

TE AWARUA-O-PORIRUA HARBOUR AND CATCHMENT Sediment Reduction Plan

Response to sediment loss from the Te Awarua-o-Porirua Harbour catchment

A document prepared by the partners of the
Te Awarua-o-Porirua Harbour and Catchment
Strategy and Action Plan

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CONTENTS

1	Introduction	5
1.1	Objective, vision and targets	5
1.2	This plan.....	5
2	The sedimentation issue	8
2.1	What is sedimentation and why is it a problem?	8
2.2	Where is the sediment coming from?	8
3	How can excess sedimentation be remedied?	11
3.1	Prevent soil from eroding	11
3.2	Catch sediment before it enters the harbour.....	12
4	Sediment reduction activities	12
4.1	Reducing erosion on public land.....	14
4.1.1	GWRC land management activities	15
4.1.2	PCC land management activities	15
4.1.3	WCC land management activities.....	16
4.1.4	Supporting volunteer restoration activities	16
4.1.5	Street sump baffles.....	17
4.2	Supporting erosion reduction on rural private land.....	17
4.2.1	Targeting erosion on steep private farmland.....	17
4.2.2	Targeting eroding stream banks on private land.....	18
4.2.3	Protecting native bush on private land	18
4.3	Statutory regulation.....	19
4.3.1	Regional Plan and Whaitua Committee.....	19
4.3.2	District Plans	20
4.4	Education and awareness	20
4.4.1	Land developers, contractors and managers	21
4.4.2	Rural landowners.....	21
4.4.3	Schools.....	22

	4.4.4 Businesses.....	22
	4.4.5 The community.....	22
5	Science and research.....	23
	5.1 Historic research and baseline data gathering.....	24
	5.2 Ongoing monitoring and investigations	25
	5.3 Water quality monitoring by community volunteers.....	25
6	Summary of activities.....	26
7	Three year operational plan.....	29
8	Summary	30
9	References.....	31
10	Appendix 1: Land use and sediment generation	33

Sedimentation is the most significant threat to the health of Te Awarua-o-Porirua Harbour

1 INTRODUCTION

This plan outlines what is being done to reduce the amount of sediment entering the Te Awarua-o-Porirua Harbour.

The *Porirua Harbour and Catchment Strategy and Action Plan 2012*¹ (the Strategy) - developed in response to community concern about the state of the harbour - identified excessive sedimentation, pollutants and ecological degradation as the three key issues that need to be addressed to restore the harbour to good health and achieve the following vision.

“A healthy catchment, waterways and harbour, enjoyed and valued by the community”

Excessive sedimentation was identified in the Strategy as the greatest threat to the ecological health and recreational use of the harbour.

A scheduled three-year review of the Strategy was completed and reinforced the vision, objectives and targets of the 2012 Strategy while updating the *Te Awarua-o-Porirua Harbour and Catchment Detailed Action Plan*. A revised document was subsequently produced – *Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan 2015*. References in this plan relate to the revised 2015 Strategy.

Strategy partners Greater Wellington Regional Council (GWRC), Porirua City Council (PCC), Wellington City Council (WCC) and Te Rūnanga o Toa Rangātira (TRoTR) have undertaken to work together to achieve the vision and objectives set out in the Strategy.

1.1 Objective, vision and targets

A key objective in the Strategy is to “reduce rates of sedimentation” to achieve the following vision.

- *“To reduce sediment inputs to harbour and waterways to more natural levels*
- *To significantly improve harbour water clarity and harbour flushing capacity”*

Targets to achieve this vision have been set as follows:

- Interim target: to reduce sediment inputs from tributary streams by 2021
- Long-term target: to reduce sediment rates to 1 mm/year by 2031 (averaged over the whole harbour)

1.2 This plan

This sediment reduction plan is the outcome of the prioritised action TB17 in the Strategy, to ‘Complete a whole-of-catchment Te Awarua-o-Porirua Harbour and Catchment Sediment Reduction Plan’. Figure 1 shows the extent of the harbour catchment.

¹ Updated in 2015

In this plan, sediment reduction activities that the project partners are already undertaking and will undertake over the next three years are outlined, together with a three-year operational plan and budget.

This plan will be formally reviewed and updated every three years, in line with scheduled updates of the Strategy. The next version of this plan will also incorporate recommendations from the *Te Awarua-o-Porirua Whaitua Implementation Programme* produced by the Te Awarua-o-Porirua Whaitua Committee. The committee was formed to develop recommendations for the *Proposed Natural Resources Plan* regarding, amongst other things, water quality limits for pollutants including sediment in waterways in the catchment. The Whaitua Committee will also recommend a range of non-regulatory methods for reducing the volume of sediment entering Te Awarua-o-Porirua Harbour. Between reviews, project partners will continually strive to improve the delivery of their sediment reduction activities.

In preparing this plan, the project partners have drawn upon two technical reports (Green et al. 2014, Handford & Cosslett 2014) which provide valuable information about existing land use cover, future land use changes and crucially, the amount of sediment expected to flow into the waterways and harbour from the various land uses. CLUES modelling² was used in both of these reports to identify likely sediment sources and volumes, estimated according to the variables of land use, geology, soils, slope, rainfall and current vegetation cover.

² Catchment Land Use for Environmental Sustainability [CLUES] is a GIS-based modelling system for predicting long-term annual average loads of sediment and *Escherichia coli*, and loads, concentrations and yields of nitrogen and phosphorus generated by different land use classes.

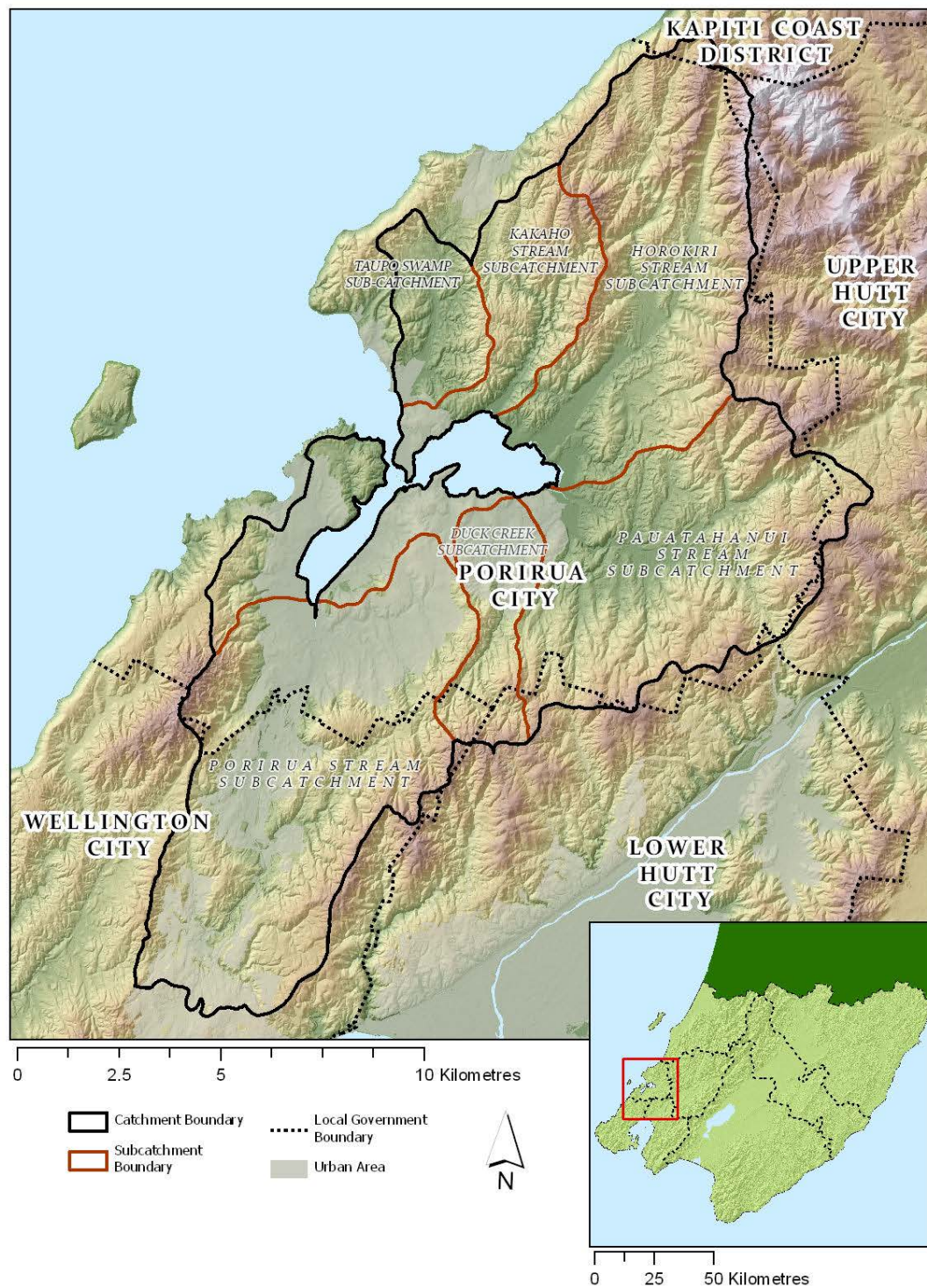


Figure 1. Te Awarua-o-Porirua Harbour lies within the Porirua district, 20km north of central Wellington. Summit ridges define the outer edge of the harbour catchment, which stretches north-south 28km from above Pukerua Bay to Johnsonville, and east-west 15km from Colonial Knob to Haywards Hill. The harbour has two arms, the larger Pauatahanui Inlet and the smaller Onepoto arm adjacent to the Porirua central business district.

2 THE SEDIMENTATION ISSUE

2.1 What is sedimentation and why is it a problem?

Sedimentation, in geological terms, is a natural process by which material, such as stone, sand and silt, is carried and then deposited by water, wind or glaciers.

Sediment accumulates in all estuaries and harbours over time but the rate of sedimentation in Te Awarua-o-Porirua Harbour significantly exceeds the natural rate of under 1mm per year (Porirua City Council 2015). Sediment entering the harbour is either:

- **terrestrial sediment**, washed off the land and carried by streams, rivers, stormwater pipes and overland flow; or
- **marine sand** carried from the sea into the inner harbour by tidal currents.

Research indicates that little marine sand is now entering the harbour and that the primary source of the excessive sedimentation is terrestrial. The excessive rate of sedimentation is broadly due to the clearance of forest and conversion of land to pasture, rural and urban development and other types of land use in the past. Together these changes have resulted in greater exposure of soils and increased erosion. The eroded material has been washed into the harbour, causing it to fill in at an unnaturally fast rate.

Data from sequential bathymetric surveys estimated the average sediment rates for the Pauatahanui and Onepoto arms of the harbour to be 9.1 and 5.6mm per year respectively, from 1974 to 2009 (Gibb & Cox 2009). However following another bathymetric survey (Cox 2015) in 2014, and seven years of sediment plate monitoring, annual sedimentation rates appear to have reduced to around 2mm (Robertson & Stevens 2015) per year between 2009 and 2015. However, this is likely to be due at least in part to relatively few storm events over this period.

The excessive rate of sedimentation in Te Awarua-o-Porirua Harbour has adverse effects. Suspended sediment reduces water clarity which discourages many fish species, is impacting sea grass growth and providing an adverse impact on amenity values. Silt deposition is smothering the seabed, affecting the seagrass and shellfish and may be depleting the harbour's ability to attract and sustain fish. Localised reduction in harbour depths is affecting navigability for motor craft, sail boats, waka and kayaks. It is also undermining the harbour's visual attractiveness. Reclamation and sedimentation have progressively reduced the amount of water that moves in and out of the harbour with the tide (its "tidal prism") and this affects the harbour's ability to flush sediments and pollutants.

2.2 Where is the sediment coming from?

The main sources of sediment being produced in the catchment have been identified. The relative volumes from different sources have been estimated by modelling and analysis of information relating to geophysical characteristics, land use and other relevant variables (Green et al. 2014, Handford & Cosslett 2014).

For example, Figure 2 shows the current estimated relative sediment yield in tonnes per hectare per year throughout the Te Awarua-o-Porirua Harbour catchment. This takes into account land use, geology, soil type, slope, rainfall and current vegetation cover – all variables that affect how much soil is likely to be lost from a given area.

Some land uses can cause soil to erode more than others. Forest and scrub cover is much better at retaining soil than pasture. Urban areas produce less sediment due to the high proportion of hard paved surfaces. However, the earthworks required to develop urban and suburban areas produce the greatest volume of sediment per hectare.

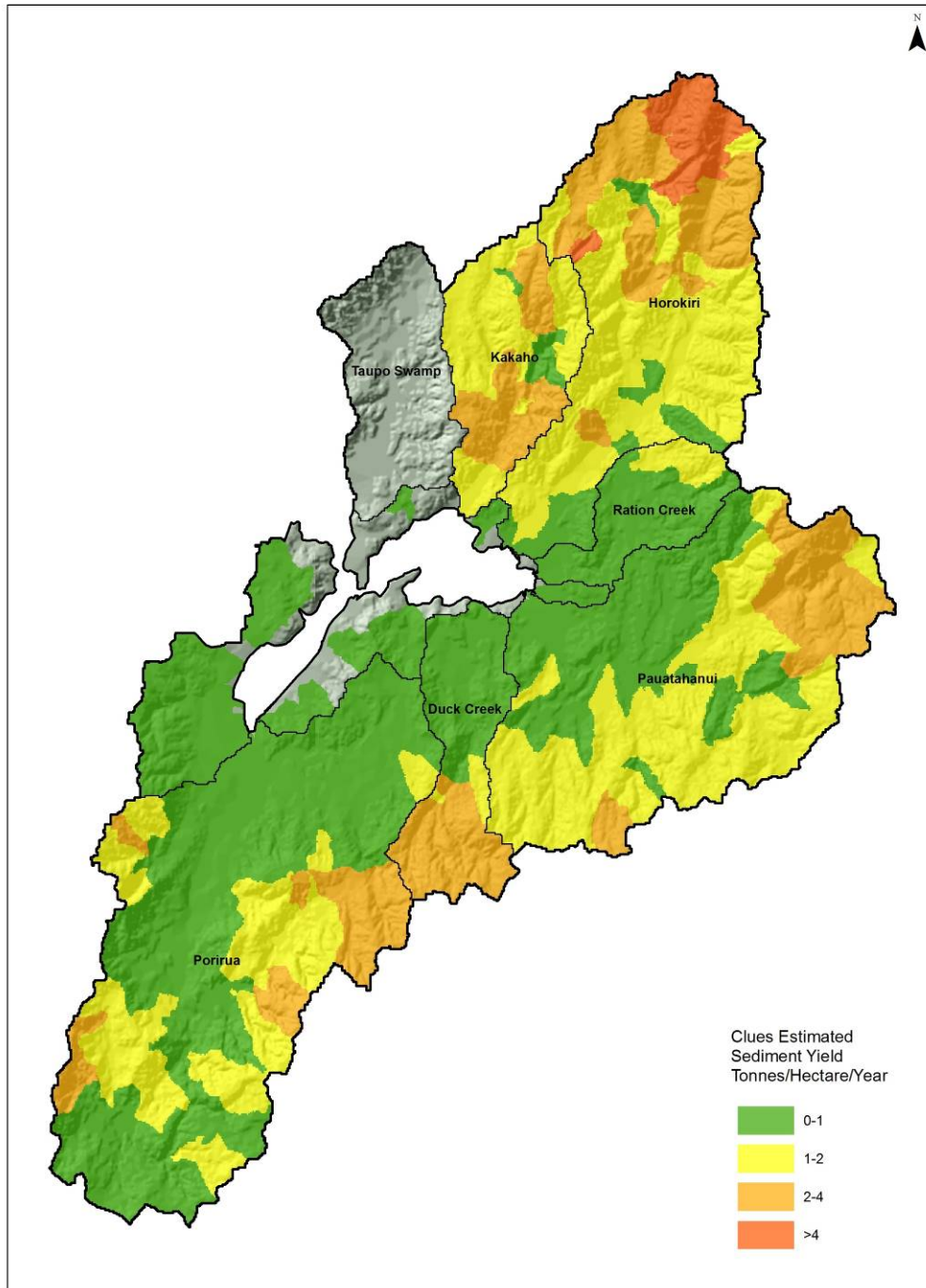


Figure 2. Relative sediment yield in the Te Awarua-o-Porirua Harbour catchment

This map (Handford & Cosslett 2014) shows broadly, the areas from which the most to least volume of sediment is being eroded in the catchment. It is a summary of the results from modelling undertaken to calculate the sediment yield, based on factors like slope, how erodible the soil is, and how much protection different types of vegetation cover, such as pasture, exotic forest and native forest, provide against erosion. Note: that this is a coarse scale of mapping and that, at a smaller scale, there will be variation in sediment production within the coloured areas.

Figure 3 shows the relative proportion of land area to estimated sediment produced in relation to the five main land uses in the Te Awarua-o-Porirua Harbour catchment (see Table 8 in Appendix 1 for more detail). Figure 3 shows that the largest volumes of sediment produced in the catchment come from pastureland and then from earthworks. Note the disproportionate amount of sediment produced from earthworks (24% of sediment from just 1% of land area).

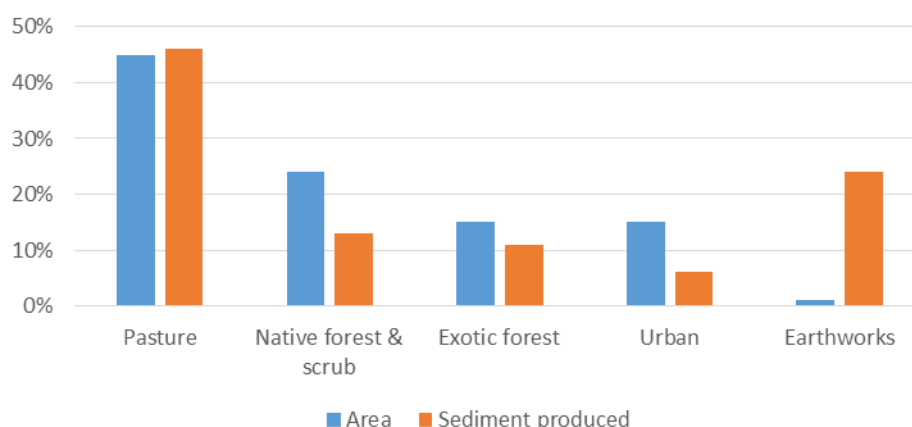


Figure 3. Percentage of land use area to sediment produced (Handford & Cosslett 2014)

Sediment can also come from eroding stream banks in rural and urban areas, although the spatial area and rate of sediment yield in the catchment is not known.

From the modelling analysis, four main sources of sediment have been identified for the Te Awarua-o-Porirua Harbour catchment as well as less significant miscellaneous sediment sources. The impact of each varies.

- **Erosion-prone pasture in the steep upper reaches of the catchment**

Much of the steepest land in the catchment is contained within large, rural land holdings, where it is mainly pasture grazed by stock.

- **Forest during harvest**

Around 14% of the Te Awarua-o-Porirua Harbour catchment is covered in plantation forest that will be harvested at some point. Even though some aspects of forest harvest such as the discharge of water from roading and skid sites are regulated by resource consent processes, which include conditions aimed at reducing the sediment generated, significant amounts of sediment can be released during and for a period of around 3 years after harvest operations. This is due to the logging itself, associated earthworks and the exposure of large areas of soil until new vegetation cover establishes.

- **Earthworks resulting from building and infrastructure developments**

Earthworks result in exposed soil. With no vegetation cover to protect it, and in the absence of suitable management, soil can be rapidly washed away into streams and the harbour. Approximately 1% of the total catchment (Handford & Cosslett 2014)³ is estimated to be under development at any one time. However, this is likely to increase as a result of the large urban developments planned by both Wellington and Porirua city councils, and major

³.Also reproduced in Appendix 1

roading infrastructure development planned. For example, the maximum expected annual load in the first six years of Transmission Gully Motorway construction is estimated to be 2500 tonnes (7% of the total annual sediment load for Te Awarua-o-Porirua Harbour) (Green et al. 2014). However, once the motorway is finished and the proposed mitigation is in place, the volume of sediment coming off the affected land will be 450 tonnes per year less than it was before the motorway was built (Green et al. 2014).

- **Erosion-prone stream banks**

Stream bank erosion is a natural process but that process can be accelerated without riparian vegetation to stabilise the banks. The high fast flows during floods can also increase the rate at which stream water will erode stream banks and carry material downstream. Despite a lack of research on the volume of sediment produced by eroding stream banks in New Zealand, overseas studies (Handford & Cosslett 2014) have found it can be the largest single source of sediment. Observations in the Te Awarua-o-Porirua Harbour catchment suggest that stream bank erosion is a significant source of harbour sediment.

- **Other sediment sources**

Other less significant, though cumulative, sediment sources include soil disturbance in urban or suburban areas, such as minor backyard earthworks, gardening, sports ground works, recreational track development and road debris.

3 HOW CAN EXCESS SEDIMENTATION BE REMEDIED?

Sediment reduction can only be achieved by changing the way things happen on the ground. Two over-riding principles apply: prevent as much erosion as possible and capture any sediment before it gets into the water.

3.1 Prevent soil from eroding

The main ways to reduce erosion are:

- Planting land susceptible to erosion, such as steep pasture and riparian margins, with deep rooting plants to stabilise it
- Protecting vulnerable land from grazing animals
- Allowing vulnerable, previously grazed areas to revert to regenerating scrub
- Minimising further land clearance and soil disturbance
- Protection of earthworks at source (eg, mulching, hydro-seeding)

For example, conversion of grazed pasture to forest is estimated to reduce the volume of sediment being eroded from the land from up to six tonnes per hectare to one tonne per hectare (Handford & Cosslett 2014)⁴. It should be noted that more sediment will erode during particularly wet years but, overall, the total amount of sediment should be significantly reduced by changing how we manage the land.

⁴ Also reproduced in Appendix 1

3.2 Catch sediment before it enters the harbour

If sediment is produced, as will inevitably happen with such activities as land or infrastructure development, farming or forest harvest, then it is important to catch as much as possible before it enters the harbour. The main tools used to achieve this include:

- Deep rooting vegetation to stabilise eroded soil collecting in gullies
- Wide vegetated riparian margins to slow rain runoff and allow sediment to drop out of the runoff before it reaches streams and the harbour
- Sediment control devices, such as silt traps, ponds and barriers, designed to retain sediment on sites where soil is exposed and disturbed
- In some areas, wetlands, swales and sediment-retaining devices can usefully filter runoff and overland flow
- Stormwater drain sumps, which collect debris run-off from roads
- Sediment traps on some drains and pipes to catch sediment before water discharges into the harbour

4 SEDIMENT REDUCTION ACTIVITIES

The Strategy lists the types of activities that can be used to target reduction of sediment. These include work on public and private land to stabilise soil; regulatory approaches to reduce erosion; and community education and awareness about best practice techniques to minimise sediment. Each of these different activities are explained in more detail in this section and summarised into a table in Section 6, which also shows the sources of sediment targeted and the audiences to be engaged.

Sediment reduction activities are prioritised by Strategy partners according to the amount of sediment being produced by different land uses. The Strategy partners are working together to ensure their combined efforts address the full range of identified sediment sources and successfully engage relevant stakeholders to help reduce the volume of sediment produced from their land or activities.

Table 1 summarises the main places where sediment sources are situated and the main ways erosion can be controlled on the ground. Figure 4 shows where these are in the catchment.

Table 1 shows that stakeholders include both public landowners, private landowners and others, such as contractors, who may need to be involved in reducing sediment. Consequently, the Strategy partners have identified four different approaches to reducing sediment, which take into account the key people or organisations that need to be involved as well as the target land areas. For instance, the three project partner councils are able to change land management practices on their public land through their internal operational and budgetary processes, whereas a quite different approach is needed to work with private landowners.

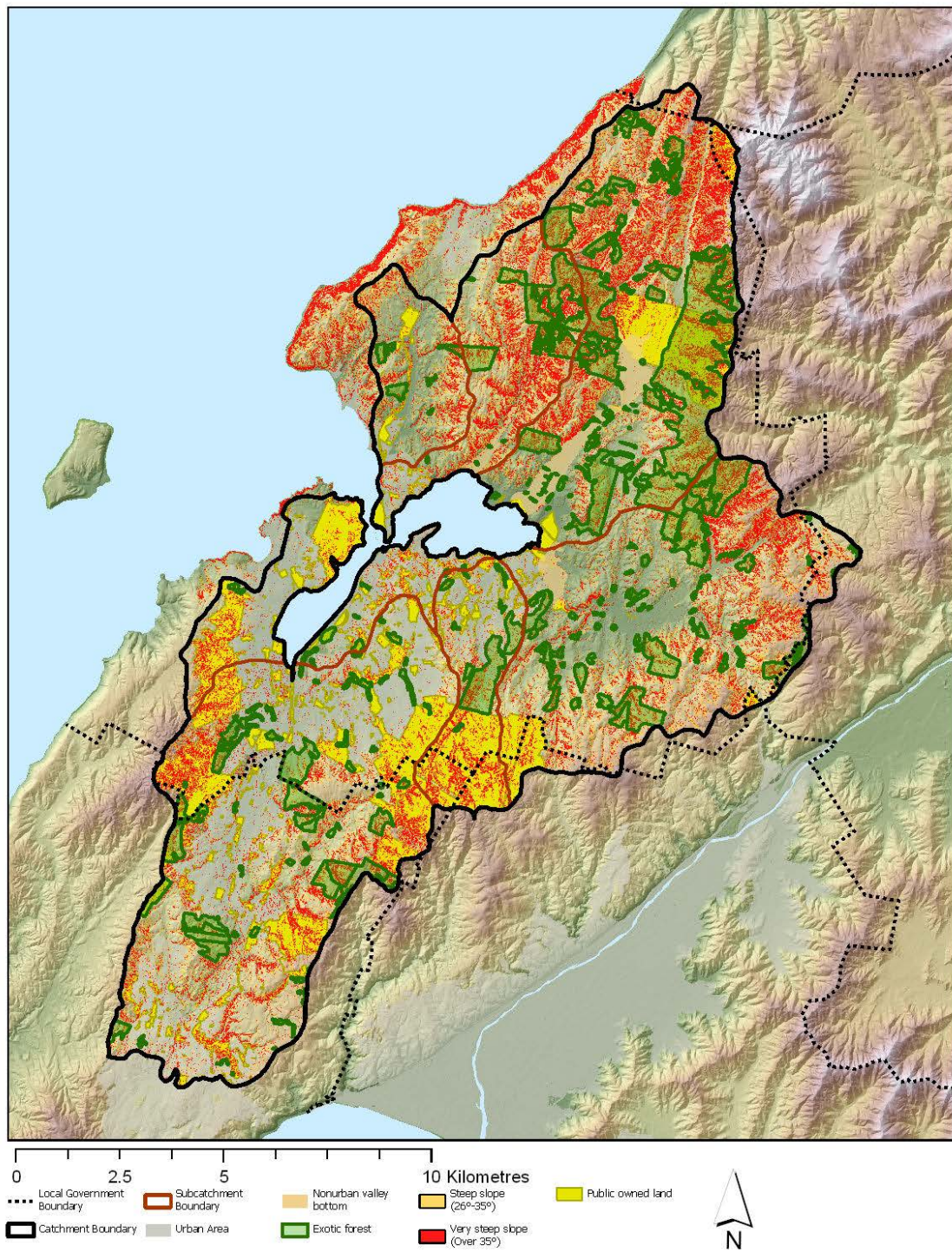


Figure 4. The majority of steep erosion-prone land is privately owned (public land is identified on the map in yellow), as is most of the harvestable forest.

Table 1. Main sediment sources in the Te Awarua-o-Porirua Harbour catchment

Main sediment sources	Steep pasturelands	Earthworks	Erosion-prone stream banks	Forest harvest	Other sediment sources
Areas	• Upper catchments	• Urban, suburban and infrastructure development areas	• Riparian land, particularly on flood plains*	• Mature production forest areas	• Urban and suburban land
Remedies	• Planting • Protecting land from grazing • Allowing scrub to regenerate	• Best site management practice	• Fencing & riparian planting • Protect existing riparian vegetation	• Best site management practice • Rapid revegetation	• Best practice erosion prevention
Stakeholders	• Public landowners • Private landowners	• Land owners • Developers • Contractors	• Public landowners • Private landowners	• Forest owners • Contractors	• Private landowners • Public landowners

*Shown in Figure 4 as non-urban valley bottoms

The four approaches to sediment reduction, which are outlined in the following subsections, are:

- Reducing erosion on public land
- Supporting erosion reduction on rural private land
- Statutory regulation
- Education and awareness

4.1 Reducing erosion on public land

Approximately 3,200 hectares (16%) of the Te Awarua-o-Porirua Harbour catchment is in public ownership and administered by the three Strategy partnership councils or by DOC. Native and other vegetation cover, which helps stabilise the soil, is being restored and protected on substantial areas of this public land through stock exclusion, planting and pest control. However, there are also some areas that are currently grazed where sediment reduction activities are planned because:

- Areas of highest sediment yield are targeted: namely, large areas of the steep, pasture-covered land in the upper catchments and some erosion-prone stream banks
- The Strategy partner landowners are already committed to taking action under the Strategy and are able to take direct action on their land
- These agencies can show leadership by setting a good example and demonstrating applied sediment reduction measures and benefits

The Strategy partners will continue to focus on reducing sediment reaching the harbour from land they manage by stabilising the pasture and using the methods outlined in Sections 4.3 and 4.4 when harvesting any plantation forest.

Where appropriate, Strategy partners will provide community, corporate and school volunteers with opportunities to help restore vegetation cover on local parks and reserves. This will encourage volunteers to learn about harbour health and spread key messages about the benefits of

revegetation, soil stabilisation and the importance of managing land in a way that reduces sediment loss.

4.1.1 GWRC land management activities

Belmont, Battle Hill and Whitireia⁵ regional parks either wholly or partly drain into the Te Awarua-o-Porirua Harbour catchment. Land management activities on regional parks are guided by Sustainable Land Use Plans (Handford & Associates 2011, Handford & Associates 2009) and the *Parks Network Plan* (Greater Wellington Regional Council 2011), which outline the following ongoing sediment reduction activities.

- **Belmont Regional Park**
 - Retirement of land from grazing and allowing natural regeneration of the upper Duck Creek and Cannons Creek catchments (since 2014-15)
 - Stream bank planting, especially Cannons Creek (since 2000)
 - Retirement of Cannons Creek catchment from grazing, with 74 hectares fenced to exclude stock in 2015-16, and possible restoration of native plant communities by community volunteers proposed from 2015-16
 - Transmission Gully highway mitigation works, including the retirement of 160 hectares fenced to exclude stock, and pest animal control, mostly in the Duck Creek catchment (from 2015)
- **Battle Hill Farm Forest Park**
 - Retirement of some steep faces from grazing and allowing natural regeneration (from 2009)
 - Riparian planting and stabilising steep areas with poplars and/or willows (since 2000)
 - Wetland development (since 2000)
 - Transmission Gully highway mitigation works (from 2016)
- **Whitireia Park**
 - Revegetation of previously burnt areas (since 2010)
 - Riparian planting (since 2010)

During the implementation of these activities, the GWRC Parks department will use good practice land management tools and techniques, to demonstrate these to other landowners in the catchment.

4.1.2 PCC land management activities

Porirua City Council manages its reserve land in the Porirua district through the *Porirua City Reserves Management Plan*. This plan covers reserve land around the district including reserves that are adjacent to stream banks and the Te Awarua-o-Porirua Harbour as well as steeper land such as the western hills. The following objectives and policies of the reserves management plan will inform sediment reduction practices:

- Riparian values will be maintained, and improved where practicable
- Existing vegetation on coastal reserves will be maintained and increased where possible
- Land and facility management should avoid contamination of intertidal and marine areas (by sediment or pesticides, for example)

⁵ Whitireia Regional Park is managed by a Park Board with representatives from Ngati Toa and GWRC

- Existing natural native vegetation cover should generally be maintained in reserves
- Planning and implementation of natural heritage improvement initiatives should nurture natural regeneration and prioritise restoration work in reserves in the lower reaches of the Porirua Stream and other waterways entering the harbour
- Stream management in reserves within the tributary Mitchell and Kenepuru Stream sub-catchments of the Porirua Stream catchment should ensure that there are no adverse impacts downstream from land disturbance, vegetation removal, structures, discharges or stream bank erosion

Each reserve is also managed to achieve specific outcomes which, in many cases, focus on the natural regeneration of vegetation and increased native planting and stream bank planting where possible. The Colonial Knob Parkland, the esplanade areas of the Porirua Stream Reserves, Bothamley Park, Camborne Walkway and Cannons Creek Lake Reserve are all examples.

Porirua City Council aims to manage all activities undertaken on reserve land to minimise erosion and sediment runoff in the catchment. Examples of work undertaken include:

- Silt and sediment controls are used during land disturbance/earthworks
- Disturbed land is immediately re-grassed or planted to minimise sediment run off (PCC requires this as a standard consent condition and condition of works in reserves)
- Community groups are encouraged to be involved and supported in protecting regeneration and planting native vegetation on reserve land

4.1.3 WCC land management activities

Wellington City Council manages reserve land in the Te Awarua-o-Porirua Harbour catchment through reserve management plans: the *Northern Reserve Management Plan* and the *Outer Green Belt Management Plan*. The plans cover numerous reserves in the upper and middle reaches of the Porirua Stream and tributary catchments, including steep, erosion-prone land on the flanking hills and ridges, and on stream banks. The management plans outline the following objectives that will contribute to sediment reduction:

- Restore a broad and continuous band of vegetation across the eastern slopes of the Outer Green Belt, linking the many stream gullies and bush remnants, stabilising land and minimising erosion
- There will be continual riparian cover on one or both sides of all streams flowing through council reserves and new riparian plantings will be no less than 5 metres wide where possible

WCC will encourage and support local communities and interested groups to develop community catchment plans, under which planting for biodiversity values will also help reduce erosion by stabilising soil.

4.1.4 Supporting volunteer restoration activities

Strategy partners support volunteers, who stabilise soil on public land through environmental restoration projects, by providing information, advice and logistical and financial support. More specifically:

- All councils provide opportunities for schools, corporate and/or other community groups to participate in council-run planting events (this is discussed in more detail in Section 4.4)

- WCC provides community groups with up to 1,000 free plants each, logistical support and advice to through the community greening programme, and supports community plant nurseries
- WCC manages a contestable grant (Our Living City fund) to assist the community with environmental projects within WCC boundaries
- GWRC supports volunteers and community groups, who are restoring native vegetation to regional park land, with advocacy and advice, event support and/or resources for projects as appropriate
- GWRC manages a contestable fund to further assist community volunteers interested in restoring native plants to eroding areas in the Te Awarua-o-Porirua Harbour catchment⁶
- As well as giving project-related advice, GWRC and WCC support community restoration projects by providing information (often via relevant publications) and will work together to provide volunteer training in good practice ecological restoration

4.1.5 Street sump baffles

All new or renewed roadside sumps in WCC jurisdiction are “baffled” to trap coarse sediments, litter and debris. WCC is aiming to increase the proportion of its baffled sumps in the Te Awarua-o-Porirua Harbour catchment from the current approximately 90% to 100%.

PCC employ a different type of roadside sump. They have installed catchers to intercept sediment and gross litter on the kerb upstand gap on 300 (out of 4,300) of their sumps so far. The intention is for catchers to be installed in all roadside sumps in new subdivisions.

Both PCC and WCC maintain street and street sump maintenance programmes to ensure effective and efficient operation of the stormwater network, including regular planned sump clearance to remove sediment accumulations from all sumps, with safe disposal to landfill.

4.2 Supporting erosion reduction on rural private land

Over 10,400 hectares (83%) of rural land in the Te Awarua-o-Porirua Harbour catchment is privately owned, of which a significant amount is managed in pasture and subject to erosion (as shown in Figure 4). Strategy partners are committed to supporting private landowners to reduce erosion on their land because:

- Areas of highest sediment yield are targeted: namely, large areas of the steep, pasture-covered land in the upper catchments and some erosion-prone stream banks
- Private land owners/managers may need advice to decide on the most efficient and cost-effective sediment-reducing actions
- Private land owners/managers may need assistance with funding and/or resources to implement sediment reduction measures

4.2.1 Targeting erosion on steep private farmland

Steep pasture is one of the main sources of sediment in the Porirua catchment (Handford & Cosslett 2014). Approximately 70-80% of the sediment comes from properties over 10 hectares in size, with the highest amount coming from those over 50 hectares in size (Handford & Cosslett 2014).

⁶ This is discussed in more detail in the project plan for supporting community restoration projects in the Porirua Harbour catchment (WGN_DOCS-#1500296).

Since 2006, GWRC and PCC have jointly funded a programme by which rural and rural-residential (eg, lifestyle block) landowners around the Pauatahanui Inlet are assisted to undertake land management practices that reduce the amount of sediment runoff from their land (the Pauatahanui Vegetation Framework, or PVF, programme). This largely involves fencing off and planting riparian margins, and fencing erosion-prone pasture to allow regenerating plants to stabilise the soil or planting native or exotic trees. Sustainable Land Use Plans have also been produced for some of the larger landholdings.

During the 2015/16 year GWRC will, with the support of PCC, replace the existing PVF programme with a Farm Environment Plan programme across the whole Te Awarua-o-Porirua Harbour catchment. GWRC staff will engage with landowners in priority sub-catchments⁷, whose properties have been identified as having the largest areas of erosion-prone land to produce property-specific Farm Environment Plans. Other landowners in the catchment with significant areas of erosion-prone land may also be targeted, if not enough priority landowners are engaged in any one year.

The Farm Environment Plans will outline how landowners can reduce erosion and retain soil on their land. Landowners will be subsidised to implement recommended actions, which may include:

- Fencing pasture and/or streams to exclude stock and allow natural regeneration
- Planting exotic or native plants to stabilise pasture and/or stream banks
- Installing hard engineering works to address erosion where appropriate
- Improving the ability of natural wetlands to collect sediment and/or building other structures such as detainment bunds⁸ to capture sediment
- Good management practices around stock management, such as reducing the impacts of winter grazing on soil and water quality
- Where landowners plan to harvest production forest, the regulatory and education and awareness methods outlined in Sections 4.3 and 4.4 will be used to ensure good practice in sediment minimisation and control including, where appropriate, guidance through Farm Environment Plans

4.2.2 Targeting eroding stream banks on private land

On smaller properties, where full Farm Environment Plans are not warranted, GWRC may support riparian restoration, which will extend the substantial legacy of stream revegetation already undertaken through the PVF programme.

4.2.3 Protecting native bush on private land

Protecting native bush ensures ongoing soil stability. In particular, ensuring understorey vegetation is intact can significantly reduce soil erosion. Bush on private land can be protected by on-the-ground management, most particularly, by excluding stock and controlling pests, and by covenants put in place by landowners to legally protect areas of biodiversity value in perpetuity. The following assistance with bush protection will be offered to private landowners:

- GWRC provides financial assistance of up to 40% of fencing costs to landowners wishing to enter into a perpetual QEII National Trust⁹ open space covenant. There may also be an

⁷ Horokiri, Pauatahanui and Porirua stream sub-catchments

⁸ It should be noted that, due to expense and logistical constraints, sediment capture options are most likely to be employed where they are addressing large-scale sediment generation from multiple properties

⁹ www.openspace.org.nz

additional one-off contribution towards the initial set-up cost for pest control and maintenance. Existing covenants may also be supported with funding for pest control

- PCC administers and provides funding for local body native forest covenants
- GWRC also protects native bush on private land through the Key Native Ecosystem (KNE) programme. KNE sites are those identified as representative samples of the highest value ecosystems in the region. Where a KNE site is on private land, GWRC undertakes pest animal control and other biodiversity management activities, and may assist landowners to fence the area to exclude stock. These measures ensure the land remains covered with native vegetation, significantly reducing the risk of erosion. There are four KNE sites on private land in the Te Awarua-o-Porirua Harbour catchment

4.3 Statutory regulation

The three council Strategy partners, GWRC, PCC and WCC, are responsible for regulating sediment management under the Resource Management Act 1991 (RMA). In doing so, the council regulations must give effect to the relevant national and regional policy directions given in the *New Zealand Coastal Policy Statement*¹⁰, the *National Policy Statement for Freshwater Management*¹¹, and the *Regional Policy Statement for the Wellington Region*¹².

In this section the regulatory approaches being taken by the three councils are outlined.

4.3.1 Regional Plan and Whaitua Committee

GWRC's *Proposed Natural Resources Plan* (Greater Wellington Regional Council 2015)¹³ introduces a new catchment-based approach to resource management to help address the management of discharges, including sediment.

The proposed plan contains rules that specify which sediment-producing activities need resource consent. It also provides guidance on what will be required to reduce potential negative effects of sediment on the environment, in order to obtain resource consent.

GWRC provides free advice to consent applicants to ensure they understand what is required. GWRC then monitors consented activities to ensure the conditions of the consent are being met.

As part of the GWRC programme for the implementation of the *National Policy Statement for Freshwater Management*¹⁴, the Te Awarua-o-Porirua Whaitua Committee was formed in early 2015 to address the land and water resource management issues in the Te Awarua-o-Porirua Harbour catchment. The Whaitua Committee will consider ways to maintain or improve water quality in the catchment, including the management of sediment.

Within three years, the Committee will make recommendations to GWRC in a *Te Awarua-o-Porirua Whaitua Implementation Programme* on the management of land and water in the catchment. This may include limits on the volume of sediment allowed to flow to the harbour as part of the package of recommendations on regulatory and non-regulatory methods to improve water quality. The

¹⁰ Published 2010

¹¹ Last updated in 2014

¹² Current version has been operative since 2013

¹³ The proposed plan was notified on 31 July 2015. It replaces five regional plans that previously provided for the management of the coast, air quality, freshwater, soil, and discharges to land. Of these, the freshwater, coastal and soil plans gave direction on sediment management.

¹⁴ www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2014

recommendations will be considered for inclusion in the *Proposed Natural Resources Plan* by way of a plan change. The implementation of sediment limits recommended by the Whaitua Committee will likely address all sediment sources described in this sediment reduction plan.

Any new sediment limits and methods to achieve sediment reduction identified in the *Te Awarua-o-Porirua Whaitua Implementation Programme* will have a significant influence on future reviews of this sediment reduction plan.

4.3.2 District Plans

Wellington and Porirua city councils use resource consent conditions under the *Resource Management Act 1991* to manage adverse effects caused by sediment. Many resource consents will include conditions that require the applicant to manage sediment. PCC is currently reviewing the *Porirua City District Plan* (the District Plan), including the provisions for earthworks controls. Part of this review involves aligning the District Plan with the *Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan 2015* (the Strategy), including the Strategy's focus on reducing the volume of sediment entering the harbour.

PCC also protects areas of native bush on private land through its District Plan provisions on vegetation clearance and landscape amenity. All ecological sites on public land are identified in planning maps and are covered by reserve provisions. There is a strong preference for vegetation retention in all but exceptional cases.

WCC enforces, through conditions of consent, the best practice sediment and erosion control recommended in its *Code of Practice for Land Development*. The objective is to control the sediment generated by development works, restrict erosion and runoff from the works, and control the amount of sediment entering receiving environments. Consent applicants must also comply with the earthworks provisions in the *Wellington City District Plan* and, where relevant, the provisions of the council's *Subdivision Design Guide*.

Both WCC and PCC will review and implement building controls and guidelines relevant to sediment management in their district plans.

4.4 Education and awareness

In a recent survey of people living in the Te Awarua-o-Porirua Harbour catchment, a third of respondents did not realise that water going into roadside gutters drained directly into streams or the harbour and most people did not identify sediment as a big risk to water quality (Keyresearch 2014). However, the vast majority¹⁵ of respondents thought excellent water quality was important for streams and the harbour and were prepared to put up with some inconvenience to help the environment. Most respondents also wanted to know more about how they could help restore Te Awarua-o-Porirua Harbour. Therefore, education and awareness activities are important to promote positive behaviour change by informing people whose activities contribute sediment to the harbour about the consequences of their actions, and alerting them to practical alternatives.

Through education and awareness, consent applicants can be made aware of how the statutory rules and regulations apply to them, and what best practice techniques they can use to reduce erosion in their situations.

¹⁵ 84% of respondents thought excellent water quality was important for the harbour and 87% thought it was important for streams. 83% were prepared to put up with some inconvenience to help the environment.

Educating people about how to reduce erosion resulting from their activities at home and at work will also target the many unregulated activities that can produce sediment. For instance, people can be taught some simple measures to reduce the volume of sediment produced when they remove vegetation or disturb soil.

GWRC is coordinating education and awareness on behalf of the four key Strategy partners, though all four partners will seek opportunities to publicise key messages about the effects of sedimentation and the benefits of good sediment control. Education and awareness is, of course, a matter of communication so the key audiences to be targeted are highlighted in this section.

4.4.1 Land developers, contractors and managers

As well as the statutory provisions in the regional and district plans (see 4.3), the councils use a number of education and awareness methods to promote best practice to those involved in activities that can produce sediment, such as earthworks and forestry.

- **GWRC *Erosion and Sediment Control Guidelines*.** Currently being updated, this document provides guidance about good practice erosion and sediment control during bulk earthworks, including soil disturbance associated with subdivision and forestry
- **GWRC Muddy Waters programme.** This programme is used to update earthworks contractors and developers about any important industry changes relating to sediment management. GWRC intends to run a Muddy Waters workshop to promote the changes resulting from the updated *Erosion and Sediment Control Guidelines* mentioned above
- **WCC *Water Sensitive Urban Design Guidelines*.** Water-sensitive urban design is an approach to water resource management in urban environments that addresses both water quantity and water quality issues. It integrates natural water systems with built form and urban landscapes, and promotes a more resourceful use of water. The use of vegetation is a key technique in this sort of design to assist in trapping sediment and pollutants
- **WCC workshops.** Different workshops will train council officers about sediment management and control, and target people carrying out works in or near streams with information about best practice techniques to avoid, reduce and deal with sediment
- **PCC and WCC codes of practice for land development.** PCC is currently reviewing its District Plan, which will lead to a subsequent realignment of codes of practice. WCC is currently reviewing codes of practice and this will involve updating the water and drainage detail and also include the addition of a new Water Sensitive Urban Design (WSUD) chapter. This technical detail builds on the information in the WSUD guidelines mentioned above. The chapter giving technical information on WSUD devices will be used when assessing land developments
- **PCC recently adopted Stormwater Bylaw.** The council will develop an education and awareness programme in association with the bylaw to encourage residents and businesses to avoid sediment entering stormwater drains

4.4.2 Rural landowners

PCC is producing *Rural Guidelines* to advise rural landowners about good land management practices that reduce sediment erosion during such rural activities as:

- Management of pasture and steep land
- Construction of tracks, trenches, bridges and culverts
- Clearance of forestry and other vegetation

The guidelines also provide good practice advice about restoration planting, stream bank stabilisation and wetland management for sediment capture as well as references to GWRC's website, publication and advisory services.

GWRC will investigate other methods to promote sustainable farm and forest management to rural landowners. These are likely to include fact sheets about some of the good practice farm management techniques that will be advocated through Farm Environment Plans¹⁶. The need for field days or other informative events will also be explored.

4.4.3 Schools

A number of education providers are assisting schools in the Te Awarua-o-Porirua Harbour catchment to teach students about harbour health, including sedimentation issues. These school programmes include:

- Healthy Harbours Porirua - this programme is funded by GWRC and delivered to schools by Island Bay Marine Education Centre staff
- Porirua Harbour Trust school resource - teachers using this resource are supported with information and advice by a coordinator, funded by the Philipp Family Foundation
- Enviroschools - GWRC funds Enviroschools facilitators to deliver environmental education to interested schools around the region. PCC and WCC fund those working in their jurisdiction in the Te Awarua-o-Porirua Harbour catchment

GWRC coordinates regular meetings to ensure these and other education providers explore synergies and opportunities to work together, and avoid duplication in the way schools in the catchment are supported.

To enable teachers to confidently teach students about sedimentation issues in waterways and marine areas, GWRC have produced school stream testing kits with associated training for teachers and education providers.

All council Strategy partners also respond to school requests for information and advice.

4.4.4 Businesses

The three council Strategy partners all provide opportunities for corporate volunteers to become involved in restoration projects on public land in the Te Awarua-o-Porirua Harbour catchment. Examples include corporate working bees in WCC's Seton Nossiter Park, PCC's Bothamley Park and GWRC's Whitireia Park.

The GWRC 'Take Charge' business education and monitoring programme is operating in the Porirua industrial areas. Where appropriate, there is opportunity to reduce discharges containing sediment eg, from vehicle and equipment washing on business premises.

4.4.5 The community

Access to information and advice about current best practice sediment control is provided to the community by council Strategy partners. This can include responding to public enquiries and giving pre-application advice about consents for activities that generate sediment.

¹⁶ See Section 4.2.1 for more detail about Farms Environment Plans

Other ways that Strategy partners advise and educate the community are outlined below.

Events and initiatives

Council partners engage in community events and initiatives to publicise the effects of excess sedimentation on the harbour and what can be done to reduce the problem. Examples of events include the 2015 Stream Extreme event in Bothamley Park and streamside planting events with schools.

Initiatives have included the *Living Waters* mini-documentary series about the values of the harbour, and challenges and solutions to improving harbour health, including erosion and sediment issues. A Samoan language video¹⁷, based on the *Living Waters* series has also been produced, as the Samoan community is the largest Polynesian group in the catchment. Both resources are available on DVD and can be either bought or viewed online at the Porirua Harbour Trust website¹⁸.

Supporting community restoration

All three councils support grassroots community volunteers with information, education and advice in response to enquiries. Examples include:

- Restoration Day - a free annual conference to upskill community volunteers in environmental restoration and provide networking opportunities
- Naturespace - a national web portal for community groups and landowners involved in ecological restoration, to help connect with each other and have access to relevant information and advice
- Restoration publications - GWRC has produced a number of publications targeting community volunteers with region-specific advice about restoring different ecosystems including wetlands, riparian areas and bush blocks. Following this advice will enhance the ability of all of these environments to retain sediment

Promoting key messages about sediment control

All three council Strategy partners will continue to work together with other agencies such as Wellington Water Ltd¹⁹ to promote key messages about sediment reduction and how residents can reduce the amount of sediment run-off resulting from their activities.

5 SCIENCE AND RESEARCH

The *Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan* outlines a commitment by Strategy partners to carry out extensive science and research to inform decision making. This commitment has resulted in a significant investment in additional scientific investigations and monitoring in the Te Awarua-o-Porirua Harbour and the wider catchment, compared to that carried out elsewhere in the Wellington Region.

Research into sedimentation rates, sediment deposition patterns, and sediment source identification and modelling has been a specific focus. The resulting information illustrates the environmental

¹⁷ Maota I le Talafatai – Home to Harbour

¹⁸ www.poriruaharbourtrust.org.nz

¹⁹ This is a council controlled organisation responsible for the maintenance and development of stormwater infrastructure in the Porirua Harbour and other catchments, whose mandate includes a strong focus on community education.

condition of the harbour over time and the impact of changing sedimentation rates on harbour health. This will inform decision-making by agencies about sediment management options and setting appropriate limits for the volume of sediment entering the harbour.

In particular, the monitoring data will inform two relevant committees. The Te Awarua-o-Porirua Harbour Catchment Joint Committee is the governance body responsible for overseeing the implementation of the Strategy and for reporting to the four Strategy partners²⁰. The Te Awarua-o-Porirua Whaitua Committee will also use the data when making its recommendations to GWRC in regard to the *Proposed Natural Resources Plan for the Wellington Region* (see Section 4.3.1).

5.1 Historic research and baseline data gathering

Today's level of knowledge about the harbour and catchment environment has been acquired over many years from a number of different research studies. These are briefly described here, as they have collectively been used to understand and quantify the sedimentation problem and provide baseline data against which to measure long-term trends in the harbour's condition.

A series of bathymetric surveys (underwater depth) of Te Awarua-o-Porirua Harbour dating back to 1849 have been used to reconstruct historical sedimentation rates and patterns. Comparison of the 2009 survey with the most accurate preceding survey, in 1974, indicated average sedimentation rates over the 35-year period were 9.1 mm/yr and 5.6 mm/yr in the Pauatahanui and Onepoto arms of the harbour, respectively (Gibb & Cox 2009). These rates are significantly higher than more natural and sustainable 1mm /yr rates typical of a forested catchment (according to NIWA and the land use modelling) (Green et al. 2014).

The bathymetric survey data have enabled models of Te Awarua-o-Porirua Harbour to be developed and used to assess sedimentation and flushing patterns, and locate depositional areas. One such model was the 'Source-to-Sink' model developed by NIWA (Green et al. 2014), to estimate where in the harbour incoming sediment would deposit, and consider how reducing sediment in various subcatchments might influence subsequent sedimentation rates.

The CLUES model has also been used to estimate the amount of sediment expected to be lost from subcatchment areas under different land uses. This model indicated that the catchments of Horokiri, Pauatahanui and Porirua streams generate the most sediment inputs to the harbour. Consequently, GWRC will preferentially target these areas for landowner engagement and the preparation of Farm Environment Plans.

Other past scientific investigations into Te Awarua-o-Porirua Harbour sedimentation that have contributed to current knowledge include:

- Reconstruction of the sedimentation history of Pauatahanui Inlet (2004) (Swales et al. 2005)
- Intertidal sediment quality with GNS Science (2004) (Milne 2006)
- Subtidal sediment quality and benthic ecology (baseline investigation in 2004, subsequent surveys in 2005, 2008 and 2010) (Oliver & Conwell 2014)
- Multiple stormwater-related investigations, including assessments of stormwater contaminants present in streambed and surface estuarine sediments at the southern end of the Onepoto Arm and the mouths of Onepoto Stream, Duck Creek and Browns Stream (2002 (Botherway & Gardner 2002), 2008 (Milne & Watts 2008), 2009 (Sorensen & Milne 2009))

²⁰ Greater Wellington Regional Council, Porirua City Council, Wellington City Council and Te Rūnanga o Toa Rangātira

- A baseline broad scale survey of the types of substrate (eg, firm vs soft sand, mud, gravel) throughout the intertidal areas of the Te Awarua-o-Porirua Harbour (2007) (Stevens & Robertson 2008)
- Fine scale estuarine monitoring at two intertidal sites within each arm of the harbour, assessing sediment texture, sediment nutrients, organic content and toxic contamination, and sediment-dwelling fauna and flora (annually since 2008 with more detailed surveys in the first three years to establish a baseline) (Robertson & Stevens 2015)

5.2 Ongoing monitoring and investigations

In 2011, a multi-agency science workshop about Te Awarua-o-Porirua Harbour identified sedimentation as the harbour's biggest environmental issue. Since then, GWRC's primary harbour-related science focus has been on determining how much sediment is coming into the harbour, where and how much is flushed out, and where it is coming from. The main data gathering methods are as follows.

Bathymetric survey. The 2009 bathymetric survey and analysis serves as the baseline (corroborated by sedimentation plate results mentioned below) against which subsequent sediment inputs and rates will be compared. Follow-up bathymetric surveys and analyses will occur approximately every five years or when the Porirua Harbour Science Group²¹ considers surveys are otherwise warranted. A second survey, in 2014, indicated a sedimentation rate in the intervening 2009–2014 period of 1-2mm/yr (Cox 2015). However, the lower rate could reflect the relatively low incidence of storm events in those five years. A longer period of surveys and records will provide a more accurate basis for assessing 'true' sedimentation rates and trends in meeting the Strategy's 1mm/yr target.

Sediment plates. GWRC has installed 18 sediment plate sites, spread throughout the harbour, at which sedimentation rates are measured annually to validate or 'ground-truth' both the CLUES and Source-to-Sink models mentioned in Section 5.1.

Turbidity monitoring. GWRC installed turbidity monitoring stations in the lower reaches of the Porirua, Pauatahanui and Horokiri streams in 2012. The continuous data from these instruments will allow sediment inputs to the harbour to be more accurately assessed and, in turn, inform the Te Awarua-o-Porirua Whaitua Committee's sediment limit-setting process.

Porirua Stream investigations. For a short period, GWRC collected water quality samples from Porirua Stream and its tributaries during wet weather events to determine which sub-catchments of the Porirua Stream and associated land uses were contributing the most sediment.

5.3 Water quality monitoring by community volunteers

Wellington City Council will be supporting community volunteers to monitor stream health. This citizen science initiative has multiple benefits additional to just collecting data on changing water quality. Participants will learn more about stream health and be empowered to become more effective advocates for initiatives that improve water quality, such as those outlined in this plan.

²¹The Porirua Harbour Science Advisory Group was established under the *Porirua Harbour and Catchment Strategy and Action Plan 2012* to guide science and research planning. It is a multi-agency, multi-disciplinary group comprised of a range of coastal scientists from throughout New Zealand.

6 SUMMARY OF ACTIVITIES

The following table summarises the different activities outlined in Sections 4 and 5. Where activities relate to those in the Strategy, the relevant Strategy action plan reference codes are shown.

Table 2. Summary of sediment reduction plan

	Approach	Sediment reduction activities	Sources of erosion being addressed	Target audience	Timeframe	*Implementation leaders	**Relevant Strategy actions
PROJECTS	Reducing erosion on public land (Section 4.1)	Public sector leadership: Provide industry leadership by demonstrating good practice sediment control for activities on public land in the catchment.	Pasture erosion Stream erosion Earthworks Forestry	Private landowners Foresters Developers Contractors	Ongoing	GWRC, PCC, WCC	EB3, EB6, EB9, TB10, TB14
		Community initiative: Support community volunteers, including corporates and schools, and initiatives that work to stabilise stream banks and other erodible areas on public land.	Stream erosion Other erosion	Volunteers Schools	Ongoing	GWRC, WCC, PCC, TROTR	SB8, EB8, EB13, EC1, TB21-22, TC7, TD4
		Stormwater management: Maintain and improve street and street drain maintenance work programmes. Use street sump baffles to capture sediment that may otherwise enter the stormwater system.	Other erosion	Operational	Ongoing	WCC, PCC	SB5, PB5, PB11
	Supporting erosion reduction on private land (Section 4.2)	On farm planning support: Work with landowners to produce Farm Environment Plans in priority areas and financially assist with any resulting land use changes to reduce sediment eroding from private land.	Pasture erosion Stream erosion Forestry	Private landowners	Ongoing	GWRC	SC3, TB23
		Riparian management: Support stream bank stabilisation on private farm land.	Stream erosion	Private landowners	Ongoing	GWRC	SC3, TB23
		Legal protection of vegetation: Support landowners applying for QEII National Trust and local body covenants for native forest remnants. Covenants contribute to sediment reduction by stabilising soil through native vegetation cover.	Stream erosion	Private landowners	Ongoing	GWRC (QEII), PCC (local body)	EB4, EB5
REGULATION	Statutory regulation (Section 4.3)	Regional regulation: In reviewing regional plan provisions, include policies, methods and rules to reduce sedimentation to maintain or improve water quality, including recommendations from the <i>Te Awarua-o-Porirua Whaitua Implementation Programme</i> .	Pasture erosion Stream erosion Earthworks Forestry Other erosion	Landowners Developers Contractors Foresters	Next 3 years	GWRC	TB7-8, TC1-2, TC4
		Local regulation: Regulate earthworks associated with development through the implementation of district plans.	Earthworks	Landowners Developers Contractors	Ongoing	WCC, PCC	SB4, TB1-2
ED LIC	Education and awareness	Guidelines: Update the <i>Erosion and Sediment Control Guidelines</i> for activities that generate sediment including earthworks and forestry harvest. Notify industry and	Earthworks Forestry	Landowners Foresters	Current	GWRC	SB1, SB9, SC1, SC4, TB2

	(Section 4.4)	other consent applicants of these changes through Muddy Waters workshops and during the consent application process.		Developers Contractors			
		Guidelines: Update regulatory guidelines for reducing sediment resulting from development.	Earthworks	Landowners Developers Contractors	Ongoing	PCC, WCC	SB2-3, SC2, TB18
		Training: Run expert-led workshops on good practice sediment control, including an understanding of Mana whenua values, tikanga māori and mātauranga māori.	Earthworks	Developers Contractors	Ongoing	WCC, TROTR	SB10
		Guidelines: Promote <i>Water Sensitive Urban Design Guidelines</i> and principles for use in new urban development and retrofitting existing development when opportune, to reduce sediment-laden runoff during development and establishment phases.	Earthworks	Landowners Developers Contractors	Ongoing	WCC	TB11
		Guidelines: Produce <i>Rural Guidelines</i> containing information for rural landowners about how to reduce the amount of sediment released from a range of activities such as track construction and stocking levels.	Pasture erosion Stream erosion Earthworks Forestry Other erosion	Private landowners	Next 3 years	PCC	TC6
		Education programme: Investigate opportunities, such as events, initiatives, publications, and media engagement to educate the public about good practice land management aimed at reducing sediment loss.	Pasture erosion Stream erosion Earthworks Forestry	Public Private landowners	Ongoing	GWRC	TB19-20, TB22-23, TD4
		Education programme: Support school programmes delivering key messages about harbour sedimentation and student action to improve harbour and waterway health, including an understanding of Mana whenua values, tikanga māori and mātauranga māori.	Stream erosion Other erosion	Schools	Ongoing	GWRC, PCC, WCC, TROTR	SB8, EB13, TB20-22, TD4
		Education programme: Maintain Take Charge business education monitoring programme which targets businesses in industrial areas to manage their stormwater discharges well, including sediment discharges.	Other erosion	Businesses	Next 3 years	GWRC	PC3
		Stormwater education: Install 'Drains to Harbour/Streams' plates on targeted street sumps.	Other erosion	Public	Ongoing	PCC	PB15
		Stormwater education: Work with Wellington Water Limited (being the storm-water manager) to promote increased public awareness of and change to better practice in relation to washing sediment into street and property stormwater.	Other erosion	Public	Next 3 years	PCC, WCC, GWRC	PC4, PC5, TB20, TB22, TD4
RESEARCH	Monitoring and reporting (Section 4.5)	Assessment: Monitor the quality and quantity of sediment entering Te Awarua-o-Porirua Harbour. Results will contribute to the evaluation of the sediment reduction activities described in this plan and may influence future land management decisions.	Pasture erosion Stream erosion Earthworks Forestry Other erosion	Strategy Partners Public	Ongoing	GWRC	SB11-12, SD2, TB27, TD5

		Assessment: Involve the community in meaningful stream health monitoring including sediments and suspended solids.	Pasture erosion Stream erosion Earthworks Forestry Other erosion	Community volunteers	Ongoing	WCC	SB8, EB13
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*Implementation leaders: GWRC = Greater Wellington Regional Council, PCC = Porirua City Council, WCC = Wellington City Council, TROTR = Te Rūnanga o Toa Rangātira

**All of the activities in this table relate to Strategy actions.

7 THREE YEAR OPERATIONAL PLAN

Over the next three years, Strategy partners will continue to work together to deliver activities to reduce erosion in the Te Awarua-o-Porirua Harbour catchment, and the volume of sediment entering the harbour.

Tables 3 to 5 outline the budgets for each of the Strategy partners to implement sediment reduction activities over the next three years. Future budgets may be subject to change in response to priorities changing as more information regarding the relative effectiveness of different sediment reduction activities becomes known. Not all activities have assigned budgets as some fall under multiple budgets or are part of a larger project or programme budget.

Progress against these activities will be reported on to the Te Awarua-o-Porirua Harbour Catchment Joint Committee through the annual Strategy implementation reporting process. They may also be included in Annual Plan and Long Term Plan reporting by Councils.

Table 3. GWRC Operational budget 2015–18

Approach	Activity	Cost 2015/16	Cost 2016/17	Cost 2017/18	Total Cost
Public land	Sediment reduction activities at Whitireia Park	\$24,000	\$24,000	\$24,000	\$72,000
	Sediment reduction activities at Battle Hill Forest Farm Park	\$29,500	\$29,500	\$29,500	\$88,500
	Sediment reduction activities at Belmont Regional Park	\$13,000	\$10,000	\$10,000	\$33,000
Private land	Farm Environment Plan development and implementation	\$140,000	\$190,000	\$240,000	\$570,000
Education and awareness	School support	\$34,000	\$34,000	\$34,000	\$102,000
	Community volunteer support	\$46,000	\$46,000	\$46,000	\$138,000
	Events and publications	\$35,000	\$35,000	\$35,000	\$105,000
Monitoring	Sediment plates	\$7,000	\$7,000	\$7,000	\$21,000
	Turbidity monitoring	\$22,000	\$22,000	\$22,000	\$66,000
Total cost		\$350,500	\$397,500	\$447,500	\$1,195,500

Table 4. PCC Operational budget 2015–18

Approach	Activity	Cost 2015/16	Cost 2016/17	Cost 2017/18	Total Cost
Public land	Maintaining street sump baffles	\$300,000	\$300,000	\$300,000	\$900,000

Public land	Revegetation programmes	\$100,000	\$100,000	\$100,000	\$300,000
Education & Awareness	Events and publications	\$20,000	TBA	TBA	\$20,000+
Private land	Riparian revegetation	\$20,000	\$20,000	\$20,000	\$60,000
	Total cost	\$440,000	\$420,000	\$420,000	\$1,280,000

Table 5. WCC Operational budget 2015–18

Approach	Activity	Expenditure 2015/16	Expenditure 2016/17	Expenditure 2017/18	Total Cost
Public land	Sediment reduction activities on reserve land delivered by staff and contractors	\$40,000	\$40,000	\$40,000	\$120,000
	Stream bank restoration and other soil stabilisation activities undertaken by volunteers on reserve land	\$25,000	\$25,000	\$25,000	\$75,000
	Renewals and upgrades of street sump baffles	\$54,790	\$42,210	\$42,210	\$139,210
	Maintaining street sump baffles	\$165,240	\$164,575	\$163,895	\$493,710
Education and awareness	Workshops on best practice sediment control	\$1,000	\$1,000	\$1,000	\$3,000
	Total cost	\$286,030	\$272,785	\$272,105	\$830,920

8 SUMMARY

The key sediment reduction activities of this plan can be summarised as:

1. **Rural erosion control** – Erosion control of steep, erosion-prone rural land under public and private ownership
2. **Riparian management** – Prioritised riparian management on public and private land
3. **Sediment capture** – Capturing sediment before it enters the harbour through street sumps and other devices
4. **Regulation** – Regulatory provisions for sediment control for urban, rural and infrastructure development through the *Proposed Natural Resources Plan* and district plan reviews
5. **Education** – Community education programmes to promote increased awareness of sediment issues and behaviour changes to reduce sediment-laden run-off
6. **Monitoring** – Ongoing monitoring to track sedimentation rates and inform sediment reduction activities

This approach will guide targeted sediment reduction by Strategy partners within the Te Awarua-o-Porirua Harbour catchment.

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10 APPENDIX 1: LAND USE AND SEDIMENT GENERATION

This table (Handford & Cosslett 2014) estimates how much sediment is released by different types of land use in the catchment and how much land is under each land use.

Table 3. Land use and sediment generation

Landuse	Sediment yield (tonne/ha/yr)	Approx area (ha) (% of total catchment area)	Comments
Native forest and scrub	1	4,004 (23%)	
Pasture	1-6	7,251 (43%)	Range identified from CLUES modelling. Most areas in the upper catchment are 1-4 tonne/ha/yr.
Exotic forest	1-2	2,411 (14%)	The sediment yield figure is for stable mid-rotation exotic forest. A major increase in sediment, to several times the stable level, occurs for up to three years following harvest.
Urban	0.75	2,400 (14%)	
Earthworks	10-100	150 (1%)	The sediment volume generated depends on the slope and period for which earthworks are open. The area of earthworks stated is an estimate of the area open at any one time.
Stream banks	Unknown	Unknown	Although the sediment resulting from streambank erosion is hard to quantify, it is recognised as significant where there is active bank erosion.

