Contents

Executive Summary

Human modification of catchments and riparian zones results in gradual stream degradation. Restoration aims to return streams to their natural state in order to improve their functions as biological and cultural resources.

This research examines the current physical condition of the Sumner and Richmond Hill Streams in the Sumner catchment of Christchurch, how other urban waterways have been restored and evaluates

Introduction

Habitat Sumner is a community-based group interested in the recovery of environmental assets to meet the needs of the Sumner community in Christchurch. This research aims to examine the physical characteristics of the highly modified Sumner and Richmond Hi

surface, it takes around 5ml of precipitation before surface runoff initiates; however on an impervious surface, the amount is effectively 0 (ARC, 2008; NZTA 2010). The level of imperviousness within a catchment is therefore a strong predictor of stream health. Many degraded urban streams have been associated with thresholds of impervious surface cover of less than 10-20% (Paul & Meyer, 2001). The overall water quality of streams is highly dependent on a number of factors, of primary interest to the current application are variables of nutrients, turbidity, dissolved oxygen and temperature. Nutrients control the rate of algae and macrophyte growth in freshwater environments. Nitrogen in the form of Nitrate, Nitrite and Ammonia are predominantly responsible for biological growth (ANZECC, 2000). Nutrients are not one of the major issues in urban catchments, where the most common source is lawn fertilizer. The lack of riparian vegetation in urban catchments increases the amount of these nutrients getting into the system as there is no buffer alongside the water way intercepting the nutrients.

stream. Turbidity increases with the amount of suspended and dissolved particles in the water column. Removal of riparian vegetation can enhance bank erosion and therefore increase the sediment load within the stream; increased runoff velocity associated with urban catchments also enhances erosion (TRC, 2010).

Dissolved Oxygen is required by aquatic animals to survive, where the amount of DO water can hold is proportional to its temperature. 30°C water can hold a maximum of ~7.6mg/L while 5°C water can hold ~13mg/L (USGS, 2011). Once DO decreases below 5mg/L, aquatic life becomes stressed. DO is also influenced by the turbulence of the stream flow, as turbulent streams induce more mixing with air while stagnant streams have less DO. Nutrients also affect DO as they promote aquatic plant and algal growth.

New Zealand freshwater invertebrates can tolerate temperatures within a certain range. Richardson et al (in NZTA, 2010) found acute mortality of most fauna occurred above 25°C. An urban stream in Long Island, USA, exhibited summer temperatures 5-8°C warmer, and winter temperatures 1.5-3°C cooler than forested streams (Pluhowski, 1970, cited by Paul & Meyer, 2001). Impervious surface also resulted in summer storm runoff being 10-15°C warmer than forested streams. Modified concrete channels and the removal of riparian vegetation reduce stream shading, heating the stream in summer and cooling it in winter.

Urban streams in New Zealand are becoming increasingly valued, not only for their recreational opportunities but also their intrinsic ecological value (Elliot et al, 2004). Because of this, more effort is being put into researching the effects of urbanisation on stream catchments and refining methods of restoring them back to their natural state. Urbanisation impacts streams in numerous ways including water flow, which further negatively impacts a streams ability to support the ecological and amenity values associated with them. Restoration aims to return streams to their optimum natural condition, to support native stream life and natural processes. Restoration should focus on restoring the natural processes that create and maintain instream habitat rather than manipulating them artificially (Roni et al., 2002).

Method

Sumner Stream Physical Setting

Sumner is one of the Southern suburbs in Christchurch, 10 kilometres from the city centre. It is located in a coastal valley of the Port Hills where the catchment extends from Cave Rock to Scarborough Head and is home to around 4000 people. The Sumner and Richmond Hill Streams are the largest waterways which drain the Sumner Valley catchment, which is approximately 5.2km². Both streams are highly variable temporally and spatially as stormwater composites a large component of their flow.

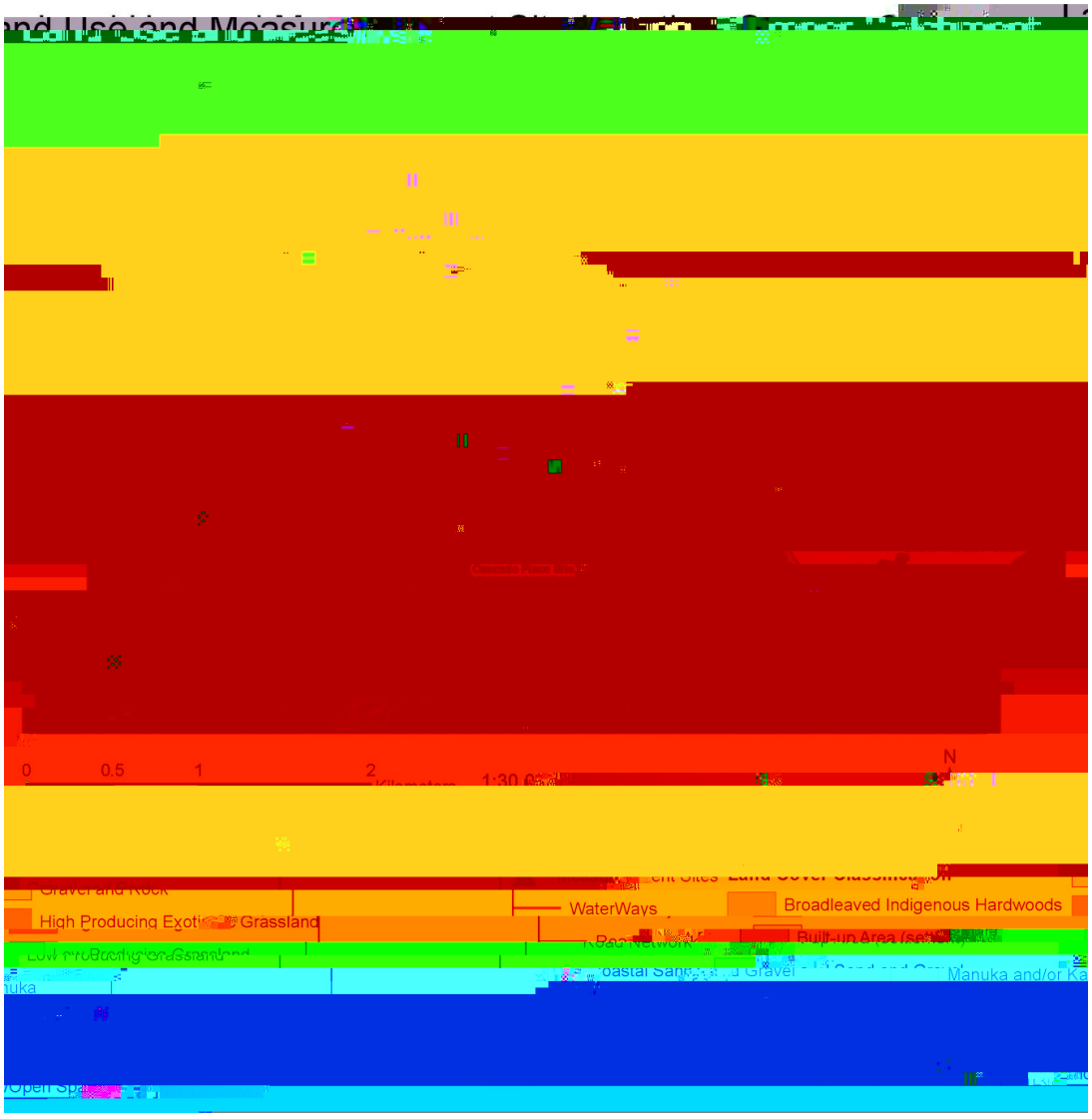


Figure 1: Sumner Catchment map indicating stream paths, land use and measurement site locations.

A number of stream sites have been identified for quantitative physical measurement and an evaluation of restoration methods. Stream flow variables including velocity, temperature, dissolved oxygen (DO), turbidity and sediment load were measured at three sites on the Sumner stream and one on the Richmond Hill Stream. DO was measured with a Eutech Cyberscan DO300 and turbidity was measured with a Eutech Turbidimeter

TN-100. Standard statistical analysis techniques were applied to the data. Data recorded from the Richmond Hill weather station in Sumner (Smith A, 2012, *pers comm,* 4 September) will be analysed in conjunction with stream flow data to examine the relationship between precipitation and stream flow. Sumner weather station data will be analysed in regards to precipitation levels prior to each measurement times and to examine past seasonal variations. At each site the Riparian Quality Index method (González del Tánago & García de Jalón, 2011) was used to characterise the surrounding riparian zone and stream banks in order to compare their human impact and degradation on a common ordinal scale. Additionally, a previous survey of the values of the Sumner community towards the streams and natural environment is examined (Osama et al., 2010). Finally, we undertook an extensive review of existing literature on urban stream restoration, stream ecology

Figure 4: Sumner Stream at Scarborough Beach: Highly modified in box culvert.

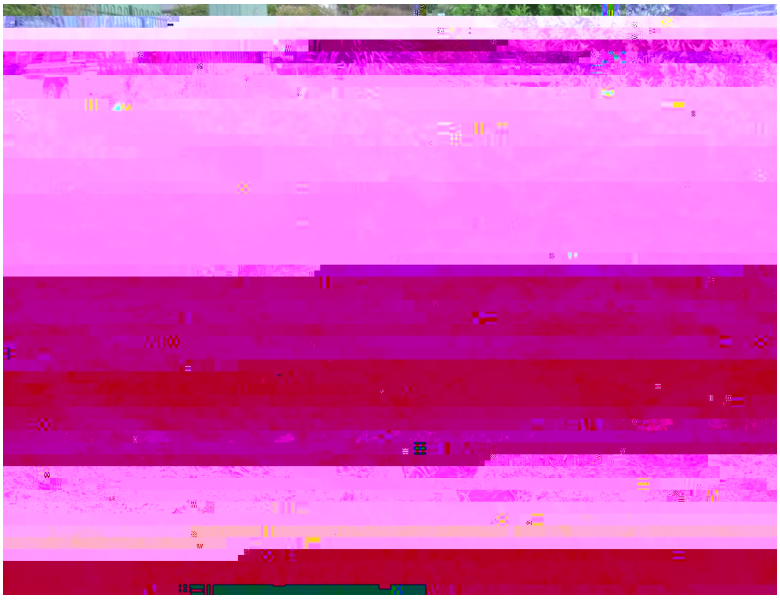


Figure 5: Richmond Hill Stream at restored site with daylighting. (Only one measurement site was

Results

Stream sampling results

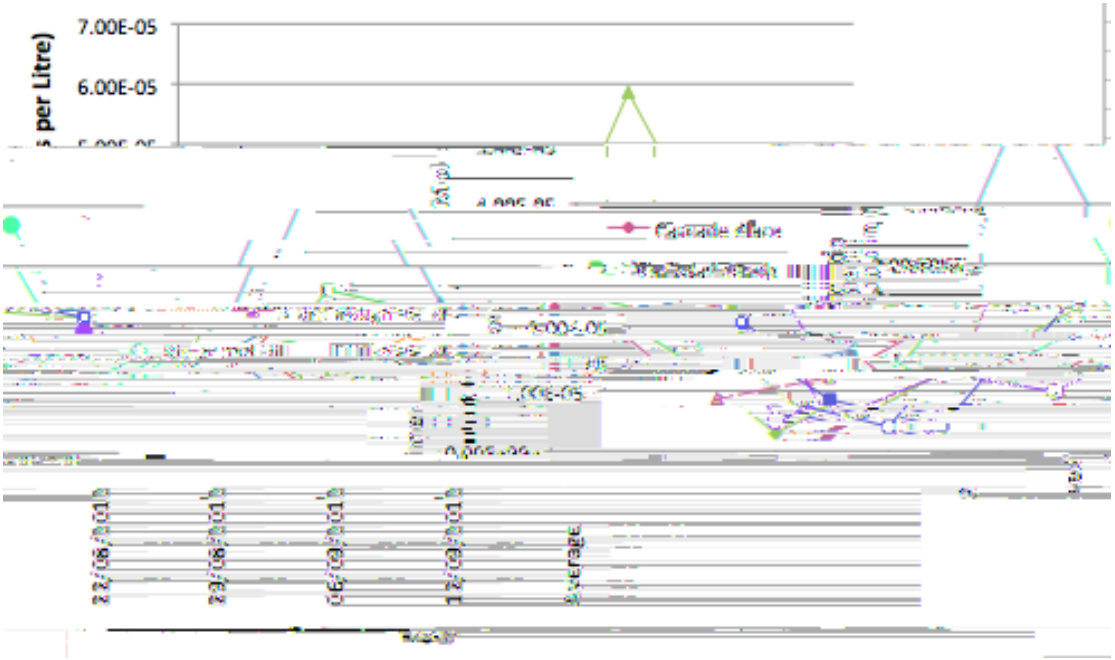
Sampling Date	Rainfall in Preceding 24

Table 1: Rainfall received 24 hr before sampling took place. (Smith, A. 2012, *pers comm 4 September)*

Table 2: Streamflow Results Descriptive Statistics

Graph 1: Average velocity measurements for each site.

Cascade Place has the highest velocity readings compared to the other locations which are all similar other than the reading for Richmond Hill on the 12th of August where it was 0.647 m/s.



Graph 2: Suspended sediment concentrations for each site.

Scarborough beach has the highest reading of 0.0000586 g/L on the 12th0 of September and Cascade Place has the lowest of 0.000002825 g/L on the 29th of August. The highest turbidity reading within the Sumner stream was 140 NTU at Cascade Place on the 12th of September. This coincided with 20.2 ml of rain the area received in the previous 24 hours increasing the runoff into the stream, this also corresponded with the increased suspended sediment concentrations on that particular day. Cascade Place had a suspended

sediment reading of 0.000023091 g/L on the 12th of September which was on average 0.0000117403 g/L greater than the other three readings taken on the 22nd and 29th of August and the 6th of September. Further downstream at the Scarborough beach site the highest suspended sediment concentrations were recorded (*Table 1*) and this site had an average water depth of 10.7 cm. Average velocities throughout the stream ranged from 0.100 at the Van Asch School to 0.669 m/s at Cascade Place. Sediment load varied spatially and temporally, and increased by ~0.0004 g/L following significant rainfall of 20ml.

Riparian Quality Index Results (González del Tánago, M., García del Jalón, D, 2011)

Richmond Hill - Score: 66

Poor (most attributes are moderately altered. Riparian systems need rehabilitation or restoration measures to reintroduce or gradually improve hydrological and ecological riparian functions. Reduce pressures and impacts as much as possible and design compensation measures to ameliorate environmental conditions)

Cascade Place and *Van Asch School* - Score: 29 and 21 respectively.

Bad (Several attributes are poorly altered. Riparian systems need rehabilitation or restoration measures to reintroduce or gradually improve hydrological and ecological riparian functions. Reduce pressures and impacts as much as possible and ameliorate the social perception of river degradation)

Scarborough Beach - Score: 9

Very Bad (Most of the attributes are badly altered. Riparian systems need new rehabilitation or remediation works, to recreate and reintroduce riparian functions. Improve environmental conditions for good potential status and ameliorate the social perception of the river degradation).

Sumner Residents Survey Results

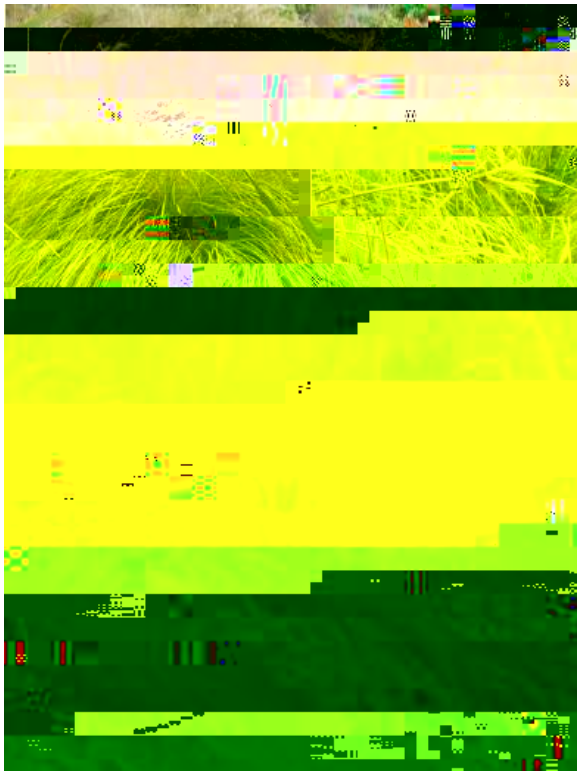
The survey of residents social perceptions of the Sumner catchment (Osama et al., 2010) received 50 out of 500 responses, and the demographics of the respondents are believed to be representative of Canterbury.

ater quality in the catchment most, followed by drainage, biodiversity, plantings and physical appearance respectively. Respondents perceived the current waterway management to be average with a bi-modal response of 5 and 7 out of 10, and ranked the level of current environmental health as above average with a mode of 8 out of 10. The perception of stormwater quality was

Discussion and Recommendations

This report aimed to examine the current physical condition of the Sumner waterways through streamflow

high flows. The stream cross-section can be divided into different zones to accommodate plants of differing tolerance to disturbance from flow, and sediment, and moisture, shade, shelter and frost. Replacing the concrete bed with cobbles and gravels is also recommended. This would provide more habitat space and reconnect the stream flow with the hyporheic zone, while also slowing water velocity. The substrate replacing the concrete bed will need to consist of larger cobbles and stones, as substrate too small (e.g. sands and silts) will be washed away during high velocity flow. Livestock in the reserve land at the head of the Sumner Valley should also be properly fenced to prevent them having access to the stream. This will help to prevent bacteria, nutrients and pathogens entering the stream from animal waste. Stage One restoration is focused on small areas of t38 T.94(i)iTJ58(O)-438 [s)-5b-3(te.)4( )cacon



Stage Two, Moderate Impact

Reshaping stream channel to include physical instream variation

Improving stormwater devices

Restoration along this section of Sumner stream is less complicated compared to areas within the township, as it is a lower density residential area. There is a wider riparian zone, therefore channel reshaping is recommended to restore natural meanders and instream features. Meanders will eventually change the distribution of bed sediments as they cause variation in water velocity across the channel. They can also lead to the eventual undercutting of banks to allow shelter under ledges. Riffles, runs and pools are three important areas of a stream that provide different conditions for different species and are therefore valuable for stream restoration at this site. Riffles are shallow, swift flowing sections with broken water surface and larger substrate due to the high energy environments (CCC, 2003). The increased turbulence created by the water tumbling over larger substrate increases the exchange of dissolved gases, nutrients and organic material between the water flow and the substrate layers, and provides good habitat for EPT taxa. Runs are the main

beneficial to the school that the stream runs through. As one side of the channel is buffered by a concrete wall, the removal of this will further add to the visual amenity and natural character the stream could provide.

Stage Two, Moderate Impact

Reshaping stream channel to include natural physical variation

Improving stormwater devices

Again, similar to Cascade Place it is recommended that meanders and natural stream features be added to the stream channel. Sumner Stream at Van Asch School is surrounded on both sides by flat grassed areas, so any reshaping of channel would have minimal impact on surrounding amenities. The channel here has a flatter profile, so it could potentially be narrowed to encourage higher water velocity, which would facilitate more gas and nutrient exchange and prevent stagnant flow. As with Cascade Place, redevelopment of stormwater drains into the stream is also an integral part of stage two for Van Asch School.

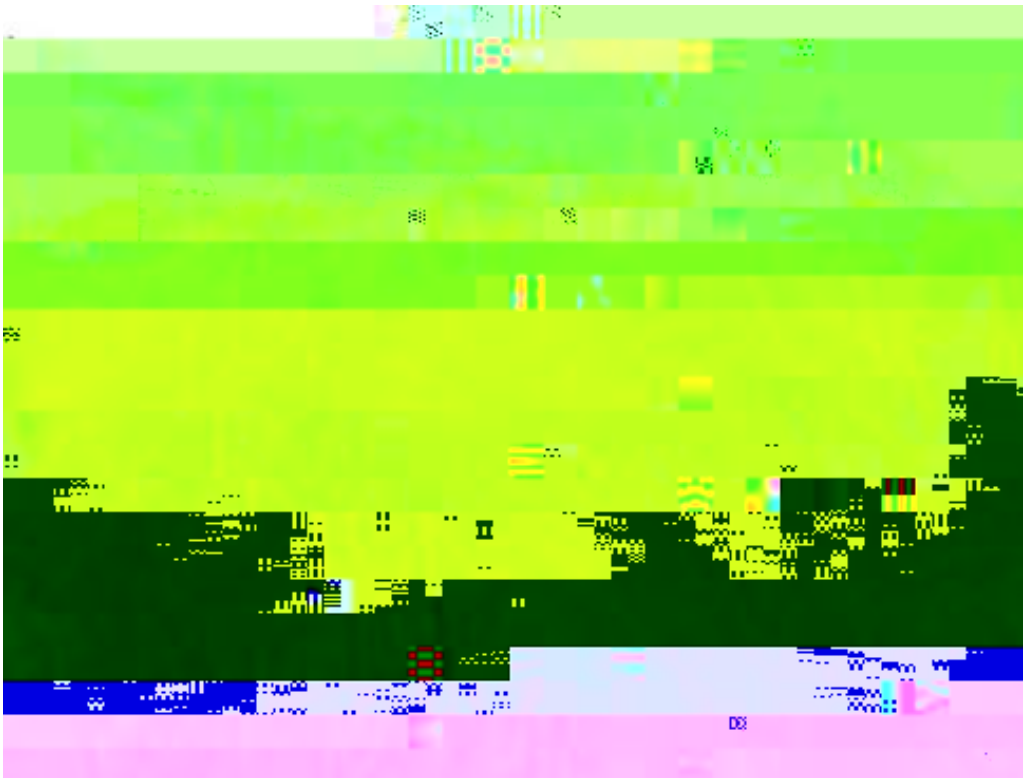


Figure 10: Example of restored stream (Radcliffe Road Drain, Christchurch)

3. Scarborough Beach Site, Sumner Stream

Stage One, Low Impact

Box culvert removed on park side
Native riparian zone, instream vegetation
Placing natural coarse substrate in the streambed

Redevelopment of the Scarborough beach site is complex due to the riparian zone being constricted, not only by the concrete culvert but by the road and toilet block located directly either side of the channel. As an initial low impact measure, it is recommended that the box culvert be removed on the park and toilet side and to create a natural sloping bank in its place. This will open the space up as a resource for the park rather than concealing it. Once again, native vegetation should be planted and natural substrate be added to the bed to increase the potential for habitat.

measures. Increasing vegetation around the stream would create more shaded areas within the stream. There is little impact that a Stage Two method would have on the Richmond Hill site, therefore Stage Three method would follow on from stage one method. This is discussed below.

5. Restoration of entire Sumner and Richmond Hill Stream lengths

Stage Three, High Impact

Stage three is the most expensive option and will have the largest impact on properties and infrastructure adjacent to the stream, however it offers the most extensive ecological, aesthetic and recreational benefits. Stormwater management devices throughout the Sumner township should be ideally re-designed to manage smaller rainfall events and promote water infiltration to maintain groundwater storage and base flows. A reduction in impervious surfaces where possible will have a significant quantifiable benefit on overall stream

precision of the data collected, these limitations are not significant in this context. It should also be noted that due to financial restrictions, recommendations from our research may not be viable courses of action. Future studies should incorporate a feasibility analysis of recommended actions. Variables should also be monitored constantly over a long-term basis at multiple sites along each stream to examine the relationship between rainfall into the catchment and resulting base flows and storm responses. This would allow for a more accurate understanding of the hydrological system and therefore a stronger basis for restoration recommendations. This was not possible for our project as only one long-term water level device was available and was found to be ineffective due to the low flow rates and water heights present in these streams.

Conclusions

This report has analysed the current condition of the Sumner Streams through quantitative measurement of physical parameters and qualitative assessment of riparian conditions. This study also examined the potential

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