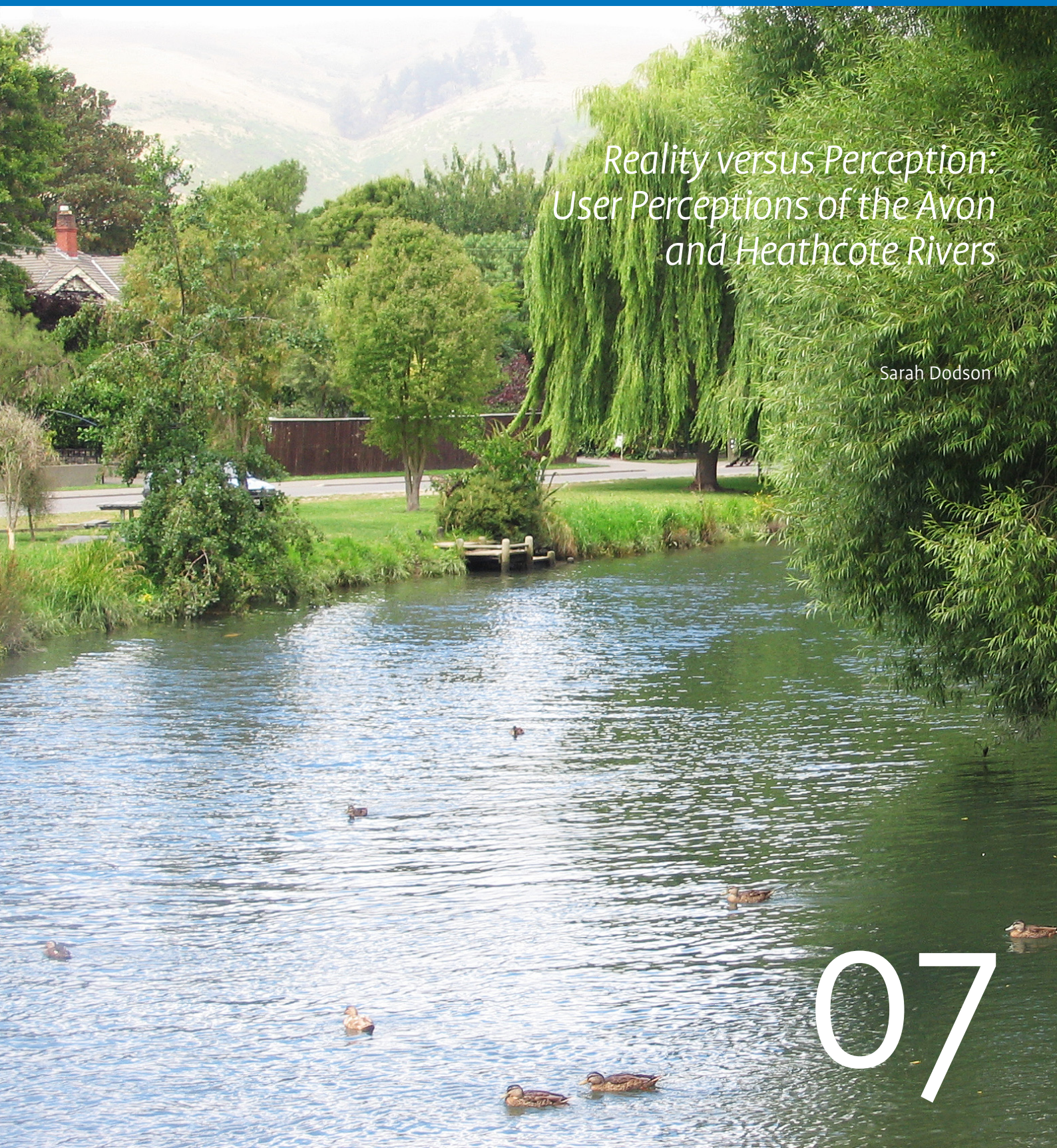
Geography

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Research Report



Reality versus Perception: User Perceptions of the Avon and Heathcote Rivers

Sarah Dodson

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Report to the Avon Heathcote Estuary Ihutai Trust and
Environment Canterbury

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Executive Summary

This report investigates user perceptions of the Avon and Heathcote Rivers in Christchurch. The purpose of this research is to investigate if user perceptions of the health of Christchurch urban rivers match the reality of the rivers as determined through scientific monitoring. In order to provide programmes that will educate people about the rivers and encourage them to live in a manner that is beneficial to the rivers, it is important to know peoples' baseline knowledge and whether or not it matches reality.

To investigate perceptions of river users, a questionnaire was carried out across four sites: Hagley Park and Kerrs Reach for the Avon/Ōtakaro River, opposite Princess Margaret Hospital (PMH) and a site in Hansens Park for the Heathcote/Opawaho River. Questions sought to investigate how users perceived water quality and what they thought the main (if any) pollutants of the rivers were. Water samples were taken at each site the day surveys were conducted in order to determine whether perceptions matched the reality the rivers' health. From analysis of these samples an ecological and public health rating was given for each survey site and the scientific ratings were compared with survey responses.

Perceptions rarely meet reality for the Avon and Heathcote Rivers. A large number of river users were unaware of the significant sources of pollution as well as how various land use activities alter water quality and the ecological health of the rivers. Public awareness campaigns need to cover these issues. When river users are informed of the public health risks in times of bad weather, it would be good to say what the pollutants of the water are. While the public are aware of the health risks of poor water quality, they are often unaware of what causes these risks. River users showed a genuine interest in their river and were willing to discuss how they felt and any concerns they had about their environment. They are likely to listen to future public awareness campaigns.

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1.0 Introduction

The purpose of this research is to investigate if user perceptions of the health of the Christchurch urban rivers match the reality of what the health of the rivers is actually like. This report was commissioned by the Avon-Heathcote Estuary Ihutai Trust, which has at its core the concept of integrated environmental management. This means the Trust is not only concerned about the health of the Estuary and its improvement but is also concerned about the health of the Avon and Heathcote Rivers that flow into the Estuary. Any improvements in the rivers will not only be beneficial to the rivers, it will have flow on positive effects to the Estuary. In order to provide programmes that will educate people about the rivers and encourage people to live in a manner that is beneficial for the rivers, it is important to know what their baseline knowledge is and whether or not it matches reality.

The Avon-Heathcote Estuary is a large natural ecosystem which is ecologically, socially and culturally significant for Christchurch, New Zealand. The Estuary is accessible to the residents of this city and is important for its large and varied wildlife population, as a valuable educational, visual and recreational resource, and historically as a collection point for shellfish and fish by *Tangata Whenua* (Environmental Services 1993).

The Estuary is an open system and is affected by various external forces including the Avon/Ōtakaro and Heathcote/Opawaho Rivers. These two rivers meander through commercial, residential and industrial parts of Christchurch City, eventually feeding into the Avon-Heathcote Estuary. The rivers provide a pathway for nutrients, fish, sediment, and pollution to enter the Estuary (Environmental Services 1993).

The Avon and Heathcote Rivers are both spring-fed, and slow flowing. Both rivers have a tidal component, with a tidal influence up to the Barbadoes Street Bridge on the Avon River and Tennyson Street on the Heathcote River. Saline and fresh water mixing occurs as far as Wainoni Road Bridge up the Avon River and to approximately the Radley Street Bridge up the Heathcote River (Environmental Services 1993).

The Avon River is 26 km in length with 8 natural streams and creeks and 2 artificial drains flowing into the Avon along various parts of the river. After negotiating through the city and the north-western suburbs of Christchurch, the Avon River eventually discharges into the northern part of the Estuary (Environmental Services 1993). The Avon catchment is 84 km^2 and rises to 30 m above sea level (Environment Canterbury 2001).

The Heathcote River originates near Wigram Aerodrome and flows through rural land before meandering through the southern suburbs of the city and discharging into the south-west section of the Estuary (Environmental Services 1993). The Heathcote catchment is 103 km^2 (Environment Canterbury 2000). Several man-made drains flow into the Heathcote River, as well one a natural tributary, the Cashmere Stream (Environment Canterbury 2001).

1.1 Ecological Values

1.11 Plants

Plant species have changed in the Avon and Heathcote Rivers since urban development, with fewer remaining native species in both the Avon and Heathcote Rivers than there were in the past. The Christchurch City Council and community groups have made an effort to restore river margins with native vegetation, which has improved the habitat for various fish and bird species in the Avon and Heathcote Rivers (Environment 2001).

Fern, rushes and sedges are still found along the banks of both rivers along with exotic trees and introduced grasses. The banks of the Heathcote River are "*dominated by introduced willows and grasses*" while the headwaters are more "*rural and natural*" compared with the Avon River (Environment Canterbury 2001: 28). Both rivers support the growth of liverwort, algae, moss and the common pond-weed. Egeria (an aquatic weed) is a problem for the lower reaches of the Avon River at Kerrs Reach (Environment Canterbury 2001). A weed-cutter boat controls the growth of weed lower parts of the Avon and Heathcote Rivers (Christchurch City Council 2003). A weed-cutter boat was cutting weed at Kerrs Reach the day surveying was carried out.

1.12 Birds

Ducks and black billed gulls are commonly found near the Avon and Heathcote Rivers. Red-billed gulls, southern black-backed gulls, black cormorant, little cormorant, welcome shallow and grey duck are found in smaller numbers near both rivers (Environment Canterbury 2001). Bank plantings by the Christchurch City Council have provided nesting sites for scaup, a small native duck found near the rivers (Environment Canterbury 2001). There was a large amount of bird life including ducks and Canadian geese the day surveying was carried out at the Kerrs Reach river site.

1.13 Fish

The number and diversity of fish species in Canterbury waterways largely depends on the type of habitat available, with the Avon River supporting a greater diversity of fish species than the Heathcote River. The latter is unproductive due to habitat degradation and the uniformity of habitat. The Cashmere Stream, a main tributary of the Heathcote River, is, however, productive due to the various habitats the stream provides with the "*predominance of slow runs with few pools and riffles*" (Environment Canterbury 2001:29). Trout, short-finned eel and upland bully are species found in both rivers.

1.14 Macro-invertebrates

Urban development has caused a reduction in number of macro-invertebrates found in streams that flow through urban areas in Christchurch. The Cashmere Stream and the upper Heathcote tend to have a greater number and diversity of macro-invertebrates as they run through rural land. Species which are found in the Avon and Heathcote Rivers include molluscs (snails), oligochaetes (roundworms), chironomids (midge) and crustaceans (shrimp-like animals) (Environment Canterbury 2001).

1.2 Water Quality

Water quality is defined by Meybeck et al. (1996) in Codd (2000: 51) as "*the suitability of water to sustain various uses or processes*." The water quality of the Avon and Heathcote River influences values Christchurch residents place on the rivers and also recreational, economic, *Tangata Whenua* and ecological uses of the rivers (Environment Canterbury 2001).

1.21 Contaminants and sources

A number of contaminants from various land use sources in Canterbury alter the water quality of the Avon and Heathcote Rivers. Various contaminants, sources and potential impacts are summarised in Table 1.

1.22 Faecal indicator organism – *Escherichia coli*

E. coli numbers are used as an indicator of water quality of fresh waters in New Zealand (Ministry for the Environment 2002). Escherichia coli (*E. coli*) are a type of bacteria and are a faecal indicator organism for pathogenic organisms (Horan 2003) (Figure 1). Pathogenic bacteria are disease causing micro-organisms and can be transmitted by contact with an infected host (Schroeder and Wuertz 2003).

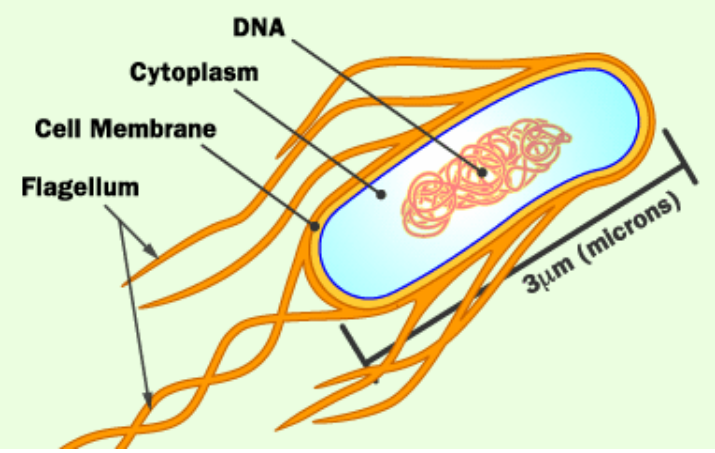

Figure 1: Structure of a simple bacterium cell (Howstuffworks 2006)

Ministry for the Environment (2002) recreational water quality guidelines in New Zealand are used by regional councils for responding to recreational water quality monitoring. According to these guidelines the Acceptable/Green Mode for recreation is a count of no greater than 260 *E. coli* per 100 ml of water. An Alert/Amber mode, when a sanitary survey should be carried out as well as more frequent sampling is for when a single sample count is greater than 260 *E. coli* per 100 ml. An Action/Red mode, when signs are erected and the public are informed, occurs when a single sample is greater than 550 *E. coli* per 100 ml (Ministry for the Environment 2002). To test the microbial quality of the water for this research, samples were analysed for the *E. coli* bacterium, a public health rating for each site was given by comparing *E. coli counts* against recreational water quality guidelines.

Table 1: Contaminants in the Avon and Heathcote Rivers (adapted from Environment Canterbury 2001: 86)

Contaminants	Sources	Potential Impacts
Faecal matter	● Aquatic birds. ● Urban stormwater. ● Rural run-off. ● Sewage overflows during storm events.	● Non-compliance with guidelines for recreational water quality.
Warm water	● Cooling water from industries.	● Encourage growth of aquatic weeds and change habitat conditions.
Sediment	● Urban stormwater run-off. ● Rural run-off. ● New subdivisions with bareland. ● Erosion from Port Hills farmland and urban development works and roads lacking a sealed side-channel. ● Bank erosion.	● Reduction in landscape values because of dirty water. ● Sediment flushed into estuary where it can adversely affect aquatic ecosystems. ● Settled sediment can smother habitats of bottom-dwelling organisms, and spawning areas of fish. ● Can lead to a build up of the riverbed, requiring dredging or digging out. ● Encourages the growth of aquatic plants.
Heavy metals	● Stormwater from roads and roofs. ● Manufacturing industries. ● Timber treatment. ● Leaded petrol. ● Run-off of fertilisers applied to rural land.	● Build up of heavy metals in food chains. ● If concentrations are high enough, aquatic ecosystem health can be adversely affected. ● Can be lethal to animal life but more commonly has effects such as inhibition of growth and resistance to disease/parasites, interference with reproduction, metabolism and behaviour.
Nutrients	● Groundwater. ● Urban/industrial stormwater run-off. ● Rural run-off. ● Fertiliser application. ● Aquatic bird excrement.	● Increase in aquatic plant growth.
Petroleum compounds	● Urban stormwater. ● Fuel/oil spills and leaks associated with use, storage and transfers.	● Most petroleum contamination in stormwater is quickly flushed out of the system. ● Major spills (rarely occur) can affect aquatic species.

1.23 Sewage contamination

Sewage contamination can occur in the Avon-Heathcote catchment from sewage overflows during stormwater events (Environment Canterbury 2001). According to Royds Garden Environmental Services report (1993) the removal of effluent from the Avon-Heathcote Estuary into the open ocean is 80-90% efficient as effluent is only discharged on the ebb tide. Effluent that is released on the ebbing tide is not able to flow up the Estuary towards Pleasant Point (Environmental Services 1993). If effluent does end up near Pleasant Point Environmental Services (1993: 4) reports that the effluent "*could only have been released before the turn of the tide, trapped within the Avon low-flow estuarine channel and carried back up the Estuary on the flooding tide*".

1.24 Sedimentation rates

There is often an increased input of sediment into a waterway during development, with discharges tending to decrease in mature and developed catchments (Christchurch City Council 2003). Other factors influencing sediment discharges include the amount and intensity of rainfall, catchment size, landuse, vegetation and wetland patterns, and geography (Williamson 1993 in Christchurch City Council 2003). In Christchurch heavier sediment discharged into low gradient streams tends to remain in the waterways and not get flushed out to sea. Sediment discharges from land use such as residential development increases sediment bedload, (sediment covering the river bed) and suspended solids (sediment suspended in water column) in the waterway (Christchurch City Council 2003). An increase in bedload in a river can change the habitats of instream aquatic life (Quinn et al. 1991 in Christchurch City Council 2003).

1.25 Stormwater

Stormwater is rainwater than runs off roads, roofs and other surfaces and eventually ends up in waterways such as the Avon and Heathcote Rivers. Stormwater contains various contaminants such as suspended sediments, micro-organisms, nutrients, and chemical contaminants. Stormwater has the greatest impact on waterbodies during dry periods when there are low flows (Christchurch City Council 2003).

1.26 Chemical contaminants

Organic chemical compounds and metals are chemical contaminants of waterways occurring commonly in mature developed urban catchments. Urban activities may result in chemical contaminants entering waterways bound to particulate matter or in a dissolved form. Degradation of water quality due to chemical contamination adversely effects aquatic life and invertebrates within the waterway. Fish are affected by either direct contact with the dissolved form of chemical contaminants or through ingestion of particulate matter (Christchurch City Council 2003). Invertebrates are often exposed to chemical contaminants by their association with river sediments (Williamson 1993 in Christchurch City Council 2003).

1.27 Nutrient contamination

Nutrient concentrations are higher where the Avon and Heathcote Rivers enter the estuary compared to the upper catchment. Tributaries of the Avon River, Dudley Creek and Horseshoe Lake contain high concentrations of dissolved reactive phosphorus (DRP) an ammoniacal nitrogen (NH_4-N) as a result of drainage from farmland such as market gardens in the upper catchment (Royds Garden

Environmental Services 1993). Levels of DRP and NH_4-N are higher in the Heathcote compared to the Avon River. Spring water that feeds the Heathcote has high nitrate concentrations while it is suspected (Robb 1992, in Royds Garden Environmental Services 1993: 7) "*that the release of residual industrial wastes (especially former gasworks effluent) which are now incorporated into riverine sediments are responsible for a measurable, progressive increase in concentrations of NH_4-N downstream of McKenzie Avenue*".

1.3 Background water quality results for the river

The Christchurch City Council regularly monitors the water quality at various sites on the Avon and Heathcote Rivers. Comparison of median values of results taken between 1988 to 1997 show that the Heathcote River had a higher counts of *E. coli* compared to the Avon River. Similarly, suspended solids levels were higher in the Heathcote River compared to the Avon River. The Cashmere stream had a significantly high median value of over 20 mg/L (Christchurch City Council 2007).

Monitoring of the Avon and Heathcote Rivers indicate that the water is often not safe for recreation. Data collected over 2005-2006 showed that the Avon River at Kerrs Reach and the Heathcote River at Catherine Street had a poor grading. The Action level was exceeded on four occasions for the Heathcote River and on six occasions for Kerrs Reach. During the summer of 2004-2005 the Avon River at the Boatsheds also received a very poor rating (Environment Canterbury 2007). This data was useful when deciding if the recreational quality rating for each river site was appropriate.

1.4 Related Literature

The Christchurch City Council (2005-2006) is using a GIS-based strategic management tool, the Christchurch River Environment Assessment System or CREAS, to create a natural asset database for various waterways around Christchurch (Von Tippelskirch 2005-2006). The first stage of the five year project was completed during November 2004 through until May 2005 and included various field surveys of physical habitat along the waterways of the Avon and Heathcote Rivers. Natural Asset Condition Reports have been released for the surveyed waterways during this period but information collected during the second stage of surveying completed over the last two years has yet to be publicly released. These various assessments are useful in providing background physical habitat descriptions for the Avon and Heathcote waterways as well as waterways such as the Cashmere Stream that feeds into them.

Stormwater alters the water quality of the Cashmere Stream in Christchurch. On behalf of the Christchurch City Council, EOS Ecology monitored suspended sediment levels at various sites along the Cashmere Stream, tributary waterways, and sumps during discharge events over the period 2005-2006. As well as linking rainfall events with concentrations of sediment, this monitoring programme provides a valuable resource for identifying how various land uses contribute to variations of water quality in the Cashmere stream (EOS Ecology 2006).

Modelling has been carried out in Christchurch for planning urban stormwater quality controls in the future as well as predictions of how different catchment controls affect stormwater quality (Elliot 1998). This is a useful planning tool for choosing appropriate controls and treatment systems in the future for Christchurch. The research is also useful for discussing how present controls are altering stormwater

quality in the Avon and Heathcote catchments. For example, stormwater treatment ponds were not found to improve sediment quality, and infiltration was found to be poor at improving sediment quality (Elliot 1998).

A technical report prepared by Main (1994) for the Canterbury Regional Council also provided insight into the influence of stormwater on the water resources in the Avon-Heathcote catchments. For example, the contaminants found in storm water vary according to land use. Comparisons were made between the type and concentrations of contaminants in stormwater originating from rural, residential and industrial catchments. The results of this study are limited due to the small set of primary data. More frequent sampling, and sampling at other locations in the Avon-Heathcote catchments, would provide a better picture of the effects of stormwater after heavy rainfall.

In addition to the scientific studies of water quality, a wide range of literature exists on perceptions of landscapes. A number of these studies focus on how sound influence landscape values. Research by Carles et al. (1999) determined that the interaction between sound and image influence preferences about a particular landscape. They found that the emotional meaning of a sound, as well as the importance of the context in which the sound occurs, influence how much a person likes a particular landscape. It would be expected for this research of Christchurch's waterways that river users would value quiet parts of the river dominated by natural sounds more highly than river sites located next to busy roads dominated by artificial noises.

A study investigating the perceptions of London residents of water quality improvements made to a catchment in North London found that frequent visitors to the area were more likely to correctly identify the main forms of pollution compared to people that visited the area rarely (Faulkner et al. 2001). The study in London used a similar methodology to this research. Using a questionnaire to investigate public perceptions and comparing the results of the questionnaire with monitoring results.

Research carried out in the Mzingwane catchment in Zimbabwe concentrated on participation by communities in water quality management (Nare et al. 2006). It was found that integrating local knowledge with the standard monitoring systems was important for allowing locals to participate in water quality management decisions as well as complementing standard monitoring data. Residents were often concerned with the physical characteristics of water quality including colour, smell, taste and odour, and were conscious of the causes and effects of pollution (Nare et al. 2006).

Past studies have found that there are spatial patterns of perceptions of water quality. Research has found that hot spots of spatially correlated perceptions can occur due to various social and location factors (Brody et al. 2005). For example, it was found that people living close to one another were more likely to have similar environmental views and values. Thus, when samples were randomly selected the pattern of results was not necessarily random (Brody et al. 2005). This research illustrates the importance of looking at the demographic makeup of residents sampled, such as what they do for a living and whether they are involved in environmental related work and interest fields.

Research by Tran et al. (2002) indicates that public perceptions should be incorporated into the decision for the sustainable management of an area such as the Avon and Heathcote River catchments. These researchers found that public perceptions were important when aiming to achieve the sustainable development of a small coastal community on Holbox Island and the adjacent Yalahau Lagoon. It is essential to understand the extent of environmental awareness of a community. If there is a gap in knowledge for a community then public awareness campaigns and environmental education were found to be essential for raising community awareness. Development policy was found to be more effective when it incorporates community desires into sustainable development decision making (Tran et al. 2002).

1.5 Predicted outcomes of this research

The main hypothesis of this research is that residents that regularly use the river, either passively or actively, have a close to accurate perception of the health of their river. Testing this hypothesis will assist in the development of future education programmes. If the perceptions of regular users do not match the scientific reality, then education programmes to encourage people to behave in a manner that is beneficial to the health of the rivers may need to start from first principles.

2.0 Methods

2.1 Field sites

Four river sites were chosen for investigation, two on the Avon River (Figure 2) and two on the Heathcote River (Figure 3). A site near the bridge crossing over Harper Ave in Hagley Park (Figure 4) was chosen as the upstream site and Kerrs Reach opposite the rowing club as the downstream site for the Avon River (Figure 5). A site opposite Princess Margaret Hospital (PMH) was selected as the upstream site (Figure 6) while Hansens Park was chosen as the downstream site for the Heathcote River (Figure 7). The downstream sites are affected by the tide and the water level fluctuates significantly. The Christchurch City Council regularly carries out monitoring of these chosen sites. These river sites are also frequently used by residents for recreational activities such as walking, running, canoeing, and rowing.

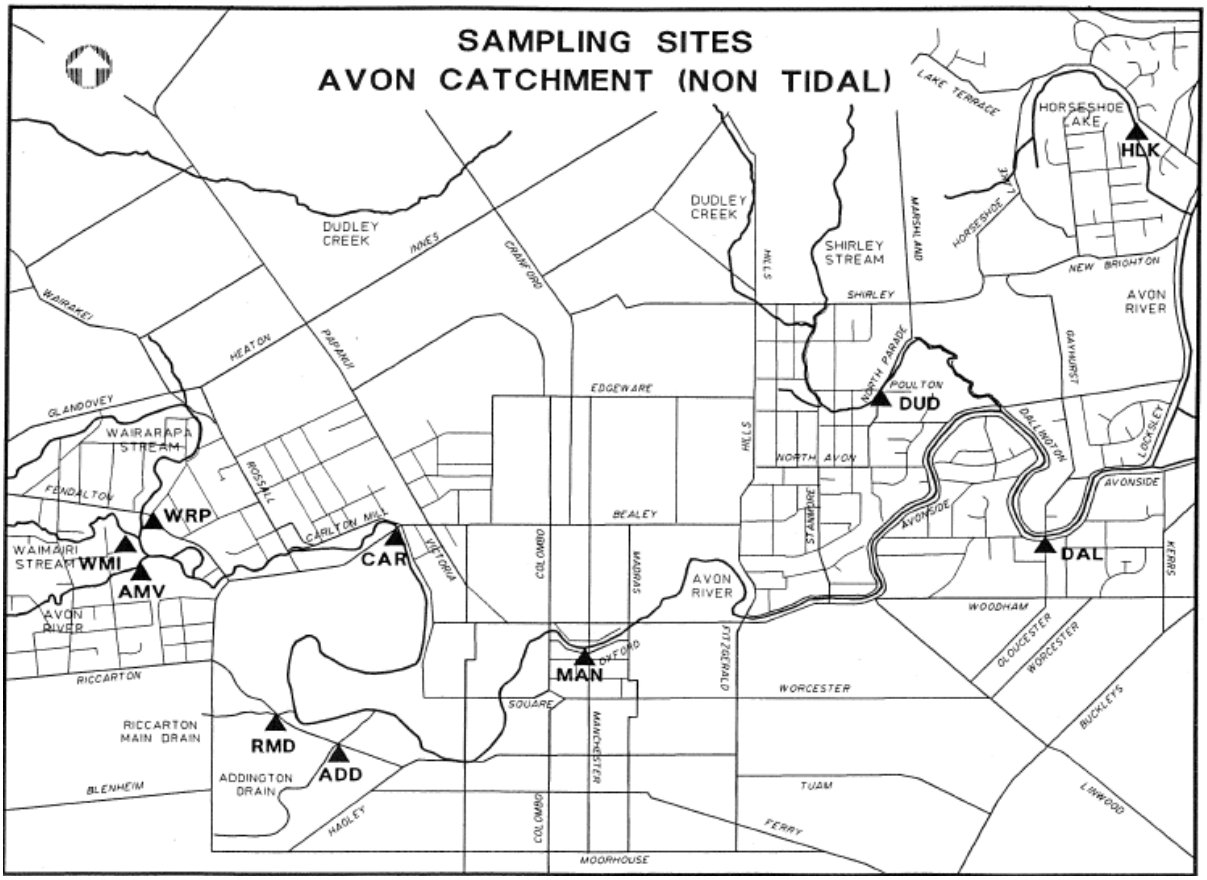

Figure 2: Map of ECAN monitoring field sites in the Avon Catchment including the Hagley Park (CAR) and Kerrs Reach (DAL) sites used in this investigation (map from Gilson 1994-95).

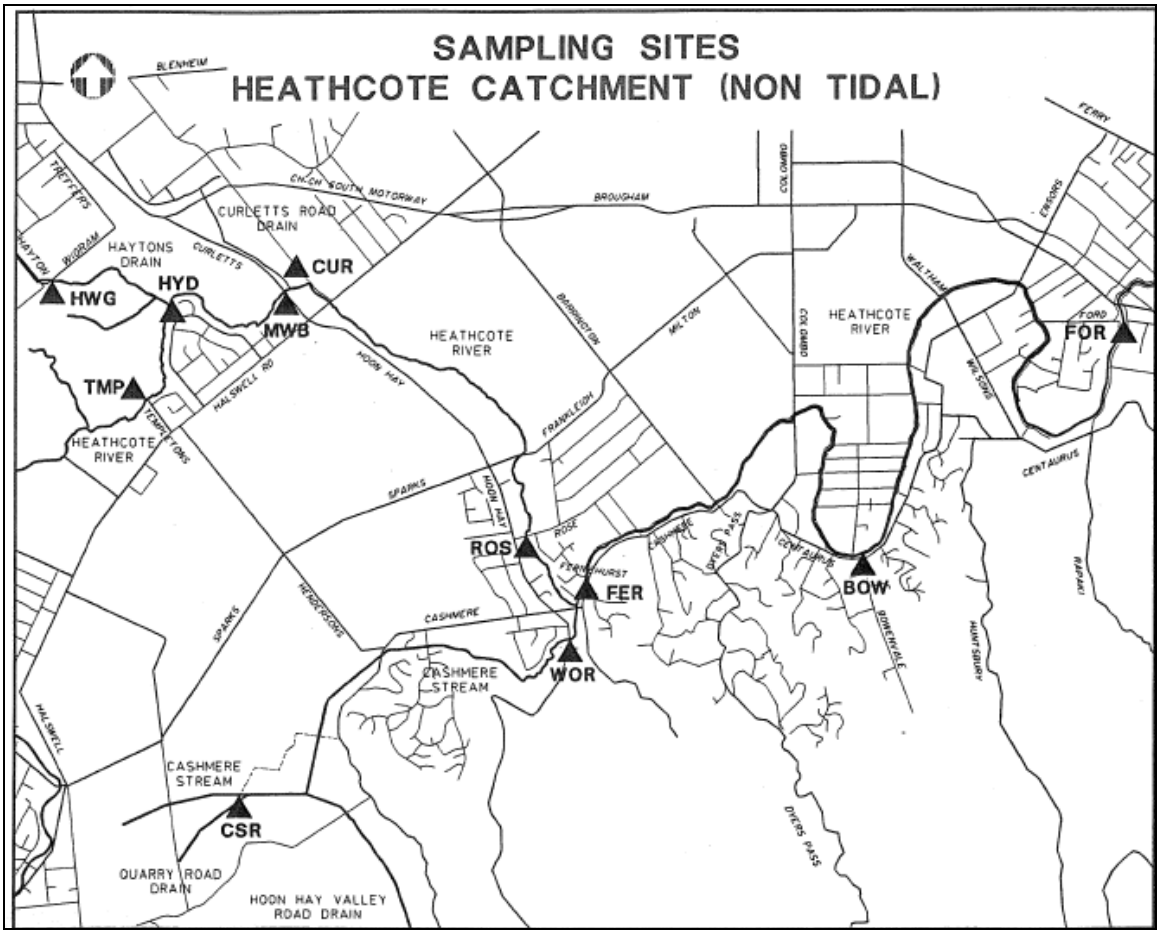

Figure 3: Map of ECAN monitoring field sites in the Heathcote Catchment including the Princess Margaret Hospital (FER) and Hansens Park (FOR) sites used in this investigation (map from Gilson 1994-95).

Figure 4: Hagley Park

Figure 5: Kerrs Reach

Figure 6: Princess Margaret Hospital field site

Figure 7: Hansens Park

2.2 Public perceptions

To investigate the perceptions of river users a questionnaire was carried out at the four sites (Appendix 1). The questions sought to investigate if users perceived a decline in water quality and what the main pollutants were for the rivers. One question dealt with water safety and whether users felt safe coming into contact with the water. The survey contained demographic questions as well as general ones concerning how frequently, and for what purposes, users visited the river. Comparisons were made between sites of the number of river users with similar perceptions. The percentage of rivers users surveyed at each site with a particular perception was used as a measure of how the public perceives a particular issue.

One day was spent at each site, over four consecutive days from 22–25 January 2007. Across all four sites 157 people were surveyed: 47 at PMH, 37 at Hansens Park, 35 at Kerrs Reach and 38 people at Hagley Park. River users were chosen at random when they walked past the surveyors. All surveying was conducted on site except for one phone interview.

2.3 Demographic information about river users surveyed

At each site approximately half of the people surveyed lived within walking distance from the river, with the exception of Hansens Park where 94.6% of river users lived near the river. A greater number of females (63%) were surveyed compared to males (37%). There was a representative distribution of age ranges surveyed (Figure 8). All survey respondents were residents of Canterbury.

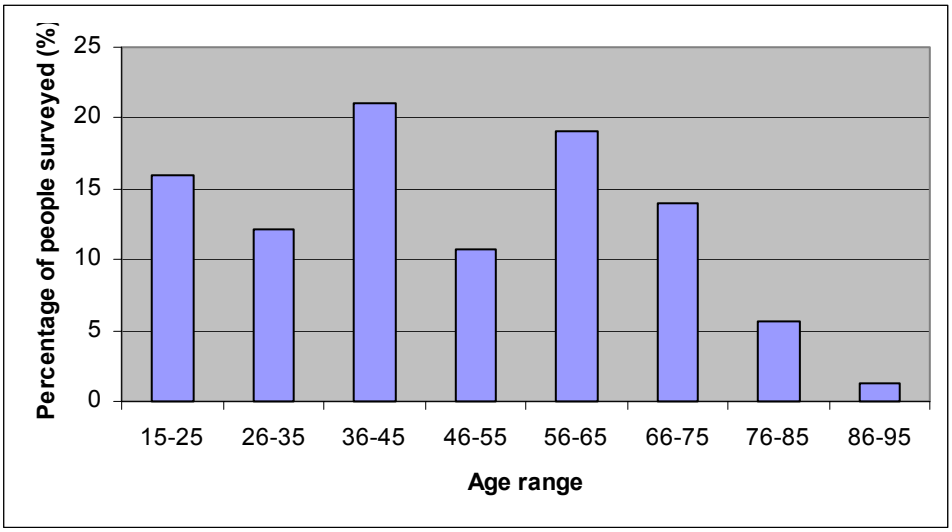

Figure 8: Age Range of total river users surveyed

2.4 Investigating the health of the river

In order to determine whether perceptions match the reality of what the health of rivers is actually like, water samples were taken at each site the day surveys were carried out. The samples were analysed for suspended solids and *E. coli.* In addition, water quality parameters were measured at each site, including water temperature, conductivity, clarity, pH and flow velocity. Aquatic invertebrate samples were taken to determine the health of the rivers. Aquatic invertebrates respond quickly to changes in the river environment and are therefore useful for determining the health of a waterway (Styx Living Laboratory Trust 2007). As a result of these measurements an ecological and public health rating was given for each site. These results were then compared with the survey responses.

A chi square test was carried out to evaluate whether or not observed perceptions of river users differed significantly from those which would be expected under various assumptions. Two tests were carried out, one for the public health rating of water quality and public perceptions and one for the ecological rating and public perceptions. Assumptions for the chi-test are that the samples are random and independently selected. The null hypothesis is that for the 'actual' water rating the proportions of perceptions of river users sampled will be the same.

3.0 Results

3.1 Results of water sampling

A public health rating was given for each site according to *E. coli* results (Appendix 2). Hagley Park, PMH and Hansens Park received a rating of 1 (poor) as *E. coli* levels were in the action/red mode according to the Ministry for the Environment (2002) recreational water quality guidelines. Kerrs Reach received a rating of 2 (fair) due to the smaller *E. coli* count. The count however was still in the alert/amber mode according to recreational water quality guidelines. Similarly, past ECan summer monitoring results also have poor water quality readings for the Avon and Heathcote River.

All four field sites received bioassessment gradings for invertebrates of 'very poor'. The upstream sites had a greater diversity of invertebrate species compared to downstream sites (Appendix 2). The most common invertebrate species found in the upper stream sites (Hagley Park and PMH field sites) were species found in the Crustacea group. Oligochaeta species in the Oligochaeta group were the most abundant invertebrate found in both downstream sites. A river health rating was given of a 1 (poor) across all four sites. Background invertebrate monitoring results were unable to be obtained therefore an assessment can not be made of the ecological health of the river on previous occasions.

Clarity readings for the four sites received a clarity rating of good (slightly turbid). According to the New Zealand Stream Health Monitoring and Assessment Kit (SHMAK) published by NIWA (2002: 9.8) the readings indicate that the clarity "may inhibit plant growth and the suspended solids could settle on the stream bed." The water looked a little murky at all the sites the day surveys were carried out. River users often looked across at the river when asked whether they had any concerns with the colour of the water. The slightly murky colour of the water in both rivers would have influenced values placed on the river and concerns raised. Surveying carried out on a day the river looked clear may have result in a lower percentage of river users expressing concerns with the colour of their waterway.

3.2 Perceptions of river users interviewed

For all four river sites, a high percentage of river users valued the aesthetic appeal and the ecological health of the rivers. The aesthetic appeal of the river environment was rated more highly than the ecological health of the river (Figures 9 and 10). A greater number of river users valued the aesthetic appeal of the Hagley Park compared to the other river sites (Figure 11). River users valued the bird life at all four sites however, they were often unaware of aquatic life in the river.

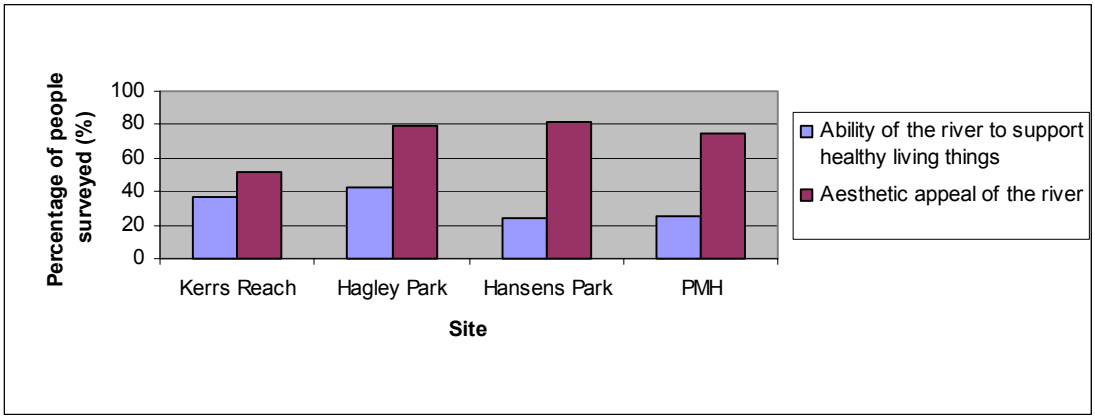

Figure 9: Comparison between sites for river users which rated the following questions as 'Good/Excellent'.

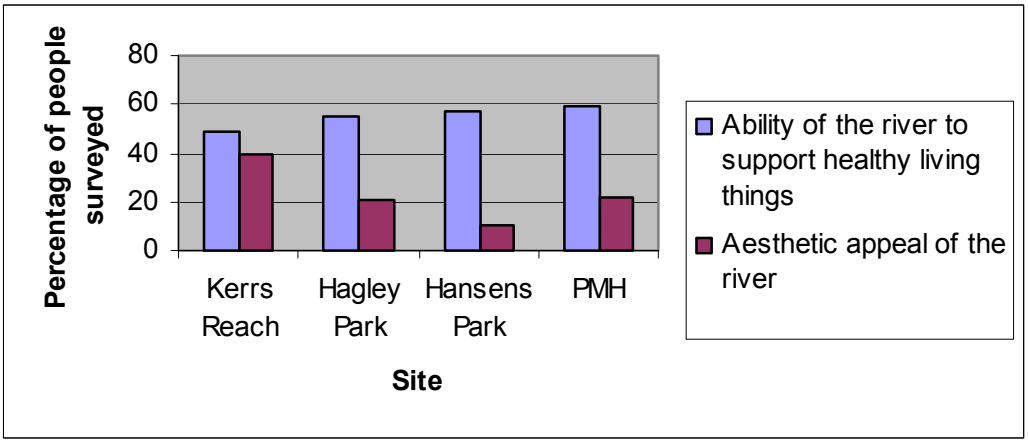

Figure 10: Comparison between sites for river users which rated the following questions as 'Average'.

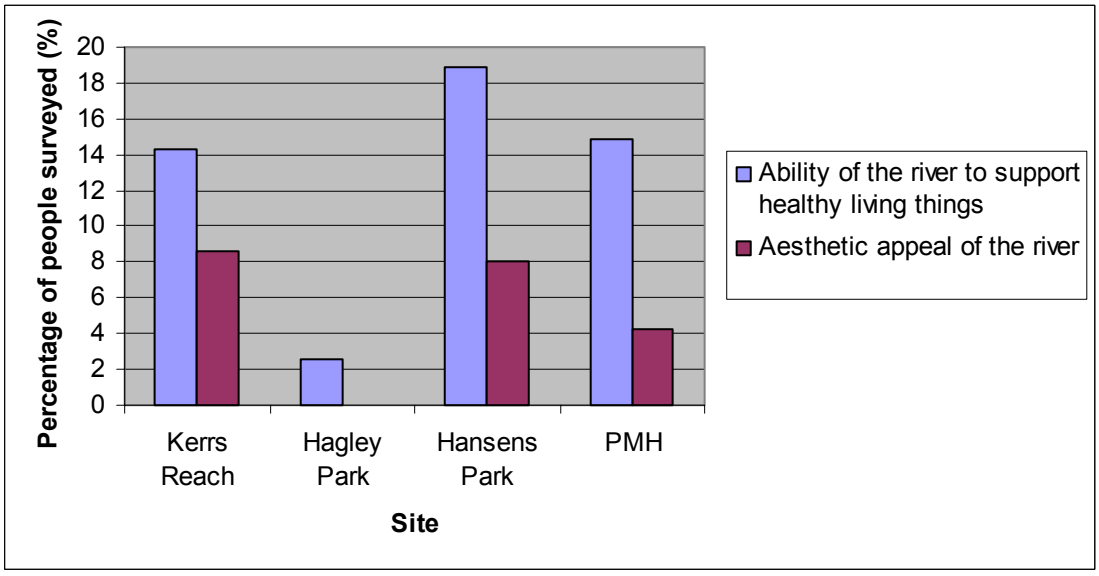

Figure 11: Comparison between sites for river users which rated the following questions as 'Poor/Not Good'.

A high percentage of river users for every site were happy with the birdlife, smell, vegetation, amount of water in the river, and amount of natural debris in the water (except for Kerrs Reach) (Figure 12). River users often expressed concern about things they were able to see such as rubbish (all sites), natural debris (Kerrs Reach), and the colour of the water (Hansens Park, PMH and Kerrs Reach) (Figure 13). A large percentage of water users across the four sites said they were unsure about the amount and type of microbes, chemicals, sediment patterns and living things in the river (Figure 14). River users showed greater concern for the colour of the Heathcote compared to the Avon River. 56.8% of river users surveyed at Hansens Park and 51.1% of river users surveyed at PMH showed concern regarding of the colour of water (Figure 13).

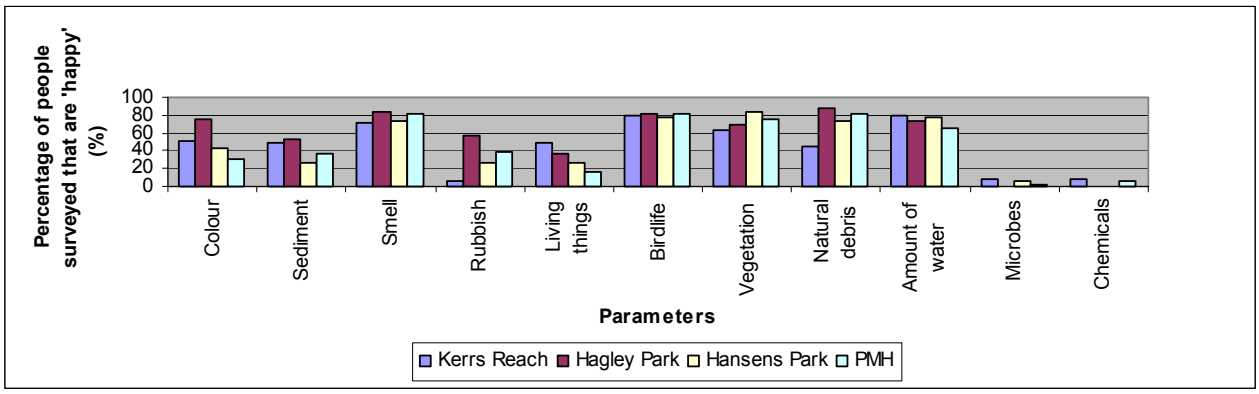

Figure 12: Comparison between sites for river users that were happy with various parameters related to the Avon and Heathcote Rivers.

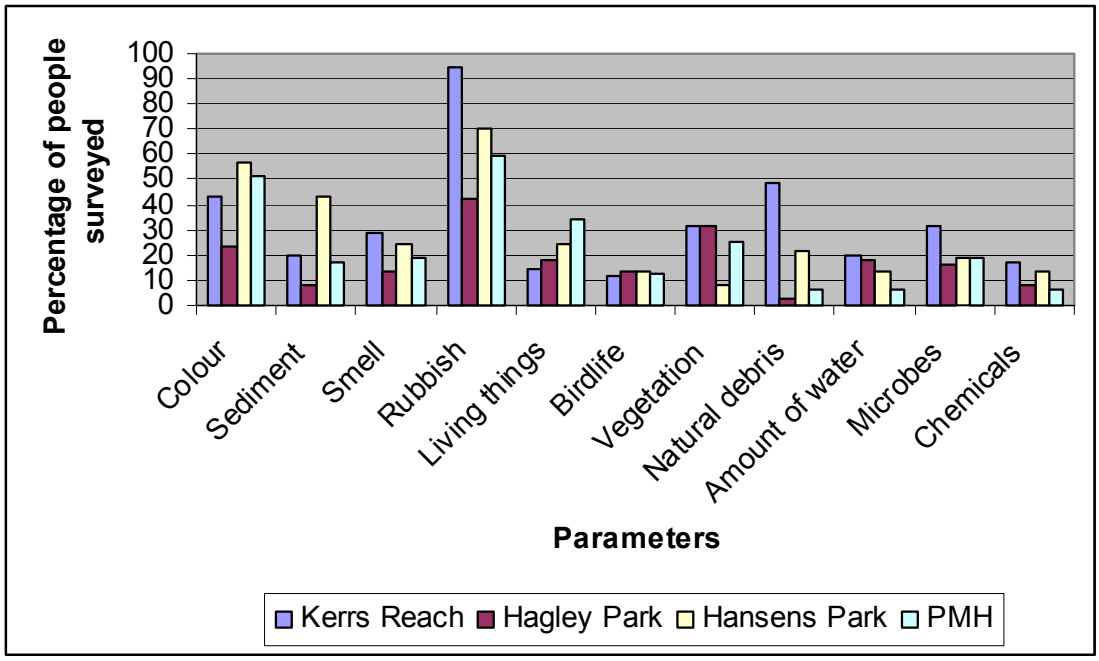

Figure 13: Comparison between sites for river users that expressed concern with various parameters related to the Avon and Heathcote Rivers.

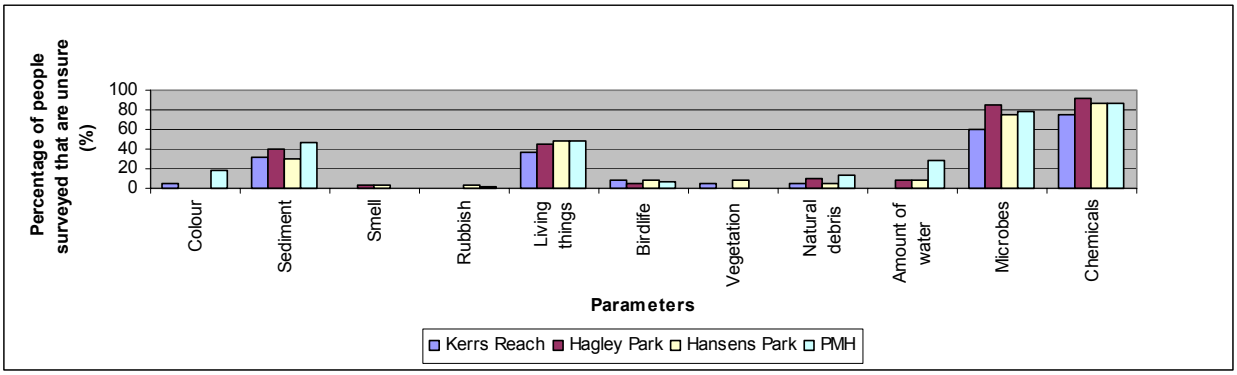

Figure 14: Comparison between sites for river users that were unsure when asked about various parameters related to the Avon and Heathcote Rivers.

A large number of river users perceived the following to be causing a decline in water quality: rubbish and oil at Hansens Park; rubbish and stormwater at PMH; rubbish at Hagley Park, and rubbish, stormwater and sewage at Kerrs Reach (Figure 15). A high percentage of river users suggested oil was not causing a decline in water quality (Figure 16). Many river users were unsure whether discharge of cooling water from boilers and air conditioners, runoff or nutrient drainage from farmland upstream were occurring and altering the water quality of the rivers (Figure 17). Similarly, users were unsure whether poor quality ground water was supplying the two rivers and whether stormwater and sewage overflows alter the quality of water in the Rivers (Figure 17). The site with the highest number of people that felt unsafe coming into contact with the water was Hansens Park followed by PMH, Kerrs Reach and Hagley Park (Figure 18). A larger number of residents felt unsafe swimming in the Heathcote River compared to the Avon River.

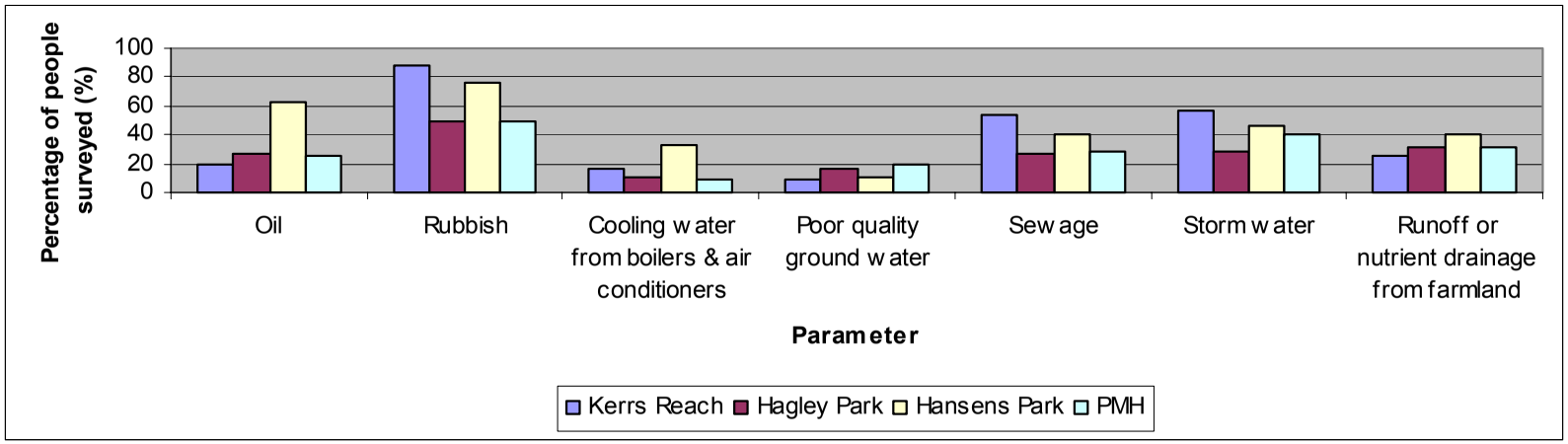

Figure 15: Percentage of river users surveyed across sites that believed various parameters were causing a decline in water quality in the Avon and Heathcote Rivers.

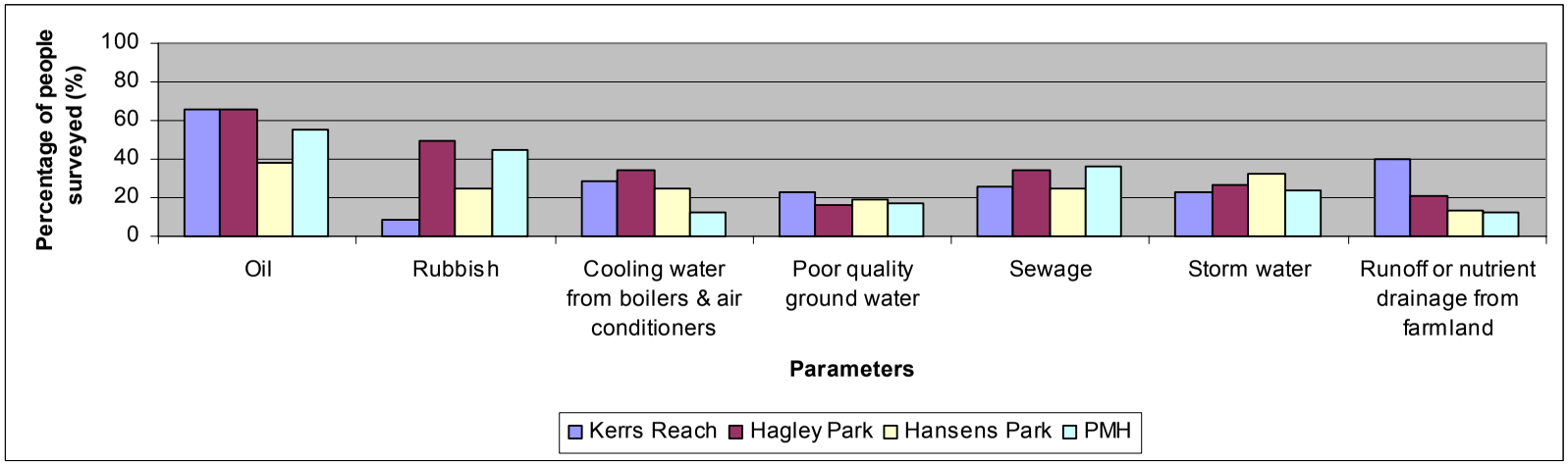

Figure 16: Percentage of people surveyed across sites that believed various parameters were not causing a decline in water quality in the Avon and Heathcote Rivers.

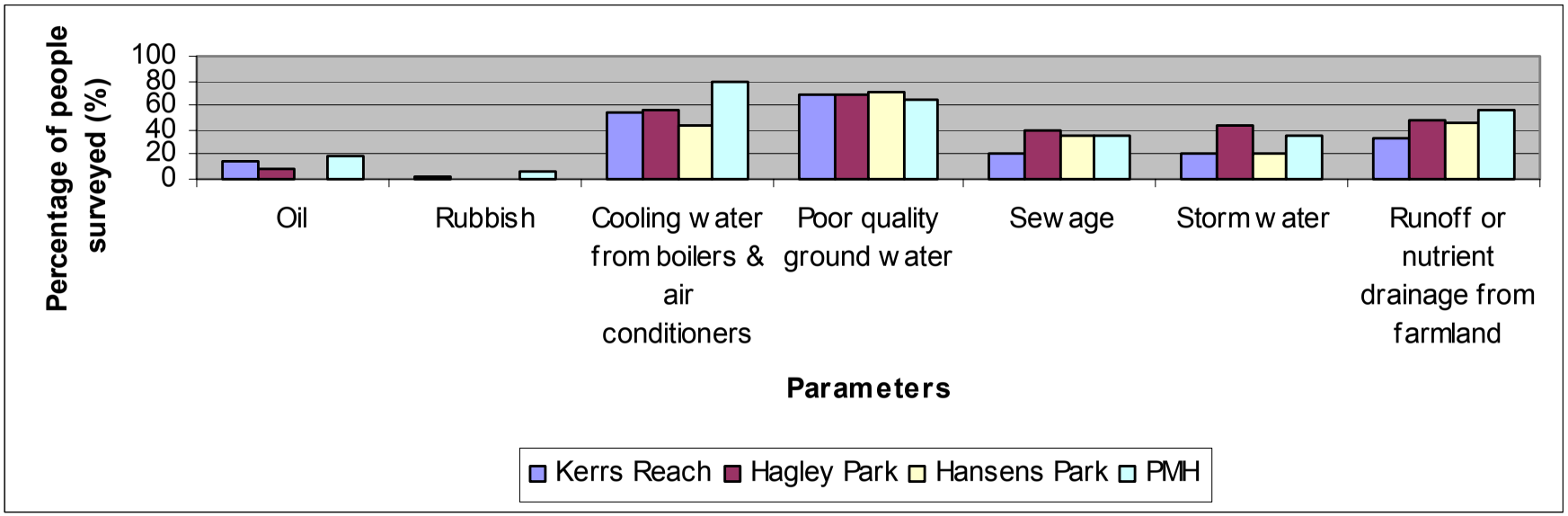

Figure 17: Percentage of river users for each site that were unsure whether various parameters were causing a decline in water quality in the Avon and Heathcote Rivers.

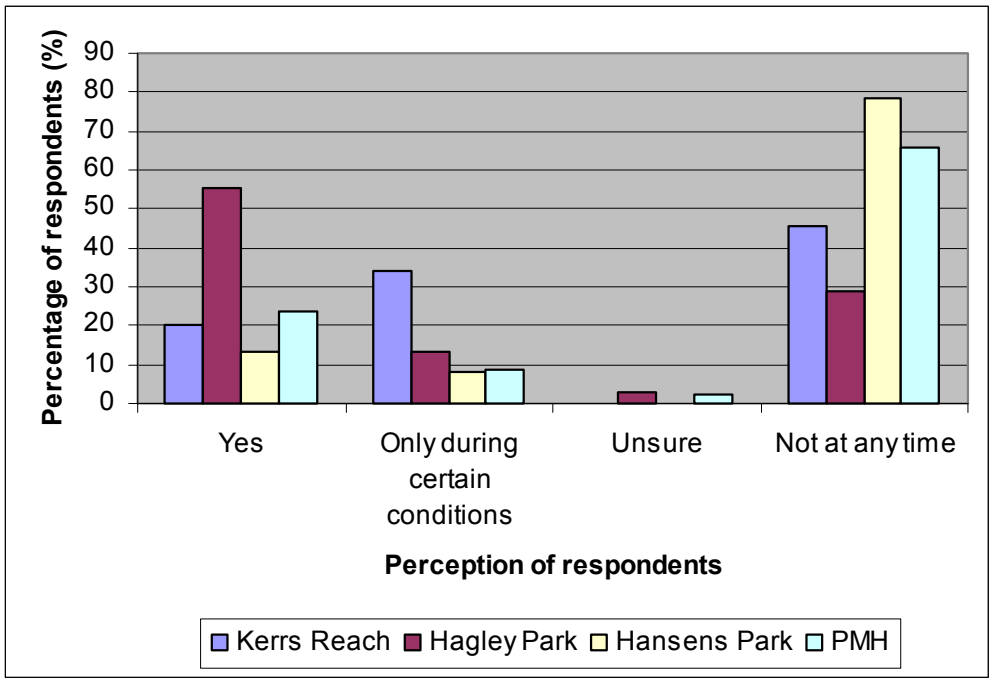

Figure 18: Comparison between sites of whether river users felt safe coming into contact with the water.

3.3 Link between monitoring results and perceptions

The proportions of perceptions of river users sampled were not equal for the public health and ecological ratings given for the field sites. The null hypothesis was rejected for both the public health and ecological chi square tests. A null hypothesis was rejected due to the fact the chi square was more than the tabulated critical value of chi square (Appendix 3). 71 out of 120 river users surveyed were aware that the river was unsafe for recreational contact at the three sites which received a 'poor' public health rating. 12 river users out of 35 sampled at the Kerrs Reach field site had an accurate perception of how safe the water was for recreational contact (rating: fair). Only 20 river users out of 157 surveyed across the four river sites were aware that the water at all four river sites did not support biological life very well (rating: poor).

4.0 Discussion

There is a difference between perceptions and reality due to the fact that the public is unaware of what and how pollutants alter the water quality of urban rivers in Canterbury. A large number of river users at all four sites thought litter was a pollutant of water quality. However, rubbish does not significantly alter water quality. Similarly, Nare et al. (2006) found that residents surveyed in the Mzingwane Catchment of Zimbabwe, were more concerned with physical parameters compared to the bacteriological quality of water. House (1996) found that the presence of rubbish on river banks did not affect perceived water quality. It is likely litter on the banks of the Avon and Heathcote Rivers did however, influence how people perceived water quality.

A small number of river users at the Hansens Park and PMH river sites identified the link between land use and altered sediment patterns. Three river users at Hansens Park spoke of an increase in the amount of clay in the river as a result of subdivision in the catchment. At the PMH river site, four people were concerned with subdivision in the catchment and an increase in the amount of sediment entering the Heathcote via the Cashmere Stream.

Different groups of river users had similar perceptions about their river environment. Rowers expressed concern at Kerrs Reach regarding the amount of natural debris in the water. Rowers surveyed at Kerrs Reach commented on how natural debris in the Avon River sometimes gets in the way while rowing. At PMH, Hansens Park, and Hagley Park river users largely consisted of Christchurch residents that did not get in the river for recreation and natural debris did not directly affect them.

Rowers at Kerrs Reach also expressed concern about the count of microbes in the river. Rowers spoke of how they had got an infection or knew of people that had got an infection from coming into contact with the water at Kerrs Reach. Rowers and coaches were aware of bacterial levels as coaches paid close attention to Christchurch City Council water quality reports and warned rowers when *E. coli* counts were high. This is a good example of public awareness and how this changes user perceptions of water quality in the Avon River.

A high percentage of river users believed oil was not altering the water quality in the Avon and Heathcote Rivers (Figure 17). This perception agrees with reality as oil spills rarely occur in Christchurch waterways (Environment Canterbury 2001). The river users that suggested oil is presently or has in the past caused a decline in water quality referred to the diesel spill in the Heathcote River in February 2005 (NZ Herald 2007). River users spoke of a decline in the number of ducks in the Heathcote River after the oil spill or had heard of the oil spill through the media.

There is lack of public knowledge therefore the public are unaware on how various land uses in Canterbury alter the water quality of water ways. Many river users were unsure whether the discharge of cooling water from boilers and air conditioners, and runoff or nutrient drainage from farmland upstream were occurring and altering the water quality of the rivers (Figure 18). Similarly, users were unsure whether poor quality ground water was supplying the two rivers.

There was also uncertainty about stormwater and sewage contamination and if and how often this occurs across all sites (Figure 18). This is a concern as stormwater is the main contributor to a reduction in water quality for water-bodies in Christchurch (Christchurch City Council 2003). The input via stormwater of sediment from construction, run-off from the Port Hills from both urban and rural land use and the input of toxicants such as metals and hydrocarbons are among the most damaging inputs into the Rivers (Hayward comms. 2007). Sewage overflows during storm events and stormwater contamination can result in water not complying with microbial water quality guidelines for freshwater recreational areas set by the Ministry for the Environment (Environment Canterbury 2001). This is a health hazard for water users.

While river users were not aware of the significant pollutants of urban rivers a large number of river users did understand that the water was unsafe for recreational contact. Perceptions agreed with reality in this instance. A larger number of residents felt unsafe swimming in the Heathcote River compared to the Avon River. Water sampling results taken the day surveying was carried out showed that the water was safer for recreation in the Avon compared to the Heathcote. Faecal coliforms contain *E. coli* and the Heathcote generally has higher coliform numbers compared to the Avon Catchment (Environmental Services 1993). While many users of the river expressed an opinion of whether they felt safe coming into contact with the water, a large number of river users were 'unsure' of the *E. coli* count at their river site. Some river users at Hansens Park were aware of signs that had been put up to warn the public that the water in the Heathcote River was 'unsafe' for recreational contact.

River users placed high values on the river landscape of Hagley Park. Hagley Park is located in the inner city of Christchurch. In the urban areas, reserves such as Hagley Park and the Botanical Gardens are highly manicured by the Christchurch City Council. This is important for promoting the character and identity of the city as a garden city (Environment Canterbury 2000). Past research has found that an initial perception of a river is based exclusively upon the aesthetic appearance of the landscape (including water and its surroundings) (House and Sangster 1991; House et al. 1994, in House 1996). Due to the fact that users rated the aesthetic appeal highly, this may have influenced their rating of the ability of the river to support aquatic life.

Traffic noise did not appear to have a significant affect on how river users rated the aesthetic appeal of the Hagley Park and PMH river sites. Both of these sites are located next to busy roads. The site opposite PMH is located next to Cashmere Road while Park Terrace runs alongside the river at the Hagley Park site. River users placed high values on the aesthetic appeal of these two sites. (Figure 8). The interaction between the traffic noise and visual elements at these field sites was not 'inappropriate' according to interpretations of sound and visual elements by Carles et al. (1999).

The ecological rating given for each site of 'poor' did not take into account how well the river supported bird life. When asked how well the river supported living things, the public often considered the amount and type of bird life. This would have influenced their ratings at each site. Each field site supports a large number of ducks and other bird species. If the question referred to aquatic life rather that living things it

would be expected that the public would have given lower ratings than what were given.

4.1 Future research and limitations

Time restrictions and lack of resources prevented a greater number of river users being surveyed for each site. This research may have benefited from a greater number of river users surveyed to strengthen field data. Enough people were surveyed, however, to gain an understanding of public perceptions for each site. One phone interview was conducted with a concerned river user. This is not a random sample and this was taken into consideration in the analysis of results.

A further limitation of this research paper is that I was unable to get hold of background invertebrate monitoring data. Comparisons were not made between results taken on the sampling day to previous monitoring done in the past. Assessment was unable to be made for whether the ecological rating given was an appropriate indication of the ecological health of the site. Future research could look at how perceptions have changed over time with various temporal changes in water quality for these rivers.

Future research could look at the best way to implement public education systems into different Christchurch communities. This may include an analysis of the best way to target different types groups that use the river such as rowers and walkers. Future projects for improvements to the rivers need to include the community. These programmes should be specifically aimed at different groups of river users.

5.0 Conclusion

Perceptions rarely meet reality for the Avon and Heathcote Rivers. A large number of river users were unaware of the significant sources of pollution as well as how various land use activities alter water quality and the ecological health of the rivers. Public awareness campaigns need to cover these issues. When river users are informed of the public health risks in times of bad weather, it would be good to say what the pollutants of the water are. While the public are aware of the health risks of poor water quality, they are often unaware of what causes these risks. River users showed a genuine interest in their river and were willing to discuss how they felt and any concerns they had about their environment. They are likely to listen to future public awareness campaigns.

6.0 Acknowledgements

I would like to thank my supervisors Deirdre Hart and Ross Barnett for their guidance and advice. To Jenny Bond for your advice and support. To Adrian Meredith and Susannah Vesey for getting in the rivers and taking the invertebrate samples. Thank you to Shirley Hayward for your input into the water quality analysis of this research. Finally, a big thank you to my field assistant Richard Langley, without you I would not have been able to survey as many people as we did.

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8.0 Appendix

Appendix 1

Questionnaire used to determine public perceptions of Christchurch's urban river health

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Questionnaire
Introduction

Hello. I am investigating what people think about the health of the Avon and Heathcote rivers. Would you like to participate in a survey that will take roughly 5 minutes?

Are you a resident of Canterbury?
_____ Yes
_____ No
If not do not continue with survey.

If yes – continue with questionnaire
My name is _____ and I am a graduate student at the University of Canterbury. This questionnaire is for a study which contributes to a three-year project called River Guardians which Environment Canterbury has just begun.

The survey is anonymous and your name would never be associated with your answers. Everything you tell me would be kept confidential. You may withdraw your participation, including withdrawal of any information you have provided any time during this interview.

Only say this if required (ie. person being interviewed wants extra information about the project) -
The information will be used by the Avon-Heathcote Estuary Ihutai Trust which has at its core Integrated Environmental Management. The Trust is not only concerned about the health of the Estuary and improvements made but also with the health of the catchments that flow into the Estuary. The main objective of this survey is to understand local perceptions and ideas of the health of the Avon and Heathcote Rivers.

SECTION A: PERCEPTION QUESTIONS

A1. How often do you visit this site at the river?

_____

A2. What for?

_____

A3. Do you use any other part of the river for recreation etc?

_____ **Yes**

_____ **No**

A3cont. *If yes* **What part?**

_____

A3cont. What for?

_____

A4. How long have you used this river for recreation?

_____

A5. Would you feel safe coming into contact with water in this river?

_____ **Yes**

_____ **Only during certain conditions** including _____

_____ **Only in certain places** including _____

_____ **Unsure**

_____ **Not at any time**

Comments

_____

_____

A6. Please rate from 1 to 3 the ability of the river to support healthy living things such as fish, insects, birds and plants?

1 = poor/not good

2 = Average

3 = Good/excellent

A7. Please rate from 1 to 3 the aesthetic appeal of this river?

1 = *poor/not good*

2 = *Average*

3 = *Good/excellent*

A8. *If answered poor/not good to either A6 or A7 ask***. How does the river need improving?**

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

A9. I am now going to ask you some questions relating to the river and could you please answer on a scale of 1 to 3, with 1 being …….

1 = Really happy/ Satisfied

2 = Unsure

3 = You have some concern/very concerned

A9a. The colour of the water 1 2 3

_____

_____

A9b. The sediment patterns of the river 1 2 3

_____

_____

A9c. The smell of the water 1 2 3

_____

_____

A9d. The amount of rubbish in the water or on the banks 1 2 3

_____

_____

A9e. The amount and kind of living things (fish and invertebrates) in the river 1 2 3

_____

_____

A9f. Any bird life found near the river (amount, type) 1 2 3

_____

_____

A9g. The vegetation planted along the banks 1 2 3

_____

_____

A9h. The amount of natural debris such as leaf litter, branches in the river or on the banks of the river 1 2 3

_____

_____

A9i. The amount of water in the river during fine conditions (normal flow) 1 2 3

_____

_____

A9j. The amount and type of tiny microbes (bugs) in the water such as E.coli. 1 2 3

_____

_____

A9k. The amount and type of chemicals found in the water such as nitrates, phosphates, lead, copper and zinc 1 2 3

_____

_____

A9l. Comments to the above question:

_____

_____

_____

A10. Do you believe the following things presently cause a decline in water quality for this river?

A10a. Oil in the water Yes No Unsure

A10b. Dumping of rubbish into the water Yes No Unsure

A10b. Input of cooling water from boilers and air conditioners Yes No Unsure

A10c. Poor quality ground water seeping into the river Yes No Unsure

A10d. Sewage contamination of the river Yes No Unsure

A10e. Storm water discharge into the river. Yes No Unsure

A10f. Runoff or nutrient drainage from farm land upstream from the city Yes No Unsure

A10g. Comments to the above question:

_____
_____
_____
_____
_____
_____
_____
_____

A11. How much of your rates would you be prepared to put towards improving/maintaining the water quality in this river?
0-10% 11-20% 21-30% 31-40% 41-50% 51-60% 61-70% 71-80% 81-90% 91-100%

SECTION B: DEMOGRAPHIC AND INDIVIDUAL QUESTIONS
Finally, I would like to ask you some questions in regard to demographic information. Everything I ask you will be kept confidential and helps with analysis of this survey.

B1. Age range 15 – 25 26-35 36-45 46-55 56-65 66-75 76-85 86-95
B2. Occupation:

_____
If they work for an organisation such as ECan, CCC, University, Environmental/Engineering consultancy etc – ask what their role is within their work place.
B3. How long have you lived in Canterbury?

_____
B4. Are you a rural or urban resident of Canterbury?
_____ Rural
_____ Urban
B5. Do you live near this river?
(Are you able to walk to the river from your house?)
Yes/No

SECTION C: Interviewer complete
C1. *Sex*

a. *Male*
b. *Female*

C2. *Please provide comments on the responses provided by the respondent.*

_____
_____
_____
_____
_____

Thank you for participating in this survey.
Enjoy the rest of your outing!
Date: ……./……/2007
Time interview starts: ……...
Time interview ends: ……
River …….
Location: ……
Vegetation present on side of river ……..
Noise that can be heard ……
Weather conditions ……...
Colour of water …….

Appendix 2

Parameter	Kerrs Reach	Hagley Park	Hansens Park	PMH
Total suspended solids (mg/L)	**2.1**	**2.90**	**11**	**5.6**
E.Coli (MPN/100mL)	**340**	**920**	**980**	**1200**
Public health category	2	1	1	1
Conductivity field (mS/m)	**180**	**150**	**280**	**230**
Conductivity rating	2	2	1	2
pH field	**7.8**	**7.7**	**7.6**	**7.4**
pH rating	2	2	2	3
Water Temp (°C)	**16.9**	**14.2**	**17.3**	**16.8**
Water temp rating	2	3	2	2
Water velocity (m/s)	**0.14**	**0.55**	**0.43**	
Clarity (cm)	**83**	**78**	**70**	**72**
Clarity Category	2	2	2	2

Category for ratings
1 = Poor
2 = Fair
3 = Good

Site Name	Date Collected	QMCI
Hagley Park	**25 January 2007**	**3.44**
Kerrs Reach	**24 January 2007**	**4.04**
PMH	**22 January 2007**	**2.74**
Hansens Park	**23 January 2007**	**3.83**

Invert group	Name	MCI-HB	MCI-SB	Hagley Park	Kerrs Reach	PMH	Hansens Park
Chironomidae	**Chironominae**	**1**	**4**	**8**	**19**	**8**	**12**
	Orthocladiinae	**2**	**3**	**1**		**7**	**1**
	Tanypodinae	**5**	**6**		**4**		**9**
Crustacea	**Copepod**	**5**	**5**		**1**		
	Ostracoda	**3**	**3**	**16**	**8**	**60**	**26**
	Paracalliope	**5**	**5**	**45**	**3**	**6**	**2**
Diptera	**Muscidae**	**3**	**3**	**1**			
Mollusca	**Physa**	**3**	**1**	**1**		**1**	**1**
	Pisidium/ Sphaerium	**3**	**3**	**1**		**3**	**3**
	Potamopyrgus	**4**	**2**	**1**		**1**	**2**
Oligochaeta	**Oligochaeta**	**1**	**4**	**13**	**66**	**4**	**46**
Trichoptera	**Hudsonema**	**6**	**7**	**1**		**1**	
	Hydrobiosis	**5**	**6**	**4**			
	Oxyethira	**2**	**2**	**13**		**12**	
Grand Total				105	101	103	102

(Note: The QMCI for the lower reach site of each river has been adjusted using soft bottomed MCI values. All of the four sites have bioassessment gradings of ‘very poor’).

Appendix 3
Chi Square Workings

Count	Actual – Public Health rating		
Perceived	Poor	Fair	Total
Poor	**71 (*67.4)*** (a)	**16 *(19.6)*** (b)	**87** ***(87/155=0.5613)***
Fair	**12 (*18.6)*** (c)	**12 *(5.4)*** (d)	**24** ***(24/155 = 0.1548)***
Good/Excellent	**37 *(34.1)*** (e)	**7 *(9.9)*** (f)	**44** ***(44/155 = 0.2839)***
Total	**120**	**35**	155

Expected a = (a + b) (a + c + e)/N
= (87) (120)/155
= *67.4*

Computations for chi-square

Cell	f_o	f_e	f_o^2	f_o^2/fe
a	**71**	**67.4**	**5041**	**5041/67.4=74.792**
b	**16**	**19.6**	**256**	**256/19.6=13.061**
c	**12**	**18.6**	**144**	**144/18.6=7.742**
d	**12**	**5.4**	**144**	**144/5.4=26.667**
e	**37**	**34.1**	**1369**	**1369/34.1=40.147**
f	**7**	**9.9**	**49**	**49/9.9=4.949**
Total	155	155		167.358

x^2 = 167.358 – 155
= 12.358

Degrees of freedom df = (r-1)(c-1)
= (3-1)(2-1)
= 2

A chi square of 5.99147 is required for rejection at the 0.050
Reject Null hypothesis

Perceived	Actual – Ability of river to support living things.	
	Poor	Total
Poor	**20**	**20**
Fair	**87**	**87**
Excellent	**50**	**50**
Total	**157**	157

Degrees of freedom (k -1) = 2 degrees of freedom

$x^2 = E [ni – E (n_1)]^2 / E(ni)$
$= (20-52.3)^2/52.3 + (87-52.3)^2/52.3 + (50-52.3)^2/52.3$
$= 19.9 + 23 + 0.1$
$= 43$

A chi square of 5.99147 is required for rejection at the 0.050.
Since x^2 is more than the tabulated critical value of x^2, 5.991, the null hypothesis is rejected.