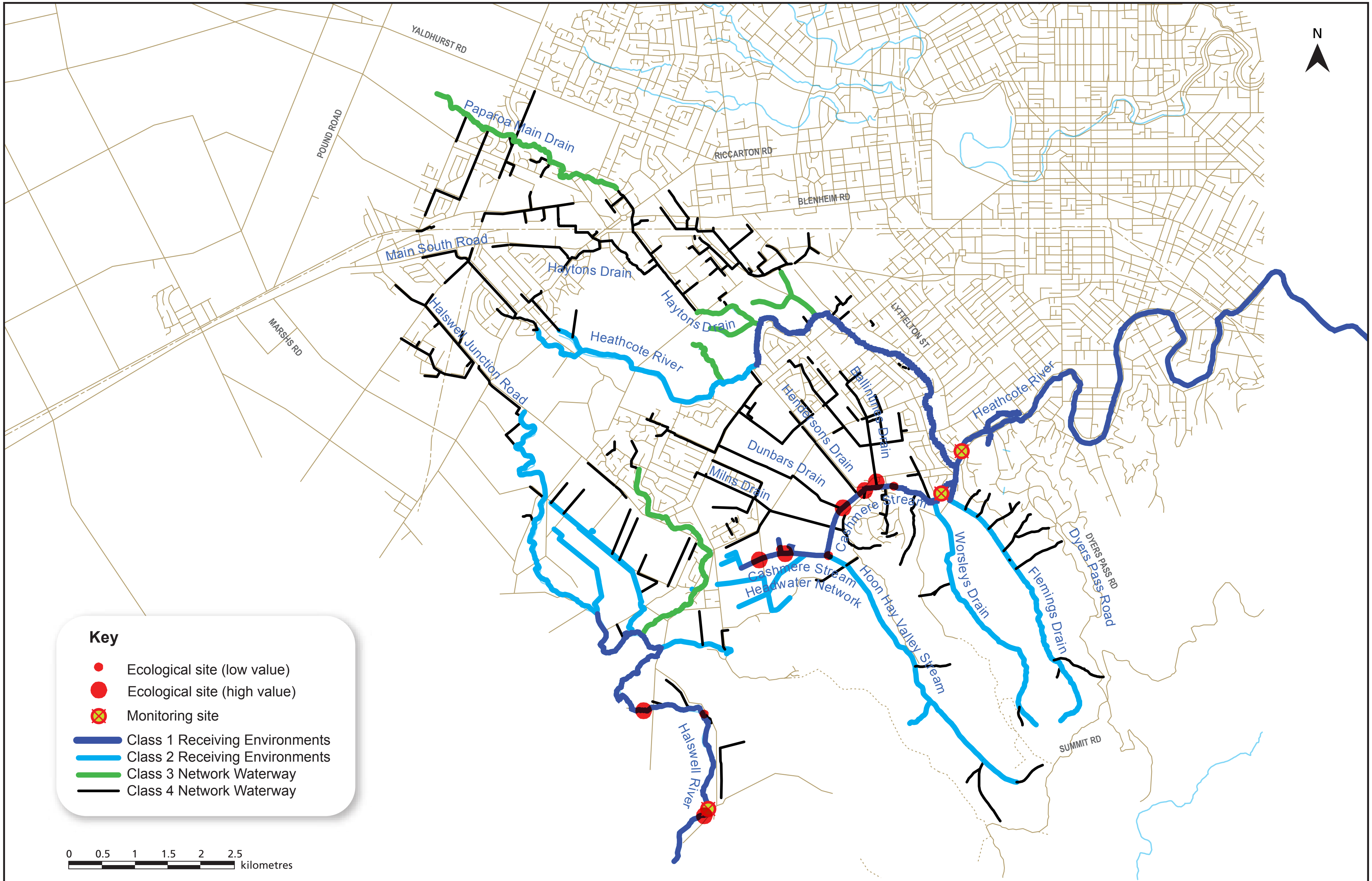
Groundwater monitoring will consist of monitoring of domestic supply wells groundwater quality for the South-West Christchurch area. The wells are currently monitored by Christchurch City Council to ensure compliance with the drinking water standards and the analyses carried out will be expanded to include stormwater specific contaminants.

Groundwater quality monitoring sites will be sampled monthly and include the following key stormwater contaminants:

- Total and dissolved zinc.
- Total and dissolved copper.
- Total and dissolved lead.
- Total Petroleum Hydrocarbons.
- Ammoniacal-N, nitrate-nitrogen, nitrite-nitrogen and dissolved reactive phosphorus.
- Enterococci, Faecal coliforms, and *E. Coli*.

6.2.2 Surface Water

The monitoring of water quality is currently carried out by Christchurch City Council at a number of sites for a wide range for parameters. The proposed monitoring of the performance of the ICMP is limited to the sites selected on the basis that they provide key indicators for general water quality of the receiving environments, and their locations are identified in Fig. 6.1.



Golder Associates

TITLE SURFACE WATER QUALITY MONITORING SITES

MAY 2008

PROJECT CHCCC-CHC-015

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The water quality monitoring sites (refer to Fig. 6.1) will be sampled monthly and analysed for the following parameters:

- Total and dissolved zinc.
- Total and dissolved copper.
- Total and dissolved lead.
- Total Petroleum Hydrocarbons.
- pH and electrical conductivity.
- TSS and turbidity.
- Dissolved oxygen.
- $BOD_{5.}$
- Ammoniacal-N, nitrate-nitrogen, nitrite-nitrogen and dissolved reactive phosphorus.
- Enterococci, Faecal coliforms, and *E. Coli*.

In addition to the water quality monitoring proposed above, turbidity monitoring will be carried out in receiving environment waterways on a monthly basis where construction is being carried out in the sub-catchment immediately upstream.

6.2.3 Stream Sediment Quality

The stream sediment quality reported in Kingett Mitchell (2005a) for Class 1 and 2 receiving environments will be surveyed every ten years, on the basis that they provide key indicators for general water quality of the receiving environments in terms of metal toxicity. The sampling programme will be designed once the final land use for the catchments has been established to ensure monitoring of the most relevant locations surveyed in Kingett Mitchell (2005a).

6.2.4 Ecological Monitoring

Ecological monitoring is also proposed for key sites within class 1 receiving environment waterways as identified in Fig. 6.1. The monitoring will be designed specifically for the values of each site (as identified in South-West Christchurch Integrated Catchment Management Plan Technical Series – Report Number 3 Aquatic Values and Management). The monitoring will be carried out annually, with at least one survey to be conducted prior to implementation of any land use change as a result of the South-West Christchurch Area Plan.

6.2.5 Water Level Monitoring

The following monitoring will be carried out to assess the performance of the ICMP against the receiving environment objectives:

- Continuation of existing water level monitoring at the following sites:
  - Heathcote River at Ferrymead Bridge.
  - Heathcote River at Ferniehurst Bridge.
  - Heathcote River at Bowenvale Flume.
  - Heathcote River at Buxton Terrace.
- Continuation of rainfall monitoring at the following sites:
  - Christchurch Airport

  - Christchurch Gardens.
  - College of Education.
  - Bowenvale Flume.
  - Upper Bowenvale Valley.

6.3 Management Monitoring

Management monitoring will include:

- Existing Christchurch City Council surface water quality monitoring sites not identified in 6.2
- Monitoring of soil quality in a number of representative soil adsorption basins to determine the required frequency for soil remediation and/or replacement.
- Monitoring of infiltration rates in a number of representative soil adsorption basins to determine the required frequency for soil remediation and/or replacement.
- Monitoring of groundwater levels and quality (same analyses identified in Section 6.2.1) at monitoring bores downstream of a selection of soil absorption basins.
- Continuation of water level monitoring at the following sites:
  - Wigram Retention Basin.
  - Halswell Retention Basin.
- Continuation of rainfall monitoring at the following sites:
  - Wigram Retention Basin.
  - Halswell Retention Basin.
- Hydraulic and hydrological modelling of the finalised surface water management system prior to construction to ensure assumptions and predictions in the ICMP remain valid.

6.4 Reporting

The results of annual monitoring shall be summarised and assessed against receiving environment objectives of the South-West Christchurch ICMP. The report shall:

- Describe the type and locations of monitoring carried out.
- Describe methodologies and approaches of each type of monitoring.
- Summarise monitoring results.
- Compare monitoring results to previous monitoring results and discuss observed and predicted trends.
- Assess monitoring results against receiving environment objectives.
- Identify receiving environments objectives not being met and either:
  - Summarise further investigation carried out to identify the reason for not meeting the receiving environments objectives and make recommendations to address the issues (including an ICMP review).
  - Or identify investigation in progress.
- Provide conclusions on the monitoring and recommendations to adjust the monitoring or review the ICMP.

6.5 Further Investigations

In the event that monitoring identifies that receiving environment objectives are not being met, additional monitoring (i.e., surface water and groundwater quality, ecological, flow monitoring and sediment quality) would be conducted to determine the source and recommend corrected actions or changes to mitigation or management approaches. In the event that changes to mitigation or management approaches are recommended an ICMP review will be carried out (refer to Section 9).

7. Institutional Capacity

This section addresses the institutional capacity of Christchurch City Council to manage the implementation of the ICMP. It is envisaged that this new capability will be developed leading into the start of the implementation of the ICMP for South-West Christchurch. Christchurch City Council does not intend to develop entirely new processes to achieve the implementation of the ICMP; rather, they intend to integrate existing systems where appropriate, supported by further development of existing systems, and some development of new systems.

Christchurch City Council intends to further develop options for monitoring and enforcement in conjunction with ECan. This approach is likely to involve a joint enforcement and monitoring approach by Christchurch City Council and ECan, and there are a number of options for achieving this.

The key is to have a regionally consistent approach around the consent requirements, which is based on a clear understanding of what Territorial Authorities can legally and practicably do:

- Manage directly under the RMA and other statutes.
- Manage indirectly through non-regulatory methods, such as education and advocacy.
- Limit responsibility for certain activities (i.e., discharges from industrial sites).

8. Implementation

Table 8.1 sets out some of the key implementation mechanisms that are being used and/or considered by Council. This is not intended to be an exhaustive list, rather is indicative of the broad range of methods will need to be employed to ensure the successful implement the ICMP.

Table 8.1: Implementation mechanisms

Mechanism	Specific Mechanism	Outcome
Local Government Act	Long Term Council Community Plan Annual Plan	Provides the funding to design, construct and maintain stormwater management facilities.
	Long Term Council Community Plan Capital Works Programme	Specifies the works to be undertaken over a 10yr period (and potentially 20yr period).
	Long Term Council Community Plan Development Contributions	Specifies the contribution to be paid towards recovering the capital expenditure associated with the work.
	Bylaws	Provides for the protection of the drainage works; public safety with regard to drainage works; and prescribes the conditions which shall apply to the drainage system.
Resource Management Act	Objectives policies and methods of the City Plan	Identifies the desired outcomes for urban growth, stormwater management, the matters that will influence Council decisions and the methods that will be adopted in the City Plan to achieve the ICMP.
	Zoning and Outline Development Plan	Identifies and protects the land area to be used for stormwater management purposes.
	Designation	Protects the land area to be used for the stormwater management purposes and secures the use of the land for that specified purpose.
	Catchment Discharge Consent	Permit the method of stormwater discharge as proposed under the ICMP and enables the operation of the stormwater management scheme.
	Subdivision Consent	Subdivides the land to create the new allotments including those for the stormwater management facilities.
	Land-use consent for earthworks	Permits earthworks to enable the creation of the stormwater management facilities.
	Monitoring and Enforcement	To ensure compliance with the Catchment Discharge Consent conditions, and assessment of the state of the environment.
Public Works Act	Land acquisition	Enables the Council to purchase the land required for the stormwater management facilities.
Education and Advocacy	Design, Development and Construction guidelines	Promotes best practise.
	Education programmes	Promotes best practise and obtains land developer and community buy-in to the ICMP
	Rating systems	Provides a baseline for new subdivisions to be assessed against to gauge their achievement of sustainability objectives.
	Research	Investigates emerging new technologies

Implementation of the ICMP will be undertaken over a long period (35 years or more), which is reflected in the projected implementation programme in Figs. 8.1 and 8.2. The projection assumes that the construction of facilities (and associated expenditure) will be sporadic due to other planning and infrastructure constraints which impact on land development staging. The programme for the design and construction of facilities will need to be closely aligned with associated planning and infrastructure programmes, to ensure facilities are created ahead of land development.

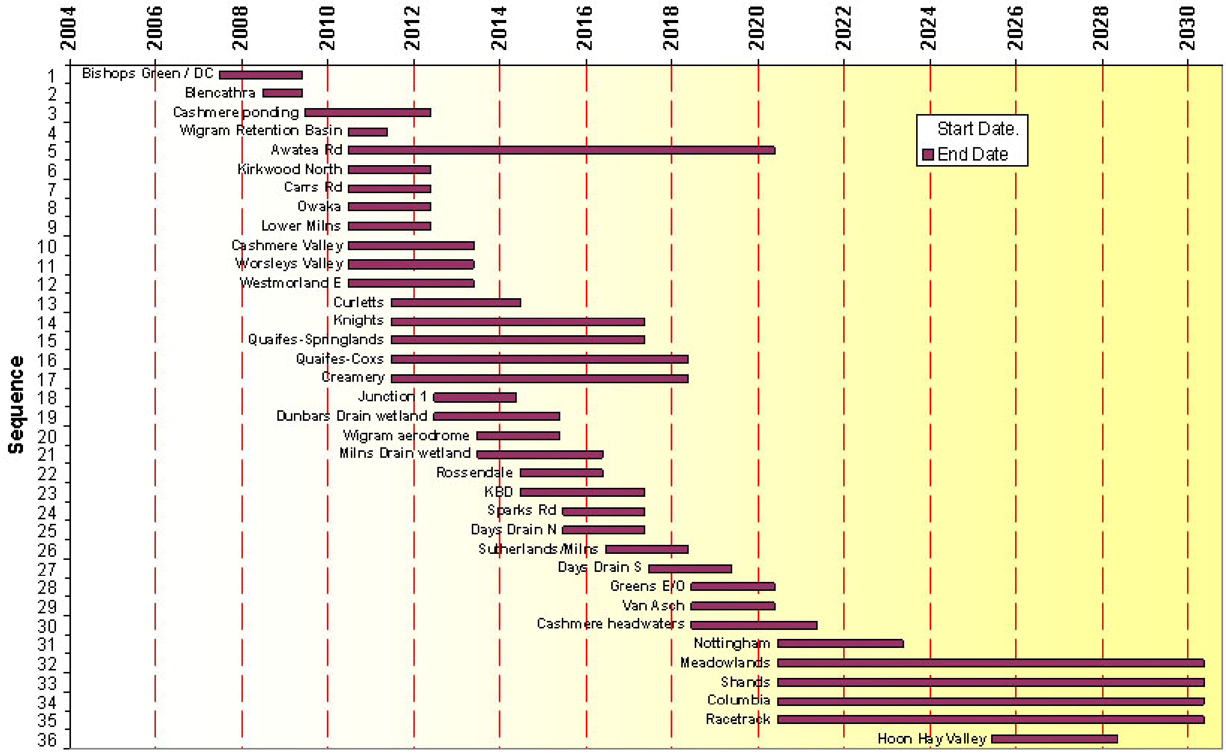

Fig. 8.1: **Implementation programme for South-West Christchurch ICMP.**

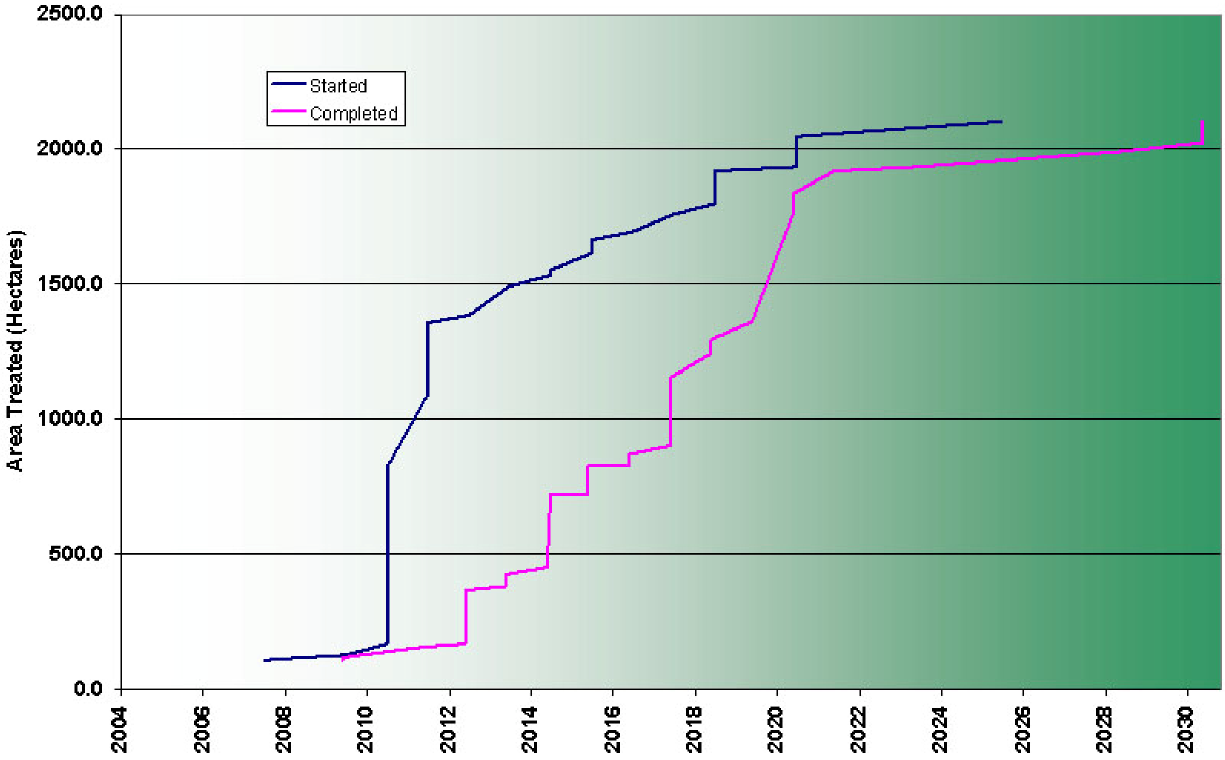

Fig. 8.2: **Mitigation programme for South-West Christchurch ICMP.**

The implementation of the ICMP represents a significant investment by Christchurch City Council to ensure effective management of the catchments and mitigation of potential adverse.

The implementation of the key measures of the ICMP are summarised in Table 8.2. The implementation process is expected to be further refined following City and Area Plan processes are completed. The ICMP will be implemented over a significant length of time in part as the result of the time for the City and Area Plan processes to be completed, subdivisions to be consented, designed and constructed and for Christchurch City Council and ECan to develop education programmes and strategies for managing industrial site management issues.

Table 8.2: Methods of implementation.

ICMP Measure	Timeframe	Comments
Level of service	The level of service is provided in the subdivision design and is implemented at the time of subdivision construction.	Level of service is subject to review and change.
Environmental education	Implement progressively in conjunction with ECan.	Awareness of environmental effects of building materials, effects of poor industrial practices and general environmental and waterway awareness.
Industrial stormwater and site management.	Implement progressively over five years in conjunction with ECan.	(ECan Pollution Prevention Guide, source control and individual site permitting).
Stormwater quality and quantity mitigation (SWMS and contingency measures).	SWMS Implemented progressively prior to any development.	SWMS will be finalised once the final land use is known following the city plan process is completed.
	Contingency measures may be implemented where water quality does not meet receiving environment objectives.	Measures can be implemented in existing and new areas.
Sediment and erosion control for construction of new subdivisions and other developments.	Draft plans will be developed and provided with subdivision consent applications and finalised during detailed design and prior to construction.	
Low impact design and source control.	Implemented progressively. SWMS elements implemented as part of the SWMS other initiatives will be developed over time in conjunction with ECan.	
Waterway enhancement programmes.	Implemented under existing waterway enhancement programmes as waterways are prioritised. Natural Asessment Management Strategy identifies waterways within South-West Christchurch.	
Green Print initiatives and land use controls.	Implemented progressively with development and over time.	
Monitoring and reporting.	Implemented prior to development for baseline conditions.	Refer to Section 6.
Further investigations.	Implemented as required or when receiving environment objectives are not met.	Refer to Section 6.
Sub-Project Area reports	Developed prior to construction of the SWSM.	Refer to Section 8.
Operation and Maintenance (develop and implement plans) of stormwater systems.	Plans developed prior to construction of facilities and implemented after construction.	Refer to Section 8.
ICMP Reviews.	Implemented as required or when receiving environment objectives are not met.	Refer to Section 9.

9. Provision for Review of ICMP

The proposed approach includes a provision for reviewing the ICMP or any aspect of the ICMP if monitoring identifies that receiving environment objectives are not being met, or if a change in philosophy is required. The proposed approach would be for Christchurch City Council to notify ECan of such a review, and for on-going consultation to occur throughout the process. The area wide discharge consent is also expected to provide conditions of consent that trigger a review in certain situations. Christchurch City Council would seek approval from ECan for the outcomes of the review, either in principle or by way of consent variation.

10. Summary

The purpose of this Integrated Catchment Management Plan is to provide a comprehensive overview of the proposed philosophy and mitigation strategy for future management of surface water and stormwater for the south-western part of Christchurch, which is also known as South-West Christchurch.

The Christchurch City Council is assessing the potential for South-West Christchurch to accommodate projected population growth. The predicted population growth will create significant demand for further development of new residential and business areas, predominantly through Greenfields development.

The Integrated Catchment Management Plan (ICMP) is a foundation document to the SWAP, which is being developed concurrently. The SWAP will assess and make recommendations regarding any future urban development of South-West Christchurch, and will form the basis for any zone changes to the City Plan. The ICMP will not determine future land use; rather, it will address how surface water management will respond to any future land use changes. The ICMP will provide background and technical assessments of surface water management that provide, along with all the other supporting assessments, the basis for the SWAP to make recommendations regarding future land use.

Existing surface water and groundwater quantity have been assessed, which identified flooding associated with the Heathcote and Halswell rivers as the most significant issue. Water quantity for surface water is a major issue within South-West Christchurch, due to existing flood issues in both the Heathcote and Halswell rivers. The sensitivities and effects of inundation of Hendersons Basin on private land owners is also a key concern.

The hydrological and hydraulic modelling demonstrates that since the Heathcote River floodplain Management Strategy (based on 1991 flood predictions) was developed, flood levels up to 2002 have increased as a result of further urban development. The increase in flood levels between 1991 and 2002 can be attributed to the development of Westmorland without mitigation.

The preliminary surface water management scheme provides a conservative level of mitigation and is predicted to reduce flood levels to below 2002 levels. The preliminary surface water management scheme is predicted to reduce levels closer to those predicted for 1991. The preliminary surface water management scheme will therefore provide a significant benefit to flood levels in South-West Christchurch (including Hendersons Basin, Cashmere Stream and the Heathcote River) and the middle and lower reaches of the Heathcote River.

It should be noted that past adverse affects relating to the period from 1991 to 2002 are addressed by the surface water management scheme by either retro-fitting mitigation to some existing areas, or using compensatory storage in one area to mitigate effects from other areas. Overall, it is considered that a significant amount of existing development has been mitigated by the proposed preliminary surface water management scheme.

The water quantity assessment for the Halswell River is based on a non-modelling approach that uses the same conservative mitigation concept proposed for the Heathcote River catchments. The preliminary surface water management scheme is expected to provide a similar level of service and protection to that predicted for the Heathcote River.

The assessment of groundwater predicts a net increase in groundwater recharge of four percent across the entire study area as a result of the infiltration and soakage systems identified in the preliminary surface water management scheme. No adverse effects on springs and baseflow are predicted. The changes in groundwater levels (i.e. mounding) as a result of the installation of infiltration basins has been determined to be localised around the immediate extent of the infiltration basins.

Existing surface water and groundwater quality has been assessed and identified as being relatively poor in many surface waterways, with the exception of Cashmere Stream, which shows moderate water quality. Water quality data for metals is limited and generally relates to network waterways, not receiving environment waterways. Existing water quality does not meet the proposed Natural Resources Regional

Plan (NRRP) water quality standards. Groundwater quality is generally high with only localised areas of poorer quality; these areas mostly relate to past site management practices within industrial areas and uncontrolled filling of gravel pits. Groundwater has been shown to be improving, and these improvements have been attributed to improved site management practices within industrial areas and prevention of uncontrolled filling of former gravel pits.

Receiving environment waterways have been identified and classified in terms of their importance and ability to be protected. Each class of receiving environment and non-receiving environment waterway has had a number of water quality (and ecological) objectives identified. Groundwater has also had a number of water quality objectives identified.

A comprehensive assessment of treatment systems and mitigation options has been carried out. The life cycle costs of each option have been assessed and presented as net present value (NPV) and, along with the compliance approach, these have been used to determine options that are both feasible and meet the required standards.

The recommended option (Option 8) to be adopted as part of the mitigation strategy involves the use of soakage basins, where suitable soakage conditions exist, and sedimentation basins followed by wetlands (or wet ponds). Option 8 also provides for other values, such as recreation, ecology, landscape, and culture, and is more consistent with the Christchurch City Council's Natural Asset Management Strategy and other policies. Option 8 is predicted to meet the United States Environmental Protection Agency (USEPA) criteria at key receiving environment waterways. The mitigation strategy is also recommended to include the provision of flexibility to allow for additional measures or systems to be inserted into the treatment train to cater for any unexpected water quality results, and in particular for high risk industrial sites. It is recommended that the option of using filtration systems capable of removing high levels of metals (dissolved and total fractions) is used in these circumstances. The filtration systems could be either located at each industrial site, or on the outlet of the sedimentation basins.

The proposed mitigation strategy is considered to be a significant increase in standards, and is predicted to achieve significant environmental benefits by meeting the USEPA criteria for metals in receiving environment waterways. Existing water quality in some areas will also be improved by way of providing treatment of existing unmitigated areas, which currently discharge directly to waterways. The recommended mitigation strategy will also include benefits of providing provisions for open space, green corridors, ecological habitat, improved landscapes, and opportunities to provide for cultural values.

Predicted changes in groundwater quality following the proposed mitigation are limited to shallow localised areas immediately around soil adsorption basins. The overall changes to the general groundwater quality are slight and considered no more than minor. These changes are not expected to impact the community drinking water wells, as a result of high levels of mitigation and the establishment of separation zones. Water quality of springs contributing to surface waterway base and low flows is not expected to change significantly.

The performance of the proposed mitigation will be measured against the receiving environment objectives by monitoring water quality and ecology within Class 1 receiving environment waterways. The strategy will also include a review provision to keep up to date with science and to respond to monitoring results.

11. References

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