

Ecological restoration priorities for the Porirua Stream and its catchment

**Paul Blaschke
Clive Anstey
Frances Forsyth**

Blaschke and Rutherford Environmental Consultants

**Report for Wellington City Council, Porirua City Council, and
Greater Wellington Regional Council**

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1 Introduction

The Porirua catchment is a low lying valley between the Wellington and Ohariu faults and the Wellington and Porirua Harbours (Figure 1). The rolling hills and gently sloping valley bottom were cleared for farming in the late 19th century. In the 1950s and 1960s large dormitory suburbs were created there to house the rapidly growing population drawn to the capital city during the post-war economic boom. During this period of tumultuous change from heavily forested land to urban development much native vegetation and soil was lost and the stream became degraded and constrained within a narrow corridor. In recent years there has been a growing trend towards conservation and restoration of the natural forest and stream systems that remain.

Community support for ecological initiatives in the Porirua Stream and its catchment¹ is growing and at least eleven groups are now actively involved with planting and other activities. Most are supported by local government and many are also associated with schools in the area. These groups are working to remove weeds and litter, plant native trees, encourage animal life and educate their neighbours. Interestingly, these groups are not all focussed on restoration issues: several of them came together and in some cases are still mainly concerned with other community development, themes such as public access or amenity, but have made a link between these issues and environmental quality. The groups have watched with pleasure as native bird populations grow as a result of increased pest animal control and they have spoken to us of their desire to see water quality improve in the Porirua catchment so that both freshwater and estuarine ecosystems can be maintained and enhanced.

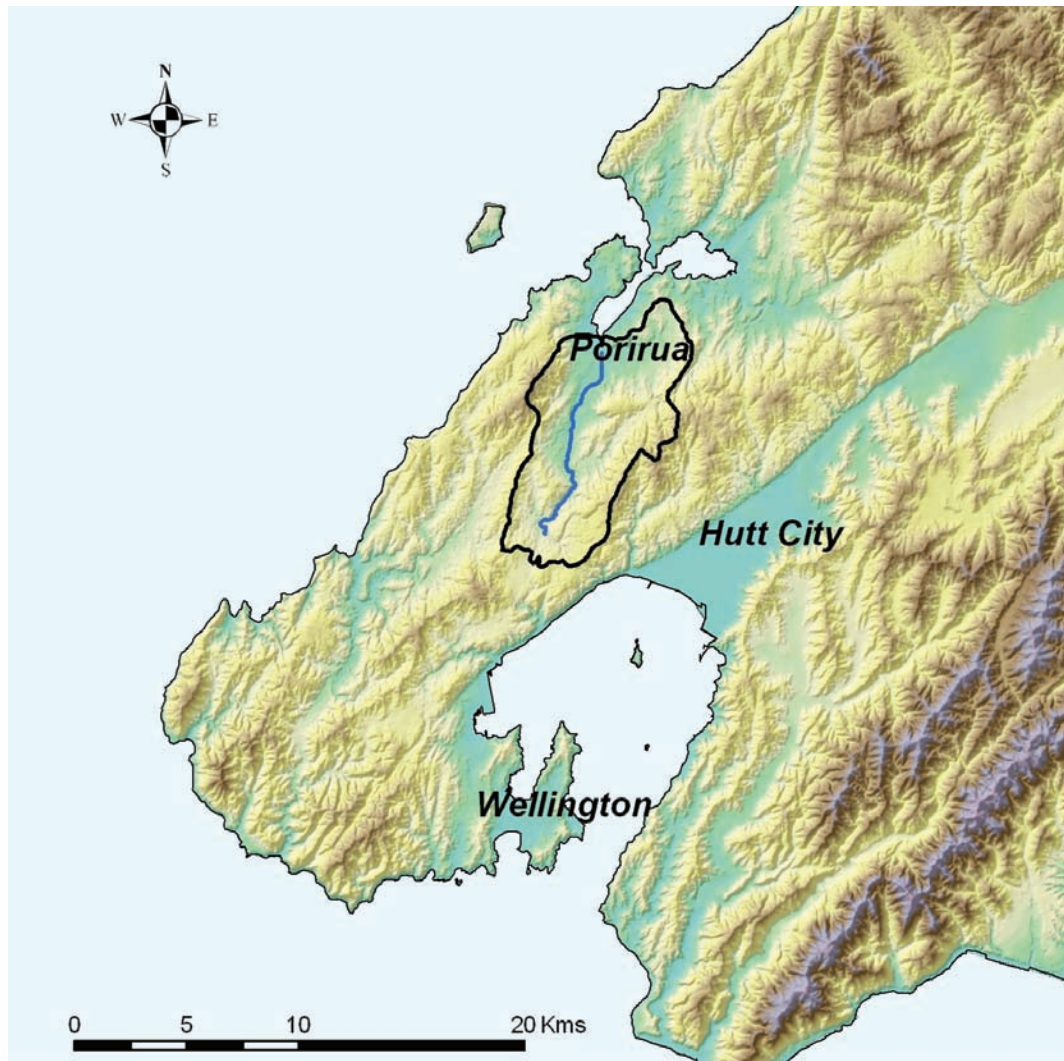
The diversity and abundance of stream life in the Wellington region is poorest in pastoral lowland and urban streams. Many of these streams are constrained by flood protection measures because development has encroached onto the natural flood plain. Access to and alongside streams is often difficult and many buildings turn their backs to them so that the streams are less visible. For these reasons a stream and the land beside it can become a no-man's-land, a haven for weeds and litter, a receiving environment for waste.

Urban streams are adversely affected by habitat loss, stormwater discharge, sewage overflow, pollutants, soil erosion and sedimentation. Urban streams are also affected by lack of shade which raises summer water temperatures and lack of cover and spawning sites for native fish. Ecosystem function can also be impaired by physical barriers, artificial stream linings and changes to stream channel morphology (meander and the occurrence of pools, riffles and runs).

Flooding is the most frequently occurring hazard event in New Zealand. Many buildings and transport routes have been constructed in low-lying areas close to Porirua Stream and this constrains the stream to a relatively narrow channel. The drainage pattern of the catchment, with a long main stem and sizeable tributaries on both sides, means that the response to rainfall is quick. A rainfall event with a return period of 100 years is likely to inundate a considerable area of Tawa, Linden and Porirua CBD. Smaller events cause streambank erosion and the reworking of streambed sediment. This is despite the fact that there are a number of flood attenuation structures in the stream.

¹ For brevity we use the phrase 'Porirua catchment' throughout this report to refer to both the Porirua Stream and its catchment, unless otherwise specified.

Figure 1: Location map of the Porirua catchment and Stream in the Wellington region.



Previous council involvement

Wellington City Council (WCC) involvement primarily stems from its Stream Protection Programme. One of the goals of this programme is to develop and implement community catchment restoration plans, and the Porirua catchment was selected as the priority catchment for its 2008-9 work. All three councils support the community restoration groups in a range of ways and to different extents.

WCC's involvement in this catchment programme builds significantly from experiences and successes of Project Kaiwharawhara where community groups and council have been working together for some years. In 2003 WCC produced a kit developed together with GWRC, the Wellington Tenth's Trust and the community groups of the Kaiwharawhara catchment (WCC, 2003). It contains practical ideas about ways community groups can help directly to further improve Kaiwharawhara Stream. The participants, who had been working to develop an overall vision for the catchment since 2001, continue to meet and discuss catchment issues.

The relationship has been beneficial for all parties but the greatest benefit has been to Kaiwharawhara catchment itself. This is because volunteer and council work, and development can be supported and directed in a manner appropriate to the catchment as a whole.

WCC's 'community greening programme' works in partnership with GWRC's Take Care programme and community groups to restore and protect the city's streams and surrounding areas. Community stream protection projects currently underway in the catchment include:

- Churton Park Stream-care group
- Glenside Stream-care group
- Friends of Willowbank Park

WCC provides support for community groups by providing advice, eco-sourced native plants, site preparation and weed control. In addition the Northern Reserves Management Plan seeks to protect the biodiversity of reserves in the northern area by protecting the natural structure and flow of streams which includes the restoration of riparian vegetation along stream sides.

Porirua City Council (PCC) involvement stems primarily from its Porirua Harbour and Catchment Management Programme, in which it is the lead agency. The Programme has a goal of “a healthy Harbour, inlet and waterways”, for which Council has set aside nearly \$2.5 million over the next five years. It has appointed a Porirua Harbour Strategy Coordinator, and funds and liaises with the Pauatahanui Inlet Community Trust and other Harbour advisory/advocacy groups. PCC is developing a walkway system for the harbour edge and is working with GWRC to identify and jointly fund research on environmental conditions in the estuary and catchment.

Citywide, PCC is reviewing or developing its stormwater action plan, a building site earthworks control bylaw, more stringent subdivision and earthworks controls, and a reserves and vegetation policy using low impact urban design principles to arrest silt and contaminant runoff. Council is also carrying out a rural review that will include minimising environmental and landscape impacts, including the development and implementation of a Pauatahanui Catchment Vegetation Framework

Greater Wellington Regional Council (GWRC) is working with PCC and WCC providing assistance to the Churton Park Care Group, Glenside Streamcare Group, Onslow College Waipahihi Project, and Friends of Maara Roa. GWRC have also been assisting schools with planting projects.

GWRC investigations and ongoing monitoring are leading to an improved understanding of Porirua Harbour and the streams that flow into it. Recent work includes: broad scale mapping and fine-scale ecological monitoring in Porirua Harbour; investigations of Porirua Harbour sediment quality, identification of whitebait spawning habitats; freshwater fish surveys; and long term water quality and biological monitoring in the Horokiri Stream, Pauatahanui Stream and Porirua Stream (two sites).

Since 2000, in partnership with PCC, GWRC has undertaken projects implementing the objectives of the *Pauatahanui Inlet Action Plan*. This has included the preparation of a broad restoration framework entitled *Vegetation Frameworks*. Implementation of *Vegetation Frameworks* since 2006 has resulted in construction of riparian fencing and planting on 3 properties, two wetland areas fenced and enhanced; and four full property farm plans had been completed. The NZ Landcare Trust is also contributing to the *Vegetation Frameworks* project.

Project objectives

Wellington City Council, Porirua City Council and Greater Wellington Regional Council engaged Blaschke and Rutherford Environmental Consultants to report on ecological issues in the Porirua Stream catchment and the priorities for ecological restoration there.

The overall purpose of this project is to facilitate management of the catchment across city council boundaries by identifying priorities and issues for all groups and organisations involved. In particular:

- To recommend objectives and research and describe priorities for ecological restoration and biodiversity protection of the Porirua catchment
- To facilitate the cross boundary management of Porirua catchment
- To begin to engage with existing community groups working in the catchment.

Specific objectives include:

- 1) To identify and provide a broad-scale ecological and landscape description of the catchment
- 2) To identify broad-scale priority areas for:
 - a) community engagement and support
 - b) riparian planting and restoration
 - c) weed control
 - d) protection mechanisms
 - e) addressing key pressures on the stream health (eg erosion, stormwater contamination, sedimentation)
 - f) restoration of fish passage.

The project covers the whole of the Porirua catchment, which comes under the jurisdiction of Porirua and Wellington City Councils. GWRC also has jurisdiction over water quality, aspects of the freshwater environment, and flood control in the catchment. The main focus of restoration recommendations in this project is on public land, but within the framework of integrated catchment management some issues are discussed with reference to both public and private land.

Method and scope

Our approach has been to firstly read background information and compile data relating to biodiversity and restoration in the catchment. We have discussed catchment management issues with council officers and community groups active in the catchment and conducted a number of site visits and a fly-over to verify information received and fill in any information gaps. We held two evening meetings with representatives of all groups, attended by councillors and staff members from all three councils². At the first meeting we introduced the project and described the catchment, the groups introduced their work and we discussed catchment restoration issues in general. At the second meeting we discussed catchment issues in more detail and the groups gave feedback on a pre-circulated set of draft conclusions and recommendations.

What follows in this report is a broad description of the catchment, including the contribution of significant vegetation and fauna to biodiversity values, and threats to the conservation of those values; discussion of issues relating to restoration, including community engagement and support; a framework to guide restoration action; a priority listing of restoration sites and habitat types; a list of likely suitable species for replanting; and recommendations about priorities for restoration and for the management of other issues that affect biodiversity in the catchment.

This report is not a full catchment management plan and only addresses some aspects of management. But we have interpreted 'restoration' widely, and have not hesitated to make linkages between restoration and other catchment management issues.

People in the Porirua catchment

Iwi

There are two iwi groups active in the Porirua catchment, both of whom we consulted with:

Ngati Toa Rangatira iwi (usually known as Ngāti Toa) are based at Takapuwahia marae north of Porirua town centre and include the Porirua catchment in their rohe. They are represented on several of Porirua City's resource groups.

Te Atiawa iwi are based around Te Whanganui-a-Tara (Wellington Harbour). They have historical connections with the southern parts of the Porirua catchment, especially the Takapu sub-catchment where they have had gardening areas in the past, and in the Belmont catchment which was the link between the Porirua and Wellington areas.

² The meetings were held on 18 August and 24 November 2008, both at the Tawa Community Centre.

Both iwi are active in various resource management activities in their rohe and are concerned about environmental issues such as pollution and water quality.

Restoration and community group involvement

For this report we consulted with a range of community and environmental groups. These groups are listed in Table 1. Summaries of the notes made from discussions with each group are given in Appendix 1.

Table 1: Community restoration groups in Porirua catchment

Community group name	Sub-catchment/s where group is working
Friends of Maara Roa	Kenepuru (Cannons Creek)
Friends of Tawa Bush	Linden, Takapu, Tawa & the lower channel of Porirua Stream
Horokiwi Reserve Group	Belmont
Seton Nossiter Park working group	Belmont
Woodridge Planters	Belmont
Churton Park Revegetation Group (including Eastcott Reserve)	Churton Park
Glenside Stream Care Group	Churton Park (Stebbing's Valley) & the upper channel of Porirua Stream
Friends of Willowbank Park	Lower channel of Porirua Stream
Tawa Porirua stream walkway/cycleway group	Lower channel of Porirua Stream
Keep Porirua Beautiful	Kenepuru, Linden, Mitchell & the lower channel of Porirua Stream
Pauatahanui Inlet Community Trust	Pauatahanui Inlet and catchments

The groups listed in Table 1 are involved in a range of activities including: clearing weeds and planting, pest animal control, clearing litter, supplying trees, supporting other groups, and the design and implementation of projects. Most groups are concerned about issues affecting biodiversity, amenity and recreation in the catchment (including the local government regulatory framework for managing these issues – see Appendix 2 for further details) and have lobbied Local Government in this regard.

These groups gave the impression of an increasingly aware community that is taking on a more active role in restoration in the catchment. On occasions some of the groups have expressed strong concerns with council performance, both in terms of council operations and in scrutinising and monitoring the activities of private and public entities in the catchment. They are also concerned about inadequate funding for environmental management, and inadequate protection in district plans. Despite these concerns we gathered that all groups wished to continue to work constructively with councils to protect and enhance the environment and their communities' well-being.

The people involved with the groups enjoyed what they were doing and were generally satisfied with the level of support they received. Their issue was to broaden engagement within their community and they wanted help to do this. They were also interested in more detailed planting advice and information to justify what they are doing to their neighbours and community (and potential sponsors). We gathered that they would benefit from a clarification of the roles and relationships of the various councils and their departments.

Acknowledgements

We gratefully acknowledge the significant assistance of many people in the preparation of this report. Most particularly we thank Amber Bill (WCC), Keith Calder (PCC) and Murray McLea (GWRC), who were our first contact points throughout the project and who gave freely of their time and experience to assist us in any way possible. We also thank a large number of council staff who made comments, provided information and attended meetings, in particular Marc Slade (WCC), Tina Mullins and Matt Trlin (PCC), and Juliet Milne, Nick Page, Alton Perrie and Summer Warr (GWRC).

We also thank PCC, WCC and GWRC councillors who took an interest and came to meetings, Graeme Hastilow (Ngati Toa), Liz Mellish (Wellington Tenth Trust), and Rodney Callender for their time in meeting with us. Becky Bliss (Bliss Design) skilfully completed layout and design at short notice. Finally, but by no means least, we thank all those dedicated members of Porirua catchment restoration and other community groups with whom we met.

2 Analysis of Porirua catchment and Stream

Porirua catchment covers roughly 56 km² and is oval in shape with rolling to steep hills and a minor floodplain (Figure 1). The steeper hills are farmed or forested and much of the rest of the catchment is residential housing, light industry, business and retail. It lies within the boundaries of two cities, Wellington and Porirua, with many residents travelling south each day to work in Wellington. State Highway One and the North Island Main Trunk Railway follow Porirua Stream for much of its length.

In the following sections we describe the catchment and stream environment and discuss issues involved with ecological management and restoration. Issues are dealt with under the sections of physical setting, terrestrial ecology and biodiversity, and Porirua Stream. The issues are further illustrated by the three case studies in Appendix 3.

Physical setting

Landscape

Our managed landscapes are an expression of our relationship with the land and of our identity. The extent to which development is woven into the natural patterns of the land is an expression of what we value. The way we see and experience our landscapes is a reflection of the choices we make. An awareness of what makes or could make our landscapes and the places where we live attractive, helps ensure that ongoing development and change better reflects our needs.

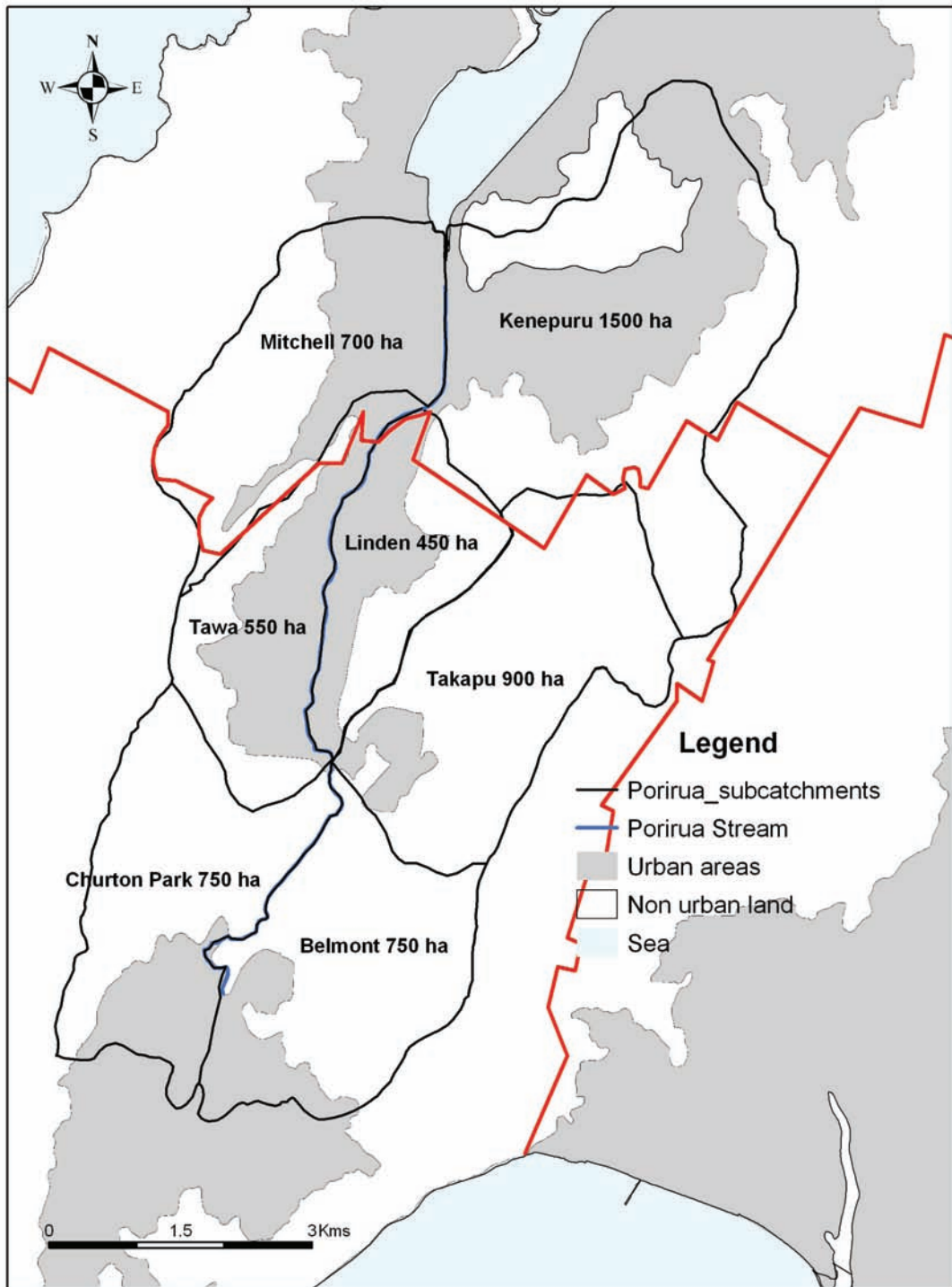
The landscapes of Wellington and Porirua cities generally, and the Porirua catchment in particular, are special and unique. This is partly because the difficult topography places limits on what can be developed, but also because far-sighted people have recognised the value of public open space. Porirua Harbour, Wellington's Town Belt, Outer Green Belt and reserve areas are defining features in the lives of people in the two cities. They provide coherent threads of connected open space through the city centres and along the western ridgeline.

There are increasing demands for outdoor recreation and a desire to enhance the cities' indigenous flora and fauna. The emphasis on ecological as well as recreational linkages has resulted in a strengthening of the natural patterns in the cities' landscapes.

In the Porirua catchment development has been less constrained by topography than in the older, southern parts of Wellington. Much of the catchment is relatively gentle in slope and has until recently been farmed: some parts are still farmed. Although the hill landforms are a dominant feature of the landscape, many natural gullies and streams have been lost to development. Clear-felling, burning and subsequent grazing have removed most of the native forest while streams have vanished into pipes and roads have cut across waterways

Almost all of the indigenous vegetation now in the catchment is recent and naturally regenerated. Indigenous vegetation does provide a continuous cover across the western faces above Tawa but for the remainder of the catchment is fragmented and restricted to reserves and steeper areas on private land. Pine plantations, a significant feature in the landscape, tend to give emphasis to culturally imposed patterns of development.

Figure 2: Porirua Stream sub-catchments.



Urban areas are shaded and the Wellington-Porirua city boundary is shown in red.

Elements in the landscape

Ridges and hilltops: Almost all ridges, hilltops, and spurs can be visually dominant and significant, even at a local scale. The ridges and hilltops along the western side of the catchment are for the most part in grazed open pasture but there are pine plantations above Tawa.

Waterways: The Porirua Stream is a defining feature on the western side of the motorway and railway corridor. On the eastern side the streams' tributaries have sculpted the landform but most of the once prolific supporting forest has gone.

Transport corridor: The road and rail corridor (State Highway 1 and the North Island Main Trunk) cuts a broad swathe across the landscape, not always in a sympathetic way. It is a central feature in the landscape, dividing the eastern from the western side, and cutting across the streams draining from the eastern slopes into the Porirua Basin.

Planted vegetation associated with the road corridor has a very significant positive visual influence for users of the motorway, adding diversity and interest, but this influence is less positive for rail passengers on the weed-infested rail track margin. Similarly, for those with views of the motorway corridor from their houses, the vegetation is critical in softening the visual impacts of the highway and the constant sound of vehicles.

Patterns and scale of housing development: The patterns of development and its density are defined by, and therefore reflect, the landform. In older suburbs houses are less dominating and the 'space left over' has been colonised by native vegetation or planted with now mature trees. There is a sense of integration - development accommodates rather than dominates nature. More recent development has been less generous and accommodating in this regard, even allowing for the development of vegetation over time. Road development cuts deep scars across the faces of steeper hills and extensive areas of fill create unnatural flat areas. Smaller and flatter sections, larger dwellings and expansive areas of hard surfacing often leave little space for people to plant trees and shrubs or for nature to simply re-invade.

Geology, geomorphology and soils

The Porirua catchment lies between the active Ohariu and Wellington faults on hardened grey sandstone-mudstone sequences generally known as greywacke (Begg & Johnston, 2000). This rock is overlain in places with alluvial gravel and loess.

The principal soils (Bruce 2000) are all derived from this base material. The main soil on the easier slopes is classified in the Judgeford soil series³. These soils have developed in deep loess and are among the most versatile in the Wellington region where they are used for intensive farming as well as being widely covered by houses and urban infrastructure. Soils on steeper slopes are known as Korokoro Hill soils, occurring on greywacke colluvium on moderately steep slopes. They are generally farmed or covered by suburban housing. Other soil series occurring in the catchment include: Makara Steepland (on the steepest slopes on either side of the catchment), Waiwhetu (poorly-drained alluvial soils) and Belmont (similar to Judgeford soils but on higher slopes).

As is typical in the Wellington region the greywacke basement rock is uplifted and tilted between the active faults. Most of the very steep slopes (>35°) in the catchment are below the highest peaks on the western and eastern edges of the catchment. Because of the generally gentle slopes and the moderately to well drained soils in other parts of the catchment, erosion risk is generally low. The silt and clay loam soil, however, is easily mobilised by wind and rain once its vegetation cover is removed, making its way into streams and damaging freshwater and marine ecosystems.

³ A soil series is a grouping of soils with a similar soil profile occurring in an environment with similar characteristics.

Climate and hydrology

The catchment stretches from Johnsonville, north to the Onepoto arm of Porirua Harbour. The main stem of the stream begins high in the catchment at Glenside and flows 11 km to the harbour. The surrounding hills average 300m in height rising to over 450m at Colonial Knob in the west and Belmont Trig to the east.

The Porirua catchment has a fault-defined drainage pattern typical of the Wellington region. It has a parallel drainage pattern with a north-flowing main stem but many south-flowing tributaries. The streams are short and steep and the soils are well drained so the system rises quickly to flood peak. The main stem of the stream reaches almost the length of the catchment and there is a narrow flood plain on roughly half of the stream length.

Climate data is obtained by comparing data from Karori, Kelburn and Belmont, as no official records are kept for Porirua catchment. A flow gauge in the main channel records stream flow automatically and this data is combined with rainfall and catchment permeability data plus topography to predict flooding scenarios.

The climate is dominated by northerly winds. These bring rain in the cooler months but exacerbate dry spells in the summer and autumn. The mean annual rainfall varies across the catchment from 1000-1200mm in the west to 1200-1400mm in the east. Sunshine hours are correspondingly higher in the west than the east due to cloud that forms over Belmont Regional Park under northwesterly conditions. The moist northwesterly airflow cools and condenses to form clouds as it rises to pass over the hills (Goulter, 1984).

There are seven main sub-catchments (Figure 2): Kenepuru, Linden, Takapu, Belmont to the east, Churton Park/Stebbing's, Tawa and Mitchell to the west. Several of these sub-catchments have little vegetation cover other than pasture grass or residential gardens. There is little natural flood retention within the catchment and any increase in impermeable surfaces or constriction of the stream channel exacerbates the natural flooding potential of the system.

Over the years there have been extensive channel modifications, not all of which were helpful from a flood protection perspective. The stream has been pushed around by railway, roads and other developments and this is why there are some unnatural bank slopes. It is because of this history of "pushing around" that we have some of today's most pressing catchment issues.

GWRC has made a commitment to reduce flooding hazard in the region and implemented a capital works programme to this end. Flood retention structures and stream bank protection have been installed in the Porirua catchment but further work is not an immediate GWRC priority. However, GWRC staff will be updating their understanding of climate change impacts and reviewing the degree of risk to people and property (J Flannagan, GWRC, pers. comm., November 2008).

Terrestrial ecology and biodiversity

Vegetation and land use

Prior to the arrival of Europeans in the mid 1800s there would have been a variety of vegetation types in the catchment ranging from swamp forest on the floodplain to broadleaf podocarp forest with a tawa-kohekohe canopy on the hills. In an account from 1851 of the neighbouring Ohariu Valley that valley was described as being:

So thickly wooded as far as the eye can reach that it has the appearance of an undulating meadow, the density and uniformity of the treetops, which at intervals are dotted with the crimson Christmas flowers or rata blossoms, heightening the illusion. (Blake, 2002)

Little remains of Wellington's old-growth lowland forest except small remnants. Of note in Porirua catchment is Porirua Scenic Reserve (and adjoining areas) where valuable timber species such as kahikatea, rimu and matai can still be found. Most other remnants contain tawa, often associated with rewarewa, kohekohe, hinau or occasional podocarp trees such as matai or totara. Most remnants are smaller than 2 hectares, with the notable exceptions of Porirua Scenic

Reserve, Colonial Knob Scenic Reserve, Redwood Bush and a few larger patches in Belmont Regional Park. However, there are a number of larger areas (more than 20 ha) of regenerating native scrub bush, mahoe being most common, in some cases associated with small remnants of old forest. Appendix 4 lists the areas for which we are aware of vegetation species lists.

The current land cover (Figure 3 and Table 2) is dominated by pasture and urban areas. Non-urbanised areas other than pasture comprise regenerating forest and scrub (both native and introduced), pine plantations, native forest, and minor disturbed areas such as quarries and landfills. Vegetation and land use differs significantly between sub-catchments. The pattern of public reserves in the catchment can be seen in Fig. 6.

Figure 3: Vegetation and land use in Porirua catchment.

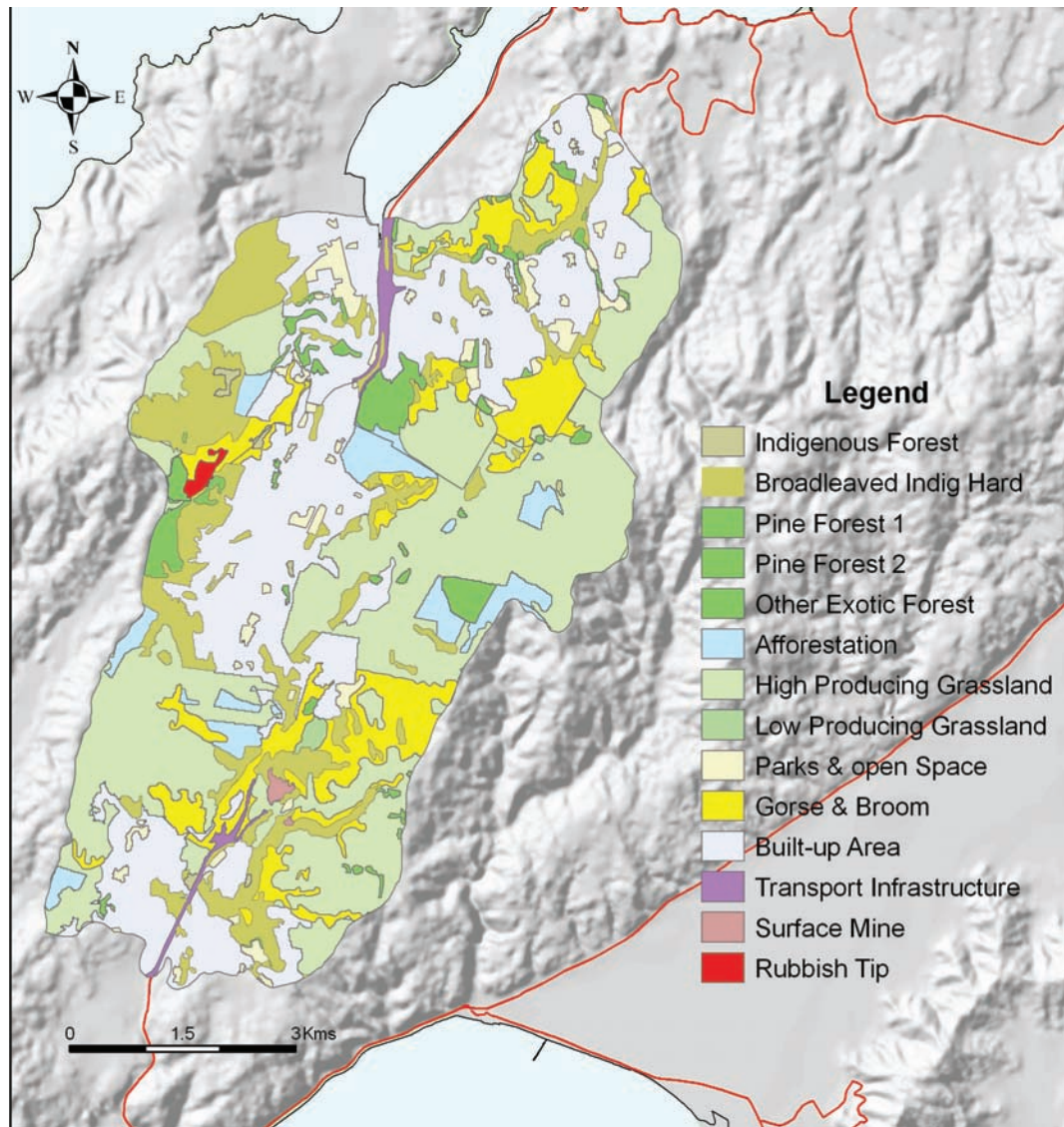


Table 2: Vegetation and land use in Porirua catchment

Vegetation/land use category	Hectares	Percent
Grassland	1907	34
Built-up area	1573	28
Native forest (including regenerating bush)	738	13
Gorse and broom	618	11
Exotic forest including recent afforestation	449	8
Park and Open Space	178	3
Transport infrastructure	51	<1
Landfill and mines	24	<1

Birds

With the introduction of predator control to the unfenced forest reserves of Wellington over the last ten years there has been an increase both in numbers and diversity of native birds seen and heard (Miskelly & others, 2005; Foude 2007). Birds that had been locally extinct moved into the Wellington Peninsula area from Kapiti Island, the Akatarawa Ranges and Rimutaka and Tararua Forest Parks. At the same time these species were also re-introduced at Karori Wildlife Sanctuary and Matiu/Somes Island. Kaka, kakariki, whitehead, tomtit and bellbird have all been observed in the Porirua catchment as well as the more common silvereye, fantail, grey warbler, tui, kereru and kingfisher.

Bush in the catchment where predator control is being carried out include: Porirua Scenic Reserve, Colonial Knob Scenic Reserve, Spicer Block, Redwood Bush, Wilf Mexted Scenic Reserve, Woodburn Drive, Porirua Park, and Cannon's Creek. Predators being targeted include possums and rats, and some stoats and cats (Moylean & Hudson, 2007). Predator control is generally carried out by GWRC, generally in a cost-sharing partnership with other agencies. Wellington City is controlling goats in Redwood Bush.

The small size of many remnants of native vegetation in the catchment does not necessarily detract from their significance as bird habitat. Lowland forest is rare in the Wellington region and the retention of primary forest species is essential to the long term recovery of native forest in the catchment. Moylean and Hudson (2007) showed that bird abundance correlates with the amount of 'woody habitat' available rather than the area of a reserve. As bush habitat grows in area, stature and diversity it will have a greater carrying capacity due to increased food availability and quality. Exotic plantation forest can also have values as bird habitat.

Pest plants and animals

There is currently a lot of pest animal control being carried out in the catchment, both by GWRC and by community groups with funding from GWRC. This is because there are areas such as Porirua Scenic Reserve that are classified as Key Native Ecosystems (KNEs). Such sites have populations of rare and threatened plants or animals, or ecosystems that need protection. Animals being targeted include possums (and rats as a by-catch), cats and mustelids (stoats, ferrets and weasels). Rabbits and hares are a problem in some areas; however control is difficult because of the urbanised nature of the catchment.

Pest plants are a major problem in many reserves and especially along streams and the rail corridor and motorway. The most serious pest plant from a restoration point of view is blackberry. There are some sites where this is compromising both flood control and ecological values (see Appendix 3, case study 1). Nonetheless, there are some sites with extensive blackberry, for example Lakewood Reserve in Churton Park, where removal of the blackberry would cost more than the ecological gains are worth. Priority should be given to areas with high connectivity potential or where weed removal will mean an end to machinery in the stream.

For further information on weeds and animal pests in the catchment see the reports from community groups in Appendix 1.

Significant natural areas

Surveys of natural areas have been carried out in both Wellington and Porirua cities. In Wellington a survey of surviving traces of the primary (old-growth) forest was undertaken in the late 1990s (Park 1999⁴). All discernable forest remnants were identified and their main species noted. They were categorised as either “primary forest” or “secondary forest with primary elements present”, based on the presence of “marker species” regarded as characteristic of primary forest, including kohekohe, titoki, tawa, pukatea and hinau. In Porirua City, all types of indigenous vegetation (ecological sites) were recorded and a wider range of information gathered, and a ranking of ecological significance provided (Boffa Miskell 2001).

There were 101 remnants identified in the catchment within Wellington City, ranging in size from less than 0.1 ha to 123 ha, with an average size of just under 12 ha. Most forest remnants are smaller than 5 ha. Most of these small remnants are on farmland and are dominated by tawa. Beyond the division into primary and secondary, there is no ranking of significance. The largest remnant was Redwood Bush Reserve and adjacent private land.

By contrast, there were far fewer (14) recognised ecological sites in Porirua City, but they were more varied, and far larger. The average size was more than 45 ha, with several very large forest areas including Porirua Scenic Reserve and the adjacent Pikarere Bush. At 305 ha this is by far the largest forest area in Porirua City⁵. Forest ecological sites are generally dominated by tawa as in Wellington City but there are more sites where kohekohe is equally prominent, and several with prominent kahikatea. The whole range of significance ranks were identified in the Porirua catchment sites, from rank 1 (of highest ecological significance, and rare or scarce in Porirua City) to rank 6 (not ecologically significant, but may have amenity or other values). Threats to and condition of the sites were recorded and it is noteworthy that most sites were threatened by weeds.

Porirua Stream

Porirua Stream is one of the largest and most important remaining streams in the Wellington urban area. After the Hutt River, it has the largest flow of rivers or streams flowing through large urban centres. As is described throughout this report, it has many remaining natural values. Porirua Stream is listed in Appendices to the Regional Freshwater Plan and the proposed Regional Policy Statement as having two criteria that identify rivers and lakes with significant indigenous ecosystems (habitat for threatened indigenous fish species and habitat for six or more indigenous fish species).

Freshwater fish

Fish sampling in the catchment has been sporadic and has been carried out mainly in the lower reaches of Porirua and Kenepuru streams. In addition to NZ Freshwater Fish database records we have some recent night fishing records of our own for a number of sub-catchments, which are shown in Table 3. Porirua Stream is home to two threatened species of native fish (longfin eel and giant kokopu, listed as being in gradual decline in the NZ Threat Classification Lists (Hitchmough & others, 2005)) plus seven other species of native fish and brown trout. Most of these are migratory and need to spend part of their lifecycle in the sea. There are a number of pressures on the Porirua Stream and its tributaries that affect the size and health of native fish populations.

The most abundant fish in the lower reaches is inanga, a major component of the whitebait fishery. These can be seen in shoals in the lower stream in the migration season and are still harvested though there are few regular fishers and their catch is thought to have decreased greatly in the last 20 years (K Calder, PCC, pers. comm. April 2009). Because the Porirua

⁴ Park's survey was unpublished but is now being updated.

⁵ Not all this forest area lies within the Porirua catchment but the average size of ecological sites is still more than 30ha even if the area outside the catchment is excluded.

Table 3: Fish presence in the Porirua catchment since 1984, by sub-catchment. Combined data from NZFFDB, Boffa Miskell (2004a,b), Kingett Mitchell (2005a), NIWA (2001), Summer Warr (GWRC, pers. comm. April 2009 and Blaschke and Rutherford night fishing records (2009, unpublished).

Fish species	Porirua Stream	Kenepuru Cannons Creek	Takapu	Belmont	Churton Park Stebbings Valley	Mitchell
Inanga (<i>Galaxias maculatus</i>)	•	•				
Giant kokopu (<i>G. argenteus</i>)	•	•			•	
Banded kokopu (<i>G. fasciatus</i>)		•	•		•	•
Koaro (<i>G. brevipinnis</i>)			•	•		
Redfin bully (<i>Gobiomorphus huttoni</i>)	•	•				
Upland bully (<i>G. breviceps</i>)			•			
Common bully (<i>G. cotidianus</i>)		•	•	•	•	
Shortfin eel (<i>Anguilla australis</i>)	•	•	•	•	•	
Longfin eel (<i>A. dieffenbachii</i>)	•	•	•		•	
Brown trout (<i>Salmo trutta</i>)	•			•	•	

Stream channel has been modified by the addition of concrete walls and rock linings there is no longer any habitat suitable for inanga spawning there. All inanga spawning takes place in the lower Kenepuru Stream between the motorway and the railway line (Taylor & Kelly, 2001).

Banded kokopu are found in some tributaries and throughout the main stem; however in some populations (Churton Park) only juveniles are present. This indicates that conditions have not been suitable to maintain adult populations. Adverse conditions for this hardy species include high water temperatures (>20°C), high levels of suspended sediment and pollution events. Banded kokopu are particularly sensitive to suspended sediment which not only prevents them from finding their prey but can also cause a reduction in the density and diversity of prey (Richardson & Taylor, 2002; Rowe and others, 2002; Rowe & Dean, 1998). It is fortunate that tributaries are being repopulated with migratory juveniles and some attention to water quality could see breeding adult populations re-established.

Other freshwater fish in the catchment include giant kokopu, koaro, redfin bully, common bully, longfin eel and shortfin eel. Giant kokopu and longfin eel are listed as being in gradual decline, in the 2005 NZ Threat Classification Lists, although data is poor. Recent spotlighting surveys in the catchment have not identified any longfin eels.

There are a number of structures (weirs, perched culverts etc) in the streambed of the Porirua Stream or tributaries that would present a migration barrier to most native fish (commonly called “fish barriers”). Some of these structures form part of vital flood control in the catchment but others appear to be redundant, without current purpose.

Water quality

Water quality of Porirua Stream is tested at two locations (Glenside and Wall Park) monthly as part of GWRC’s Rivers State of the Environment water quality monitoring programme. The most recent annual freshwater quality reports (Perrie 2007a and Perrie 2008) classify water quality in Porirua Stream as “poor” at both sites. This is primarily a result of elevated faecal bacteria, dissolved nutrient concentrations and poor water clarity. Aquatic ecosystem health, as measured through biotic indices such as the Macroinvertebrate Community Index (MCI)⁶, was classified as “fair” in both 2006/07 and 2007/08.

Contamination of freshwater by microbial organisms such as faecal bacteria is a significant contributor to poor water quality. Despite a significant decreasing trend in faecal coliform bacteria counts being reported by Milne & Perrie (2005) for the years 1997 to 2003, faecal contamination remains high in Porirua Stream. The elevated faecal bacteria results, coupled with elevated dissolved nitrogen concentrations, indicate that there may be significant sewage/stormwater cross connection issues in the catchment. Perrie (2007b) suggests that water clarity has also deteriorated at both Porirua Stream monitoring sites since 2003. This should be investigated further; decline in water clarity may possibly be related to increased runoff associated with land development.

Sediment is a physical rather than a chemical pollutant, but is in fact one of the main pollutants of Porirua Stream. Its effects on some fish species have already been mentioned. It adversely affects waterways in a number of other ways, including direct smothering of aquatic habitat by the build-up of sediment in the stream bed, causing changes to community structure; reduction of habitat quality and diversity due to deposition on the stream bed; disruption of migration and smothering of eggs, and disruption of water quality for human use and recreation.

Soil and sediment discharge to water occurs when stream banks are eroded, when there are slips or other mass movement erosion events in the catchment, or when there is overland flow from exposed soils or earthworks. It is estimated that a typical hilly subdivision site in the Wellington region, in the first few years after being cleared of vegetation, could lose up to one thousand tonnes of soil per hectare per year (GWRC, 2006).

⁶ The Macroinvertebrate Community Index (MCI) is a measure commonly used to reflect the degree to which a freshwater community is impacted by pollution, as shown in the composition of its macroinvertebrate species.

Other less commonly monitored aspects of water quality, such as stormwater-derived toxicants like heavy metals, may be partly responsible for the generally low macroinvertebrate scores in the Porirua Stream main stem (J Milne, GWRC, pers. comm. April 2009). Dissolved heavy metals are now being monitored monthly at both sites in Porirua Stream and results to date confirm that copper and zinc are regularly detected. Monitoring and investigations by GWRC have also shown the accumulation of stormwater-derived (and rural-derived) contaminants in streambed sediments. For example, Milne & Watts (2008) reported elevated concentrations of one or more of polycyclic aromatic hydrocarbons (PAHs), DDT and Lindane in the sediments from the Porirua Stream catchment. Similarly, a study undertaken in 2001 by Montgomery Watson (In Kingett Mitchell, 2005b) showed ISQG-low guidelines⁷ for DDT and its breakdown products were exceeded at all sites on the Porirua Stream, with levels greatest in the Takapu Stream sediments.

Poor water quality in the Porirua Stream catchment has flow-on effects for aquatic and marine biodiversity, as discussed below. While existing concentrations at GWRC's long-term intertidal and subtidal monitoring sites have not yet been linked with adverse effects on aquatic life, Botherway & Gardner (2002) showed that heavy metals such as zinc and lead had a negative effect on the ecology of the intertidal soft shore community adjacent to the Semple Street stormwater drain.

There are a number of closed landfills (WCC and private) in the catchment and one owned by PCC that is still operating. One closed private landfill in the Belmont Stream headwaters (known as "Cottles") is known to contain a number of waterways pollutants and was a poorly managed site. No landfills in the catchment are considered to be significant pollution sources at present, but this judgement is based in little information, while monitoring does indicate that there are unexplained sources of pollution in some catchment headwaters areas (N Conland, GWRC, pers. comm., Nov 2008). Waterways below closed landfills tend only to be monitored if GWRC Pollution Control are called out in response to reports of perceived leachate coming from a site (P Sorenson, GWRC, pers. comm., May 2009).

Water quality cannot be managed without attention to stormwater management. In 2004 an ecological assessment of Stebbings Stream in Churton Park (Boffa Miskell 2004a,c) showed that the ecological condition of the Stebbings Stream was on a cusp and that without appropriate intervention the ecological condition of the stream would likely tip toward dramatic decline. More recent monitoring shows that the condition of Stebbings Stream and the Porirua Stream system as a whole continues to decline. The report recommended riparian buffers and appropriate stormwater treatment as part of an integrated water-sensitive urban design process, if this decline is to be halted.

The relationship between Porirua Stream and Harbour

Porirua Stream enters the southern end of the Onepoto Arm of Porirua Harbour, and is the major freshwater input to the Onepoto Arm. Monitoring and investigations by GWRC (e.g., Milne & Watts 2008, Perrie 2008) indicate that, along with sediment, the stream carries significant nutrient, toxicant and pathogen loads to the Onepoto Arm, especially after high rainfall events. Elevated concentrations of zinc and copper are present in the surface sediments in the southern end of the Onepoto Arm (e.g., Robertson & Stevens 2008, Stephenson & Mills 2006, Sorenson & Milne in press).

Persistent stormwater contaminant inputs are a major concern for the Porirua Harbour and Catchment Management Programme. Runoff from the stream deposits mainly fine-grained sediments to the estuary that smother some of the harbour habitat. The stream has other biological effects, reducing salinity and supplying dissolved nutrients such as nitrate, phosphate and silicate for phytoplankton growth (Morton, 2004). Productivity is limited, however, when suspended particles prevent the penetration of sunlight through the water and also when pollutants enter the system. Eutrophication occurs with high nutrient inputs, when the death and decay of organisms deplete the oxygen to the extent that biological life ceases. The species richness on and near the floor at the southern end of the Onepoto Arm is poorer than elsewhere

⁷ Interim Sediment Quality Guidelines (ISQG) are contained within the Australian & NZ Guidelines for Fresh and Marine Water Quality (ANZECC 2000).

in the Harbour (Robertson & Stevens 2008). This is a reflection of both pollutant input and the smothering effects of fine sediments.

Productivity at the phytoplankton level has a direct effect on primary and secondary consumers from cockles and shrimp to commercial fish species. An earlier report (Jones & Hadfield 1985) showed that Onepoto Arm and Pauatahanui Inlet are hatchery and nursery areas for juvenile elephant fish, rig, sand flounder and kahawai. The Onepoto Arm also supports a wide range of benthic (bottom dwelling) organisms including cockles and other bivalves, crustaceans (crabs, sandhoppers etc), slugs, snails and worms (Botherway & Gardner 2002; Robertson & Stevens 2008; Stephenson & Mills 2006).

Unlike the open sea coast, estuarine waters are usually calm and may lack the energy to remove sediment supplied by the stream and to oxygenate the water. The volume of seawater entering and discharging from the harbour with each tide (the tidal prism) is likely to be greater than the stream discharge so that tides usually dominate the hydrology of the harbour (Hume 2003). Thus sediments accumulate in the upper and middle reaches of the harbour and can develop thick sequences.

Between 1996 and 2000 Porirua Stream deposited an average of 520m³ of gravel a year in the City Centre Reach of the stream just above the estuary entrance (WRC 2001). No other quantification of sediment amounts is available for the stream but it would seem that despite gravel removal by GWRC's Flood Protection team, considerable volumes of sediment are reaching the harbour. Current bathymetric studies are clarifying the amount and origin of these sediments.

Sediment deposition, sea level rise and fall and tectonic movement (earthquakes) have all played a part in the shape and dynamics of the harbour today. A former arm of the harbour is now Taupo Swamp, an entirely freshwater system (Cochran 2000). The Onepoto and Pauatahanui arms may also evolve in this direction in the long term, through sedimentation. The rate at which such change may occur is dictated by a complex inter-relationship of the rate of deposition, the rate of sea level rise and the frequency and magnitude of earthquake events (Blaschke & others in press).

A further human-caused factor which has influenced the shape and dynamics of the Onepoto Arm today is harbour reclamation at Elsdon and coastal realignment e.g. Aotea Lagoon. Also, the Onepoto Arm and the lower reaches of the Porirua Stream are almost entirely ringed by roads that carry heavy traffic and which deliver high volumes of contaminated stormwater into the Harbour.

Flood protection

As stated in the climate and hydrology section, the Porirua catchment has short steep streams feeding in along the length of the main stem, and little natural flood detention in the upper catchment. Add to this a high level of urbanisation and resultant pressures on the stream channel (increased runoff, squeezing and relocation of the main channel), and flooding on what was the natural floodplain is inevitable. Even though regeneration of former farmland to scrub and bush has increased permeability in these areas, the amount of urbanisation that has occurred in other areas in the last 50 years has more than counteracted such increases.

The Flood Protection Division of GWRC has implemented a number of measures to reduce the risk of flooding but no amount of money or innovative technology can eradicate that risk completely. It is entirely natural for a stream to move across its floodplain in response to high or prolonged rainfall, and for stream levels to rise more rapidly when there is a larger amount of impermeable surfaces in the catchment. The case studies in Appendix 3 describe specific examples of the tensions between flood protection needs, development proposals and ecological considerations.

In order to protect development and human life on the floodplain a number of structures have been built including flood retention dams, floodwater dissipation structures, weirs and streambank protection. Some of these structures are barriers to native migratory fish and some change in-stream habitat, resulting in less variety of runs, riffles and pools; and less in-stream debris, streambank cover and gently sloping, wetted edges for spawning. This variety of habitat is vital if the stream is to continue to support the rich variety of fish and insect species that it has in the past. Because a number of native fish feed on terrestrial invertebrates such as ant, cicadas, moths and caterpillars, as well as aquatic invertebrates, riparian vegetation that supports these is also important.

A close study of the engineering plans for both Stebbings dam and the Seton Nossiter flood retention structure shows that these are not barriers to fish migration⁸. There are a number of smaller structures which do present barriers to migratory fish: these barriers are known to GWRC staff and some of them will need to be eliminated or modified if full fish passage in the catchment is to be achieved. In the meantime, other factors discussed in our report are more critical to the overall quality of the aquatic habitat than fish barriers.

Permeability and piping of streams

Permeability is a word used to describe whether rain water percolates slowly into the soil or rushes across the surface of the ground. In a densely forested catchment rainfall may be intercepted long before it reaches the stream. Some water evaporates off the trees back into the atmosphere and some percolates into the soil and moves into the groundwater system. It may move from there into underground storage such as an aquifer or make its way through the soil or rock to a stream. Some water moves directly across the soil surface to a stream. Some catchments have a lot of potential to store water in the soil and underground, with over-ground flows and in-stream flows only becoming a problem when the soil is totally saturated.

Changing land use by converting forest or pasture to residential development lowers the permeability of the catchment because a high percentage of hard surfaces (roofs, roads, yards) are impermeable. This means that rainwater moves far more quickly into streams and if the rainfall is widespread across the catchment then the flow in the main stem of the stream will increase rapidly and may over-top the streambanks.

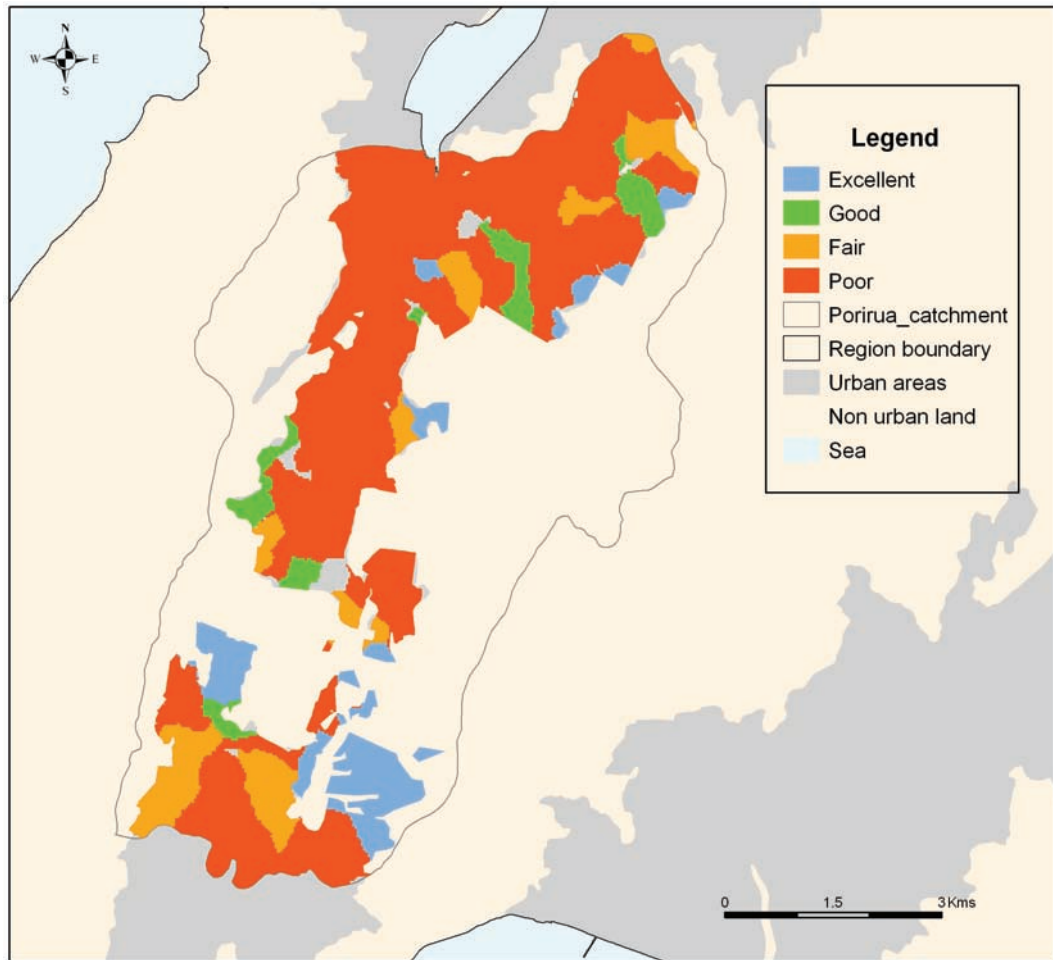
In the Wellington region, stream macroinvertebrate health has been found to be inversely correlated with catchment imperviousness (as estimated from roof and road area data). This relationship is currently being used to classify the ecological values of urban streams in the Wellington region. Preliminary work (S Warr, GWRC, pers comm. April 2009) has identified thresholds for the relationship between macroinvertebrate community health in urban streams and impervious cover in the surrounding catchment. Figure 4 shows what this looks like for the urbanised parts of Porirua catchment. Further work is being undertaken to integrate native fish values into the classification.

A table listing the length of streams piped or reclaimed in the Wellington region over the last five years can be found in Appendix 5. This shows that Porirua City streams (including all of Porirua catchment) contributed the greatest amount of loss of streams through piping or reclamation in Wellington region, accounting for more than a third of stream loss in the entire region. Lining stream banks and beds with rock or concrete can also impair stream health.

GWRC is currently working on an urban stream management strategy for the Wellington region. This will require urban streams to be classified according to their ecological value. Porirua Stream is likely to be classed as having high ecological value under this classification.

⁸ Plan references: A9629/13-RC & A1-9068/6-RC

Figure 4: Ecological health in the urbanised parts of Porirua catchment as a function of catchment imperviousness.



Excellent = 1-5% imperviousness, Good = 5-15%, Fair = 15-20% or Poor = 20-100%.

Summary of catchment issues

Threats and opportunities for ecological restoration of the Porirua Stream and its catchment.

Landscape and physical setting

The landscape of the catchment has been greatly modified since it was first settled. Reclamation of harbour and streams, re-contouring for transport infrastructure, modification of the stream channel for flood protection and removal of original vegetation cover have effected the greatest changes.

The topography is relatively gentle except on the catchment margins. Undeveloped areas retain many natural characteristics, in particular regenerating vegetation, natural stream channel shape and variety of habitat. Some sections of the main stream and many tributary reaches are picturesque, and both these and road and rail reserve associated with the transport corridor provide opportunities for enhancing amenity and biodiversity.

The catchment has a moderate rainfall, high sunshine hours and a northerly aspect, meaning that restoration work is not limited by climate. However, the drainage pattern and free-draining soils mean the catchment responds quickly to intense rainfall, with associated flooding problems. The natural flooding potential of the catchment is exacerbated by any reduction in catchment permeability and constriction of the stream channel.

Ecology and biodiversity

Most of the original native vegetation cover has been lost and the present day forest is almost all second growth. However, at this point the catchment is showing some promising signs of recovery of terrestrial biota. These signs include: increasing maturity and plant diversity in some bush areas; increasing numbers and diversity of birds, seed sources and dispersal vectors to aid revegetation and increasing areas set aside for reversion to native vegetation. Much of this recovery is due to increased pest management in the catchment.

Many natural linkages remain in place, including significant areas of native vegetation contiguous with neighbouring catchments, and significant sections of the stream network. Nevertheless some important remnants have been lost to development and others have insufficient protection. Despite their inclusion in various council inventories many significant natural areas remain unprotected and have been reduced in size or ecological health over recent years.

The numbers and diversity of fish populations appear to be declining. We put decline in fish populations down to a combination of factors:

- *Pollution and sedimentation:* There is insufficient control of pollution and sedimentation to ensure that high quality fish habitat is maintained.
- *Fish barriers:* There are many barriers to fish migration which means that prime habitat in the upper catchment is not available to many species.



Onepoto Arm, the receiving environment for the Porirua Stream

Stream crossing of Mitchell Stream at Park constitutes a significant fish barrier

Weed-infested banks of lower Mitchell Stream

- *Flood management:* Flood control channelling in the main stem of the stream means that the inanga spawning area is reduced to a few metres in Kenepuru catchment; in the lower stream there is little riparian protection, and floodway maintenance involves large machinery working regularly in the stream during the fish migration season.
- *Over-fishing:* Whitebait and longfin eel continue to be part of commercial and recreational fisheries.

There is an urgent need to enhance linkages along the streams and reverse the overall trend of decreasing aquatic diversity in the catchment. At the same time there is potential for supporting threatened plant and animal species by incorporating them into restoration projects.

Stream and Harbour

Much of the stream has good vegetation cover which keeps water temperatures down and provides food and cover for fish. The local community has become more vocal about the state of the stream and estuary and is beginning to make more recreational use of these areas. Local government has begun investing money to investigate the drivers behind the perceived degradation of the stream and harbour.

The movement of sediment along the stream system and into the Onepoto Arm appears to have increased in recent years and has also delivered a range of other pollutants and toxicants. These inputs, along with pollutants directly entering the Harbour from its edges, have changed the dynamics of the Harbour, altering and decreasing the quality of the aquatic habitat.

Aquatic biodiversity is further threatened by reclamation of streams and the Onepoto Arm, and loss of habitat to development, and through lack of legal protection for significant natural areas. Water quality is threatened by: sewage contamination, contaminated stormwater and sediment; and is further vulnerable to: development, building intensification, lack of education, knowledge gaps.

Flood protection measures, although required to protect community values, can cause adverse effects in the stream, from structures in streams and streambank protection, maintenance regimes, loss of streamside cover, changes in stream channel shape and associated habitat loss.

Piping of streams and any development that decreases the net permeability of the land surface, threaten natural values through increased flooding, increased risk of cross contamination, lower groundwater reserves, increased stream erosion, loss of habitat, and the isolation of fish populations.



Porirua City landfill in Spicers Valley at head of Mitchell Stream

Cannons Creek in channelised steps below impoundment lakes

Stebbings Stream discharge from Stebbings Dam

3 Opportunities for integrated catchment management

Integrated catchment management (ICM) has been defined as “a process through which people can develop a vision, agree on shared values and behaviours, make informed decisions and act together to manage the natural resources of their catchment” (Murray-Darling Basin Commission 2004). The framework for the Porirua Harbour and Catchment Management Strategy suggests that restoration in the Porirua catchment is best addressed through a framework of ICM.

This seems desirable, especially in an urban catchment where the large numbers of residents form an integral part of the catchment’s environment. Integrated management was suggested as an overarching theme of management in the neighbouring Pauatahanui Inlet catchment nearly a decade ago (PIAG 2000). As discussed in Chapter 1, this report comes within the framework of the Porirua Harbour and Catchment Programme and is seen as a major input to the Strategy, development and outcomes of that programme.

However, achieving ICM is not an easy objective in practise. It involves a process of aligning the need for healthy functioning of natural systems and processes with the needs of landowners and their communities to achieve mutually sustainable relationships. The process poses two challenges:

- Gaining a consensus on critical natural processes and how to manage these
- Reconciling conflicts between what individuals wish to achieve in the development and use of their land with the needs of the wider catchment and community

Urban catchments, especially those as complex as the Porirua catchment, have very fragmented patterns of use and ownership. Land is dominantly private, and public land tends to exist as discrete, unconnected parcels. Most public land is set aside for recreational and cultural, rather than ecological, purposes. Residential properties, for the most part, have limited outdoor space in which to plant native and/or exotic trees and shrubs.

What individual residents do manage to plant however, can contribute in significant ways to the wider patterns of vegetation and ecological systems. This vegetation provides soil stability, habitat for insects, birds and other wildlife, shades the stream and adds to the amenity of the neighbourhood. In steeper parts of the catchment landowners often own, and use for production, areas that are particularly important to the overall stability, ecological resilience, and amenity values of the catchment.

Gaining a consensus on what matters

We are fortunate in having a well informed and interested community in the Porirua catchment. There is little disagreement about what matters, and councils have well developed and supportive policies. Councils also support an integrated approach to catchment issues, spanning integration across administrative boundaries, sectors and disciplines. In short, there seemed to be little disagreement, either to the concept of ICM in the sense of thinking about the whole catchment and how one part affects another. The challenge is in agreeing which parts of the catchment are most important and the management needs for these. We hope that information and maps in this report can highlight existing values and provide cues to ongoing needs.

We can think of catchments like Porirua catchment as composed of these elements:

- *The outer edges:* the ridges and hilltops, prominent peaks and spurs. These provide an ‘outer’ containing visual framework that provides coherence and identity.
- *Wetlands, streams, rivers, and their associated vegetation:* Waterways are frequently entrenched in their middle reaches and may have high banks with steep slopes above them. Collectively these form an ‘inner’ catchment framework that provides resilience as well as connectivity and cohesion within the catchment.

- *The upper catchment areas* where water soaks into the ground or is gathered up in ephemeral streams. In urban catchments development tends to cover over these important natural areas. In such developed areas, water collected from hard surfaces (roofs and tarmac) at times of high-intensity rain (stormwater flows) surges down pipes into streams that are often unable to cope with sudden and large influxes of storm water.
- *The lower catchment* where the grade of the stream flattens and may naturally meander across a flood plain. To avoid flood hazards and enable residential development the stream may be channelled with stop banks. Flooding is exacerbated when development causes a faster response to rain and a higher peak flow and when the stream breaks its banks. Erosion is exacerbated by high velocity flows at peak caused by channelisation.

For practical purposes a conceptualised view of the catchment can be established, allowing us to focus on both the physical and social components of restoration priorities in the catchment. Here we call this conceptualised view a catchment 'framework', that provides ecological linkages while simultaneously affording cultural connections. For example, waterways and their associated vegetation can be venues for walkways and cycleways. Such frameworks give emphasis to natural landforms and heighten awareness of indigenous vegetation patterns. Development that recognises a catchment framework make landscapes visually attractive and coherent. Once mature these frameworks of vegetation break up the impacts of built structures and contribute to the character and identity of developed 'enclaves'.

As development along these lines proceeds, environmental results should be monitored, and management plans need to have the flexibility to change in response to those results. This approach of 'learning by doing' (often called adaptive management) can provide increased understanding of the environment, as well as improved environmental outcomes.

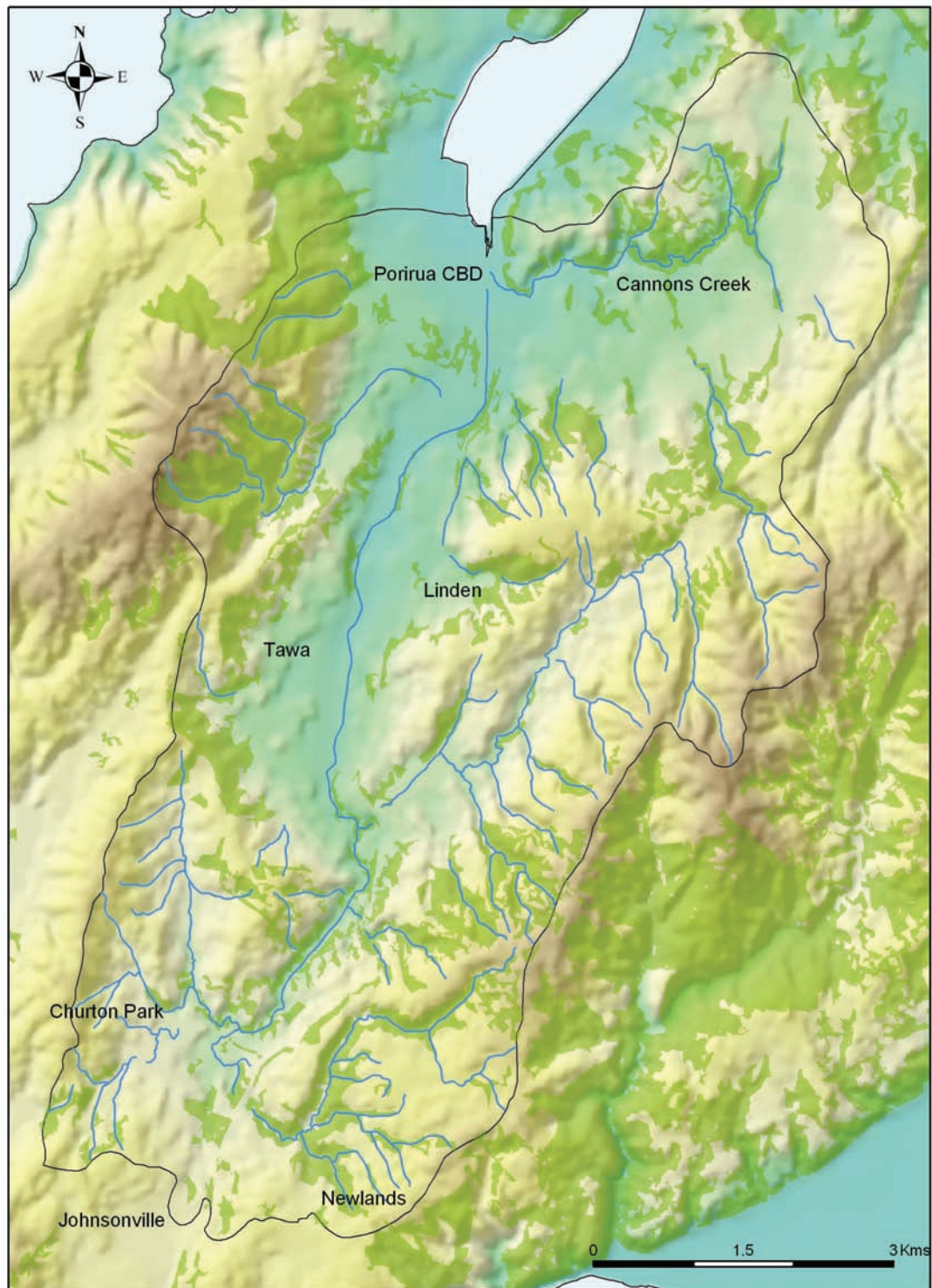
Well established and stable catchment frameworks benefit the whole catchment, and the whole community. A desirable process for ICM is to establish a framework in consultation with communities and interest groups, agree what needs to be done and where, and to resource individuals and community groups to carry out the works needed in their particular section of the wider framework. Given that such frameworks are comprehensive and well supported it becomes possible to contain new development within their constraints, to ensure values at the top of a catchment are recognised and provided for and that downstream values are not threatened. For example, in the upper catchment where water is collected, developers can be encouraged to leave wet areas and ephemeral streams free of disturbance and to minimise hard surfacing. They can also be encouraged to avoid pipes and to allow storm water to move naturally into watercourses.

A framework for Porirua catchment

Consultation with community groups in the Porirua Catchment has gone some way to defining areas that might be contained within a central physical framework. Excellent cues are provided by areas of remnant indigenous forest and advanced regeneration in reserves and on steeper slopes across private land. Areas of pine forest clothe some outer areas of the catchment and shelter fingers of indigenous regrowth in gullies. As a general rule it is agreed that slopes of 35 degrees and over should be left to naturally regenerate (Hicks & Anthony 2001). On easier slopes forming the backdrop to residential development, building density should be low and residents encouraged to retain (and nurture) natural vegetation.

A natural features framework based around topography, streams and native vegetation is shown in Figure 5. Note that several sub-catchments currently lack significant vegetation in riparian areas, and that breaks in the stream system in Figure 5 indicate significant lengths where streams are culverted.

Figure 5: A natural framework of significant indigenous vegetation, streams and topography in Porirua catchment.



Topography is shaded from aqua (lowland and basins) through to brown (hill summits). Significant native vegetation is apple green. Streams are in blue; breaks in streams show piped or hard-lined sections.

Reconciling conflicts and aligning interests

The processes of defining a catchment framework and reconciling potentially conflicting interests tend to run in parallel. Individuals who engage in consultation tend to think in terms of personal interest, and the interests of their immediate community or restoration group, as well as the sustainability of the catchment as a whole. The consultation process needs to be flexible and of a strategic nature and there needs to be a long term vision embodied in a catchment plan that identifies the existing situation and highlights actions needed to achieve a stated long-term 'ideal'. There must also be commitments to various actions, at individual, small group, and community levels. Roles and relationships need to be defined, for public bodies and private interests.

Although there must be an ongoing commitment to activities such as weed and pest control, some actions will be opportunistic; activities undertaken when money is available, when community groups are vibrant, and when opportunities to undertake planting or fencing arise. Monitoring to retain an overview and ensure that activities are generally focused in the most important places for the greatest gain is essential, with regular feedback to all of those involved.

In the process of reconciliation there is a need to acknowledge that personal interests may be quite specific and involve only that area of the framework adjoining a property. Alternatively the interest may primarily be one of amenity rather than ecological enhancement. Interest in connectivity may be more related to pathways and cycleways through natural corridors than to ecological connectivity.

A requirement for successful ICM is to accommodate all of the various interests in the catchment framework. Throughout the process of defining areas and agreeing actions the implications for ecological sustainability, water management, and recreational and amenity benefits must be simultaneously considered.

4 Goals and criteria for restoration selection

It has proved difficult to develop overall objectives for restoration in the Porirua catchment. The diversity of the catchment and the restoration activities that are taking place in the catchment make such an exercise very difficult. The following recommended objectives attempt, however, to take into account this diversity and to suggest both outcome-related and process-oriented objectives, as follows:

Table 4. Recommended goals for ecological restoration in the Porirua catchment

1. To maintain or where possible increase biodiversity values.
2. To ensure that new developments in the catchment provide for native biodiversity habitat, particularly through on-site stormwater retention.
3. To use all opportunities for restoration to complement other catchment management work.
4. To obtain maximum community and stakeholder ownership for enhanced environmental values in the Porirua catchment.

In developing recommended priorities to implement these objectives, we found it useful to test options against the criteria shown in Table 5.

Table 5: Criteria for prioritising restoration in the Porirua catchment

- Maximise opportunities to maintain or increase biodiversity values, through:
 - preventing further biodiversity loss;
 - addressing current threats to biodiversity; and
 - increasing ecological linkages (in practice this means a strong emphasis on the Porirua Stream as the most important corridor in the catchment).
- Provide for native biodiversity habitat, through:
 - maximising on-site stormwater retention in all parts of the catchment; and
 - improving habitat quality through animal pest and weed control and establishing new habitat.
- Look for opportunities to use restoration to complement other catchment management work, including:
 - sediment and pollution control;
 - stormwater management;
 - flood protection; and
 - reserves and open space planning.
- Seek maximum community and stakeholder ownership, through:
 - working with existing restoration group efforts;
 - working with developers;
 - supporting new landowners with advice (covenanted, restoration activities, etc);
 - strong emphasis on access and recreation benefits; and
 - promotion of public and private amenity benefits (including property value enhancement) through environmental enhancement.

This project aims to prioritise such work across the catchment, in contrast to projects in the past that have focussed on particular sites or species. This framework recognises that restoration work at any site will ultimately have catchment-wide repercussions but that some approaches will have greater biodiversity gains than others.

5 Restoration places in the catchment

In this chapter we summarise restoration issues and opportunities for the different parts of the catchment, categorised by land types and tenures. As discussed earlier, the Porirua catchment has enormous variability, so that restoration issues and opportunities need to be approached in this way, even while appreciating the need for integration. In line with our brief, we concentrate on public land categories, but there are also important opportunities for private landowners.

Council Parks and Reserves

Wellington and Porirua Cities both have numerous reserves in the catchment. Reserves represent many of the natural ecosystems of ecological domains in the catchment (WCC 2008, Table 2; Boffa Miskell 2001), although reserves with important ecological values are scattered over the catchment and there are significant gaps in coverage. They are of several different categories⁹ and not all are suitable for restoration purposes. But a number of them are critical to any restoration strategy.

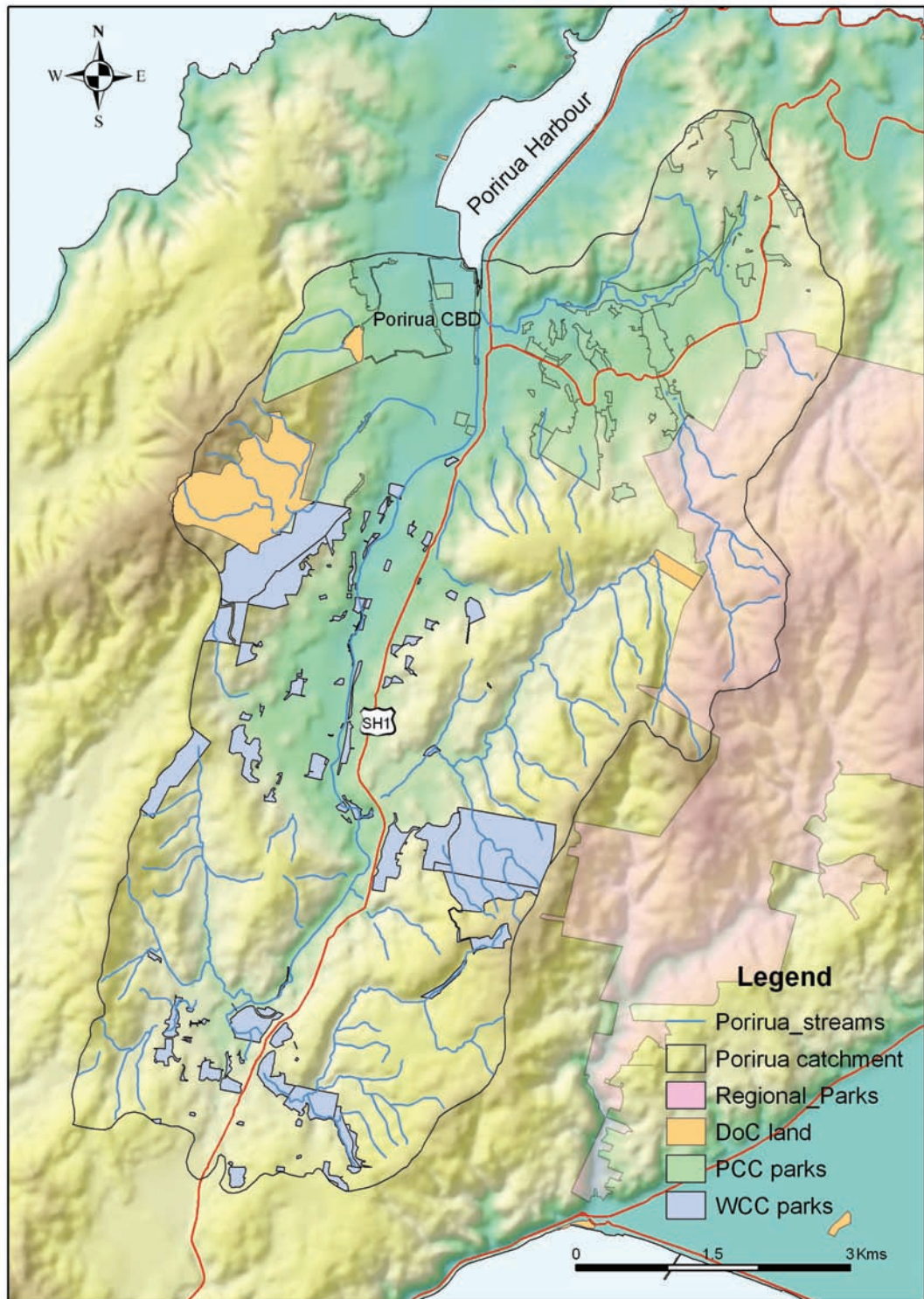
Wellington City Reserves are covered by the Northern Reserves Management Plan (WCC, 2008). This plan describes all the reserves and sets out objectives and policies for them, including objectives and policies for ecology. Key gaps in ecological connectivity of the reserve network in the catchment identified in the Northern Reserves Management Plan include the Tawa basin, Grenada North, Churton Park and Glenside. We would add to this list the headwaters of the Belmont and Takapu sub-catchments (see Figure 2). Reserve acquisition in these areas is a priority, especially with the potential for reserve contributions from greenfields developments. The Northern Reserves Management Plan also emphasises weed and pest control in these three reserves and throughout the catchment reserves to enhance their condition. Our observations suggest that pasture management associated with horse grazing in one of the reserves may be threatening biodiversity values.

There are fewer reserves in Porirua City, and correspondingly greater gaps in ecological connectivity. However, a number of the Porirua City reserves are large and have high ecological values. Two areas are of particular significance for restoration. Firstly, the Cannons Creek sub-catchment where ongoing work by Friends of Maara Roa and Porirua City Council has the potential to link the area with Belmont Regional Park, Hutt Valley and Wellington Harbour. Secondly, Bothamley Park offers significant riparian habitat along the Kenepuru Stream and a key green buffer between the urban areas of Porirua East, the developing Aotea Block and the Pauatahanui Inlet catchments. Reserves such as Bothamley Park are not being managed as laid out in the PCC Revegetation Policy 2004 (Appendix 2). However, these types of projects will be essential to the success of any future Porirua Harbour Restoration Strategy.

Part of the Belmont Regional Park lies at the eastern edge of the Porirua catchment. There are opportunities within the park to enhance ecological values and linkages, mainly through fencing of covenanted areas within the dominant grazing land, and to manage reversion in some of the steep gullies. However, we consider that widespread reversion of the grazing land should only be considered as a long-term option. Currently there are other important recreation and landscape values recognised by the community for the current grass covered tops. The Belmont Regional Park Management Plan, which was under development in 2006-7, has been put on hold until a Regional Parks Network Strategy has been completed, which is due to be confirmed by mid 2010. Revision of the old Management Plan, which has been operative since 1996, should then be progressed as a matter of urgency. The Management Plan process will be able to address the issue of the long-term balance of grazing, conservation and other land uses.

⁹ For example, scenic reserve, recreation reserve, esplanade reserve.

Figure 6: Public reserves in Porirua catchment



Department of Conservation land

The most important reserve managed by the Department of Conservation (DOC) in the catchment is the Colonial Knob Scenic Reserve. This is a large (130ha) and popular reserve which has important ecological values and is contiguous with the Porirua Scenic Reserve and Spicer Park (managed by PCC).

The ecosystems within this reserve include an unused water supply dam which needs significant remedial work if the lake is to be retained¹⁰. It may have significant native fish populations. However the current Wellington Conservation Management Strategy proposes investigation of the lake for recreational fishing. Further investigation and implementation of management options for this lake is a priority. Pest animal control is currently managed by GWRC for DOC, but there may be opportunities for pest control or restoration activities or sponsorship from adjacent community groups or Spicers Valley businesses.

Housing New Zealand

The housing complex at Cannons Creek complex is about to have a major revamp. Housing New Zealand would like to incorporate rain gardens and drainage swales but PCC would have technical difficulties and high costs associated with modification of stormwater systems, etc. Keep Porirua Beautiful have supplied street trees for two or three streets per year in the Housing NZ area for the last four years. This initiative could be usefully expanded: the Housing NZ complex represents an important publicly-owned area in a part of the catchment where natural areas are highly under-represented and where there are opportunities to add to the diversity and amenity of the catchment. As for the council reserves opportunities discussed above, these kinds of urban design approaches will be essential to the success of any future Porirua Harbour Restoration Strategy.

State Highway 1 Motorway corridor

The State Highway 1 (SH1) route (land owned by Transit NZ) that runs the length of the catchment, is a lot wider than just the roadway. It is currently quite weedy in places, especially with tree species. There is a huge potential for north-south oriented corridor sections to be more continuously planted and then linked through east-west oriented gullies to sub-catchment headwaters, especially in places such as Linden where the potential connections already exist.

Rail corridor

The North Island Main Trunk Railway route, land owned by OnTrack, is similar to the road corridor in its catchment position, but is closer to the main stem of Porirua Stream. There are greater biodiversity gains to be had from enhancing riparian areas such as these, compared with converting pasture to forest elsewhere in the catchment. An essential first step in enhancement is better liaison between council departments and infrastructure providers such as OnTrack.

Transmission Gully and major proposed road links

The proposed Transmission Gully route and long-term planned link roads, such as a possible Grenada to Petone link, offer both potential biodiversity losses and gains. Both these routes involve major stream crossings of Porirua Stream tributaries, with potentially significant adverse effects on stream biodiversity, and also potentially significant vegetation clearance. On the other hand, well planned and executed roadside planting can enhance connectivity in the catchment. Mitigation planting for potential sedimentation has begun on parts of the Transmission gully route and could be extended to portions in the Porirua Stream catchment.

¹⁰ A second water storage dam identified in the Conservation Management Strategy has already been decommissioned.

Floodway

There are significant restrictions on what can be planted in the Porirua Stream floodway (see Appendix 3, Case Studies 1 and 3). However, there is a potential to achieve large gains by progressively replacing blackberry with floodway-appropriate riparian species. This would reduce the distance and time spent in the stream by heavy machinery and therefore damage to aquatic life.

Care and restoration groups could take on some responsibility for riparian maintenance (perhaps in a joint venture mechanism with GWRC) as an alternative to tractor mowing and blackberry clearance. It would be feasible to look for national and local biodiversity enhancement funding for such a project.

Schools

There are an unusually large number of secondary schools in the catchment: Newlands College, Tawa College, Bishop Viard College and Porirua College. Onslow, Aotea and Mana Colleges are just beyond the catchment boundaries. It seems almost all of these colleges have some involvement with catchment restoration planting or use the reserves for education and recreation. There is potential to involve the Enviroschools Programme in future restoration projects. There are also many primary schools many of which are busy planting at least their own grounds. For example, Ngati Toa primary won Keep Porirua Beautiful's "Tidiest School" award in 2008.

These projects should be continued and if possible expanded. There are mutual benefits for restoration groups to forming partnerships with schools groups, for example by providing areas for planting projects and otherwise supporting them. We noted that the Wellington and Porirua offices of Enviroschools run independent programmes for their respective areas in the different parts of the catchment. As with other aspects of catchment management, joint planning and good liaison is also necessary for the best environmental outcomes.

Kenepuru Hospital

The hospital lies within a large area of land in an important section of the lower Mitchell Stream catchment, of which only a relatively small part is occupied by the hospital. The stream is likely to have significant values and is known to have significant native fish populations. There are opportunities for enhancement of stream values by riparian planting and other activities. If subdivision is intended for any part of the site, potential environmental constraints and opportunities need to be planned from the outset.

Plantation forest

Much of the plantation forest in the catchment (almost all *Pinus radiata*) is in relatively small privately-owned blocks and is scattered throughout the catchment. However, there is one large contiguous stretch of forest on the western boundary of the catchment, owned in several lots by public and private owners¹⁰. We encountered considerable disquiet among community groups that these areas could be developed for housing following future harvest. The concern arises from the landscape, visual and recreational values as well as ecological values of these forest areas, which would all be affected by a change of land use.

Opportunities for ecological linkages and enhanced indigenous biodiversity exist within plantation forests just as in regenerating bush. Landscape and visual issues are also attached to the interface between native and plantation forest and open grazed land. There are also important access opportunities with the plantation forests along the western catchment boundary (including a section of the new *Te Araroa* pathway). Spicer Forest forms the northernmost part of Wellington City's Outer Green Belt and links to both Colonial Knob and other Porirua reserves.

¹⁰ Spicer Forest, Airstrip block and Forests of Tane block respectively. Spicers Forest is a joint venture between Wellington and Porirua City Councils and GWRC.

Where subdivision for residential use is an option for any currently forested land, it is important to manage subdivision to maintain and enhance ecological values. These are also opportunities to manage all plantation forest areas for carbon storage and other ecosystem services (both in private and publicly owned land). These opportunities should be investigated well before pending changes in land use.

Closed landfills

A number of landfills occur in the catchment including a current landfill at Spicers Valley and old landfills at Grenada North and at the head of the Belmont sub-catchment. The last named of these is the so-called “Cottles” landfill on Horokiwi Road which is noted as Category V hazardous site on the GWRC database (see discussion under ‘Water Quality’ in Chapter 2). No landfills in the catchment are considered to be significant pollution sources at present, but ongoing monitoring of water quality parameters on and below all known contaminated sites is warranted.

Ecosites on private land

Both in Wellington and Porirua cities, many sites with ecological values are on private land. Most of these sites are recognised in Porirua City’s ecosites database, and Wellington City’s database of primary forest remnants. Although inclusion in these two databases does not in itself confer statutory protection, we consider that protection of all these sites is a priority in any restoration strategy. Negotiation to protect ecosites through the reserves contribution process should be part of assessment of all development.

Species for replanting

It is clear from our conclusion about the spatial variability in the catchment, that any replanting needs to take account of this variability. With this in mind, we have chosen a range of species that are our suggested ‘Best Bets’ for restoration planting in different parts of the catchment. The full list is shown in Appendix 6.

Our list comprises selected groupings of species present in the catchment as ‘natural’ vegetation at some time between 1968 and 2004. They are all included in species lists compiled for places in the Porirua catchment (see Appendix 4). The aim of our list is to provide a choice of species for propagation and planting out, suitable for restoration groups. The list suits the range of environments (shown as ‘growing zones’) in the catchment, and aims to increase the diversity of the range currently planted, but from species for which propagation material can be reasonably readily obtained and grown on.

Places with safety issues

Restoration work is generally regarded as a safe and healthy pastime. However, when working on steep slopes, beside streams, busy roads or a railway line particular attention must be paid to safety. This does not mean that restoration work should not be carried out at such sites. A thorough health and safety plan should be devised for such sites, recognising the hazards and showing how they will be mitigated. This may mean that very young or infirm volunteers are unable to work at these sites. Some restoration work adjacent to the railway line may only be able to be carried out by ONTRACK staff or their contractors and biodiversity funding could help to cover the cost of this. The consultants have identified a number of sites with high priority for restoration that may require health and safety plans, for example Middleton Road, Glenside.

6 Conclusions and recommendations

Porirua catchment is complex, combining pasture, rural and lifestyle properties, forest (native and plantation), the satellite suburbs of two cities, several light industrial areas, a central business district and national road and rail routes (existing and proposed). The flood plain was settled early in the history of the region with many private properties located close to, or actually including, the stream. This stream responds quickly to rain and will overflow its banks during a very large rainfall event. With large tracts of land in the catchment recently zoned for green field development this is a good time to take stock of natural resources and to establish some sense of priority for ecological restoration and protection.

Conclusions

Our analysis in previous chapters indicates a number of threats to biodiversity in this catchment, including (in no priority order):

- Stream bank instability
- Insufficient vegetation to provide cover for fish and shade the stream
- Fine sediment inputs
- Pollution from nutrients, toxicants and litter
- Weeds
- Lack of connectivity
- Fish barriers
- Lack of protection for remnant native, and riparian, vegetation
- Lack of knowledge about natural resources other than vegetation

Human activities or factors that contribute to, or exacerbate, these threats include:

Planning

- Permissive rules for stormwater discharge and setbacks from streamside development
- Flood protection measures do not align with ecological objectives

Economic

- Increasing levels of land development
- Changing land values (e.g. demand for greenfields development)
- Budget constraints

Management

- Increasing areas of impervious surfaces
- Piping of first and second order streams
- Structures in streams block fish access
- Lack of monitoring and enforcement of erosion & sediment control rules
- Lack of fences and buffer planting around remnant vegetation
- Rubbish and recycling collection systems contribute to litter

Community

- Low public profile of the stream, especially of the contribution of sub-catchment streams to the whole catchment
- Volunteers unevenly spread across the catchment
- Support for volunteers is not equitable across political boundaries
- Illegal dumping of garden waste
- Lack of legal protection for remnant vegetation

Recommendations

In this final section we set out our key recommendations for priority restoration actions in the Porirua Stream and its catchment. There are two groups of recommended actions: the first that are generic to the whole catchment, and the second that are more site-specific (sub-catchment or reach). Priority actions (i.e. recommended within the next two years) that are location-specific are shown in Figure 7.

Protection and enhancement of existing native vegetation must be a priority of restoration, but this alone will not be sufficient to maintain or enhance ecosystem processes or environmental



Subdivision must avoid sedimentation effects into streams and headwaters

quality throughout the catchment. Vegetation protection and enhancement only addresses some of the above threats and human factors. But a number of the activities identified above are activities that are regarded as normal components of economic growth and development. These activities need to be tackled in a more integrated way, looking at analysis, statutory planning, monitoring and enforcement, and public education as well as restoration actions that are more hands-on. Both types of activities need financial resources, in some cases substantial amounts. To cover the full range of recommended actions in depth would require a full catchment management plan.



Collaborative approaches necessary: restoration group meeting at Glenside

Neither this list nor the analysis that has accompanied it constitutes a catchment management plan, but are focussed at actions that integrally involve the community and private sector, although many actions will need to be initiated and led by councils. We have not hesitated to suggest actions that go beyond “simple” restoration actions – particularly those that apply to the whole catchment (the list below). Several of these generic recommendations address the need for the full catchment management attention that the complexity of the issues requires.



Bottom of stream and entrance into Onepoto Arm is a key area for restoration

This project has provided a focus on generic issues for the Porirua Stream and on areas and sites where actions need to be taken to respond to these issues. In identifying these issues and focusing on critical sites and areas the plan also highlights areas within the catchment where any new development needs to be closely scrutinised to ensure that potentially adverse effects are recognised and appropriately managed. This objective was not specifically a requirement of our brief so our recommendations do not have that focus. Nevertheless we have provided a recommendation directing attention to the value of the study in providing the basis of statutory planning provisions to address new development proposals; in particular in informing the resource consenting processes of councils.

Table 6: Priority actions for ecological restoration in the Porirua catchment (whole catchment)

Protect and enhance habitat:

1. Protect and enhance existing native vegetation, and populations of birds, lizards, insects and fish. Priority to be for strategic planning for reserve contributions and enhancements associated with subdivision applications.
2. Increase and enhance vegetation corridors and linkages within and outside the catchment to increase connectivity.
3. Prioritise the arterial road/rail corridor for ecological restoration and habitat linkages, focussing on targeted weed control, enhancement planting and linkages between the transport corridor and headwaters areas where feasible.

Reduce sediment, pollution and water run-off:

4. Reduce rapid run-off, sediment inputs and water temperature by setting aside a high proportion of riparian land (regardless of current vegetation cover) in green field developments for protection and/or restoration.
5. Review District Plan rules regarding the footprint of impervious surfaces and for large industrial and retail complexes with regard to onsite stormwater detention. This recommendation can be implemented through future consents (including retrofits) and through the Stormwater Action Plan for the Wellington region.
6. Review erosion and sediment control guidelines to minimise the risk of fine sediment from developments entering waterways.
7. Establish protocols for monitoring water quality below contaminated sites e.g. closed landfills, and investigate possible causes for the deterioration in water clarity at the State of Environment monitoring sites.

Enhance the ecological design elements in flood and stream management:

8. Increase the width of the riparian corridor, where possible, along the main stem of the stream to reduce the slope of the stream bank, reduce erosion, increase the capacity of floodway and allow more vegetation to shade the stream.
9. Develop a feasible floodway building/yard restriction that recognises access requirements for maintenance and owner obligations for erosion control work.
10. Review structures in streams with regard to the possibility of enhancing fish passage.
11. Utilise land set aside for flood attenuation, flood protection and transport corridor reserves with appropriate planting and with regard to public amenity.

Promote catchment-wide planning:

12. Establish the feasibility of a statutory combined (district/regional) catchment plan for the Porirua Stream catchment.
13. Develop a catchment-wide "Porirua Stream and catchment forum" of agency, community group and stakeholder representatives to coordinate and promote a full catchment management plan (including a restoration monitoring strategy) and catchment restoration actions. This forum should be complementary to statutory planning and any implementation structures to be developed under the Porirua Harbour and Catchment Management Programme.
14. Hold a forum/focus group to discuss and develop objectives for sediment management in the Porirua catchment. This forum should be complementary to statutory planning and any implementation structures to be developed under the Porirua Harbour and Catchment Management Programme.
15. Improve liaison between councils and infrastructure providers, especially ONTRACK.

Community support and awareness:

16. Standardise support for volunteer care groups across territorial boundaries to ensure equity and a transparent process of resource allocation.
17. Raise public awareness of pollution and litter problems and direct actions towards prevention by highlighting amenity and recreation values of stream and bush areas.

Table 7: Priority actions for Porirua catchment, by sub-catchment

Sub-catchment	Area (ha)	Priority recommendations & opportunities (short to medium term)
Kenepuru	1500	Reserves management, plan future reserves contributions. Enhance inanga habitat in lowest of reaches of Kenepuru Stream. In Belmont Regional Park, complete fencing covenant areas and identify other areas with high biodiversity values. Weed control and riparian enhancement in Bothamley Park. Fence covenanted areas in Belmont Regional Park.
Linden	340	Ecological linkages between transport corridor and rest of sub-catchment.
Takapu	850	Stream stability, vegetation retention & protection. Riparian enhancement on Takapu Stream, fence stock out of stream.
Belmont	720	Vegetation retention & protection, plan future reserves contributions. Include rail and motorway land in restoration plans for Glenside Reserve
Churton Park	700	Set aside and plant riparian land currently in pasture. Vegetation retention & protection, plan future reserves contributions. Active adaptive management approach to development and enhancement of the Stebbings Stream and catchment, including any planned road connections, with careful monitoring of biodiversity and water quality trends.
Tawa	350	Complete reserves planting, especially adjoining main stem. Assist planting the proposed walkway/ cycleway. Vegetation retention & protection, plan future reserves contributions. Investigate long-term opportunities for plantation forest areas, including carbon storage.
Mitchell	800	Reduce stream bank erosion, especially Spicer Road reach. Investigate lake in Colonial Knob Scenic Reserve. Investigate long-term opportunities for plantation forest areas including carbon storage. Manage structures for fish passage and apply adequate setbacks in hospital reach.
Upper channel	–	Planting and weeding riparian land and transport/rail corridor, development setbacks
Lower channel	–	Raise public awareness & access, reduce erosion, increase amenity values. Support ecological aspects of cycle/walkway project and extend to estuary, protect fish habitat, plant transport/rail corridor and estuary, development setbacks. Joint council/ community project for floodway enhancement/ maintenance, focussing of stream estuary area (council and OnTrack land).

Figure 7: Porirua catchment restoration priorities, by sub-catchment (A3 inset)

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Appendix 1 Summary of discussions with community groups

Churton Park Revegetation Group (including Eastcott Reserve)

Background: Churton Park group began with a small area of planting off Westchester Drive before starting on a major project at Wingfield Reserve which includes the southernmost tributary of Porirua stream. This stream gully had been cleared by PD gangs a long time ago but had reverted to a blackberry choked valley. The group wished to improve visual amenity by planting native trees. They received Greater Wellington (Take Care) funding for 5 years which has been extended to six and has two years to run. They have prepared a map of the site with planting blocks shown and a draft management plan.

This group does not have regular working bees but instead organises monthly work days through the winter and at other times. Special work days have been held supported by corporate groups, the local church and Girl Guides. Their work involves clearing sites, planting, mulching, weeding, creating a temporary access track and planning permanent track. This is a self-managing group which purchases plants with GWRC funding, and receives an annual allocation of plants from WCC. When the work at Wingfield is completed (probably a year or two after funding ceases) they may look for another project in Churton Park or they may disband.

Species used in planting: include: *Phormium tenax*, *Cortaderia toetoe*, *Carex secta*, *Sophora microphylla*, *Leptospermum scoparium*, *Olearia paniculata*, *Pittosporum eugenoides*, wineberry, kahikatea, nikau and *Metrosideros robusta*. They have had issues with plant mortality on steep dry banks, access, and volunteer education.

Stream channel maintenance is an issue. This part of Porirua stream is not covered by the Regional Council Watercourse Agreement so channel maintenance is a landowner responsibility. Within the reserve the landowner is WCC who appear to have no special budget for maintenance. The group removes snags and rubbish to reduce erosion so that planting areas are not threatened. They are concerned at the amount of sediment in Porirua stream and would prefer to see it managed as an asset for protection rather than a stormwater channel. One suggestion is that the local council should supply plants for privately owned riparian areas as it does for road reserve.

Pest plants: Blackberry, tradescantia, Old mans beard, ivy, montbretia, oxalis, sycamore, cherry, hawthorne, macrocarpas and pines with small areas of pampas and bamboo. Many of these weeds have been removed with but seedlings are now popping up.

Eastcott Reserve is a small area of bush and grass with a stream and is almost surrounded by new houses. The goal here was to enhance biodiversity and visual amenity. The group evolved out of the local gardening group and was funded by WCC. Planting is now complete and the group disbanded.

Friends of Maara Roa

Background: Friends of Maara Roa evolved out of the Cannons Creek Valley Protection Group in 1998 and became Friends of Maara Roa in 2000. They were keen to prevent the frequent gorse fires that threatened native bush by planting a buffer zone. The group works in Cannons Creek catchment at the top end of the Lakes Reserve and Belmont Regional Park in the Cannons Creek catchment (only as far as Takapu Rd). This includes two covenants one called Takapu covenant (29.5 ha). It is also looking at restoration opportunities in the lower Cannons creek catchment. They expressed an interest in finding out if *Watercress tuna*¹¹ still lived there despite the concrete channelling. They have funding from Greater Wellington (Parks) that ends in 2010 and support from Keep Porirua Beautiful. Volunteers come from Cannons Creek and the wider Porirua catchment. They are joint winners of the 2008 Rata Community Partnership Award, one of four environmental awards given by Greater Wellington annually.

¹¹ Character (eel) from a story by Patricia Grace.

The volunteers are involved with gorse removal, planting and release weeding. They have created green firebreaks behind the local schools where many fires have started, replacing gorse with native trees. They are also buffer planting around the two covenants and clearing gorse in 3-4m strips alongside tracks and planting. The group has a small plant nursery in the grounds of a local school and have been advised to source plants from between Otari to Kaitoke. The group has a strong advocacy role and has made detailed submissions to Greater Wellington and Porirua City Council on land management issues in the catchment.

Species used in planting: Plantings include: *Melicytus rhamiflorus*, *Pittosporum tenuifolium*, *Hebe stricta*, *knightia excelsa*, *coprosma grandifolia*, *Neopanax arboreus*, *Solanum avicularum*, *Corynocarpus laevigatus*, *Leptospermum scoparium*, *Sophora tetraptera* plus, in lesser numbers: tawa, titoki, matai, totara, rimu, kahikatea, kotukutuku. They monitor their plantings and keep written records of successes and failures which they would be happy to make available. Some monitoring has also been done for the group by Owen Spearpoint (GW).

Issues: The greatest issue for the group is fire. There have been a number of fires in the past including two very large ones that burnt plantings as well as gorse. This is very disheartening for the group. They are no longer really planting in Lakes Reserve as sediment accumulation after heavy rainfall has covered past plantings. The lakes were purpose built as stormwater retention ponds for the attenuation of flood flows. Other concerns are fencing of the covenants, concrete channelling in Cannon creek and the loss of Te Awaiti springs when school playing fields were created. Also some upstream erosion issues and distance from other forest in Bothamley Park Takapu valley and Korokoro.

Pest plants include: gorse, broom, blackberry, old man's beard, honeysuckle (Himalayan and Japanese) and pampas. Some karo was planted in the past.

Pest animals: 56 bait stations throughout, GWRC supply bait. Seem to be continual incursions by possums from the farmland above but they are winning the battle. Hares and rabbits are a different story. Volunteers are not allowed to shoot on Regional Park land. It is very labour intensive applying hare nets and wire takes a lot of their budget. There is a rahui in place to protect pukeko. Because there is little planting where the pukekos are the group does not have a problem with them pulling up plants.

They are guided by a number of management plans including their own (Cannons Creek Reserve Management Plan); also Porirua City Amenity Lakes Management Plan and the Regional Pest Management Plan.

Finally, Friends of Maara Roa really enjoy the support they get from GW, PCC and KPB. They have a vision of vegetation on Cannons Creek hills that will balance Porirua Scenic Reserve on the western hills.

Friends of Tawa Bush Reserves Inc.

www.tawabush.wellington.net.nz

Background: This group came about as an advocacy group in response to a proposed subdivision at Larsen Crescent in 1996. They became an Incorporated Society in 2001 and took on on-the-ground roles in pest control and planting. They are involved with restoration at six sites in Tawa (Larsen Crescent Reserve, Redwood Bush Reserve, Wilf Mexted Scenic Reserve, Woodburn Drive Bush Reserve, Charles Duncan Reserve and Westwood Reserve). The group also supports the Friends of Willowbank Park and the Porirua Stream walkway/cycleway group.

The group carries out pest animal and plant control and plant out about 1,000 plants a year. They are also involved with boundary fencing, signage, track development and maintenance in association with WCC. They plant on the fringes of regenerating bush and in gaps and weeded areas within reserves. They plan to continue with pest plant and animal control and to do more monitoring of pests and the overall health of the reserves over time including plant/ animal

relationships and ecosystem processes. They would like to enhance access to proposed walkways along the Porirua Stream and to the ridgeline and the Outer Green Belt.

Issues: Larsen Crescent and Wilf Mexted Reserves should have their own management plan in order to recognise distinctive features such as a matai stand. The Northern Reserves Management Plan under which it falls mainly applies to currently grassed/farmed areas, not bush remnants. There is a lack of weed control on railway, motorway and Porirua Stream land. These are corridors which encourage the spread of weeds such as pampas. Floodway management involving the use of a tractor in the streambed, the group feel that Greater Wellington should look at alternatives. Public access to bush reserves and walkways. Concern at the small size of some bush remnants and the need for buffer planting to ensure remnant protection and ecological viability. Concern about development plans for plantation forests on the western hills and the preservation of existing green landscapes. They are interested in linkages with bush remnants in upper Stebbings valley and concerned that the planning process will not adequately protect that bush from development. They note the lack of stock control by neighbours in Stebbings valley.

Species used in planting: The group is supplied with plants from WCC nurseries, plus they grow on plants, sourced from seed from Tawa bush reserves, in home nurseries.

Pest animals: possums

Pest plants: Old mans beard, Japanese honeysuckle, blackberry, wandering willie

Friends of Willowbank Park

Formed in 2008, Friends of Willowbank Park is a lobby group that is keen to see improvements to the park including: pathways, lighting, weeds and amenity planting. They have participated in two planting days organised by Wellington City Council where they planted sedges and other riparian vegetation and cutting-grown apple trees sourced from an historic orchard in reserve. They have no further plans to plant in Willowbank Park

Issues: Main concern is erosion at the junction of Takapu stream and the bend at the Dressmart shopping centre. The stream junction is becoming wider and shallower and some streambank trees have been lost into the stream. This area is immediately downstream from the Takapu Island development.

Glenside Stream Care Group

www.glenside.wellington.net.nz

Formed in 2001 this group has planting and maintaining sites in Glenside since 2002. Their vision statement is *Restoring streams and bush to their former glory.*

This group is strongly focussed on improving stream and roadside areas in Glenside. They have worked together on projects at Stebbings Dam, Rowells Road lay-by and the Middleton Road debris arrester. They are supported by Greater Wellington and WCC with funding, plants and training. The group has its own nursery facility, a seed collection permit and have raised saplings from plugs. There are regular working bees plus they often have extra volunteers from Volunteer Wellington and Volunteer Porirua. The group has spoken about their work to a number of community groups and they also support other local care groups. They have been involved with Restoration Day, Eco Restoration Day, Clean up New Zealand Week and Conservation Week activities.

Work involves: clearing, planting, release weeding, mulching and propagation. Other activities: collecting streamside rubbish with the Johnsonville Lions. In the future they would like to work in Glenside Reserve.

Species used in planting: They are planting: Broadleaf, broom, cabbage tree, *coprosma grandifolia*, flax (*P. tenax*), fivefinger, grasses (sedges?), *griselinia lucida*, hangehange, hebe, kanuka, kohekohe, kowhai, lancewood, mahoe, wineberry, wharangi, ngaio, *oleria solandri*,

Pittosporum sp, pigeonwood, raukawa, red matipo, rewarewa, ribbonwood, toetoe, totara and tree fuschia. They have problems with wind, frost and compacted soils, trouble germinating pittosporum and five finger and would like a list of threatened plants suitable for the area plus phenology tables (bird food-plant lists).

Issues: Cross connected sewers and stormwater drains, strain on existing drains and stream as greenfields development progresses, Flood Protection mowing regime and designated flood channel, in-stream pollution, would like lost streams and springs mapped and to know where utilities lie around the stream. Safety issues with working close to roads and stream on steep banks. Erosion downstream from the junction of Stebbings and Porirua streams and sediment load in Stebbings stream.

Pest plants: Blackberry, gorse, periwinkle, wandering Willie, convolvulus, onion weed, gunnera, old man's beard (36 sites on Middleton Road), willows (some removed) ivy, cherry, sycamore, pines at Stebbings.

Pest animals: Possums present but no bait stations. Hares at Stebbings Dam but these have not touched planted trees.

Horokiwi Reserve Group

The reserve had been leased for cattle grazing for some years. Locals were keen to extend some planting begun by the lessee and have now taken over the whole reserve which is no longer grazed. The group has been supplied with some plants and grown others in their nursery. Supported by WCC with whom they have a memorandum of understanding. Horokiwi is a close knit community that has rallied behind this revegetation initiative but residents already have a huge commitment to their own properties. They would like to improve aquatic and vegetation links with Belmont stream.

Species used in planting: Standard revegetation species plus northern rata. They have a good understanding of environmental conditions but would like more guidance on what to plant.

Pest plants: pasture grasses.

Keep Porirua Beautiful

This organisation began in 1990 as a sub group of Keep NZ Beautiful. Their aim is to make Porirua visually attractive and a nice place to bring up children. They plant trees, pick up litter, support World Environment day, Clean up New Zealand week support Women Against Graffiti and are building relationships with schools including the Tidy Schools programme. The group makes use of PD workers and corporate volunteers, and school children (Adopt a Spot). They also assist in running the Creekfest (at Cannons Creek) and the NZ Housing Corporation street makeover programme, both annual events. They work at a large number of sites throughout Porirua. Most notable recent revegetation work is a joint project with Bishop Viard school on the banks of Porirua stream (Appendix 3).

Planting: a range of revegetation and amenity trees sourced from the Porirua City Council Nursery. They tend to choose species that are tough and easy care.

Issues: Rubbish in the stream, GWRC Flood Protection management programme,

Pest plants: The group targets a number of species on visual amenity grounds especially gorse. They are no longer planting karo. They encourage people to cut and spray fennel and actively discourage blackberry.

Pest animals: Rabbits.

Seton Nossiter Park Group

Background: The group is involved with Seton Nossiter Park on Belmont Stream, between Granada Village and Newlands. The group grew out of the residents association. One man in particular (Lawson Robinson, died 2007) was the driving force behind the planting work. He propagated and planted thousands of trees, helped by family, neighbours and friends, and the Newlands College Ecological Group.

Initial work started in 1993 when WCC revisited the Outer Green Belt link through Woodridge to Belmont Regional Park. The community worked with WCC on a Management Plan for the Park (covers 1996-2006). The residents association stays involved, regularly submits on issues in their part of the catchment, especially residential development, run-off, visual amenity, road connections.

Species used in planting: The person who did the majority of planting and home nursery work has recently died. There are no records of what has been planted or where in the reserve planting has been done.

Issues: There is currently a low commitment to working bees and the group is not recruiting. It is continuing work through schools. The group has planted throughout the reserve in earlier times, especially around the remnant tawa-titoki grove. Tawa has regenerated in this vicinity since WCC cut and chipped hawthorn trees. The Park Management Plan needs updating and inclusion of more of Belmont Stream and gully system that became part of the park as a result of Lincolnshire farm development.

The Main Trunk Line tunnel runs under the park and stream. It has altered groundwater in the area, springs have dried up, and fill from tunnel was spread on valley floor.

A number of issues have arisen through residential development (Woodridge and Lincolnshire Farm). Tops were taken off some ridges – landscape effects. Sedimentation was bad during Woodridge subdivision development. The group is worried about effects from development for a planned extra 9-10,000 people). Scouring & deposition in lower Seton Nossiter Park; increased sedimentation; floodwater management, fish passage. Fish passage was created in Lincolnshire Farm development but results not known.

Weeds: Pest plants listed in Management Plan.

Pest animals: Possums, goats, rabbits. Dogs can be a nuisance and group does not want park to become a dog exercise area.

Tawa-Porirua Stream Walkway/Cycleway Group

Background: This group of keen cyclists want to put back into the community by developing a largely off road route highlighting the scenic values of Porirua stream and nearby reserves and parks. The route starts at Willowbank Park and finishes at Kenepuru Station. The project has a greater emphasis on amenity than on biodiversity and the group recognises that issues such as sightlines and safety are priorities.

The group is liaising with Wellington City Council and Opus to draw up plans and negotiate access for the route. This will have multiple entry and exit points and they expect it to have multiple-uses from commuting to recreation. They will approach Porirua City Council about extending into Porirua City when the Tawa route is finalised. There are also plans to link their route to Johnsonville. Track construction will be contracted out.

This group made submissions on Wellington City Council's Northern Reserves Management Plan. They support the transport corridor routes through Porirua valley because of the potential to create longer term behaviour changes in transport activities in the area. They also endorse the plan's emphasis on connections linking reserves.

Species used in planting: The group will plant mainly for visual amenity and to deter graffiti. Native plants are preferred for this but they will also use exotic specimen trees where appropriate.

They hope to source plants from WCC & PCC nurseries which, they understand, supply eco-sourced native plants

Issues: Graffiti has long been a problem in this area. Erosion is an issue, particularly at the Redwood Tawa junction (by the railway station). The cycleway has been designed to enhance streambank stability. Rubbish from upstream is also a problem. They had wished for the route to be accessible to both walkers and a range of small vehicles from mobility scooters and wheelchairs to skateboards and cycles. A concrete surface will likely prove to be too expensive and a cheaper alternative will need to be found.

Woodridge Planters

Background: This a small remnant of regenerating bush, gazetted as a reserve. It lies between Seton Nossiter Park and Gilbert reserve. The area was farmland until recently but is now bounded by recent sub-division. The group got up and running in 2006 after work by individual members. They expect to carry on working for three or four years after the council funding runs out.

A small stream runs through the bush and the grassy reserve land below where the streambed has been re-contoured. The group is planting the grass edges of the bush and streambanks with help from corporate volunteers, scouts and other groups. They have funding from Wellington City and also local businesses and NGOs. They wish not only to improve their reserve but also raise awareness among the local community of stream health issues.

Issues: Road runoff polluting the stream. The group would like information on how to enhance freshwater biodiversity and more information on the catchment so that they can take a more holistic approach to their patch. They are developing their understanding of what to plant, how to get more people involved and how to involve children.

Species used in planting: Common riparian species including griselinia, kowhai, tarata, kohuhu, cabbage tree, toetoe, flax etc. They have also planted future canopy and emergent species including totara, miro, rewarewa, hinau, rimu and kahikatea. In the 2008 season they planted 500 from WCC, grew 300 themselves and purchased 500 ecosourced plants. Altogether they have planted almost 3,000 plants. They are keeping a photo record of plantings.

Pest animals: Haven't seen a possum in years.

Pest plants: Mimulus, wild turnip, watercress, blackberry, gorse, wandering willie.

Appendix 2 Planning context

This appendix lists council management plans, rules, regulations and strategies with an effect on management of native biodiversity and on restoration initiatives.

Greater Wellington Regional Council plans

Operative Regional Policy Statement 1995

The Regional Policy Statement (RPS) is the overarching statement of policy for the region under the Resource Management Act; it directs regional, city and district plans. It identifies the regionally significant issues around the management of the regions natural and physical resources and sets out what needs to be achieved (objectives) and the way in which the objectives will be achieved (policies and methods).

Proposed Regional Policy Statement 2009

This is the region's revised RPS, currently being consulted on. It contains many policies relevant to the Porirua catchment. For example the purpose of Policy 8 is to reduce the effects of non-point source pollution on water quality, bank erosion, and riparian ecosystems and to promote the benefits of riparian margins.

Stormwater action plan for the Wellington region 2007

Voluntary agreement providing a framework for coordinated stormwater management in the region. It involves GWRC and all territorial councils in the region.

Belmont Regional Park Management Plan 1996-2006

Aim: to provide for the development and management of Belmont Regional Park for outdoor recreational use, while protecting and enhancing its natural character, intrinsic values and cultural heritage. This plan is now out of date, in particular some land ownership has changed from Landcorp Farming to GW. However, review of the plan has been put on hold until a Regional Parks Network Strategy has been completed, which is due to be confirmed by mid 2010.

Administration of Watercourses Agreement 1980 (non-statutory)

This was developed in order to clarify the situation with regard to maintenance of watercourses on private property in urban areas over those sections of the stream where the Wellington Regional Water Board has agreed to contribute towards the cost of maintenance. Maintenance is defined as being any works required to remove impediments to the flood carrying capacity of the stream.

Erosion and Sediment Control Guidelines for the Wellington Region 2003

A non-statutory document intended to assist all persons working in earthwork situations with implementing methods and devices for minimising erosion and sedimentation. The Guidelines should be seen as a 'living' document and may be subject to future revision.

Greater Wellington's Riparian Management Strategy 2003

Non-statutory strategy guiding GWRC actions for riparian management on private land. Provides rationale and priorities for provision of information and financial assistance to private landowners.

Wellington City Council plans

Wellington City Council Biodiversity Action Plan 2007

This action plan coordinates WCC's biodiversity activities and identifies local priorities and actions to protect and restore biodiversity. Identifies the Porirua Stream as the largest in the city and issues for all city streams as: infilling, piping and culverting, water quality, weeds and pest animals. Visions: identify the state of Wellington's biodiversity, protect biodiversity from further fragmentation and loss, strive to restore biodiversity; and research to enable continuing successful management of biodiversity.

Draft Northern Reserves Management Plan 2008

Purpose is to provide WCC with a clear framework for day to day management and decision making for Council owned reserves and open spaces in the northern area for the next ten years. In particular it will ensure appropriate protection and management for important natural values on Council owned reserve land and open space.

Seton Nossiter Park Management Plan 1996

Northern Growth Management Framework 2008

A non-statutory guideline for future development within the northern area of Wellington. Its vision is to ensure that Wellington's northern suburbs will continue to develop as an integrated, liveable, diverse, sustainable and prosperous community.

Draft Suburban Centres Review

This is a draft plan change for chapters 6 and 7 of the Wellington City District Plan. A formal plan change will be prepared during 2009 following the consideration of feedback on an issues paper. This review represents an opportunity for staff of all councils and the public to push for wider streamside margins.

Draft Centres Policy

Defines character areas for protection and areas for more intensive development. The general philosophy being to intensify development around suburban centre hubs which are situated on a high quality transport corridor. The plan is to enhance the multi-functional nature of centres by facilitating residential development (including up to six stories), employment growth and increasing the range of facilities and services available there. Currently being finalised following receipt of submissions on draft.

Porirua City Council plans

Porirua harbour and catchment management programme

PCC, with the support of GWRC and WC, is committed to developing and implementing a Harbour and Catchment Strategy aimed at Harbour protection and restoration. The Council will continue an existing work programme for landowner assistance, restoration planting and a landowner advisory service aimed at reducing catchment erosion and improving stream water quality. While this programme is based on the Pauatahanui catchment, PCC is contributing towards the current report on restoration priorities in Porirua catchment because of its direct relevance to the Porirua Harbour and catchment programme.

Reserves network asset management plan 2004

This includes recreation, scenic, and local purpose (neighbourhood, esplanade, plantation, community use, fitness trail, and civic) reserves.

Revegetation policy 2004

This Policy has been produced by the PCC Leisure and Recreation Group to assist in the management and development of revegetation and planting works on land administered by the PCC.

Much of the Policy has arisen as a response to Council's need to clear pine plantations, and the subsequent rehabilitation of the land. The policy also provides for a consistent and integrated approach to other amenity and habitat restoration planting, the ongoing management of existing areas of vegetation and the integration of the people, groups and agencies involved in this work.

Porirua Scenic Reserve Management Plan 1991

Porirua Park Management Plan 1992

Amenity Lakes Management Plan 2004

These three plans cover management of specific PCC Reserves. The Amenity Lakes Management Plan applies to the Cannons Creek Lakes Reserve.

Draft Tree and Vegetation Policy 2009

The draft policy covers council Land and has the aims of:

- strategic planning of tree and vegetation management on Council land across the city so that long term benefits to the community are maximised and conflicts avoided.
- providing a consistent basis for making day to day decisions about managing vegetation and trees on all types of council land throughout the city.

Appendix 3 Case studies

Case study 1: Managing floodways and protecting biodiversity

Case study 2: Stream setbacks: working within the rules of multiple agencies

Case study 3: Riparian restoration and floodway management, a successful negotiation

Case study 1: Managing floodways and protecting biodiversity



Flooding in Porirua catchment has been managed by instigating a number of measures. Flood flows are attenuated (held back) by flood protection detention structures which hold some of the water from rainfall events back in the upper catchment, easing flows in the main stem of the stream. These measures, plus planning rules requiring development to be set back from the stream (see Case Study 2), and streambank protection work and vegetation management in the lower stream, are all designed to protect the Porirua CBD from flooding. The measures keep stormwaters in the channel and direct them into the harbour promptly without risk of blockage.

One of these measures is that some of the Porirua floodway is maintained by mowing a wide grass strip alongside the stream. Access to the grass for a tractor-drawn reach mower is difficult owing to the historic placement of buildings and other structures close to the stream. As a result, some of the grass is mown by driving the tractor along the streambed, in the water, while the mower reaches up the bank. There is also an area of streamside blackberry infestation which has to be cut back annually from the waterway, again using machinery in the stream. This maintenance regime causes considerable disturbance and damage to the bed of the stream, the waterway and the fish and insects that inhabit these areas.

Some flood control work, by its very nature, can be in direct conflict with policies that direct agencies to protect biodiversity, and aquatic ecosystems in particular, from harm. Resource availability is at the heart of this conflict. Flood protection works and maintenance are expensive and the Porirua catchment has a relatively low priority within the region. However, the sensitive nature of the lower stream environment suggests the need for greater accommodation of ecological factors in flood management, as discussed in the text.

For example, GWRC records show that the resource consent for this work (expiring in 2016) has no conditions covering ecological matters. For example, this method could be limited to the months outside the main fish migration period (October to mid March). Porirua Stream is home to two threatened species of native fish plus at least six other fish species. Most of these are migratory and need to spend part of their lifecycle in the sea. However, in the 2007/08 financial year 23 hours or nearly half of the total hours worked were during the main fish migration period.

In the longer term, the streamside environment may need to change to a form whereby riparian vegetation does not impede floodwaters but still allows land-based grass mowing and provides good riparian protection. Such changes would need to be made in the context of the Porirua Flood Management Plan and would require close cooperation between GWRC Flood Protection, territorial councils, other infrastructure providers and community groups.

Case study 2: Stream setbacks: working within the rules of multiple agencies



Development of the land at the margin of Porirua Stream is a continuing process. However, recent consent applications have resulted in disagreement between councils on the required width of setbacks from the stream edge. At issue is a lack of consistency between territorial authority rules, and disagreement over the application of those rules with regard to: onsite sediment control, access to and maintenance of the floodway, downstream erosion and sedimentation effects, and ecosystem function.

A retirement village development was recently planned for Tawa. WCC District Plan rules require a 5 metre setback on the selected site as it is in a designated floodway. GWRC Flood Protection Department (GWFP) asked for the setback to be increased to 7 metres. GWFP was concerned that active stream movement and the actions of the watercourse would erode the high streambanks, making it unsafe to carry out stream maintenance within a narrower setback. GWFP also felt that there was a potential for structural works to be necessary to allow continued maintenance of this section of Porirua Stream. There were also concerns about adverse effects of erosion followed by structural work, on stream water quality and ecosystem function. GWFP has made similar requests for other developments in this area.

The applicant's response was that the land use provisions only require a five metre setback from the stream, and therefore limit what Council could reasonably require by way of an increased setback. WCC subsequently approved the consent without increasing the setback from 5 to 7 metres. If this development was in Porirua City the required setback would be 20 metres.

The policies and rules surrounding this issue are complex. They are set out in the Regional Policy Statement, Regional Freshwater Plan, PCC's Stream Flood Management Plan and the WCC District Plan¹³. WCC is currently reviewing the Suburban Centres provisions in the District Plan, which includes rules on setbacks applicable to Porirua Stream.

¹³ See for example: Operative Regional Policy Statement Policies 8, 10, 12; Proposed RPS Policy 13; WCC District Plan 7.6.3.5.2 (Suburban centre standards); PCC District Plan C6.1 Subdivision objectives, D2 Industrial Zone rules and Standards (D2.2.1); D3 Suburban Zone Rules and Standards (D3.1.4.v and D3.2.1).

Case study 3: Riparian restoration and floodway management, a successful negotiation



Riparian restoration and floodway management, a successful negotiation

As discussed in the previous two case studies, where rivers and streams are involved there will always be conflict between protecting human life and property, developing land for economic or community benefit, and managing effects on the natural landscape, flora and fauna. The results are usually a compromise with gains and losses on both sides. This is the story of a successful negotiation between GWRC Flood Protection, GWRC Take Care programme, Keep Porirua Beautiful and Bishop Viard College, Porirua.

In Porirua City the banks of Porirua Stream have large areas of mown grass interspersed with regenerating native forest and residential gardens. Much of the regenerating forest is clogged with weeds (blackberry in the main) and garden escapees. These areas look unsightly, reduce the potential diversity of native species and can impede flood flows. Students and staff from Bishop Viard College wanted to improve an area of the streambank close to their school and started working with Keep Porirua Beautiful to this end. GWRC Flood Protection did not want the whole area planted because they were concerned that shrubs and trees would impede flood flows.

The GWRC Take Care community environmental programme, which supports volunteers, especially those working with streams, was asked for their help. They provided a list of native plants that would be appropriate in the situation. The flood protection maintenance crew were available to explain where trees could be planted so that they would not impede flood flows and where areas needed to remain as mown grass. Plants were supplied by Porirua Nursery and funded by Keep Porirua Beautiful.

Bishop Viard College students are enthusiastic about the spot they have adopted on the banks of Porirua Stream and intend to continue their work there in the future.

Appendix 4 Bibliography of plant species lists for Porirua Catchment

These species lists are sourced from Sawyer (2001) and are mainly available from the Department of Conservation, Wellington Conservancy.

Anonymous, No date: Cannon's Creek Lake Reserve. Proposed Porirua City Amenity-Lakes Management Programme.

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Ogle CC, 1969: Collins Rd Linden. Unpublished list held by Department of Conservation.

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Appendix 5 Length of streams lost into pipes across the Wellington region 2003-2008

(From GWRC database information)

Porirua catchment	1.214 km
Pauatahanui catchment	1.624 km
Aotea Block	1.89 km
Porirua City including all of Porirua catchment	4.728 km
Hutt Valley	1.419 km
Upper Hutt	2.219 km
Wellington City except Porirua catchment	2.448 km
Kapiti Coast	1.589 km
Masterton	0.251 km
Regional total	12.79 km

Appendix 6 ‘Best Bets’ species for restoration planting in the Porirua catchment

From the list of native plant species known to be present in the catchment as ‘natural’ vegetation the consultants have chosen a range which are their suggested ‘best bets’ for restoration planting in the catchment. The aim of this list is to provide a choice of species for propagation which suits the range of environments (ecodomains) in the catchment, and is wider than the range currently being planted, but for which propagation material can be reasonably readily obtained, grown on and be established.

Important proviso: not all species can be established and grown in all parts of the catchment. A major aim is to provide suitable species for all environments, and hence some species are only suitable for some environments, as shown by the indication of growing zones for the species chosen (column 2). Further notes on cultivation and value for birds are shown in column 3. Some tree species (mainly larger trees) are only suitable for planting later in a restoration programme, once a canopy is established.

When planting in a floodway particular care must be taken that flood flows are not impeded. Use 2 metre standard trees (and only at the top of the stream bank) and plants from the “riparian specialty” list below which can tolerate flooding. Swamp flax (*Phormium tenax*) is not suitable for planting in a floodway. Floodway plantings will need ongoing maintenance to prevent the build up of woody debris such as fallen branches. Any debris that might be gathered up by flood flows has the potential to cause a blockage downstream and make flooding worse.

Key to growing zones:

- 1=gullies and valleys - sunny,
- 2= -gullies and valleys - shady,
- 3=hill slopes - north facing/sunny,
- 4=hill slopes - south facing/shady
- 5=bluffy upper slopes

Key to cultivation tips and value for birds:

- A=alluvial, fertile soils
- D=dioecious (male and female sexes on different plants) so several individuals, grown from seed not cuttings, are needed to ensure fruiting
- F=fruit for birds, F*=fruit all year round
- H=hardy
- N=nectar for birds, N*=nectar all year round
- Q=quick growing,
- R=riparian
- S=sun-loving, canopy gaps and track edges
- T=frost tender
- W=water’s edge or damp spots
- X=shade
- Z=dry soils

“Best Bet” species for the Porirua catchment

Species	Growing zones*	Cultivation Tips *see key above
Trees and shrubs		
akiraho (<i>Olearia paniculata</i>)	1, 2, 3, 4	N
broadleaf (<i>Griselinia littoralis</i>)		T, D, F
cabbage tree (<i>Cordyline australis</i>)	1, 2, 3, 4, 5	H, F, N, S and partial shade, Z, W, soil holding ability
<i>Coprosma lucida</i>	1, 2	D, F
<i>Coprosma propinqua</i>	1, 2, 3, 4, 5	T, D, F
five-finger (<i>Pseudopanax arboreus</i>)	1, 2, 3, 4	Q, T, D, N, F*
hangehange (<i>Geniostoma ligustrifolium</i>)	1, 2	
kahikatea (<i>Dacrycarpus dacridioides</i>)	1, 2	A, F, W, frost hardy, will not tolerate drought
kamahi (<i>Weinmannia racemosa</i>)	1, 2, 3, 4	N
kanono (<i>Coprosma grandifolia</i>)	1, 2	D, F
kanuka (<i>Kunzia ericoides</i>)	1, 2	N
karamu (<i>Coprosma robusta</i>)	1, 2, 3, 4, 5	Q
kawakawa (<i>Macropiper excelsum</i>)	1, 2	T, F*
kohuhu (<i>Pittosporum tenuifolium</i>)	1, 2	D, Q, N, F
koromiko (<i>Hebe stricta</i> var <i>Atkinsonii</i>)	1, 2, 3, 4, 5	N, S
kotukutuku (<i>Fuchsia excorticata</i>)	1, 2	T, D, N, F, S
kowhai (<i>Sophora microphylla</i>)	1, 4	S, N
lacebark (<i>Hoheria populnea</i> var <i>sexstylosa</i>)	1, 2,	Q, N
lancewood (<i>Pseudopanax crassifolius</i>)	1, 2, 3, 4	D, F
lemonwood (<i>Pittosporum eugenoides</i>)	1, 2	D, Q, F, N
<i>Lophomyrtus bullata</i> x <i>obcordata</i>		
mahoe (<i>Melicetyus ramiflorus</i>)	1, 2, 3, 4, 5	T, D, F
manuka (<i>Leptospermum scoparium</i>)	3, 4, 5	N
mapou (<i>Myrsine australis</i>)	1, 2, 3, 4	T, D, F
matai (<i>Prumnopitys taxifolia</i>)	1, 2	S, F, frost hardy
miro (<i>Stachypitys ferruginea</i>)	1, 2	F, W, Z, drought intolerant
mountain horopito (<i>Pseudowintera colorata</i>)	4	F
ngaio (<i>Myoporum laetum</i>)	1, 2, 3, 4	S, N, F
nikau (<i>Rhopalostylis sapida</i>)	1	A, T, S, and partial shade, D, N, F, W, H
northern rata (<i>Metrosideros robusta</i>)	3	S, N
<i>Olearia solandri</i>	3, 4, 5	T
puka (<i>Griselinia lucida</i>)		D, F
putaputaweta (<i>Carpodetus serratus</i>)	1, 2, 3	F
ramarama (<i>Lophomyrtus bullata</i>)	1, 2	N, F
rewarewa (<i>Knightea excelsa</i>)	1, 2, 3, 4, 5	T, N
rimu (<i>Dacrydium cupressinum</i>)	1, 2, 3	A, S, F, W, problems eco-sourcing
rohutu (<i>Lophomyrtus obcordata</i>)		N, F
swamp maire (<i>Syzygium maire</i>)		Shallow muddy streams

titoki (<i>Alectryon excelsus</i>)	1, 2	D, F
totara (<i>Podocarpus totara</i>)	1, 2, 3	S, F, W, Z, frost hardy
tutu (<i>Coriaria arborea</i>)		S, F, streamside
wharangī (<i>Melicope ternata</i>)	1, 2	
wineberry (<i>Aristotelia serrata</i>)	1, 2, 3	D, Q, F
Grasses & sedges		S
<i>Carex secta</i>	1	S, W
<i>Carex solandri</i>	1	S, W, X
<i>Carex virgata</i>	1	S, W
<i>Gahnia pauciflora</i>	1	S,
<i>Gahnia setifolia</i>	1	S,
purei (<i>Carex flagellifera</i>)	1	S, W
toetoe (<i>Cortaderia toetoe</i>)	1, 2, 3	S
Herbs		
blueberry (<i>Dianella nigra</i>)	1, 2	F
harakeke, swamp flax (<i>Phormium tenax</i>)	1, 2	H, N, not suitable for floodways
kakaha (<i>Astelia fragrans</i>)	1, 2	D, N, F
kowharawhara (<i>Astelia solandri</i>)	1, 2	D, N*, F*
mikoikoi (<i>Libertia grandiflora</i>)	1, 2	S
mikoikoi (<i>Libertia ixioides</i>)	1, 2	S
mountain flax (<i>Phormium cookianum</i>)	1, 2, 3, 4, 5	H, N
rengarenga (<i>Arthropodium cirratum</i>)	1, 2	N
spaniard (<i>Aciphylla squarrosa</i>)	1, 3, 5	S

“Riparian specialty” plants. These are particularly suited to riparian areas anywhere in the catchment. Many of the trees selected grow tall with clean trunks. They make fine specimen trees but may ultimately grow very tall and be more suited for large public areas than domestic gardens. See previous pages for keys and notes about planting in the floodway.

Species	Cultivation Tips
	*see key above
Trees and shrubs	
cabbage tree (<i>Cordyline australis</i>)	H, F, N, S and partial shade, Z, W, soil holding ability
fivefinger (<i>Pseudopanax arboreus</i>)	F
kahikatea (<i>Dacrycarpus dacrydioides</i>)	D, A, F, W, frost hardy, will not tolerate drought
kanuka (<i>Kunzia ericoides</i>)	N
kohuhu (<i>Pittosporum tenuifolium</i>)	D, Q, N, F
kotukutuku (<i>Fuchsia excorticata</i>)	T, D, N, F, S
kowhai (<i>Sophora microphylla</i>)	N, S, H
lacebark (<i>Hoheria populnea</i> var. <i>sexstylosa</i>)	N, A
miro (<i>Stachypitys ferruginea</i>)	S, F
ngaio (<i>Myoporum laetum</i>)	N, F

nikau (<i>Rhopalostylis sapida</i>)	T, S, D, N, F, A
pigeonwood (<i>Hedycarya arborea</i>)	F
pukatea (<i>Laurelia novae-zelandiae</i>)	T, A
rewarewa (<i>Knigthea excelsa</i>)	T, N
ribbonwood (<i>Plagianthus regius</i>)	A
rimu (<i>Dacrydium cupressinum</i>)	S, F, A
tawa (<i>Beilschmiedia tawa</i>)	T, F
titoki (<i>Alectryon excelsus</i>)	F, A
tutu (<i>Coriaria arborea</i>)	F
Grass	
toetoe (<i>Cortaderia toetoe</i>)	S
Sedges	
<i>Carex gaudichaudiana</i>	W, S, A
forest sedge <i>Carex dissita</i>	W, S, A
forest sedge <i>Carex solandri</i>	W, S, A
Forsters sedge <i>Carex forsteri</i>	W, S, A
pukio <i>Carex virgata</i>	W, S, A
purei (<i>Carex secta</i>)	W, S, A
trip me up <i>Carex flagellifera</i>	W, S, A

