Review of Recreational Value from Urban Waterway and Stormwater Management

WCFM Report 2019-005

Waterways Centre for Freshwater Management
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REPORT: WCFM Report 2019-005

TITLE: **Review of Recreational Value from Urban Waterway and Stormwater Management**

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DATE: **18 April 2019**

Executive Summary

Increasing stormwater runoff from roads and buildings as a result of urban expansion in Christchurch has led to the pollution of urban waterways, in particular with hydrocarbons and heavy metal contaminants such as zinc and copper. Under the Resource Management Act 1991 (RMA), regional councils, city councils, and district councils in New Zealand have legislated roles for water management, including managing rivers, mitigating discharge of contaminants, flood control, and protecting environmental and social values of waterways. After the Christchurch Drainage Board was established in October 1875, wastewater and stormwater in the city were managed by constructing separate wastewater and stormwater networks. In 1989, Christchurch City Council (CCC) took over the responsibility for stormwater management in Christchurch. The Council's management of stormwater aims to avoid or mitigate pollution of urban waterways and reduce flood risk and impacts. In the wider context of the management of stormwater and the urban water environment, it is recognised that not only do urban rivers and streams provide various recreational and aesthetic benefits to the city's inhabitants, but so too can different forms of stormwater management infrastructure, especially different kinds of green infrastructure.

The primary goal of this literature review is to explore how different forms of green infrastructure that are being installed (or may be installed) by CCC to mitigate stormwater contamination might produce additional value for local residents and communities. The benefits of these installations (such as detention basins, constructed wetlands, and swales) may occur through reducing contamination of (and thereby enhancing) urban waterways, or through various use and non-use values associated with green infrastructure itself. In considering such benefits, this report focuses on recreational values in particular, and compiles findings from the international literature that might be applicable to and relevant for Christchurch.

A total of 28 (19 international and 9 New Zealand) relevant studies found through an internet search using the Environmental Valuation Reference Inventory (EVRI)[1] database were reviewed. The major findings from the literature review are reported below.

[1] https://www.evri.ca/

General recreational values: Seven international studies suggest that general recreational value associated with urban waterways ranged between $0.27 and $43.08[2] per household per year. In the New Zealand context, Kerr (2004) determined recreational benefits (involving a range of recreational activities) of between $16.56 and $17.94 per recreational user per day.

Walking and cycling: The majority of studies treat cycling and walking paths together as 'green routes' or 'greenways'. Three international studies estimated that the provision of cycling and walking paths provides benefits of between $4.37 and $91.28, expressed in mean willingness to pay (WTP) per household per year. In the New Zealand context, Matthews (2009) calculated $27.84 per individual per year in economic benefits from a streamside walkway in Hamilton city. Tait, Vallance, and Rutherford (2016) determined an annual WTP of $26.11 per household for having urban cycling and walking paths in the Christchurch Avon Red Zone.

Water sports: According to six international studies reviewed, the benefits from various water based activities are:

- Fishing/Angling: The annual benefit for each angler ranged between $271.87 and $2,338.32.
- Kayaking/Punting: Total consumer surplus per kayaker per year was estimated at $637.56, and consumer surplus for punting at $54.16 per day trip.
- Swimming: Implicit benefit for residents living within a river catchment ranged from $107.14 to $153.22 per household for improvement of a one kilometre length of river to swimmable standard.

River corridor aesthetic values: In the international studies reviewed (as shown in Table 9), the benefits of having native riparian vegetation along river banks were estimated at between $2.15 and $7.98 per household per year for 1% of a river's length with healthy native vegetation. Similarly, the value of native water birds and other fauna in a river corridor was estimated at between $5.07 and $31.66. In New Zealand, Kerr and Sharp (2004a) estimated Mean WTP per household per year for water clarity at between $91.08 and $92.46. Moreover, the same authors calculated mean WTP per household per year for moderate native

[2] All dollars ($) are adjusted 2018 New Zealand dollars unless otherwise specified.

vegetation and plentiful native vegetation at between $22.08 and $38.64, and $28.98 and $56.58, respectively. For Christchurch, Tait et al. (2016) found that annual WTP among Christchurch residents for improved river water and habitat quality, and native plants and habitat was $14.45 and $27.93 per household respectively.

Wetland values: A study from Sweden shows that marginal WTP per individual for having high biodiversity and walking paths within an urban wetland was $217.84 per year and $209.75 per year respectively. In the New Zealand context, Ndebele (2009) estimated that Mean WTP for wetland restoration ranged between $35.10 and $90.09 per household per year for a period of five years. For Christchurch, Tait et al. (2016) found that residents were willing to pay $7.06 per household per year for restoration of wetlands in the Christchurch Avon Red Zone.

Overall, the literature review finds a lack of data on recreational benefits of small urban streams and rivers. There is, on the other hand, an abundance of non-market valuation studies conducted on large rivers, lakes, and natural wetlands. Furthermore, New Zealand non market valuation studies of recreational benefits of waterways are primarily focused on fishing and swimming as opposed to other recreational activities.

In summary, there is insufficient economic data available on recreational benefits specifically from small urban waterways such as those of Christchurch to allow for a benefit transfer study for Christchurch. A growing number of international studies, however, do show that urban waterways and green infrastructure offer a range of recreational benefits and other values. Some of the data may offer insights into where benefits might lie for Christchurch, but in order to assess this with accuracy, primary research is likely required.

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1. Introduction

1.1. Background

The expanding urban landscape has immensely increased the coverage of impermeable surfaces in the form of roads, carparks, footpaths, and roofs. Consequently, higher volumes of untreated stormwater enter urban streams and rivers, with greater peak flows of surface runoff from hard surfaces, which exacerbates the pollution of waterways and flooding in the urban space (Vermont Department of Environmental Conservation (VDEC), 2018; Zoppou, 2001). Historically, stormwater management primarily focused on reducing surface flow and flooding (Donofrio, Kuhn, McWalter, & Winsor, 2009) by constructing gutters, storm drains and other infrastructure to carry away stormwater as rapidly as possible. However, more recently integrated approaches to stormwater management have incorporated different kinds of green infrastructure and associated environmental services to avoid or mitigate the impact of stormwater runoff in urban waterways and spaces (Holm et al., 2014). In addition to reducing stormwater flood risk and treating contaminated stormwater to protect the health of waterways, various types of green infrastructure constructed as part of an integrated stormwater management approach may provide diverse recreational opportunities and amenity benefits for community well-being. Such recreational services can be enhanced through different attributes of green stormwater infrastructure that provide for both active and passive uses.

Infrastructure development represents a significant capital investment for local authorities, and communities will inherit the outcomes, good or bad, from any public investment decision. Therefore, exploring additional benefits – in this case recreational benefits – provided by stormwater infrastructure can help to understand more fully the potential costs and benefits of financing the construction or upgrading of stormwater infrastructure to facilitate recreational opportunities.

Christchurch urban area hosts one of New Zealand's largest networks of spring-fed waterways, which is highly interconnected with surrounding shallow aquifers, the Avon-Heathcote estuary/Ihutai, and the coastal environment (ECan & CCC, 2010). Stormwater from Christchurch City is carried to the sea through four major river systems – the Halswell River/Huritini to the south, the Avon River/Ōtākaro, the Heathcote River/Ōpāwaho, and to

the north the Styx River/ Pūharakekenui (see Figure 2 below). Increased stormwater runoff from roads and buildings as a result of urban growth and development in Christchurch has highly polluted urban waterways, in particular with hydrocarbons and heavy metal contaminants (CCC, 2018b).

Under the Resource Management Act 1991, regional councils have responsibility for water management, including managing rivers, mitigating discharge of contaminants, flood control, protecting environmental and social values of waterways, and promoting sustainability and well-being in the development and implementation of regional policy statements and plans (Kaye-Blake, Schilling, Nixon, & Destremau, 2014). In addition, stormwater management-related activities are further guided by the Local Government Act 2002 and the Building Act 2004, and the Building Code (NZWERF, 2004).

With the introduction of the Waterways and Wetlands Natural Asset Management Strategy 1999, the Christchurch City Council (CCC) began to manage urban waterways as resources according to six values; Ecology, Drainage, Culture, Heritage, Landscape, and Recreation. According to Environment Canterbury Regional Council (ECan) (n.d. accessed on January 15,2019) , CCC has applied for a resource consent for a Comprehensive Stormwater Network Discharge for 25 years. In the process of applying for this consent, CCC has prepared stormwater management plans for the Avon, Halswell and Styx rivers, with the stormwater management plan for the Heathcote River due for completion by 30 June 2019. The plans acknowledge that measures for the management and treatment of stormwater are developed in consideration of the six values, including recreation and landscape values.

1.2. Purpose and Objectives

The primary purpose of this study is to review the New Zealand and international literature on the economic value of recreational benefits derived from urban waterway stormwater management, with a focus on information that is relevant for use within the Christchurch context.

The specific objectives are to:

- Review information from the literature on recreational benefits provided by stormwater management infrastructure, and extract key economic data and information that may be relevant, useful and transferable within the Christchurch context.
- Identify gaps in the literature and recommend further work.

1.3. Report Structure

The report is structured as follows:

- Section 1 describes the background, purpose and objectives of the study.
- Section 2 describes the literature review methodology.
- Section 3 describes an economic valuation framework for assessment of recreational benefits derived from urban waterways stormwater management.
- Section 4 provides a brief description of urban waterways and current stormwater management infrastructure in the Christchurch context.
- Section 5 describes values of recreational benefits, particularly cycling, walking, water sports, and amenity values along urban river corridors and waterways.
- Section 6 provides a brief discussion of key findings
- Section 7 describes the value of recreational uses of constructed wetlands.
- Section 8 concludes the report and provides recommendations.

2. Methodology

2.1. Literature Review

Relevant literature was identified through an online search of the Environmental Valuation Reference Inventory (EVRI) database (www.evri.ca). The EVRI database is a leading repository of case studies of environmental valuation, and was therefore chosen as a pragmatic means of identifying relevant case studies that were economic in nature. After selection of literature relevant to the case of urban waterways and stormwater management in Christchurch, economic data and findings that may provide insights into the Christchurch context were extracted. Moreover, the type of recreational service considered in each study, the respective economic valuation technique, transfer conditions, and specific characteristics of waterways and wetlands from the study area, were reviewed and recorded. The various economic values

provided in this review are indicative, and they should not be applied in other study areas unless criteria for benefit transfer are satisfied. A total of 27 studies (19 international and 8 New Zealand based) were reviewed (Table 1).

Table 1. Studies included in the review, by recreational services

Recreational services	Number of studies*
General recreation	8
Walking and cycling	6
Water sports (swimming, kayaking, punting, recreational fishing)	11
River corridor and aesthetic	11
Wetlands	5

*Number of studies contained in 28 papers. Numbers do not sum to 28 as some papers reported non-market valuations of multiple recreational services.

The economic data retrieved through the studies were expressed in different currencies. Therefore, all the data were converted to current (4th Quarter 2018) New Zealand dollars. The website platform XE Currency Converter (https://www.xe.com/currencytables/) was used to calculate historic exchange rates, and Reserve Bank of New Zealand's inflation calculator (https://www.rbnz.govt.nz/monetary-policy/inflation-calculator/) was used to inflate historic New Zealand dollars to 4th Quarter 2018 New Zealand dollars on the basis of the Consumer Price Index (CPI). All dollar values reported in the text are expressed in adjusted 2018 New Zealand dollars.

3. Ecosystem Service Valuation Framework

The total Economic Value (TEV) framework provides a framework for classifying types of values from ecosystem services, and combines both market and non-market values (Plottu & Plottu, 2007) for a fuller picture of value. For example, while a monetary value can be assigned to the cost of installing and operating a stormwater management system, the wider benefits to cities and communities of having appropriate and functioning stormwater infrastructure cannot be assessed in terms of monetary value alone. This is in part due to the fact that stormwater infrastructure can deliver a diverse range of benefits. For example, when

stormwater is collected, treated, and used (bought or sold) for irrigation, the benefit of the water has market value, but it is complicated, in contrast, to assign economic values to individuals' satisfaction and appreciation when visiting (e.g. for recreational purposes) urban green spaces or swales, which may be primarily constructed for stormwater management, but serve dual or multi functions. Such benefits that are not valued in the market are known as 'non-market values'. Non-market valuation provides a means to account for unpriced ecosystem service values, which can then inform cost-benefit analyses. Hein, Van Koppen, De Groot, and Van Ierland (2006) provide a breakdown of different classes of ecosystem service values, as shown in Figure 1.

TEV addresses two broad types of value; use values and non-use values (see Table 2). Use value is defined as benefits obtained from actual use of an ecosystem – e.g. urban waterways. The use value can be further classified into direct use values and indirect use values. The direct use value can rest on extractive or non-extractive values. Recreational benefits derived from urban waterways are (non-extractive) direct use values. Non-use values represent, for example, benefits derived from urban rivers and streams through their contribution to maintaining ecosystem functions and environmental integrity. Moreover, people's appreciation of waterways and their desire to see waterways protected, even though they may never use services rendered by these waterways, also reflect non-use values.

Table 2 shows different non-market benefits of urban waterways, including recreational values. The recreational benefits mentioned in the table are not a complete list, but rather provide some examples.

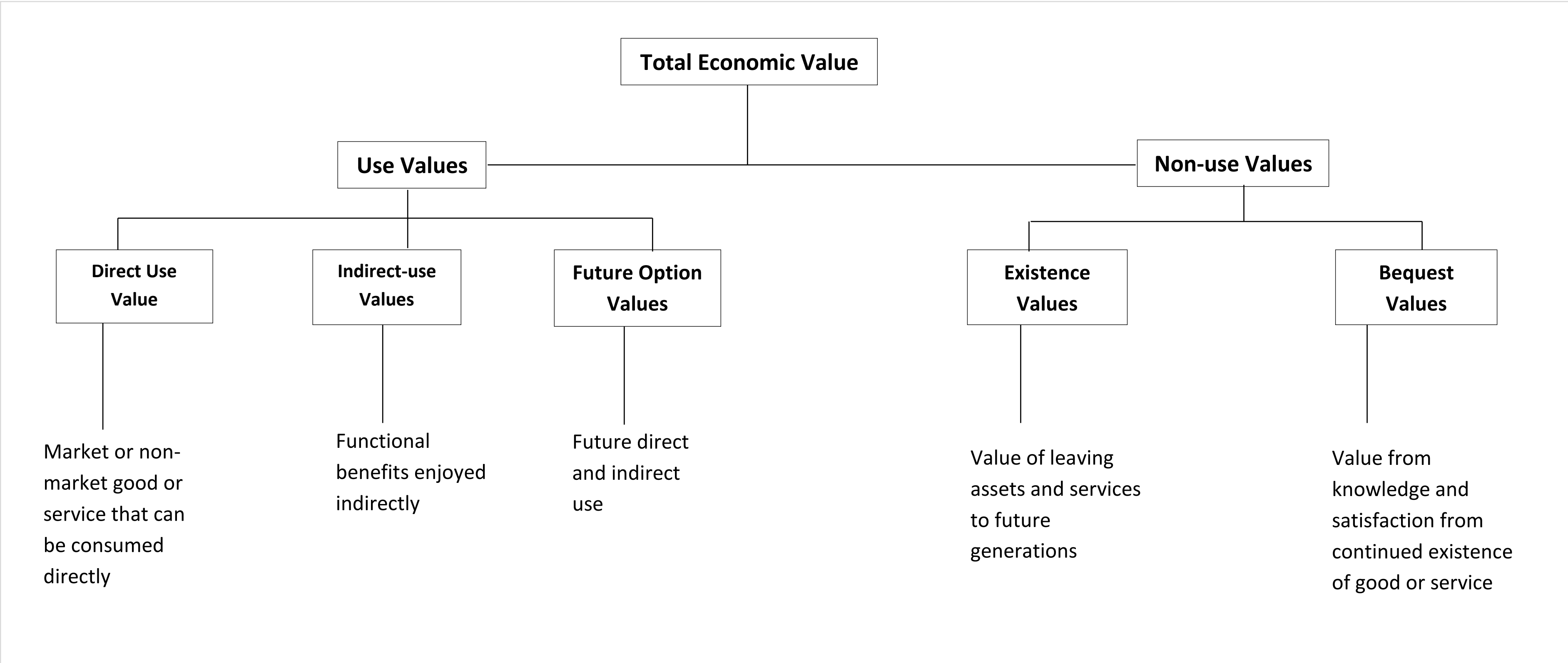

Figure 1. Total Economic Valuation framework

Source: Adapted from (Hein et al., 2006; Pascual et al., 2012, p. 193)

Table 2. Non-market values associated with urban waterways

Total Economic Value	Use values	Direct use values	In-stream	Contact recreation	Swimming, rowing, punting, canoeing, boating, etc.
			Withdrawal	Agriculture	Irrigation, water for livestock, etc.
			Aesthetic/ Environment based	Passive-shoreline recreation	Walking, cycling, picnics, events visitation, recreational fishing, wildlife watching, photography, etc.
		Indirect use values	Functional benefits	• Habitat provision for flora and fauna • Improvement of water quality • Erosion control • Flood water control • Other fresh water ecological function	
			Future direct and indirect values	• Future recreational use • Water reserve for future	
	Non- use values	Bequest value	Environment integrity for future generations	• Habitat and species preservation • Spiritual and cultural values	
		Existence value	Value from knowledge of continued existence	• Aesthetic/landscape values • Educational and scientific information	

Source: Adapted from Aither (2015); Marsh and Mkwara (2013).

3.1. Valuation methods

Liu, Costanza, Farber, and Troy (2010, pp. 56-57) provide an excellent summary of non-market valuation methods. The key section (p.56-57) of their paper is summarised below in Table 3.

Table 3. Ecosystem service (non-market) valuation methods

A. <u>**Revealed preference approaches**</u>
- **Market methods:** Valuations are directly obtained from what people pay for a service or good (e.g. timber harvest).
- **Travel cost:** Values of site-based amenities are implied by the costs people incur to enjoy them (e.g. cleaner lakes used for recreation).
- **Hedonic methods:** The value of an ecosystem service is implied by what people are willing to pay for it through purchases in related markets, such as housing markets (e.g. open space amenities).
- **Production approaches:** Ecosystem service values are assigned from the impacts of those services on economic outputs (e.g. increased fish catch from an increased area of wetlands).

B. <u>**Stated preference approaches**</u>
- **Contingent valuation:** People are directly or indirectly asked their willingness to pay for, or accept compensation for, some change in ecological service (e.g. willingness to pay for cleaner air).
- **Attribute-based methods:** People are asked to choose or rank different ecosystem service scenarios, or ecological conditions, that differ in the mix of those conditions (e.g. choosing between wetlands scenarios with different levels of flood protection and fishery yields).

C. <u>**Cost-based approaches**</u>
- **Replacement cost:** The value of a natural system or service is evaluated in terms of what it would cost to replace it (e.g. tertiary treatment values of a wetland if the cost of replacement is less than the value society places on tertiary treatment).
- **Avoidance cost:** An ecosystem service is valued on the basis of costs avoided, or of the extent to which it allows the avoidance of costly averting behaviours, including mitigation (e.g. clean water reduces costly outbreaks of waterborne illnesses)

D. <u>**Benefit transfer**</u>
- The application of existing ecosystem service value data to new policy contexts or cases (e.g. values obtained by tourists viewing wildlife in one park used to estimate values of viewing wildlife in a different park).

The studies reviewed in this report used various non-market valuation tools (Table 4).

Table 4. Non-market valuation tools used in the studies reviewed

Economic valuation tools		Total studies*
Revealed preference approaches	Market method	0
	Travel cost method	5
	Hedonic pricing	2
	Production approach	0
Stated preference approaches	Contingent valuation	8
	Attribute-based methods	14
Cost-based approaches	Replacement cost	0
	Avoidance cost	1
Benefit transfer		1

* Some studies used multiple non-market valuation tools.

4. Waterways and stormwater management

4.1. Christchurch urban waterways and recreational uses

The major rivers in Christchurch are shown in Figure 2. Each river catchment contains several other streams. For example, Knights Stream and Nottingham Stream flow into the Halswell River, while more than 20 streams, creeks, and drains feed the Avon River. Similarly, Cashmere Valley Stream, Worsley Valley Stream, Curletts Road Stream, Hayton's Stream and Steam Wharf Stream flow into the Heathcote River. Cavendish Road Stream and several creeks and drains flow into the Styx River.

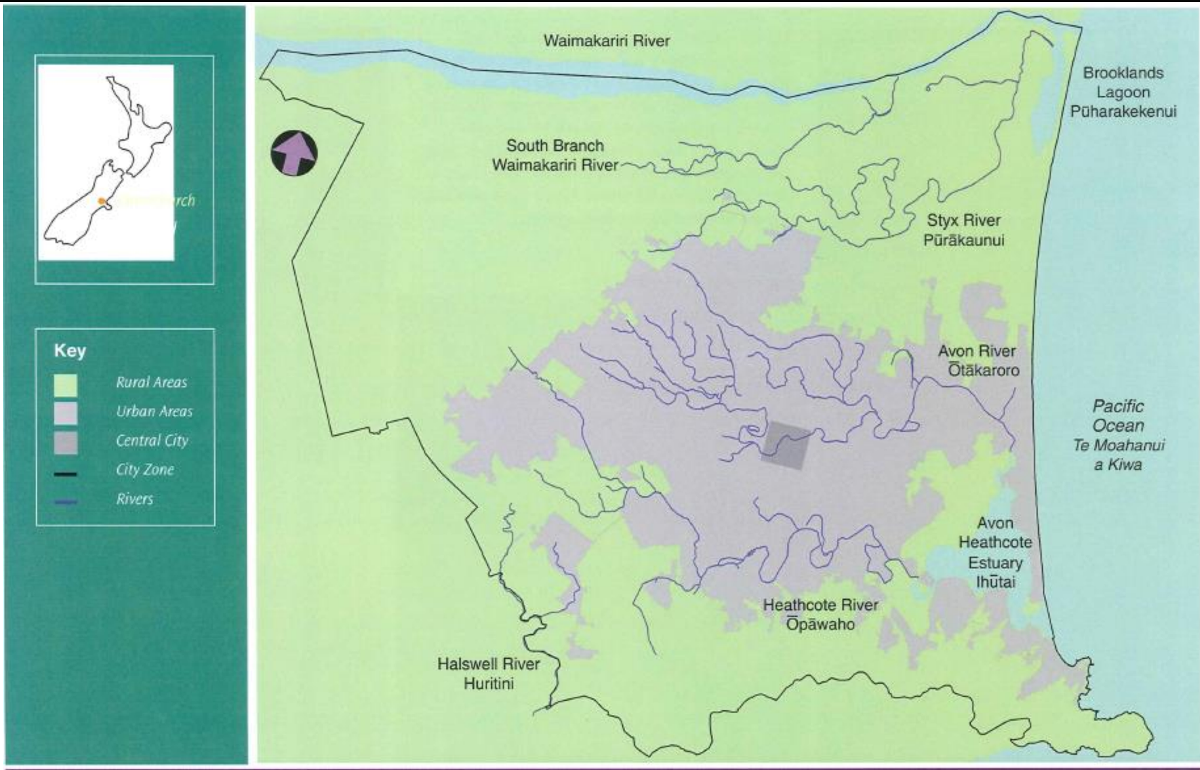

Figure 2. Major waterways within the Christchurch area
Source: CCC, 2003, p.2-4.

Since 1999, these rivers and their tributaries have been managed by the CCC as 'valued natural resources' according to the six core values of ecology, drainage, culture, heritage, landscape and recreation – which are intended to serve as drivers for improved surface water management to support the social, cultural, economic and environmental well-being of Christchurch residents.

In terms of recreation, the benefits commonly associated with urban waterways in Christchurch are (CCC, 2016a, 2016b, 2016c, 2017):

a) Walking
b) Cycling
c) Fishing
d) Kayaking/Canoeing/Rowing/Punting
e) Greenspace/Parks/Playgrounds and children's activities
f) Artwork/Photography
g) Bird watching
h) Dog and horse activities

According to the results of an urban waterways survey conducted by CCC (CCC, 2018a), many respondents (47%) frequently used waterways and adjoining areas for running or walking,

while 36% often visited areas surrounding waterways for relaxation. In contrast, rowing or kayaking (3%) and fishing (4%) were less common recreational activities in the City.

Significantly, 79% of respondents considered it very important or extremely important that waterways are safe for recreation. However, 48% perceived the quality of Christchurch urban waterways for recreational uses as poor or terrible, mostly because of contaminated stormwater coming from industrial sites, rubbish and litter, and run-off from residential building sites.

CCC has made significant investments in stormwater treatment devices and infrastructure in an effort to restore and enhance the health of urban waterways. Where this investment has supported green infrastructure systems, one objective has been to deliver additional benefits and added values to communities, such as from new recreation and amenity values. Council data for the Heathcote River catchment shows that capital investment in the recreational component of stormwater treatment systems ranges from 0.42% to 28.18% of total construction budget. This recreational component typically consists of the addition of walking paths and cycle ways (and associated fencing, signage, etc.). Detailed budget information for drainage and stormwater projects in the Heathcote Catchment is provided in Appendix I.

4.2. Stormwater management infrastructure

After the Christchurch Drainage Board was established in October 1875, wastewater and stormwater in Christchurch were managed by constructing separate sewers (Watts, 2011). In the process, the Board constructed open drains, concrete channels, and pipelines to convey wastewater to treatment plants, while stormwater was discharged to the nearest river or stream. Over time this significantly polluted the city's waterways (Wilson, 1989).

Since the Christchurch Drainage Board was merged with the new CCC in 1989, the City Council and Environment Canterbury have had responsibility for managing the urban waterways.

The CCC 'Waterways, Wetlands and Drainage Guide 2003' (CCC, 2003) has a dedicated chapter on stormwater treatment systems, including detailed descriptions of measures and tools for stormwater management (CCC, 2003). In addition, the 'On-site Stormwater Management Guideline 2004' (NZWERF, 2004), provides detailed information and guidance

on different stormwater management devices and tools. According to the Waterways, Wetlands and Drainage Guide, 2003, p.6-3, the primary objectives of stormwater treatment for urban catchments are:

- To remove highly contaminated fine particulate matter.
- To reduce dissolved contaminant concentration, particularly during rainfall events.
- To reduce bioavailability of residual (after whatever treatment is used) dissolved contaminants.

Moreover, the guideline also encourages stormwater treatment infrastructures (such as constructed wetlands, soakage systems, and basins) to incorporate other resource values (ecology, recreation, culture, landscape, heritage and drainage), with an emphasis on public safety. Stormwater treatment system types and functions, as well as potential additional values, are summarised on the Waterways, Wetlands and Drainage Guide 2003 (CCC, 2003, pp. 6-9), as per Table 5 below.

Table 5. Stormwater treatment systems, functions and additional values

System type	Facility and *ownership*	Specific function	Additional values
Pre-treatment device	Macro pollutant traps *Private or public system*	Trap coarse sediment and macro pollutants	Protection against blockage, safety
	Swales *Small scale on site private or public system*	Temporary stormwater detention, some filtration, trap sediment	Streetscape, avoids sumps and traps, conveyance
Soakage system	Rapid infiltration chambers *On site private system or communal public system*	Stormwater retention Stormwater treatment	Groundwater recharge
	Soakage basins *Public system*	Stormwater retention, filtration, denitrification and phosphorus removal	Groundwater recharge, landscape, recreation
Detention ponds	Wet ponds *Public system*	Temporary stormwater detention, removal of coarse to fine particles	Wildlife, landscape, recreation
	Dry basin (mostly dry except during and after storms) *Public system*	Temporary stormwater detention, removal of coarse to medium particles	Landscape, recreation, adds to reserve areas
Constructed wetlands	Surface/subsurface flow *Public system*	Removal of dissolved contaminants and fine particles, medium term stormwater detention, filtration and denitrification	Encourages a more natural functioning system, increases plants diversity, ground water recharge, landscape, cultural

5. Recreational use of urban waterways

A growing number of studies provide evidence that urban waterways deliver a range of recreational and amenity benefits. For a better understanding of these benefits, this section is divided into five sub-sections that address: general recreational value, walking and cycling, water sports, river corridor and aesthetic values, and recreational use of wetlands.

5.1. General recreational value

Among the literature reviewed, a range of studies identify recreational benefits of urban rivers and streams. In these studies, the researchers have typically evaluated a range of general/non-specified recreational benefits from waterways, without providing economic values for specific activities undertaken in the waterway or its corridor (see Table 6). Moreover, the eight studies reviewed generalised recreational benefits as 'recreation', 'primary contact recreation' or 'outdoor recreation facilities'. The seven international studies suggested that general recreational benefit value associated with urban waterways ranged between $0.27 and $43.08 per household per year. The original economic data for each study is reported in Table 6, along with a conversion to 2018 New Zealand dollars. General recreational value as described in these studies included, but was not limited to, combined benefits of recreational activities such as swimming, fishing, canoeing, amenity, and streamside park and playground values. In the context of New Zealand, it was found that park recreational benefits ranged between $16.56 and $17.94 per individual per day (Kerr, 2004). The valuation tools that were used for estimating general recreational value of urban waterways in these studies are choice experiments, contingent valuation, travel cost method, hedonic pricing, and benefit transfer.

Table 6. General recreational values of urban waterways

Ecosystem Services	Authors	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Outdoor recreation facilities (e.g. playgrounds)	Lanz & Provins (2013)	UK	Seaham	-	Discrete choice experiments	To examine preferences of Seaham residents for the provision of local environmental improvements via regeneration policies	Areas of open space for informal recreation (walking, dog-walking, etc.)	WTP (household/hectare/year) for areas of open space: **GBP 0.11 – 1.75** *Data collected 2010 via face-to-face interviews.*	**$0.27 – $4.32**
Recreation and Aesthetic	Kenney, et al. (2012)	USA	Baltimore City	Urban streams	Contingent valuation	To examine recreational and aesthetic values of urban stream restoration	Recreation & aesthetic	Aesthetic & recreational benefit per foot of urban stream restoration project: **USD 560.00 – 1,100.00** *Values in 2008 US dollars.*	**$868.60 – $1,706.19**
Recreation	Sinden (1990)	AU	Victoria	Ovens & Kings rivers	Travel cost method, Hedonic pricing	To quantify recreational benefits of Ovens and Kings rivers to inform management planning process	Recreation	Total annual present value over 5 years: **AUD 1.45 million** Mean WTP for river management options per recreationalist per year: **AUD 8.90 – 16.00** *Data collected in 1990 via interviews with recreation groups.*	**$3,39 million** **$20.81 – $37.41**
Recreation (swimming, fishing, canoeing)	Walpole (1991)	AU	Victoria	Ovens & Kings rivers	Contingent Valuation	To value recreation benefits of sites connected along Ovens-Kings river system	Recreation (swimming, fishing, canoeing)	Average recreational benefit value for 25 sites estimated at: **AUD 15.90** *Data collected 1989-1990.*	**$37.91**

Ecosystem Services	Authors	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Primary contact recreation (e.g. swimming)	Bennett et al. (2008)	AU	Victoria	Moorabool, Gellibrand, & Goulburn rivers	Choice experiment	To value improvements in health of Victorian rivers from policy initiatives & management projects	Percentage of river suitable for primary contact recreation without threat to public health	Implicit Price (WTP per in-catchment household): Moorabol: **AUD 0.09** Gellibrand: **AUD -0.05** Goulburn: **AUD 2.12** *Data collected 2005 via choice modelling mail survey.*	**$0.13** **-$0.07** **$3.04**
Recreation	Willis & Garrod (1999)	UK	Cornwall, Devon, Dorset, Gloucester shire, Somerset, Wiltshire, Avon	Allen, Piddle, Avon, Wylye, Tavy, Heavy & Otter rivers	Contingent valuation, Choice experiment	To assess benefits to anglers and other recreation users of increasing flows along low-flow rivers	Recreational uses	Aggregate WTP/ household/year among recreational users for 130km reduction in length of low-flow rivers: **GBP 6.16** (stated preference survey) **GBP 10.78** (discrete choice contingent valuation method). *Data collected 1996 via WTP surveys.*	**$24.62** **$43.08**
Primary contact recreation (e.g. swimming and paddling)	Kragt, et al. (2007)	AU	Victoria	Goulburn River	Choice experiment	To estimate the value households attach to attributes of improved river health	Primary contact recreation	Mean WTP/household/ year (as one-off compulsory payment) for 1% of river's length suitable for primary contact recreation: **AUD 1.94** *Data collected Nov. 2005-Feb. 2006 via mail survey.*	**$2.87**
Recreation	Kerr (2004)	NZ	Waitaki	Lower Waitaki River	Benefit transfer	To estimate lower Waitaki River recreation values, based on existing information	Park recreation	Benefit per recreationalist per day for park recreation: **NZD 12.00 – 13.00** *Values in 2003 NZ dollars*.	**$16.56 – $17.94**

5.2. Walking and Cycling

A majority of studies treat cycling and walking paths together as 'green routes' or 'greenways'. Lindsey (2003, p. 165) defined greenways as "linear open spaces or parks along rivers, ridgelines or historic infrastructure corridors such as canals or railroads that connect people with place and provide opportunities for recreation, conservation, and economic development". Three of the international studies reviewed estimated that provision of cycling and walking paths provide benefits of between \$4.37 and \$91.28, expressed in mean willingness to pay (WTP) per household per year. In the context of New Zealand, Matthews (2009) calculated \$27.84 per individual per year in economic benefits of a streamside walkway in Hamilton city. Tait et al. (2016) estimated annual WTP of \$26.11 per household for having urban cycling and walking paths in the Christchurch Avon Red Zone. In addition, economic benefits expressed in terms of annual avoided health costs per average recreationalist from cycling, walking and jogging in Christchurch, New Zealand were \$628.09, \$425.86, and \$205.44 respectively (Vallance & Tait, 2013). The economic data for all international and New Zealand based studies are provided in Table 7. In the studies reviewed, non-market valuation of cycling and walking ways was estimated using choice experiment methods.

Table 7. Walking and cycling values

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Green routes (cycling & walking paths)	Lanz & Provins (2013)	UK	Seaham	-	Discrete choice experiments	To examine preferences of local residents for provision of local environmental improvements from regeneration policies	Provision of cycling and walking path	WTP/household/year for provision of 1 kilometre of cycling and walking path: **GBP 1.77 – 4.09** *Data collected 2010 via face-to-face interviews.*	**$4.37 – $10.11**
Greenway	Lindsey & Knaap (1999)	USA	Indiana	Crooked Creek Greenway	Contingent valuation method	To estimate WTP for projects to improve the Crooked Greek Greenway	Owners: All residential property owners in Crooked Creek Greenway, Renters: Apartment dwellers in the greenway, and Marion County residents	Mean WTP/year for: Owners: **USD 23.00** Renters: **USD 3.26** County residents: **USD 3.92** *Values in 1997 US dollars.*	**$51.79** **$7.34** **$8.83**
Walkway	Bae (2011)	South Korea	Seoul	Urban stream of Hong-je	Choice experiment	To estimate consumer WTP for restoration of an urban stream of Hong-je	Provision of a streamside walkway	Mean WTP/household/year: **USD 26.00** *Data collected 2001 via face-to-face interviews.*	**$91.28**

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Recreation (cycling, walking, jogging)	Vallance &Tait (2013)	NZ	Christ-church	Avon River	Choice experiment	To estimate the value of the benefits of a recreation reserve or river park in the Avon River residential red zone (ARRRZ)	Public health cost savings derived from a recreational reserve	Annual avoided public health costs per average recreationalist: Cycling: **NZD 587.00** Walking: **NZD 398.00** Jogging: **NZD 192.00** *Data collected 2013 via interviews.*	**$628.09** **$425.86** **$205.44**
Walkway	Matthews (2009)	NZ	Waikato	Urban streams in Hamilton City	Choice experiment	To estimate the value of environmental improvements to streams in Hamilton	Provision of a walkway	Mean WTP/individual/year: **NZD 24.00** *Data collected 2009 via web-based survey.*	**$27.84**
Recreation (cycling, walking, jogging)	Tait et al. (2016)	NZ	Christ-church	Avon River	Choice experiment	To identify & quantify Christchurch residents' preferences for different land use options in the Christchurch Red Zone	Cycle/walking /jogging paths	Annual WTP/household: **NZD 24.40** *Data collected 2013 via interviews.*	**$26.11**

5.3. Water sports (swimming, kayaking, punting, recreational fishing)

The studies reviewed were concerned with diverse in-stream recreational activities in urban streams and rivers. A total of ten studies provided economic data on specific recreational activities. The major recreational water sports considered were fishing/angling, kayaking, punting, boating, and swimming. According to the six international studies reviewed, the benefits from various water based activities are:

- Fishing/Angling: The annual benefit for each angler ranged between $271.87 and $2,338.32
- Kayaking/Punting: Total consumer surplus per kayaker per year is $637.56, and consumer surplus for punting is $54.16 per day trip.
- Swimming: Implicit benefit for residents living within a river catchment ranged from $107.14 to $153.22 per household for improvement of a one kilometre length of river to swimmable standard.

Four studies from New Zealand were reviewed. The studies mainly estimated recreational benefits from fishing and swimming. A benefit of $35.88 per angler per day for freshwater fishing was calculated by Kerr (2004). In the context of urban waterways in Christchurch, Tait et al. (2016) valued household willingness to pay for 'water based opportunities' in the Christchurch Avon Red Zone at $11.34 per year, however the study did not specify particular water based opportunities. The detailed economic data from the respective studies are reported in Table 8.

Table 8. Water sports values

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Kayaking	Hynes & Hanley (2006)	Ireland	County Kerry	River Roughty	Travel cost method	To estimate recreational values of river to be affected by hydropower development	Kayaking	Total consumer surplus per kayaker per year: **EUR 235.74** *Data collected 2003 via questionnaires distributed to kayakers in person or online.*	**$637.56**
Punting	Grossmann (2011)	Germany	Branden-burg	Spree River catchment	Travel cost method	To estimate recreational values in the Spree River basin & assess effect of summer water deficit on recreational value	Punting	Consumer surplus per day trip: **EUR 19.00** Consumer surplus per 1-3 day trip: **EUR 33.00** Marginal recreational loss per $1m^3$ of summer water deficit below a $25m^3$ deficit: **EUR 0.08** *Data collected 2002 via onsite face-to-face interviews.*	**$54.16** **$94.06** **$0.23**
Angling	Sinden (1990)	AU	Victoria	Ovens & Kings rivers	Travel cost method, Hedonic pricing	To quantify recreational benefits of Ovens & Kings rivers to inform management planning	Angling	Annual benefit (est.) per angler: **AUD 1,000.00** *Data collected 1990 via interviews with recreation groups.*	**$2,338.32**

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Fishing, Swimming	Morrison & Bennett (2004)	AU	New South Wales	Bega, Clarence, Murrum-bidgee, Gwydir, Georges rivers	Conjoint analysis	To estimate value of the improved health of rivers in New South Wales in terms of four environmental attributes	Suitability for fishing & swimming	Implicit prices per in-catchment household for improving water quality of 1km length of rivers to swimmable and fishable across rivers (river: swimmable / fishable): Bega River: **AUD $100.98** / **$51.33** Clarence River: **AUD $72.77** / **$46.63** Georges River: **AUD $73.88** / **$45.26** Gwydir River: **AUD $104.07** / **$48.94** Murrumbidgee River: **AUD $75.24** / **$54.16** *Values in 2004 Australian dollars.*	**$148.67** / **$75.57** **$107.14** / **$68.65** **$108.77** / **$66.63** **$153.22** / **$72.05** **$110.77** / **$79.74**
Angling	Willis & Garrod (1999)	UK	Cornwall, Devon, Dorset, Gloucestershire, Somerset, Wiltshire, Avon	Allen, Piddle, Avon, Wylye, Tavy, Heavy, Otter rivers	Contingent valuation, Choice experiment	To assess the benefits to anglers & other recreational users of increasing flows along low-flow rivers	Angling	Mean WTP/Angler/year: **GBP 68.03** *Data collected 1996 via WTP surveys.*	**$271.87**

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Recreation and Biodiversity	Georgiou et al. (2000)	UK	Birmingham	River Tame	Contingent valuation	To estimate value of benefits from improving water quality in the River Tame	Improvement: Large = Water quality restored to pre-industrial level; trout & salmon return; water good for swimming, fishing & boating. Medium = some game fish species, insects, birds & wildlife, river is good for fishing and boating. Small = a few species of fish, water suitable for boating	Mean WTP/household/ year for improvement: Large: **GBP 18.12** Medium: **GBP 12.07** Small: **GBP 7.60** *Data collected 1999 via in-person interviews*	**$95.17** **$63.39** **$39.92**
Swimming	Kerr & Swaffield (2007)	NZ	Canterbury	Lower Selwyn River	Choice experiment	To estimate preference of stakeholders for attributes of streams & stream corridors in Canterbury	Safe to swim	WTP/household/year estimated for anglers and farmers for swimming benefits: **NZD 67.98 – 298.58** *Data collected 2007 via in-person choice experiment survey.*	**$83.62 – $367.25**
Swimming	Marsh & Philips (2012)	NZ	Canterbury	Hurunui River catchment	Choice experiment	To quantify preference of Canterbury residents for different land & water quality scenarios	Suitability for swimming & recreation	Mean WTP/household/ year: **NZD 33.00** *Data collected 2011 via online market research panel.*	**$35.97**

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Recreation	Kerr (2004)	NZ	Waitaki	Lower Waitaki River	Benefit transfer	To identify the likely order of magnitude of lower Waitaki River recreation values, based on existing information	Fishing	Benefit/angler/day for freshwater sport fishing: **NZD 26.00** *Value in 2003 New Zealand dollars.*	**$35.88**
Water based opportunities	Tait et al. (2016)	NZ	Christ-church	Avon River	Choice experiment	To identify, assess and quantify Christchurch residents' preferences for different land use options in the Christchurch Red Zone	Water based opportunities	WTP/household/year: **NZD 10.60** *Data collected 2013 via interviews*.	**$11.34**

5.4. River corridor aesthetic value (riparian native plants and animals)

According to the New Zealand Resource Management Act, 1991, amenity or aesthetic value can be defined as "those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreation attributes". The literature reveals that urban river and stream corridors offer diverse aesthetic values to inhabitants and communities. A total of eleven international and New Zealand-based studies were reviewed in relation to amenity and/or aesthetic values. They associated river corridor aesthetic values with factors such as streamside native riparian vegetation, visual appearance of rivers or water clarity, amount of litter in a river, and native water birds and other fauna.

From the international studies reviewed (see Table 9), the benefits of having native riparian vegetation along river banks were estimated to range between $2.15 and $7.98 per household per year for an increase of 1% of a river's length with healthy native vegetation. Similarly, the benefit value for native water birds and other fauna was estimated at $5.07 to $31.66. In New Zealand, Kerr and Sharp (2004b) estimated mean WTP per household per year for water clarity at between $91.08 and $92.46. Moreover, the same authors calculated mean WTP per household per year for moderate native vegetation and plentiful native vegetation at between $22.08 and $38.64 and $28.98 and $56.58 respectively. For Christchurch, Tait et al. (2016) found that annual WTP among Christchurch residents for improved river water and habitat quality, and native plants and habitat was $14.45 and $27.93 per household respectively. The detailed economic data on river corridor aesthetic values are reported in Table 9.

Table 9. River corridor aesthetic values

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Healthy native riverside vegetation, native fish species	Morrison & Bennett (2004)	AU	New South Wales	Bega, Clarence, Murrum-bidgee, Gwydir, Georges rivers	Conjoint analysis	To estimate value of the improved health of rivers in New South Wales in terms of four environmental attributes.	Value per 1% increase in length of river with healthy native vegetation, number of native fish species present	Implicit prices per in-catchment household (River: improvements in native vegetation per 1% length / number of native fish species present): Bega: AUD **2.33 / 7.23** Clarence: **AUD 2.07 / 0.05** Georges: **AUD 1.51 / 1.77** Gwydir: **AUD 1.46 / 2.12** Murrumbidgee: **AUD 1.46 / 2.77** *Values in 2004 (publication date) Australian dollars.*	**$3.43 / $10.64** **$3.05 / $0.07** **$2.22 / $2.61** **$2.15 / $3.12** **$2.15 / $4.08**
Riverside vegetation, native water birds & other animals	Bennett et al. (2008)	AU	Victoria	Moorabool, Gellibrand, Goulburn rivers	Choice experiment	To value improvements in Victorian river health arising from policy initiatives & management projects	1% increase in length of river with healthy riverbank vegetation, 1% increase in number of native water birds & animals	Implicit price per in-catchment household (River: 1% increase in length of river with healthy riverbank vegetation / 1% increase in number of native water birds & animals): Moorabol: **AUD 5.56 / 22.07** Gellibrand: **AUD 2.91 / 17.33** Goulburn: **AUD 3.56 / 3.90** *Data collected 2005 via choice modelling mail survey.*	**$7.98 / $31.66** **$4.17 / $24.86** **$5.11 / $5.59**
Riverbank condition in terms of vegetation & soil erosion	Hanley et al. (2006)	UK	Durham & central Scotland	Wear & Clyde rivers	Choice experiment	To estimate the value of improvements in ecological status of River Wear & River Clyde	Quality in terms of riverbank vegetation & erosion	WTP /household/year to improve riverbanks from 'fair' to 'good' in terms of vegetation & erosion: Wear: **GBP 12.67** Clyde: **GBP 42.99** *Calculated via random parameters logit model with data collected in 2001 via choice experiment survey.*	**$63.02** **$213.83**

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Riparian vegetation and aquatic vegetation, aesthetic/ visual appearance	Robinson et al. (2002)	AU	South-east Queens-land	Bremer River catchment	Choice experiment	To assess value of improvements in three attributes in Bremer River catchment	Riparian & aquatic vegetation, visual appearance of river	WTP/household/year for 1% improvement in total length of river or stream, with: Riparian veg.: **AUD 1.37 – 1.47** Aquatic veg.: **AUD 1.27 – 1.08** Appearance: **AUD 0.61 – 0.37** *Values in 2002 Australian dollars.*	**$2.22 – $2.38** **$2.06 – $1.75** **$0.99 – $0.60**
Aesthetic in terms of amount of litter in the river	Hanley et al. (2006)	UK	Durham & central Scotland	Wear & Clyde rivers	Choice experiment	To estimate the value of improvements in ecological status of River Wear & River Clyde	Aesthetic in terms of the amount of litter in the river	WTP/household/year to improve aesthetics (amount of litter in the river) from 'fair' to 'good': Wear: **GBP 12.07** Clyde: **GBP 28.57** *Calculated via random parameters logit model with data collected in 2001 via choice experiment survey.*	**$60.04** **$142.11**
Wildlife, riverside vegetation	Kragt et al. (2007)	AU	Victoria	Goulburn River	Choice experiment	To estimate the value that households attach to attributes of improved river health	Native birds and fauna, healthy riverside vegetation	Mean WTP/household/year, as a one off compulsory payment to improve 1% of river's length with: Native birds & fauna: **AUD 3.42** Native veg.: **AUD 3.20** *Data collected Nov. 2005 to Feb. 2006 via mail surveys.*	**$5.07** **$4.74**
Amenities (clear water, native vegetation)	Kerr & Swaffield (2007)	NZ	Canter-bury	Lower Selwyn River	Choice experiment	To estimate preference of stakeholders for attributes of streams & stream corridors in Canterbury	Clear water, native vegetation	WTP/household/year estimated for anglers and farmers for: Clear water: **NZD -1.92 – 182.53** Native veg. **NZD 20.27 – 82.09** *Data collected 2007 via in-person choice experiment survey.*	**-$2.36 – $224.51** **$24.93 – $100.97**

Recreational Services	Authorship	Country	Study area	Waterways	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Landscape/ Aesthetic	Kerr & Sharp (2004b)	NZ	Auckland	North Shore & South Auckland	Choice experiment	To estimate the values of environmental attributes of streams in the Auckland region of New Zealand	Water clarity, native streamside vegetation	Mean WTP/household/year for water clarity: Nth. Shore: **NZD 66.00** Sth. Auckland: **NZD 67.00** Moderate vegetation: Nth. Shore: **NZD 28.00** Sth. Auckland: **NZD 16.00** Plentiful vegetation: Nth. Shore: **NZD 21.00** Sth. Auckland: **NZD 41.00** *Data collected 2003.*	**$91.08** **$92.46** **$38.64** **$22.08** **$28.98** **$56.58**
Landscape/ Aesthetic	Matthews (2009)	NZ	Waikato	Urban streams in Hamilton City	Choice experiment	To estimate the value of environmental improvements to streams in Hamilton	Good water clarity, native riparian vegetation, natural channel	Mean WTP/Individual/year for: Good water clarity: **NZD 56.00** Riparian vegetation: **NZD 52.00** Natural channel: **NZD 39.00** *Data collected 2009 via online survey.*	**$64.96** **$60.32** **$45.24**
Habitat & vegetation	Tait et al. (2016)	NZ	Christ-church	Avon River	Choice experiment	To identify, assess & quantify Christchurch residents' preferences for different land use options for Christchurch Red Zone	Improved river water & habitat quality, native plants & habitat	WTP/household/year for improved: Water & habitat quality: **NZD 13.50** Native plants & habitat: **NZD 26.10** *Data collected 2013 via interviews.*	**$14.45** **$27.93**

6. Value of recreational use of wetlands

Apart from removal of dissolved contaminants and fine particles, medium term stormwater detention, filtration and denitrification as primary purposes, various contributions to the literature recognise additional social benefits and services from the construction of wetlands. Although the main objective of this section was to review recreation-specific benefits of constructed wetlands, the literature identified through the review process provides information on general wetland benefits and values. Streever, Callaghan-Perry, Searles, Stevens, and Svoboda (1998) found that mean WTP among Australian households for conservation of wetlands, including for their recreational benefits, was $220.01 per household per year. However, when asked to prioritise wetland types for protection, these respondents favoured 'wetlands containing rare species of plants' and 'wetlands which provide flood protection, water supply, and water pollution control' over 'wetlands which provide recreation and food'. Similarly a study from Sweden shows that marginal WTP per individual for having high biodiversity and walking paths within wetlands was $217.84 per year and $209.75 per year respectively.

In New Zealand, Ndebele (2009) estimated that Mean WTP for wetland restoration ranged between $35.10 and $90.09 per household per year for a period of five years. For Christchurch, Tait et al. (2016) found that residents were willing to pay $7.06 per household per year for restoration of wetlands in the Christchurch Avon Red Zone.

Table 10. Wetland values

Wetland Ecosystem Services	Authorship	Country	Study area	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Wildlife (Pheasant)	von Haefen & Phaneuf (2003)	USA	Iowa wetlands	Travel cost method	To calculate recreational value in reference to changes in site quality and user fees in Iowa wetlands	20% increase in pheasant count indices at three zonal sites, 50% access fee at riverine wetlands	WTP/individual/year for 20% increase in pheasant count scenario: **USD 11.45 – 14.22** Negative WTP/individual/year for 50% access fee scenario: **USD -37.66 – -$57.21** *Data collected 1997 via mail survey.*	**$25.78 – $32.02** **$84.79 – $128.81**
Diverse wetland benefits	Streever et al. (1998)	AU	New South Wales	Contingent valuation	To estimate WTP value & examine attitudes about wetland conservation in New South Wales	Wetlands with diverse attributes	Mean WTP/household/year to conserve wetlands providing residents with food & recreational benefits, flood protection, water supply & water pollution control: **AUD 124.37** *Data collected 1996 via mail survey.*	**$220.01**
Biodiversity & recreation	Carlsson et al. (2003)	Sweden	Staffanstrop proposed constructed wetland	Contingent valuation	To examine residents' WTP for wetlands & related attributes	High biodiversity, provision of a walking path	Marginal WTP/Individual/year for wetland attributes: High biodiversity: **SEK 673.00** Walking path: **SEK 648.00** *Data collected 2001 via mail survey.*	**$217.84** **$209.75**

Wetland Ecosystem Services	Authorship	Country	Study area	Valuation Method	Study Objective	Indicator	Benefit Estimate	Current $NZ conversion
Diverse wetland benefits	Ndebele (2009)	NZ	Pekapeka Swamp	Contingent valuation	To estimate benefits of restoration & preservation of Pekapeka Swamp	Preservation of diverse wetland benefits by ecological restoration, construction of walking track & picnic areas, educational and cultural installations.	Mean WTP/household/year for wetland restoration for a period of five years: **NZD 30.00 – 77.00** *Data collected Nov. 2008 to Jan. 2009 via mail survey.*	**$35.10 – $90.09**
Diverse wetland benefits	Tait et al. (2016)	NZ	Wetlands in Christchurch Red Zone	Choice experiment	To identify, assess & quantify residents' preferences for different land use options for Christchurch Red Zone	Restoration of wetlands	WTP/household/year for restoration of wetlands: **NZD 6.60** *Data collected 2013 via interviews.*	**$7.06**

7. Discussion

The literature examined in the course of this review on recreational benefits of urban waterways and stormwater infrastructure suggests that urban waterways do provide recreational and aesthetic benefits to residents and communities. However, most of the non-market valuation studies that were identified were conducted on large perennial rivers, lakes, reservoirs, natural wetlands, and lagoons. Thus, the results and economic data contained in a lot of that research is not clearly applicable to small urban waterways (such as those in Christchurch), and were not included in this literature review. Apart from this bias towards large non-urban waterways, much of the literature addresses recreational benefits in a highly generalised and aggregated way, as opposed to specifying particular recreational activities or aspects of recreational benefits.

In the context of New Zealand research, most of the studies on recreational benefits of rivers were focused on fishing and swimming. New Zealand literature assessing other recreational activities and streamside activities such as walking and cycling in urban corridors was not identified. While some studies did examine benefits (including recreational value) from urban wetlands, this review did not identify any New Zealand research examining recreational benefits of artificial or constructed wetlands, basins or swales for stormwater management.

Overall, therefore, there appears to be very limited data on non-market valuation of recreational benefits of small urban streams and rivers, or by wetlands constructed for urban stormwater management, that could be easily applied to the Christchurch case. Furthermore, it must be noted that due to the wide variety of kinds of benefits reported in the literature, and variety of indicators and units used, it is very difficult to draw comparisons across the cases surveyed.

The research reviewed, however, does provide some information that may suggest where benefits may lie. For example, international studies suggest that people do value the outdoor recreational opportunities afforded by urban river corridors. While swimming and fishing/angling are relatively highly valued by some, these ecosystem services may not be feasible to enable or sustain in the short term for many urban waterways in Christchurch. However, provision of facilities for recreation (such as cycling, walking, picnicking etc.)

adjacent to waterways along with in-stream and riparian ecological restoration are also valued, and may help achieve progress towards suitability for fishing, swimming, and other contact recreation. Insofar as stormwater green infrastructure installations (such as constructed wetlands, basins and swales) deliver such amenities for outdoor recreation, they are also likely to deliver additional value to communities.

Cycle ways and walkways appear to be valued by communities, and cycling, walking and jogging appear to have considerable benefits in terms of individuals' avoided healthcare costs. Cycling and walking routes through urban green spaces/greenways seem to be considerably more highly valued by home/property owners as opposed to renters, suggesting that such facilities are seen as enhancing neighbourhood amenity and property values. The value of linking up paths and greenspaces to establish larger contiguous greenways and routes is likely to yield greater value.

Both international and New Zealand research suggests that communities are willing to pay to enhance the ecological values and associated amenity values of urban waterways and riparian margins. Research suggests that WTP will vary for different communities and groups of users, as well as for different catchments in an urban area. Data from Auckland, Hamilton and Christchurch suggest that urban residents do value aesthetic attributes such water clarity and native flora and fauna in and around urban waterways. And willingness to pay for such benefits may denote substantial non-market values at a city scale. The value of urban wetlands in this regard is also likely to be considerable, and the research suggests that communities value wetlands as sites of biodiversity and recreation, as well as for their flood mitigation functions. Insofar as constructed wetlands and other forms of stormwater infrastructure can deliver such outcomes, they are likely to produce considerable additional value in these areas.

8. Conclusions and recommendations

This literature review has demonstrated that there are significant recreational and aesthetic benefits that communities derive from urban waterways and wetlands. Stormwater management can enhance the quality of urban water, enabling and enhancing various recreational opportunities. Moreover, stormwater management infrastructure (such as

constructed wetlands) may deliver additional recreational and amenity values for urban communities. However, recreational and aesthetic value estimates are highly dependent on the particular waterway (e.g. river or wetland) being assessed, thus the economic values presented in this literature review may serve as a general reference, but they do not reflect the actual recreational benefits offered by urban waterways of Christchurch.

In order to better understand this, further, primary research would be required to survey residents and determine preferences and values at the local or neighbourhood level, because there is not sufficient data for a benefit transfer study. Primary research of this nature could be considered as a means to determine non-financial costs and benefits of various potential stormwater infrastructure options with more accuracy. Primary research of this nature is however potentially expensive and time-consuming. The broad values provided in this report may form a starting point for considering where further research could be relevant. In approaching this, the additional cost associated with adding amenities and aesthetic features to stormwater infrastructure and urban waterways restoration projects might be compared to the benefits that are likely to accrue to different groups of beneficiaries (see the cost-benefit matrix in Table 11). For example if the addition of a walkway to a stormwater detention basin was to cost $200,000, Council might be looking for at least $200 of benefit to at least 1,000 beneficiaries (e.g. individuals or households) or, alternatively, at least $20 of benefit to 10,000 beneficiaries, in order to justify this expenditure. The relative merits of different measures will therefore depend of the multiple different benefits delivered, and the population(s) of beneficiaries that benefit.

Table 11. Evaluative cost-benefit matrix

		Benefits per beneficiary ($)					
		$5	$10	$20	$50	$100	$200
Number of beneficiaries	1,000	$5,000	$10,000	$20,000	$50,000	$100,000	$200,000
	10,000	$50,000	$100,000	$200,000	$500,000	$1,000,000	$2,000,000
	100,000	$500,000	$1,000,000	$2,000,000	$5,000,000	$10,000,000	$20,000,000
		Additional cost of provision of benefits					

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Appendix I: Land Drainage and Stormwater Project Budget (Heathcote Catchment)

Project Name	Phase	Project Total	Recreational Component	Recreational Component (NZD)	Recreation Investment (%)
SW Sutherlands Basin (Welsh) Stormwater Treatment	Execute	6763429	Walking/Biking paths/boardwalks/seats	300000	4.43
SW Sparks road development drainage works	Execute	3676186	Walking/Biking paths/boardwalks/seats	200000	5.44
SW Owaka Corridor	Execute	3889212	Recreational (in the same way roads are) Active transport link (parks funded)	500000	12.86
SW Owaka Basin	Execute	1111383	None	0	0
SW Natural Waterways Rolling Delivery Package	Execute	958271	Walkway	10000	1.04
SW Mundys Drain	Closed	173458	None	0	0
SW Highsted Land Purchase & Construction of Waterways, Basins & Wetlands	Execute	7168150	None	0	0
SW Highfield North Basins	Concept	2596974	None	0	0
SW Creamery Ponds	Concept	1307500	Nothing yet (probably pathway)	0	0
SW Cashmere Worsleys Wetlands	Concept	500000	Walkway	25000	5
SW Bullers Stream Naturalisation and Facility	Execute	2581451	Walkway & cycleway	500000	19.39
LDRP 54 Dudley Creek	Execute	53228957	Walkway & cycleway	15000000	28.18
LDRP 529 Heathcote Low Stopbanks	Execute	21268333	Walkway along Heathcote	135000	0.63
LDRP 528 Eastman Wetlands	Execute	18202600	Walkways & cycleways		0
LDRP 526 Curletts Flood Storage	Execute	9447677	Walkway along Curletts	40000	0.42
LDRP 525 Southshore Emergency Bund	Execute	2130000	Replacement of paths disturbed by works	50000	2.35
LDRP 520 Wigram East Retention Basin	Execute	8477203	Walkway & bridges (re-instalment cost - not new)	200000	2.36
LDRP 509 Knights Drain Ponds	Execute	8281229	Walkway & cycleway	50000	0.60
LDRP 507 Temporary stop bank management	Execute	6537589	Walkway & cycleway	1500000	22.94
LDRP 502 Matuku Waterway	Execute	2820080	Walkway		0
LDRP 501 Bells Creek	Execute	19159028	Walkway, new park, park enhancements/reinstatements	1700000	8.87
LDRP 500 Cashmere Worsleys Flood Storage	Execute	27484772	Walkways & cycleways	200000	0.73
LDRP 527 Lower Heathcote Dredging	Execute	14948000	Walkway and park improvements	400000	2.68

Source: Christchurch City Council, 2019

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