Lyttelton Harbour potential contaminant sources study, 2007

Report No. U08/17
ISBN 978-1-86937-795-3

Environment Canterbury
Your regional council

Lyttelton Harbour potential contaminant sources study, 2007

Report No. U08/17
ISBN 978-1-86937-795-3

Report prepared by Resource Care Section of Environment Canterbury

April 2008

Environment Canterbury
Your regional council

Report U08/17
ISBN 978-1-86937-795-3

58 Kilmore Street
PO Box 345
Christchurch
Phone (03) 365 3828
Fax (03) 365 3194

75 Church Street
PO Box 550
Timaru
Phone (03) 688 9069
Fax (03) 688 9067

Website: www.ecan.govt.nz
Customer Services Phone 0800 324 636

Executive Summary

The waters and seabed of Lyttelton Harbour receive sediment and other contaminants from the harbour catchments. However, information on the sources of these contaminants has, to date, not been investigated in detail nor collated into a stand-alone document. Thus the aim of this investigation was to research and present detailed information on the potential sources of sediment and other contaminants to the waters and seabed of Lyttelton Harbour. Information within this report has come from field investigations, discussions with Lyttelton Harbour residents, Environment Canterbury and the Christchurch City Council.

There are a large number of potential sources of sediment and other contaminants to the water and seabed of Lyttelton Harbour. These sources relate to:

- historic and/or current land use, e.g. deforestation, farming, subdivision development, housing and quarrying
- infrastructure, e.g. wastewater treatment and discharge, stormwater, landfills and roading
- activities within the Port of Lyttelton, e.g. shipping and the dry dock
- on-water boating activities (not covered in this report).

The sources of sediment and other contaminants throughout the harbour area have been mapped. In addition, a detailed evaluation of the major potential sources of sediment and other contaminants in nine sub-catchment management areas is presented. Subdivision developments, wastewater treatment and discharge, port activities and landfills and quarrying are in specific areas of Lyttelton Harbour, while historic and active erosion, roading, waterways and stormwater are widespread. Three wastewater discharges and numerous stormwater discharges add contaminants directly into the sea. Sediment and considerable volumes of stormwater enter the sea indirectly via the waterways and to a lesser extent roading. The quantities and flow of sediment and stormwater into the sea is influenced by rainfall.

Recommendations for future work are provided. These include investigations, potential monitoring programmes and options for management based on current guidelines. For example the recommendations for historic and active erosion include:

1. Assess the risk of active and historic erosion signatures within 20 m of waterways and roading

2. Develop an information pack on how to identify and manage potential active as well as historic erosion signatures

Of relevance to the issue of sediment runoff is land use. The way that land can be used is defined in zoning plans. Given that the Christchurch City Council (CCC) has proposed new land use zoning (2007 CCC Banks Peninsula Landscape Study) of the Lyttelton Harbour area, the details of this zoning are presented. The proposed new zones are compared to the existing rural zoning. The proposed zone changes may exacerbate existing potential sediment sources, as well as create new ones.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

Lyttelton Harbour is a muddy bottomed, relatively shallow, rocked walled inlet on the northern side of Banks Peninsula (Figure 1.1). There are numerous embayments around the harbour and a major shipping port about midway down the northern side of the harbour.

This study on Lyttelton Harbour was commissioned in response to information presented to the Lyttelton Harbour Issues Group (LHIG[1]) by Dr James Goff in December 2005. Dr Goff determined that there had been significant increases in sediment accumulation to the mudflats of the inner harbour following the arrival of Europeans in the Lyttelton Harbour area (Figure 1.2). This finding confirmed the group's anecdotal evidence that a significant proportion of harbour sedimentation was attributed to human induced erosion. Sedimentation is considered a major issue for this harbour.

1.2 Scope of this report

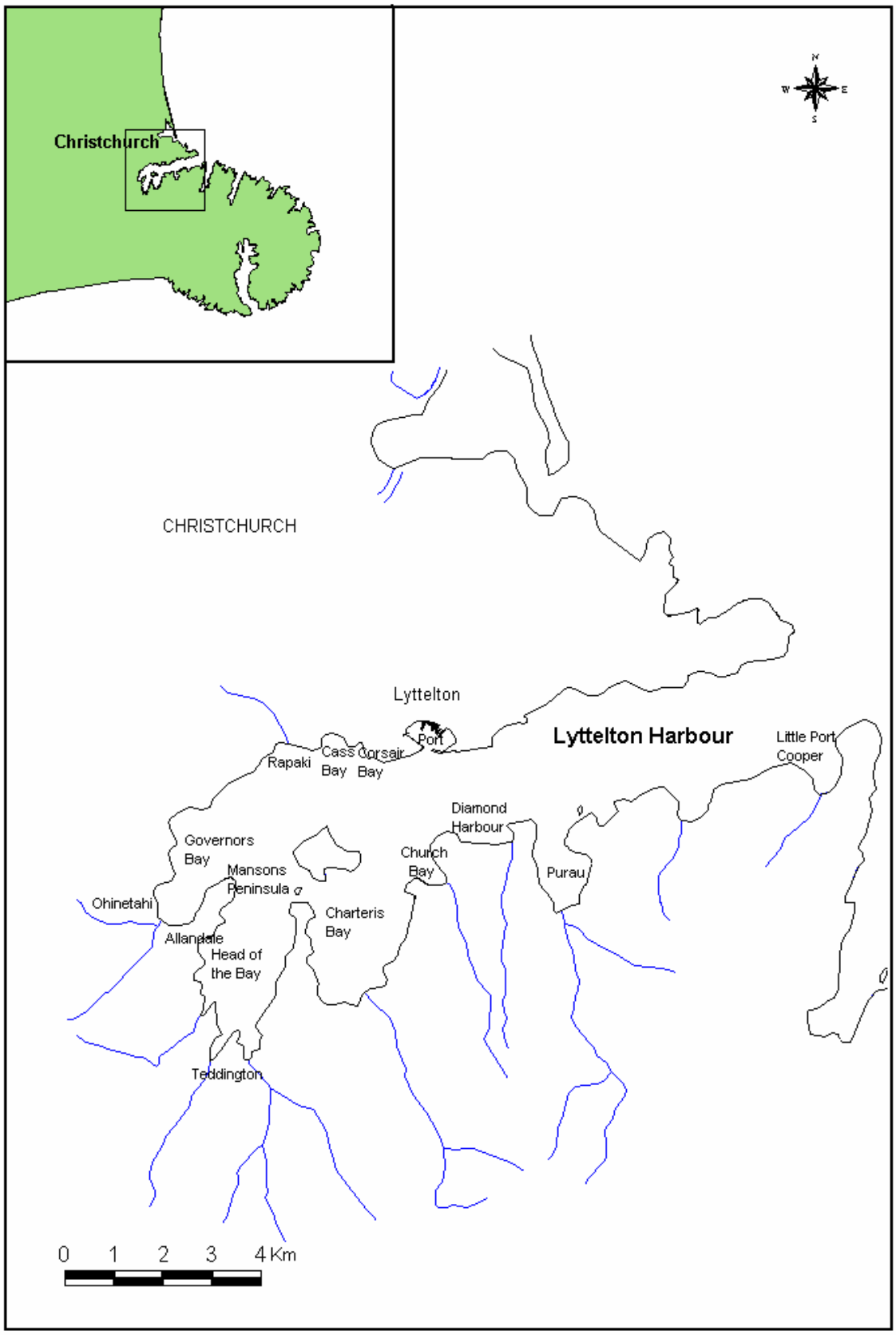
This report has the following components:

- Background information on the geology and erosion of the Lyttelton Harbour area.
- Identification and discussion of the major potential sources of sediment and other contaminants throughout the harbour area, including additional data from investigations conducted as part of this project.
- Mapping of each type of contaminant source.
- Detailed evaluation of the major potential sources of sediment and other contaminants in nine catchment management areas
- Recommendations for future work. This includes a description of/reference to best practice management based on current guidelines, and potential monitoring programmes and research.
- A list of information sources.

Note: Land use can impact the supply of sediment and other contaminants to the harbour. The way that land can be used is defined in zoning plans. In Appendix I the proposed Christchurch City Council (CCC) land use zoning (2007 CCC Banks Peninsula Landscape Study) is compared to the existing Lyttelton Harbour rural zoning. The proposed rural zone revisions may exacerbate existing potential contaminant sources, as well as create new ones. By plotting these proposed zoning areas against the existing zones, an understanding of the potential effects of future development can be obtained.

[1] The LHIG was formed by members of the Lyttelton Harbour community who wanted to contribute to the management of environmental issues affecting Lyttelton Harbour and its catchments. To date the group has been involved in a number of initiatives and assist Environment Canterbury with the Safe Water Information Monitoring (SWIM).

Figure 1.1 Lyttelton Harbour and its bays



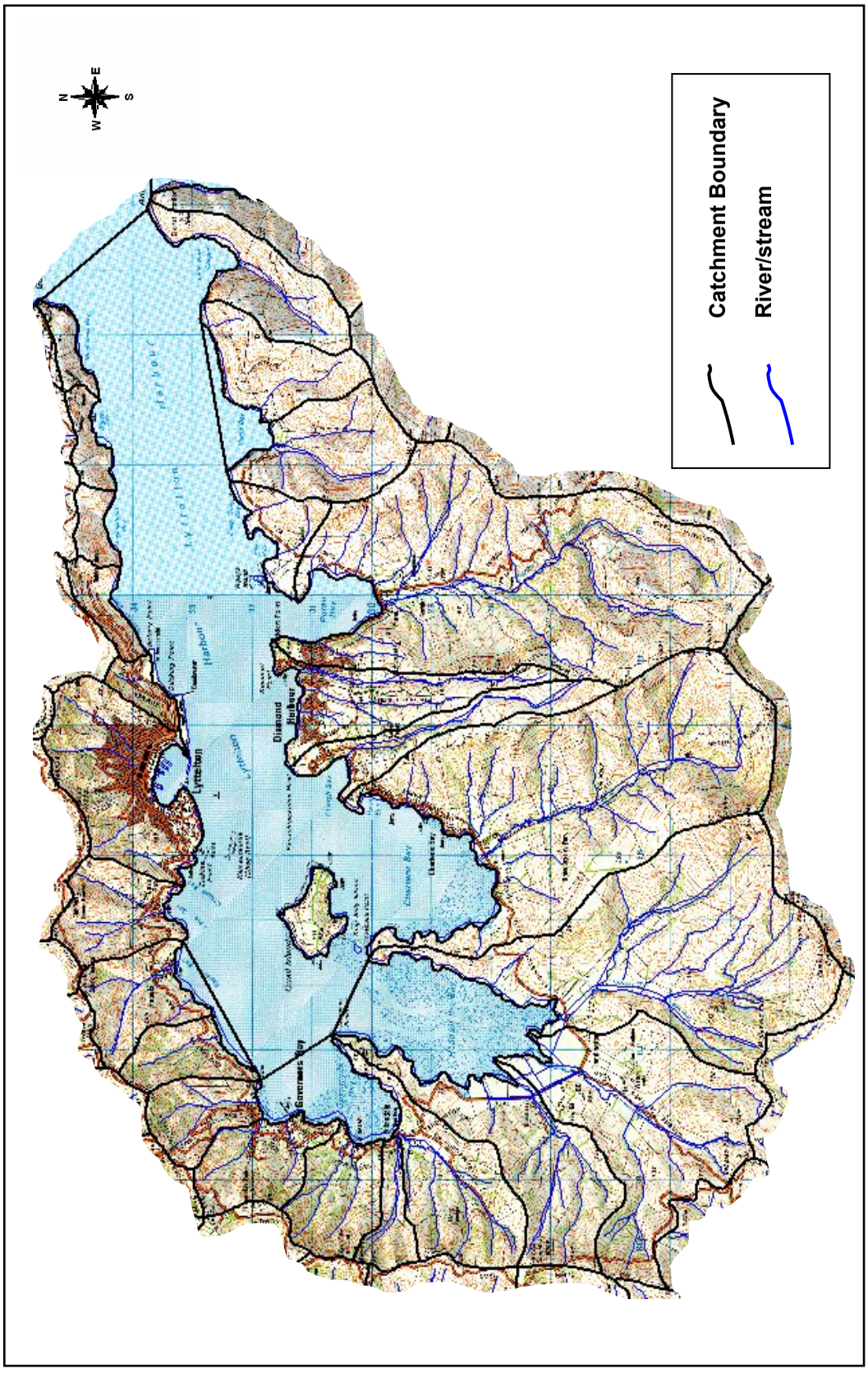


Figure 1.2 Lyttelton Harbour Topographic Map with Catchment Boundaries and Rivers/Streams

1.3 Intent of this report

This report was written in response to the concerns expressed by the LHIG about sediment and other contaminants entering the sea in Lyttelton Harbour. As such the intent was to document current information and provide recommendations that the LHIG can action or follow up on. It does not specifically identify who should carry out the recommendations or when. It is important to note that the local and regional councils, through processes and activities, may be inadvertently making progress on some of the recommended actions.

2 Aims and Objectives

2.1 Aims

Identify and map the potential sources of the contaminants that affect the water and seabed of Lyttelton Harbour.

2.2 Objectives

1. Identify and map potential sources[2] of land-derived sediment
2. Identify and map potential sources of other contaminants such as micro-organisms (bacteria, viruses), nutrients, metals (zinc, copper, lead, nickel, cadmium, chromium and the metalloid arsenic) and hydrocarbons
3. Prioritise sources of sediment and bacterial contamination entering the sea from each catchment.
4. Identify steps that could be taken to reduce the levels of contaminants entering the harbour.

3 Background information on geology and erosion

Lyttelton Harbour was formed through the eruption of the now dormant Miocene volcano Mt Lyttelton approx. 2 mybp. Nowadays the harbour basin is approximately 15 km long and 2 km wide at mean low water springs (MLWS) (surface area of approx. 43km^2). The hillsides around the margin are generally steep and cover an area of about 9968 ha.

The pre-European ecosystem and soil characteristics of Lyttelton Harbour have been identified (Lucas *et.al*., 2005) (Table 1). Essentially, there were five major soil/habitat complexes each specific to certain areas of aspect and altitude. The specific soil profiles are primarily basaltic mantle substrates beneath Pleistocene loess ($\leq$ 20 m) and loess colluviums (volcanic detritus) (Hart, 2004). From the soil map (Figure 3.1), Takahe, Takahe-Kiwi, Stewart-Summit and Pawson soil types dominate. That is, greywacke loess is a predominant constituent of almost all of the soil types present.

[2] "Potential" has been used as an umbrella term in this report for all actual and potential contaminants

Due to the high proportion of loess and steep slopes of the harbour margin, the soils are highly susceptible to erosion, particularly when there is no vegetation cover (Hart, 2004). As a consequence of historic deforestation by Maori and European settlers, and the introduction of European pasture grasses (now the dominant vegetation), soil erosion has been/is a significant issue. Eroded soils from the hillsides has in-filled the harbour basin with up to 47 m of sediment. Through thousands of years of accretion, extensive tidal flats have formed at Governors Bay, Head of the Bay and Charteris Bay. These flats cover a combined area of 11km^2 at MLWS (Hart, 2004).

There is evidence of a number of periodic sediment erosion events and accretion of sediment within the harbour over the period 1849 to the present day (Curtis, 1985, Goff 2005) (Table 2). There was significant sediment accretion between 1849 and 1951 as a result of port activities, deforestation and intensive land use. After 1951 there was a reduction in accretion as development and hence erosion stabilised. However, since1977 there has been significant sediment accretion in the area from Cass Bay to the Head of the Bay. Erosion and accretion likely continue because in recent years there have been continuous earthworks for development.

Table 3.1 Pre European Lyttelton Harbour Ecosystems/Soil Characteristics

(from Lucas *et. al.,* 2005)

- Predominantly: Matai, Totara and Kereru, moist forest ecosystem
  Soils: Heathcote, Takahe, Pawson, Akaroa, Rapaki, Kiwi Hill and Cliffton
- Mid-upper areas: Kowhai, Jewel weed gecko, dry rocky ecosystem
  Soils: Cashmere, Stewart and Evans
- Highest areas: Kaikawa, Inaka, Karearea, humid sub-alpine ecosystem
  Soil: Bossu, Summit, Rapaki & part Stewart
- Gully and Swamp areas: Kahikatea, Kaikomako, Kotare, Gully and Swamp Forest Ecosystem/Harakeke, Pukio, banded Kokopu, swamp and stream ecosystem
  Soils: Horotane and part Heathcote
- Mainly Coastal Areas: Sea Rush, Ngaio, Kokora, coastal ecosystem (rock beach and marsh)
  Soils: Motukara, Taylors Mistake, and part Evans

Table 3.2 Periods of erosion and accretion in Lyttelton Harbour

(from Goff, 2005; Curtis, 1985)

1849-1903 Considerable scouring at the head and middle reaches, with accretion towards the entrance. Volumes of spoil were estimated to be 209 000 t a^{-1} over this period. These sediments originated from dredging and erosion (as a result of settlement development).
1903-1951 A large amount of accretion occurred at the head and entrance, whilst a small amount of scour occurred in the middle reaches. Average accretion was estimated to be 351 000 t a^{-1}. These high levels are considered to be as a result of deforestation and intensive landuse
1951-1976 Small accretions occurred at the head and entrance, with a moderate amount occurring in the middle reaches. Average accretion was estimated to be 73 000 t a^{-1}. This was probably higher than pre 1849.
1977 - Present General accretion occurring across the harbour but an order of magnitude higher in the area between Cass Bay and Head of the Bay. Average accretion estimated to be 44 300 t a^{-1}

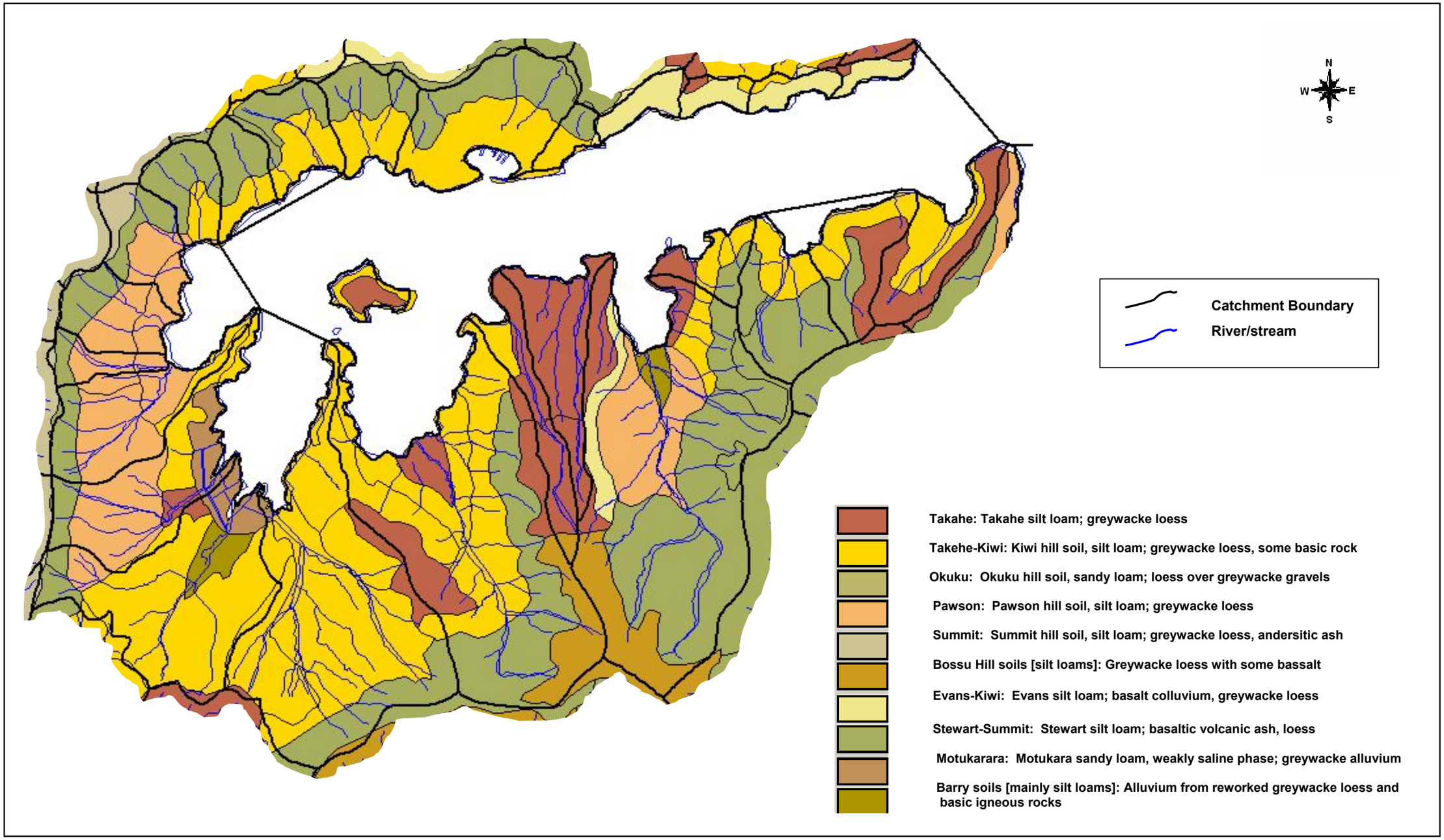


Figure 3.1 Lyttelton Harbour Catchment and Soil Boundaries, Rivers/Streams

4 Sources of contaminants to the harbour

4.1 Subdivisions

During development subdivisions are a source of sediment. Once developed the residential areas are a source of stormwater.

As of early 2007 there are at least 10 subdivisions of various sizes and at various stages of development within the Lyttelton Harbour area (Figure 4.1). These appear to be concentrated in the areas between Lyttelton and Cass Bay and Church Bay and Diamond Harbour, and in Governors Bay (bays are named in Figure 1.1). In addition, there is a proposal for a development in the Purau Bay area (not shown in Figure 4.1), but as yet no consent applications have been lodged.

Within Lyttelton township there is a subdivision development atop Brenchley Road at Hyllton Heights (a gated community type development approx 20 Lots) and a new site is being developed at Walkers Road (approx 10 Lots). For the Walkers Road site access is steep and there are concerns about sediment runoff. Developers of this site will need to put in place appropriate erosion and sediment control measures to mitigate for sediment discharges.

In the Cass Bay area there are two current developments, one is above the Governors Bay Road at the township (approx. 25 Lots), and the other is along Mariners Cove (approx. 8 Lots).

In the Governors Bay area there are three current developments, one around lighthouse lane (approx. 29 Lots), one along Bay Heights (approx. 10 Lots), and a recently underway one to the south of the bay in the valley above the Church Lane/Governors Bay Road intersection (approx. 12 Lots). At Lighthouse Lane there has been a problem with the discharge of considerable quantities of sediment into the stream. At the Bay Heights development a response to requests to assess the impacts of discharge is pending. At the development at the intersection of Church Lane/Governors Bay approaches are being made regarding appropriate sediment and control measures, as the development site is steep. To date vegetation removal from the site appears to have resulted in sediment in the stream below.

In the area from Church Bay to Diamond Harbour there are currently three subdivisions either under development or about to commence. Development is under way at James Drive (approx. 50 Lots) and Stoddart Terrace (approx. 15 Lots). Development is about to commence at Black Rock on the south western side of Church Bay (approx. 40 Lots).

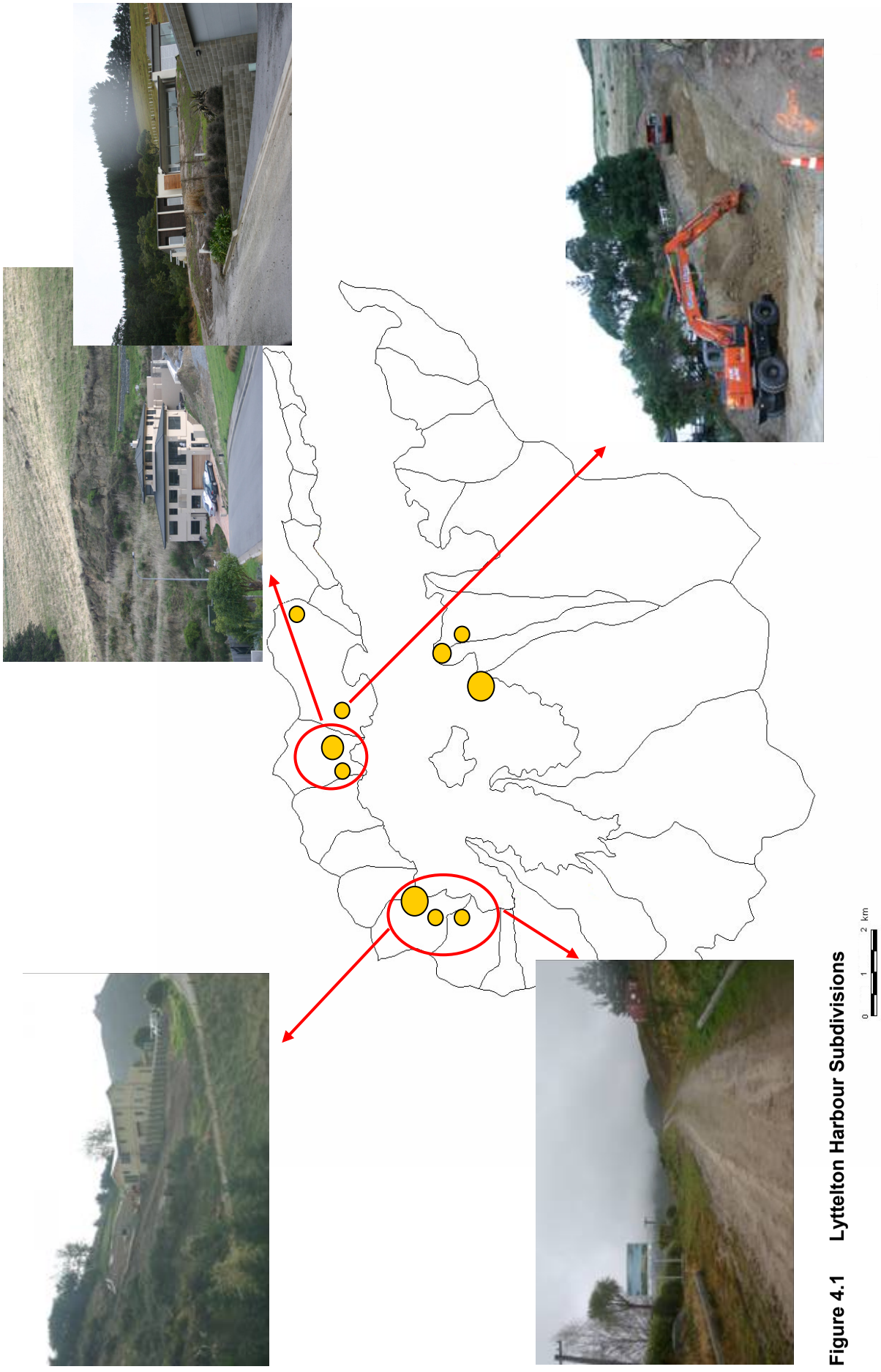


Figure 4.1 Lyttelton Harbour Subdivisions

4.2 Lyttelton Harbour Roading

Roading is a source of sediment and stormwater.

There is approximately 289 km of road (Figure 4.2) in the Lyttelton Harbour area. Of this about 1.5km is State Highway 74 (from the container terminal through to the Lyttelton Tunnel Entrance), and managed by Transit New Zealand, the remainder is managed by the CCC. Roading extends around the harbour from Lyttelton to Purau with access to/from the harbour via Evans Pass, Gebbies Pass, Dyers Pass and a road from Purau to Port Levy. Portions of the summit road along the upper crater rim are within the Lyttelton Harbour Catchment. There is extensive roading around Lyttelton, Diamond Harbour and to a lesser extent Governors Bay.

Roading contributes contaminants into the harbour in the following ways:

1. via the construction/upgrading/repair of the roads
2. erosion of exposed road cuttings
3. as a pathway for the flow of runoff from the land
4. the metals and other contaminants from vehicles

Roads can require significant earthworks. Earthworks, which are typically for a relatively short period of time, can expose highly susceptible soils to rainfall events, creating sediment runoff into waterways and eventually the sea.

Sediments are continually eroding from exposed road cutting cliffs with this process exacerbated by rainfall. The sediment ends up in roadside drains, and from there enters the waterways and eventually the sea. There are a number of exposed road cuttings of up to 10m high at various locations along the main road between Lyttelton and Purau, with cuttings most evident along the roadsides from Rapaki-Governors Bay, Teddington-Head of the Bay, Head of the Bay-Charteris Bay, Charteris Bay-Church Bay and Diamond Harbour-Purau Bay (Figure 4.2). One site of road stability strengthening at the hairpin beneath Taukahara Valley has exposed a significant amount of soil and subsoil to erosion. In many areas the road cuttings are devoid of vegetation due to slope angle and poor soil quality.

The roads serve as a drainage pathway for sediment and stormwater runoff from the hillsides above (including subdivisions) and the metals and other contaminants from the vehicles that travel along it. From the road surfaces the contaminants end up in the roadside drains and culverts and from there moves down slope into waterways and eventually the sea.

High volumes of runoff through the culvert systems can significantly erode the areas that absorb the velocity of the water as it hits the ground. For example, there is evidence of culvert undercutting in the Teddington area where a section of concrete culvert appears to have been undermined by its own discharge flows and dislodged under its own weight (Figure 4.2).

4.3 Stormwater

Stormwater is a source of nutrients, micro-organisms, sediment, metals, hydrocarbons and other contaminants.

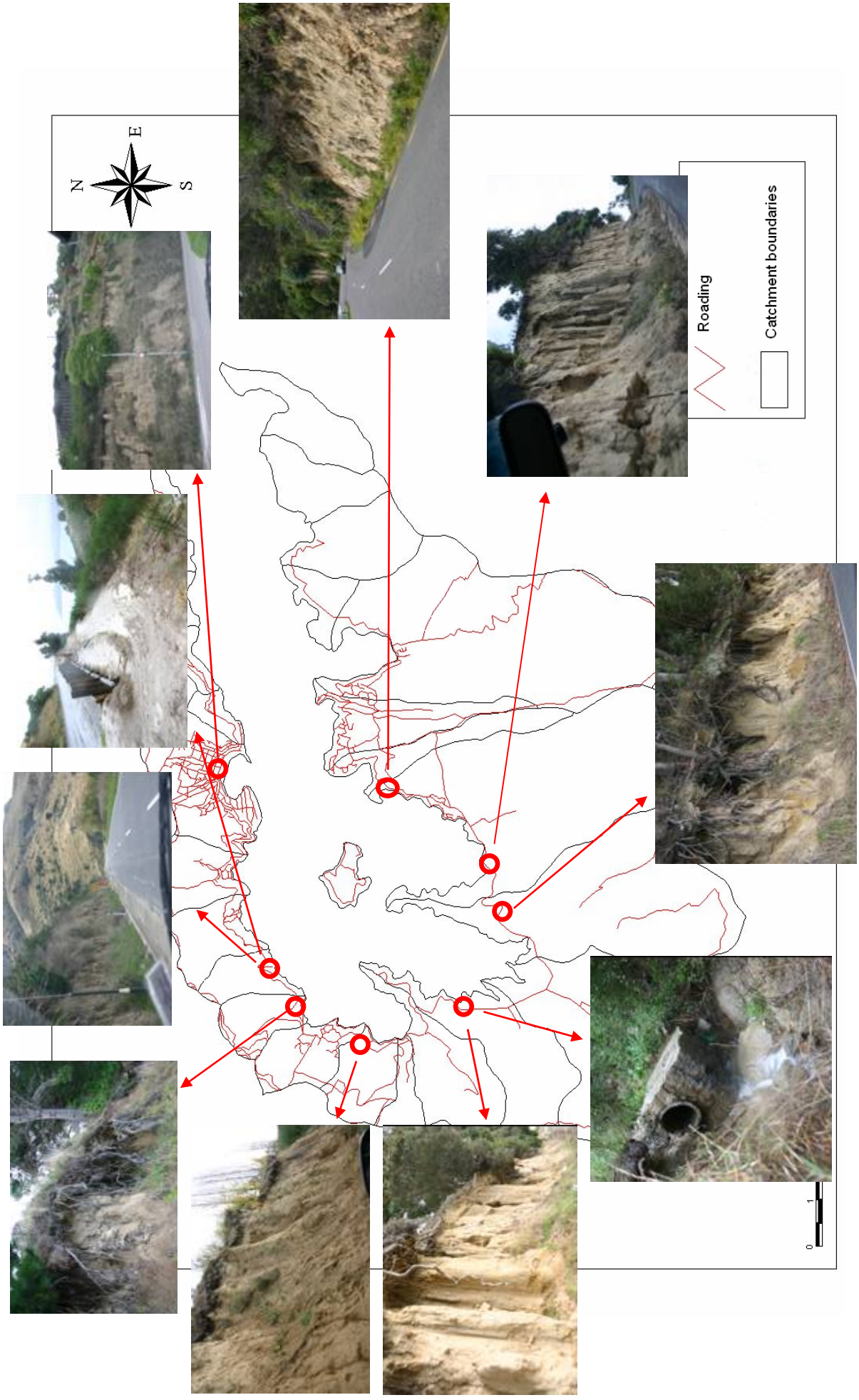


Figure 4.2 Lyttelton Harbour roading and roadside erosion

Stormwater is rainwater that flows over impervious surfaces such as roofs and roads to then discharge into adjacent waterways or directly into the sea. As the water flows over surfaces it entrains any fertilisers, pesticides, herbicides, metals, hydrocarbons, organic matter, nutrients, sediment and micro-organisms that are present.

4.4 Landfill sites

Landfills are a source of sediments, metals, micro-organisms and nutrients.

There are two known landfill sites within Lyttelton Harbour (Figure 4.3). The Lyttelton Landfill is located at the former quarry site at Gollans Bay (Lot 1 DP 23001, Lot 2 DP 23001 PT, Lot 6 DP 22486). The current resource consent for this site (CRC951238) allows for the discharge of contaminants (including gases from decomposition of waste odour) to air and has been granted for 35 years (30/11/1995 to 30/11/2030). Since 2003 new clean fill material had been sporadically deposited without being spread, compacted and planted with grass. ECan has informed (ECan ref: 606C/6871, 6875, 6873, 6863) the consent holder that any deposition of new material, and especially anything other than material suitable for capping may result in enforcement action.

The second landfill site is located at what is now known as Allendale Reserve. The available information suggests that the site is no longer used as a landfill and has been part of a rehabilitation programme.

In addition to these two sites, it is assumed that there are a number of historic landfill sites in other areas. Such sites were operated privately and over varying time frames for specific disposal requirements for various land use activities. No information has been found about these sites.

4.5 Quarry sites

Quarries are a source of sediment.

There are two existing quarry sites (Figure 4.3). The Gollans Bay quarry is mentioned above as the site of the CCC Landfill. No specific information is available about quarrying activities at this site.

The second quarry is an active operation at Head of the Bay on the corner of Governors Bay Teddington Road/Foleys Road. There is no specific consent information available about quarry activities at this site. Hence, it is assumed that quarrying at the site had been long established and allowed based on use rights established under previous government management regimes. There is a significant discharge of sediment from this quarry site following medium rainfall events (pers.obs.).

- 15/6/07: there was no truck wash facility operating on site. Such a washing facility removes quarry material and sediment from vehicle wheels and tyres as they leave the site. Hence, quarry material and sediment was left on the surface of the Governors Bay Teddington Road and appeared to be accumulating along roadside drains and in the harbour.

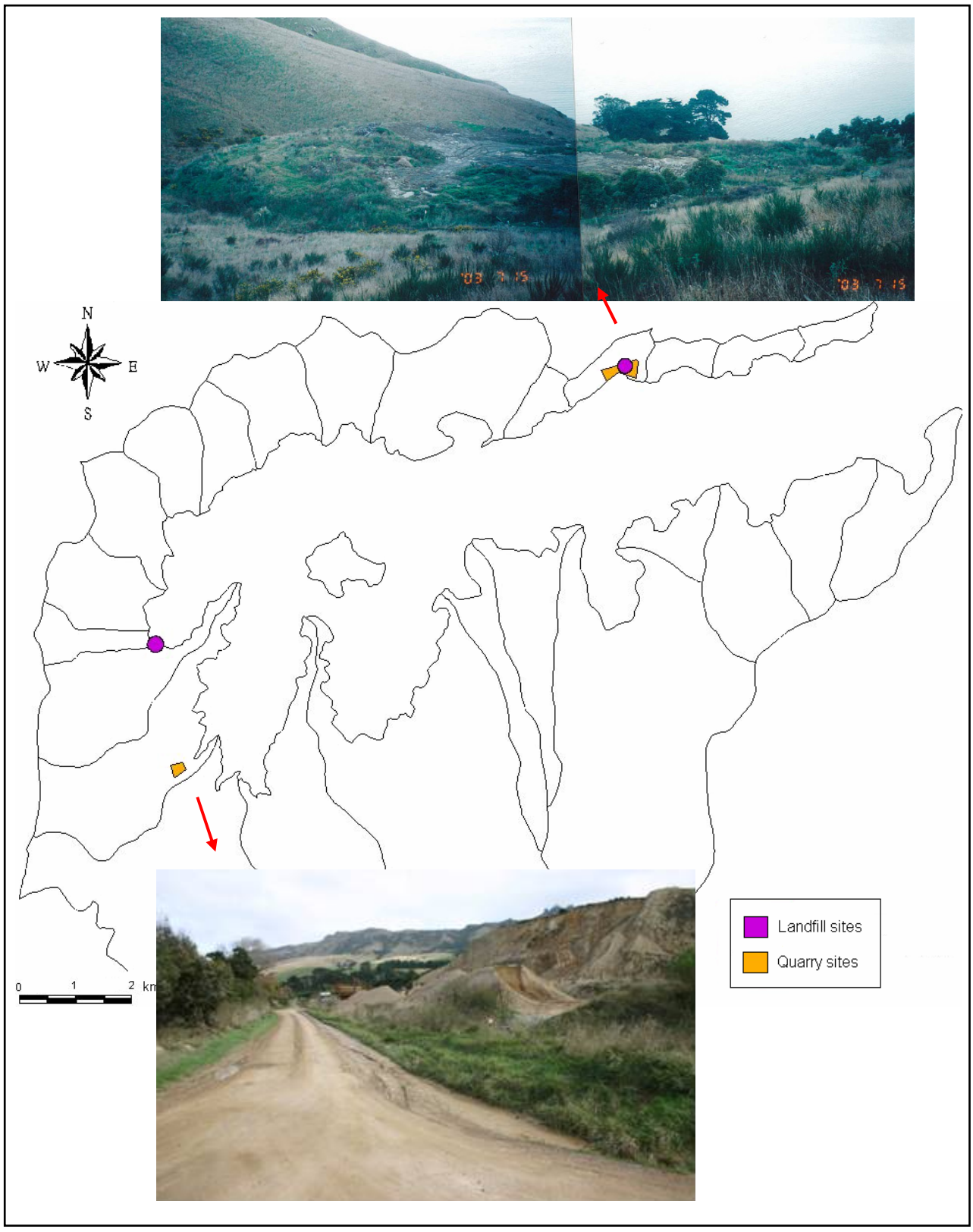


Figure 4.3 Landfill and Quarry sites

- 29/6/07: sediment laden water was flowing from the site and into the drain along the northern side of Foleys Road. From there it flowed along the southern side of the Governors Bay Teddington Road and directly into the nearby stream and then the harbour. At present, there appears to be no obvious erosion/sediment control measures on this site.

As a consequence of the above observations, the quarry owner was approached and subsequently agreed to install a truck wash facility. This facility must be of acceptable design in order to obtain a resource consent, so in the short term it is probable that the issue of mud on the roads will be addressed by best practice standards. More investigation and liaison are required with regard to sediment runoff from the site.

4.6 Lyttelton Harbour active and historic erosion

Erosion is a source of sediment.

All Lyttelton Harbour catchments display signatures of historic and/or active erosion (Unpublished ECan study) (Figure 4.4). These signatures which are indicators of 'potential' areas of future erosion require further investigation and potential management.

The types of erosion commonly seen, both historically and actively, are tunnel gully, slip and in some cases slump and gully erosion. Road cutting erosion tends to fall into the category of active rilling and in some cases in combination with tunnel gully and slip[3].

The identified historic erosion areas (Figure 4.4) are generally re-vegetated cover scars that show no remaining evidence of exposed soil surfaces. These areas tend to be less susceptible to future erosion than those deemed active. The areas of potentially active erosion (Figure 4.4) are typically characterised by exposed soil surfaces with an unexposed worming type signature displayed down slopes where tunnel gullying is occurring. These areas tend to be more susceptible to future erosion and therefore as contributors of sediment.

The areas of historic erosion appear to be predominantly in the north facing slopes of the harbour, i.e. between Teddington and Purau Bay. They typically follow the narrow gully and valley floor lines with streams. However, there are also broader areas that cover particular slope faces. The areas of historic erosion in the south facing slopes are in the narrow gullies and valley floors.

There are four prominent active erosion areas (Figure 4.4).

- the slopes above Cass Bay and Rapaki Bay
- the slopes of Mansons Peninsula below Teddington
- the north-western slopes of Head of the Bay.
- from the eastern slopes of Purau Bay east to Little Port Cooper

There is also a scattering of active signatures around the whole harbour.

[3] For a detailed explanation of erosion types and processes see Soil Conservation Technical Hand Book (MfE, et. al, 2001)

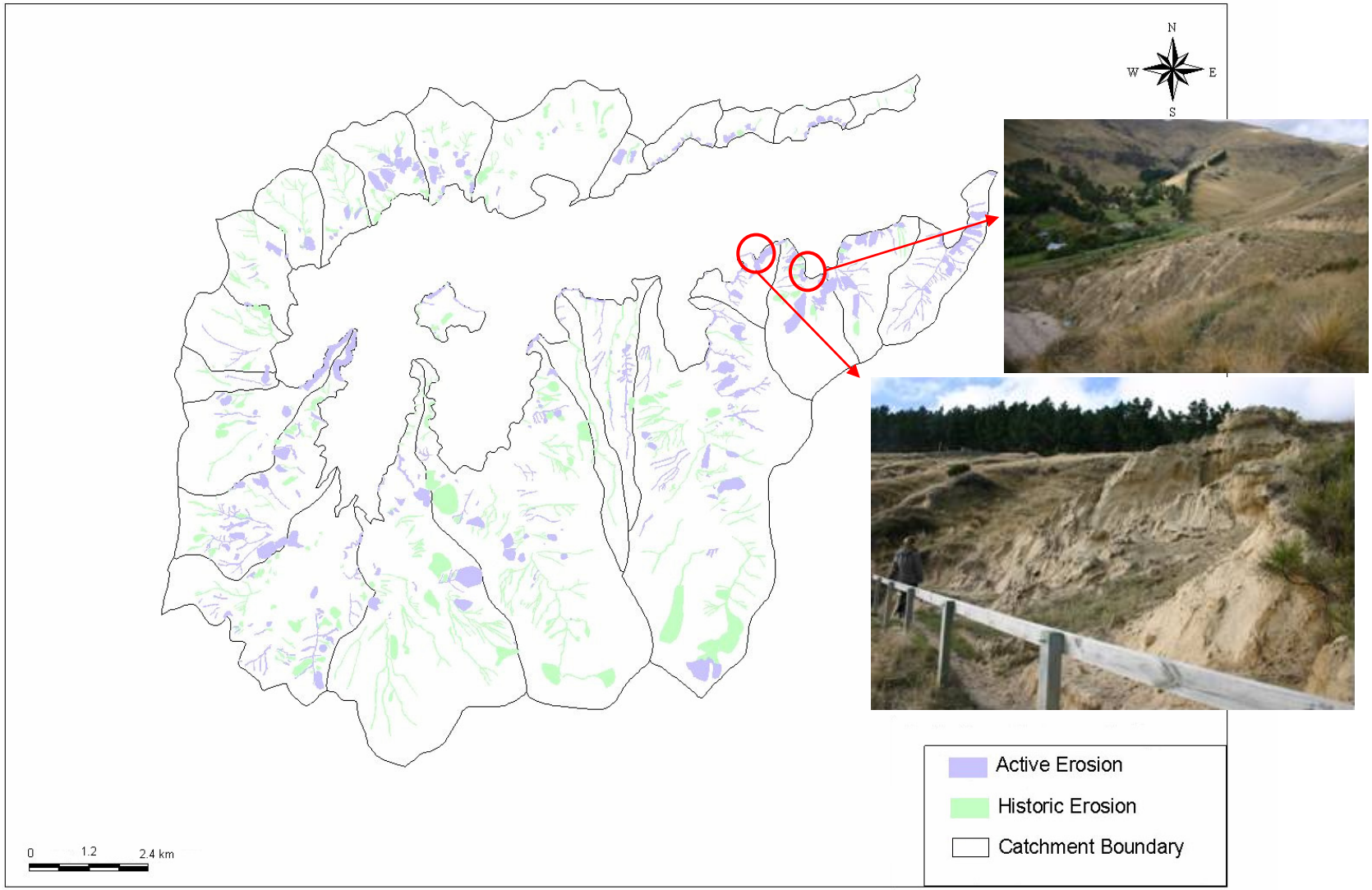


Figure 4.4 Lyttelton Harbour historic and active erosion signatures

(From Unpublished ECan report)

The area of active erosion is more extensive than that of historic erosion. In general the historic erosion areas appear to be concentrated within the narrow gullies and valley floors while the active erosion areas are concentrated on exposed slopes.

4.7 Forestry

Commercial forestry has a large potential to be a source of contaminants to the harbour, particularly at harvest time. Contaminants include sediment from the roading and log hauling, and organic matter such as pine needles and woody debris.

The identified commercial exotic forestry areas within the Lyttelton Harbour area are shown in Figure 4.5. There are sizeable areas of commercial exotic forest on the south western slopes of Head of the Bay. The coastal margin including the peninsula between Head of the Bay and Charteris supports a considerable stand of commercial exotic forest. Smaller stands of exotic forest are scattered around the harbour margins. The status of these forests, i.e. how old they are and when they will be harvested is unknown.

Forestry planting and harvesting can influence the physical chemistry, algal productivity and invertebrate fauna of adjacent waterways. Harvesting can result in inputs of sediment and woody debris and other organic matter to the waterways. High sedimentation is associated with ground preparation, roading, vehicles crossing streams and windfall of trees along stream banks. Roading and stream crossing also have major impacts on the invertebrate and other fauna of the waterway while woody debris and organic material can reduce dissolved oxygen concentrations. Buffer zones around waterways are important for reducing impacts.

The conversion of pasture to pine forest can generate large amounts of sediment through bank collapse as pines shade out grasses previously stabilising the banks (Thompson, 2003).

Afforestation can reduce stream temperatures, positively affecting fish. Afforestration has no predictable effects on level of major nutrients (N and P) in streams, harvesting creates short-term increases. Water yields and peak flows are reduced when grasslands become forests, and increase again after harvest, however flows can become more ‘flashy’ (Thompson, 2003).

Forestry should follow industry environmental best practice codes and regulatory rules and consent conditions to minimise impact on streams and the coastal environment throughout the establishment and life of the operation (pers.comm: Paul Pritchett). Useful management practices include: directional felling and hauling – away from edge of streams or through the stream channel; the use of riparian buffers of native vegetation; and minimising vehicle movement and stream crossings (Thompson, 2003).

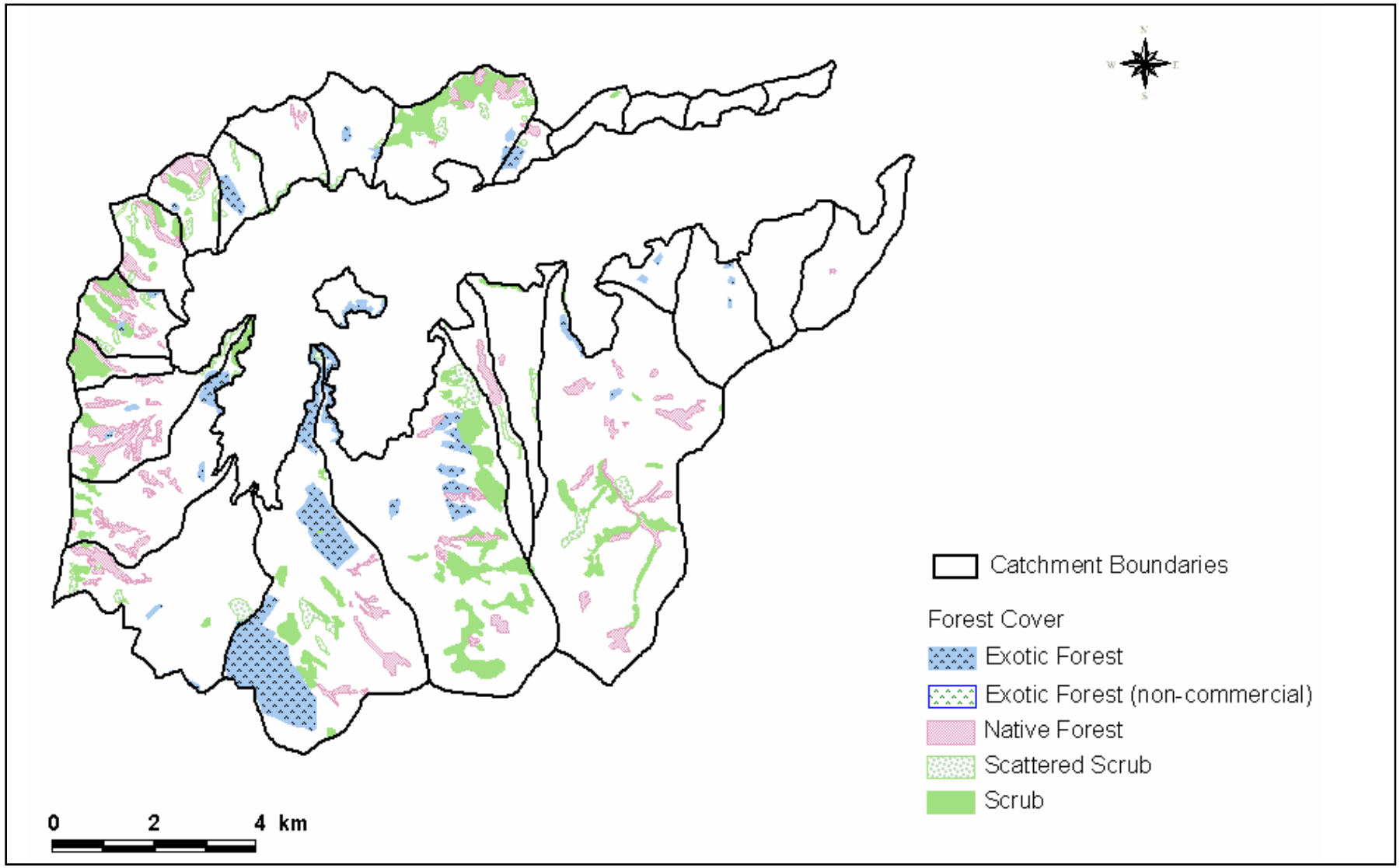


Figure 4.5 Forest and other land cover

4.8 Port Activity

Port activities are a potential source of metals, hydrocarbons, nutrients and micro-organism.

Port activities occur within and north east of the breakwaters protecting the Port of Lyttelton (Figure 4.6). Port activities include loading and unloading of cargoes such as a diversity of dry goods, timber, coal and petroleum products. These cargoes are transferred to and from ships via container, hook, pump, manual labour and roll on/roll off. Adjacent to the water front are storage area for timber (inner Port area), coal (east of the container terminal) and petroleum products (South Western end). Within the port there are mooring for fishing boats, passenger ferries and tourist boats while outside and south west of the breakwaters is the marina complex (between the petroleum storage tanks and Corsair Bay). There is a dry dock on the south western shore of the port with the seabed in the immediate vicinity of the dry dock being the only know Lyttelton Harbour contaminated site. This contaminated site is monitored and managed.

Figure 4.6 Port of Lyttelton

4.9 Wastewater Treatment[4]

Wastewater is a source of nutrients and micro-organisms.

The population of the Lyttelton Harbour area in 2006 was 5334. The largest population was in Lyttelton Township (3075), with the remaining inhabitants scattered around the harbour and in particular in Diamond Harbour (1089) and

[4] Detailed information for all treatment infrastructures across all Lyttelton Harbour sites see Appendix 2.

Governors Bay (870). To service the ever-increasing population there are four reticulated sewage treatment systems. Three are publicly owned by the CCC (Lyttelton, Governors Bay and Diamond Harbour) and each discharge treated wastewater into the sea (Figure 4.7) (Appendix 2).

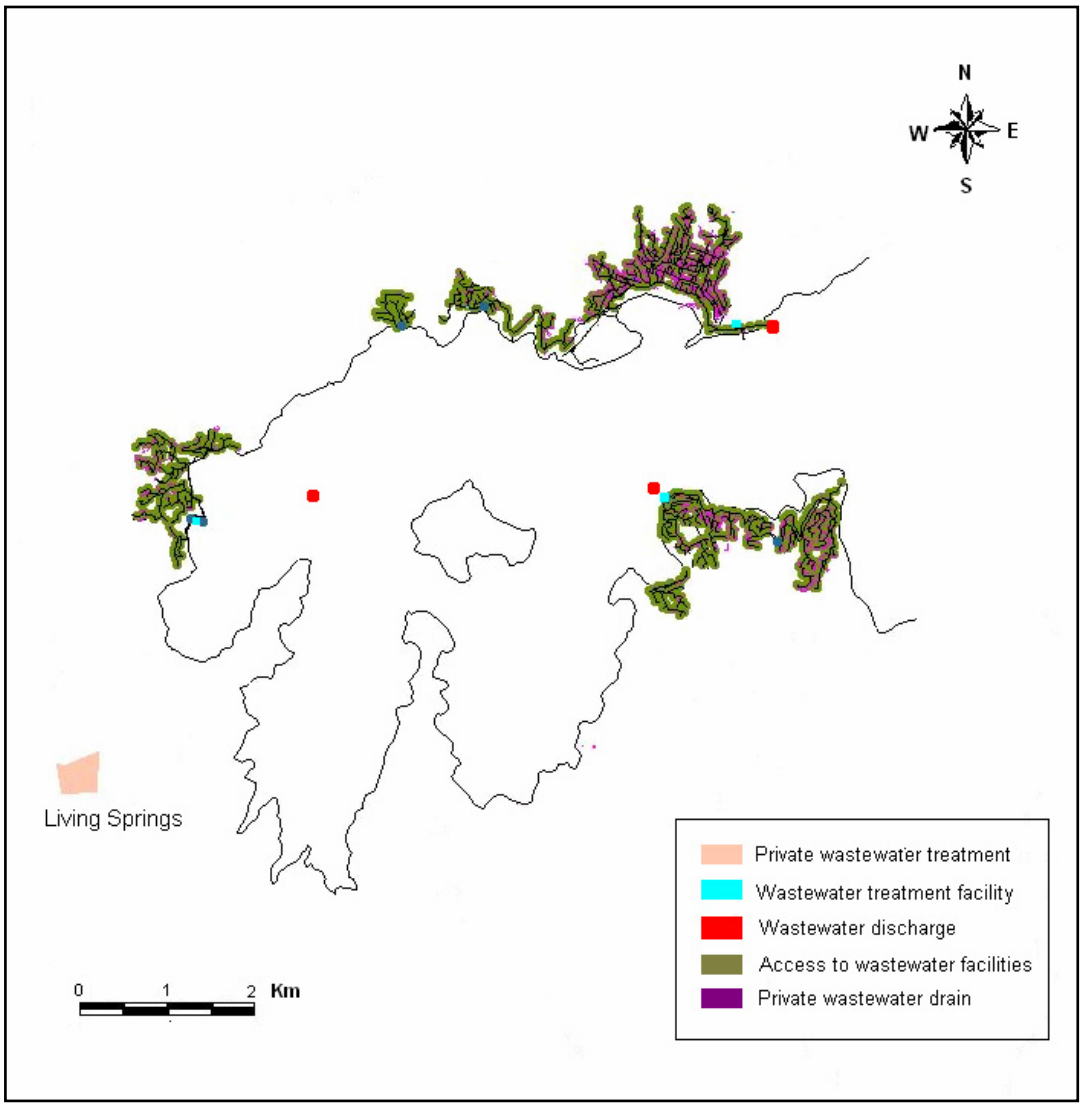


Figure 4.7 Wastewater treatment infrastructure

(Location data – CCC, 2006)

The remaining site (Living Springs - Governors Bay) is privately owned and discharges to land following treatment. In areas where reticulated sewage systems are not available, septic tank systems are prevalent; these areas include Allendale, Ohinetahi, Teddington, Head of the Bay, Charteris Bay, and Purau.

The Lyttelton treatment plant caters for a population of 3700 via 1378 connections. It has a maximum capacity of 4000 people (the Lyttelton Township population is expected to reach 4700 by 2020). The issues that have arisen about the performance of this plant include:

- the effect of coal dust infiltration from coal storage at the nearby Port
- the high level of leakage within the sewerage network.

The Governors Bay treatment plant caters for a population of 730 via 292 connections. It has a maximum capacity of 900 people (the Governors Bay population is expected to reach 1300 by 2020).

The Diamond Harbour treatment plant caters for a population of 1000-1500 via 720 connections. It has a maximum capacity of 2200 people (the Diamond Harbour/Church Bay population is expected to reach 3500 by 2020).

The discharge of treated wastewater into the sea from these three sewage treatment plants is of concern to the local community, including the local Runanga at Rapaki. There is potential to upgrade the performance of the plants. However, the CCC is currently investigating various options for the future disposal of sewage from the three treatment plants.

4.10 Summary of potential contaminant sources

There are a large number of potential sources of contaminants to the water and seabed of Lyttelton Harbour. These sources relate to:

- historic and/or current land use, e.g. deforestation, farming, housing and quarrying
- infrastructure, e.g. wastewater treatment and discharge, storm water, landfills and roading
- localised activities within a catchment
- activities within the Port, e.g. shipping and the dry dock
- on water boating activities (not covered previously).

Subdivision developments, wastewater treatment and discharge, port activities, forestry and landfills and quarrying are in specific areas of Lyttelton Harbour, while historic and active erosion, roading, waterways and stormwater are widespread. Three wastewater discharges and numerous stormwater discharges add contaminants directly into the sea. Sediment and considerable volumes of stormwater enter the sea indirectly via the waterways and to a lesser extent roading. The quantities and flow of sediment and stormwater into the sea is influenced by rainfall.

Summary points

- The soils within the catchments are predominantly greywacke loess, and greywacke loess/basalt complexes.
- The soils are highly susceptible to erosion when vegetation cover has been removed.
- There are significant areas of active and historic erosion
- Sedimentation of the Harbour has occurred since European colonisation due to deforestation and intensive landuse practices
- Human activity creates specific contaminants and exacerbates existing natural processes.
- There are a number of subdivision developments around the harbour
- Waterways and roading are key corridors for the flow of contaminants to the sea
- There are two identified quarry sites. The Gollans Bay site is no longer active, while the site at the corner of Foleys Road/Governors Bay Teddington Road has been identified as a source of sediment
- There are two known non active landfill sites, one has been identified as having minimal contaminant risk (Gollans Bay). Nothing is known about the site at Teddington
- There are stands of commercial exotic forest around the harbour. The status of these forests, i.e. how old they are and when they will be harvested is unknown.
- The Port contaminant inputs are localised. A confirmed Lyttelton Harbour contaminated site is the seabed in proximity to the dry dock which is in the Port.
- Four reticulated wastewater treatment plants are in operation around Lyttelton Harbour. Three (CCC operated) of these discharge treated waste water directly into the sea at separate outfalls, while the other (privately operated) plant discharges to land.
- Various options for the future disposal of wastewater from the three CCC treatment plants are being investigated.

5 Contaminant source assessment

In this section each source of contaminants to the harbour is summarised, the potential risk of contamination from the source is ranked (to assist in prioritising management) and recommendations made for future investigations and/or monitoring.

Subdivision
At present there are ten significant recent/active subdivision developments. During development these subdivisions have the potential to contribute considerable quantities of sediment to the water and seabed of the harbour.

Risk and Management Priority

High

Recommended actions

i) ECan and the CCC ensure that developments meet best practice guidelines for sediment control

ii) The LHIG receives regular reports from an ECan Environmental Protection Officer regarding sediment controls and runoff

iii) The LHIG receives regular reports from CCC regarding subdivision development and standards

iv) An LHIG/ECan programme be developed to monitor sediment loads in potentially impacted waterways

vi) Members of the LHIG and wider community monitor sediment discharges from the development sites and report incidents to the ECan pollution hotline

Roading
Roading contributes sediment during construction/upgrading/repair of the roads and through the erosion of exposed road cuttings. The roads also serve as a drainage corridor for sediment and stormwater runoff from the hillsides above (including subdivisions) and the metals and other contaminants from the vehicles that travel along it.

Risk and Management Priority

Road Cuttings: Moderate - High

Road Construction/repair/maintenance: High

Recommended actions

i) Areas where erosion control can take place are identified and erosion controls then put in place

ii) Sediment controls are put in place for all road works

Landfill Sites

The impact of the landfill sites at Gollans Bay and Allandale on the water and seabed of the harbour is unknown.

Risk and Management Priority

Gollans Bay: Low (based on the current information)

Allendale Reserve: Unprioritised (insufficient information)

Recommended actions

i) An investigation of the water quality in the vicinity of each landfill site be undertaken

ii) The current monitoring programmes be assessed and if no monitoring programme exists determine if it is appropriate to have one

Quarrying

The quarry site in the Head of the Bay (Cnrs Foleys Road and Teddington Governors Bay Road) is a contributor of sediment to the road, adjacent drains and the harbour. The quarry operator has proposed the installation of a truck wash, but work is required to reduce sediment runoff.

Risk and Management Priority

Gollans Bay: Low (further assessment of this site is required)

Head of the Bay: High

Recommended actions

i) An investigation on the operation of both quarries is undertaken

ii) Sediment control measures be established for each site

Active and historic erosion

Active and historic erosion signature sites require investigation to identify the contaminant risk they pose to the water and seabed of the harbour. Waterways and roading that pass through areas with active and historic erosion and subdivisions in active and historic erosion areas should be identified.

The active and historic erosion signature areas that are 20 m either side of waterways and roading are depicted in Figure 5.1. The areas adjacent to roading can be assessed via roadside investigation, while the areas adjacent to waterways could be assessed during stream walks. However, access to some areas is an issue because they are on private property. For the active and historic signature areas more than 20 m from waterways and roading the landholder would need to be involved. Such involvement could consist of the landholder assessing the potential risk of erosion on their property using ECan developed information. In cases of uncertainty, ECan could assist the landholder.

Risk and Management Priority

Within 20 m of streams, roading or land development activity: High

More than 20 m from streams, roading or land development activity: Low-High (depending on scale and predisposing factors)

Recommended actions

i) Assess the risk of active and historic erosion signatures within 20 m of waterways and roading

ii) Develop an information pack on how to identify and manage potential active as well as historic erosion signatures

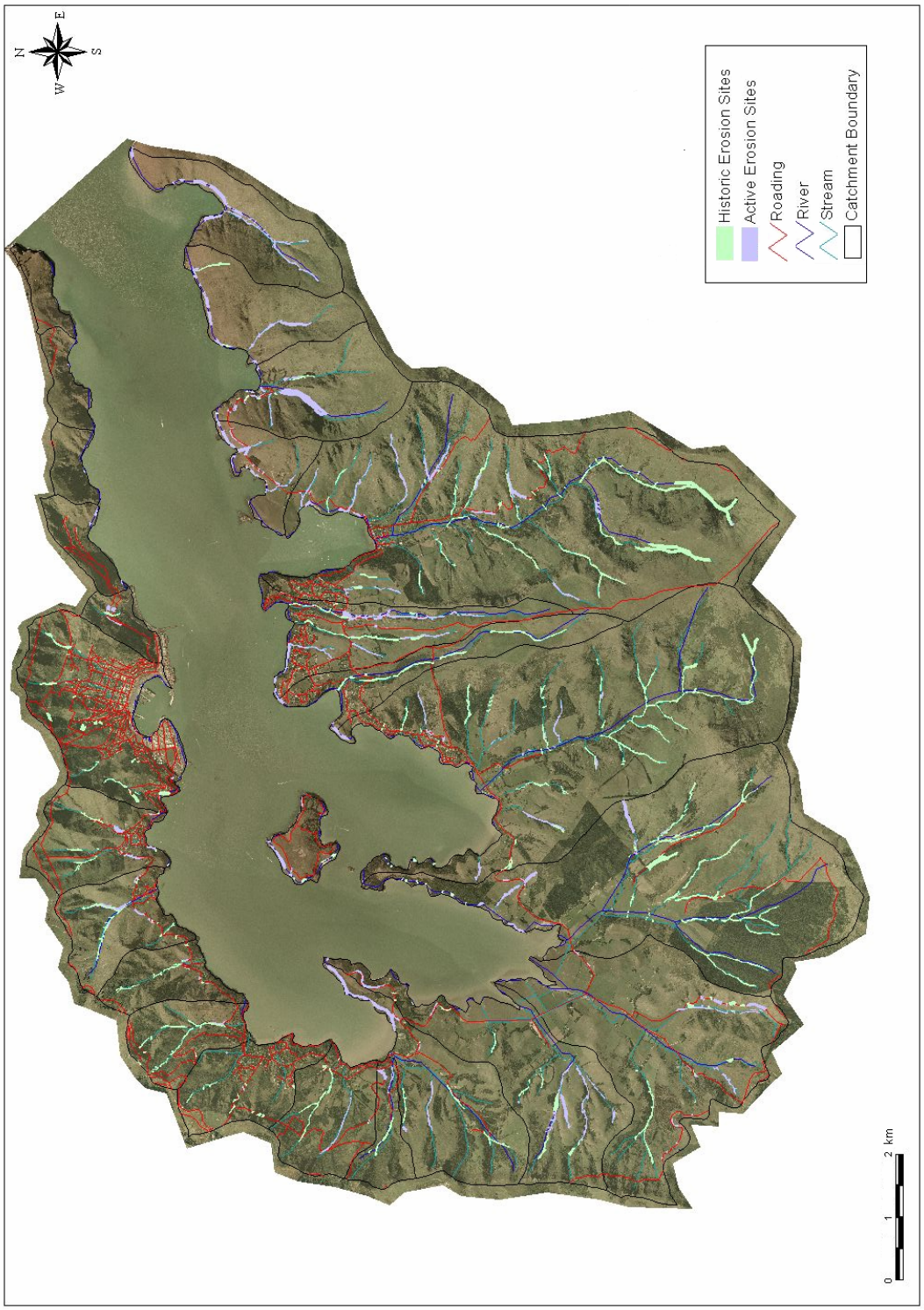


Figure 5.1 Erosion sites for potential investigation

Forestry
Stands of exotic forest occur around Lyttelton Harbour. They have the potential to result in sediment and organic matter in the form of pine needles and woody debris getting into the waterways and then into the sea.

Risk and Management Priority

Moderate – High

Recommended actions

i) Investigate and document the proposed harvesting dates of the stands of exotic forest

ii) Work with the forest owner to ensure that industry environmental best practice codes and best practice guidelines for sediment control are in place

Waterways
The quality of the water that flows in the waterways will influence the quality of the receiving sea water. The quality of the water within the waterways is influenced by stormwater runoff, stock access and susceptibility of the catchment to erosion.

Risk and Management Priority

Streams from farmed catchments: Moderate – High

Streams from urbanised catchments: Moderate – High

Recommended actions

i) An LHIG/ECan water quality monitoring programme be developed for the waterways flowing into the harbour

ii) Undertake stream walks in each waterway flowing into the harbour to identify risks and assess management options

ii) Encourage landholders to apply for funding (ECan Environment Enhancement Fund (EEF) or other funding sources (use fundview a database free to use at libraries) to help with preservation and enhancement project establishment

CCC Wastewater Treatment Facilities

The Lyttelton, Governors Bay and Diamond Harbour treatment plants all discharge treated wastewater into the sea. The maximum concentration of micro-organisms and in some case nutrients in the wastewater discharged has been is set in consent conditions. The Governors Bay treatment plant has operated efficiently in that it has met all consent conditions. However, the treatment plants at Lyttelton and Diamond Harbour have breeched consent requirements on occasions in the past (Appendix II). Additionally the Lyttelton sewer network has a high rate of infiltration due to the age of the system. The impact of the discharge from this infiltration is not clear. The current resource consents expire in 2010 for Governors Bay, 2014 for Diamond Harbour and 2029 for Lyttelton.

At each of the three treatment plants there is potential for upgrade including nutrient removal, fine solid filtration, and increased disinfection (Appendix II). However the capacity of each site is expected to be reached before 2020 as a result of the growing population. The general issues of wastewater treatment and disposal are under investigation by the CCC in conjunction with the Lyttelton Harbour Wastewater Working Party. This includes the evaluation of a number of wastewater disposal options. The current disposal of wastewater directly into the sea within the harbour is not an acceptable option for local iwi and many members of the local community.

Risk and Management Priority

Moderate

Recommendations

i) Support the adoption of the best option offered by the current CCC investigation into wastewater treatment options

ii) The infiltration of the Lyttelton sewer network is investigated and long term solutions developed

Private Wastewater Treatment Facilities

The wastewater from the private reticulated system and septic tanks is discharged to land. The future of the private reticulated treatment facilities at Living Springs and the non-reticulated private septic tanks is being considered as part of the CCC wastewater treatment investigation.

Risk and Management Priority

Moderate

Recommendations

i) Support the adoption of the best option offered by the current CC investigation into wastewater treatment options

ii) An inventory of private treatment site locations and performance be undertaken

Port Activity

Activities in the Port of Lyttelton have the potential to result in accidental spills of a range of contaminants. In addition within the port the seabed in the vicinity of the dry dock is an identified contaminated site.

Risk and Management Priority

Moderate - High

Recommendations

i) That the Port of Lyttelton informs the LHIG group about accidental discharges and the management responses to each discharge

Proposed Marina

The structures erected have the potential to influence water movement and sediment dynamics. Activities within the marina have the potential to influence water quality.

Risk and Management Priority

Low - Moderate

Recommendations

i) A detailed Assessment of Environmental Effects including water movement and sediment dynamics be undertaken

6 Lyttelton Harbour Catchment Management Areas

To provide more specific details of the contaminant sources the overall Lyttelton Harbour area has been split into eight catchment management areas (Figure 6.1). The eight catchment management areas are in part determined by significant ridgelines. Ideally specific details should have been presented for each of the 25 defined sub catchments (Figure 6.1). However, limited time and resources have meant sub catchments have been grouped. It is important to note that the groupings are not to identify priority of management of one area over another rather they are for the purposes of closer investigation of the contaminant sources.

In the following sections, the potential contaminant sources in each catchment management area are presented and discussed. Included is a list of each contaminant source in order of management priority for that area. These lists are from highest (1) to lowest priority. The colour of the writing and surrounding box denotes the level of risk of the contaminant source. Red writing in a red box denotes high risk, orange writing in an orange box denote moderate risk and black writing in a black box denotes low risk (refer to section 5) .In general, the figures for each catchment management area include the identified potential contaminant sources (a magnified version for the area) taken from the overall harbour catchment views in Figures 4.1 – 4.7.
NOTE: Forestry is not included in the assessment of the catchment management areas.

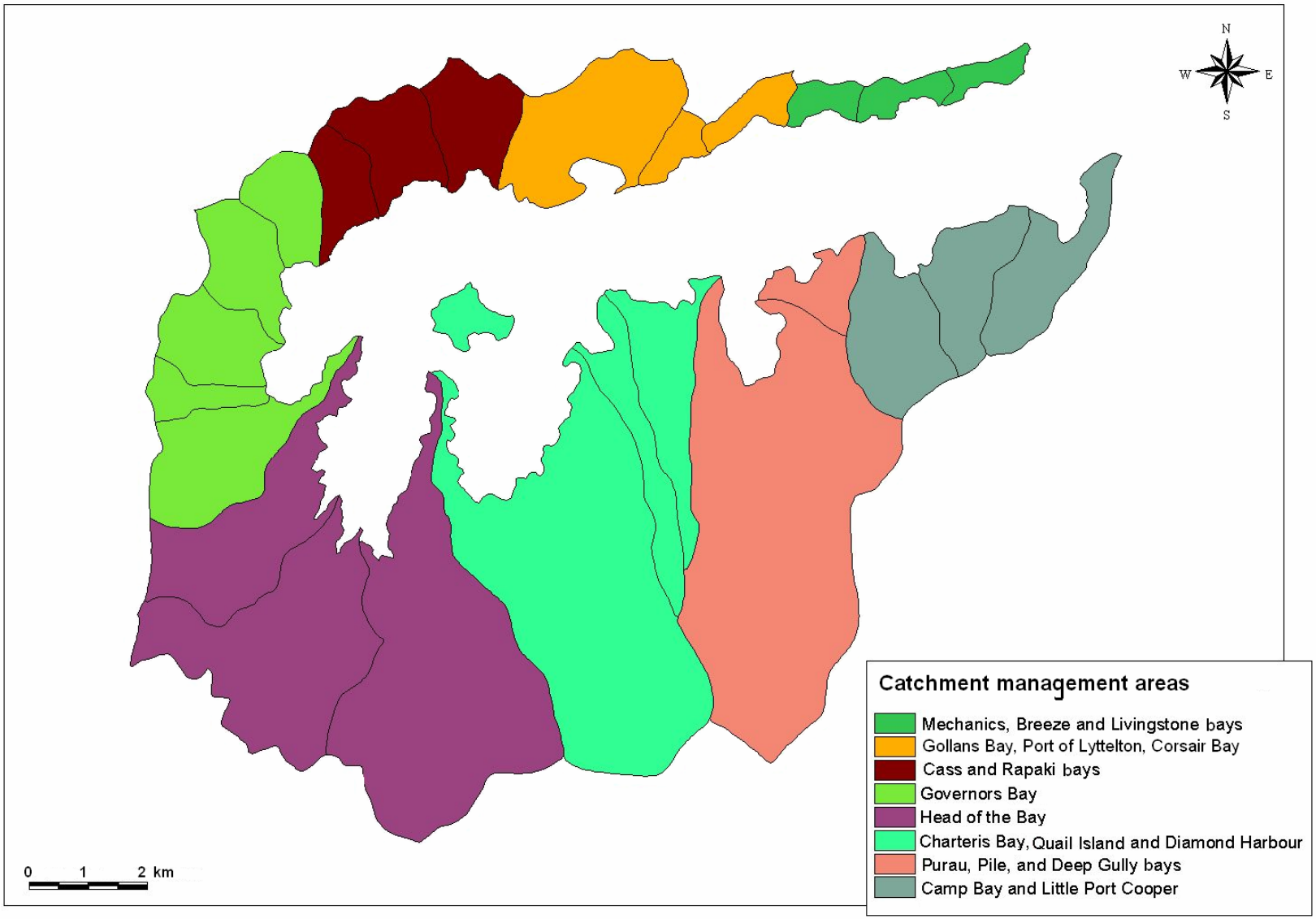


Figure 6.1 The eight catchment management areas

6.1 Mechanics, Breeze and Livingstone bays

Contaminant sources

The potential sediment sources in this catchment management area include roading and active and historic erosion (Figure 6.2). There are no streams in this area.

Roading

There is approximately 100 m of gravel road in this area. This road does not intersect active or historic erosion and is not a significant source of sediment to the harbour.

Active and Historic Erosion

The active erosion signatures lie in the lower slopes of Mechanics and Livingstone bays. The historic erosion signatures are present in Breeze and Livingstone bays. There are more and a larger area of active than historic erosion signatures in this management area. Access to the sites is likely to be an issue for any erosion control.

Recommended order of management priority for this catchment management area:

1. Active and historic erosion

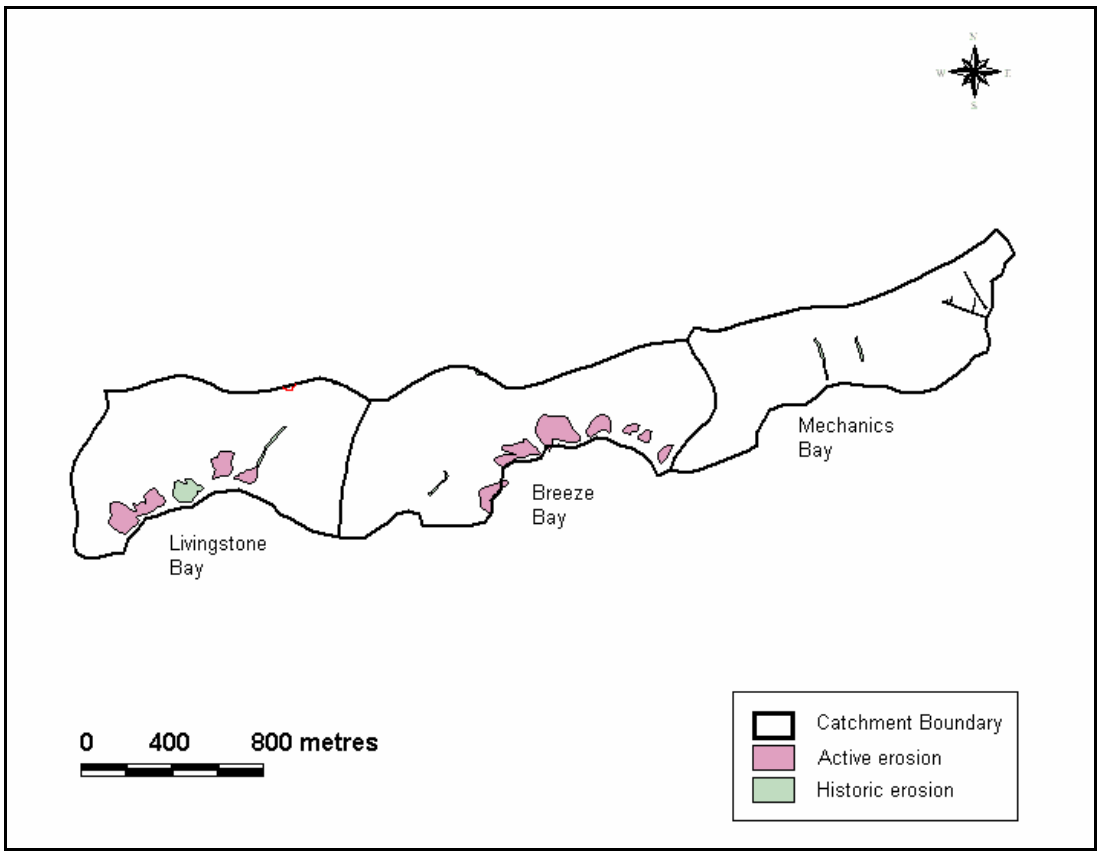


Figure 6.2 Sources of sediment in Mechanics, Breeze and Livingstone bays

6.2 Gollans Bay, Port Lyttelton, Corsair Bay

Contaminant sources

The potential sediment and other contaminants sources in this catchment management area include almost all sources identified in the study.

Wastewater

Lyttelton township has the largest network of wastewater infrastructure (connections and pipeline) in the Harbour. The wastewater treatment facility is located adjacent to the container terminal area with the outfall located south of this facility (Figure 6.3).

Roading

There is an extensive roading network within Lyttelton township.

Stormwater

During rainfall stormwater flows off the roads and the extensive areas of impervious surface within Lyttelton township.

Streams

There are ephemeral streams in this management area. One in Corsair Bay, three above Lyttelton township, one above the coal storage facility and one in Gollans Bay.

Subdivisions

There are subdivisions to the North East of Lyttelton Township at Hyllton Heights, and to the West at Walkers Road (Figure 6.3).

Active and historic erosion

Active erosion signatures occur in the lower slopes of Gollans Bay and in the upper slopes behind the Port of Lyttelton coal storage facility. Historic erosion signatures are in the Western areas above Corsair Bay, and in the slopes above the Lyttelton Township and coal storage area.

Where streams intersect (within 20 m) erosion signatures, there are more intersects with historic than active erosion signatures. Where roading intersects (within 20 m) erosion signatures there is about an equal number of intersects with historic and active erosion signatures. However, there are only a small number of intersects of roads with erosion signatures in this management area.

Port activity

Port activity occurs in the coastal areas below the township and toward Gollans Bay. From West to East this activity includes: current and proposed marina activity, the petroleum tank farm, dry dock, the inner port wharf area (mooring of numerous commercial fishing, cargo vessels and passenger ferries), the quay, container terminal and breakwater area, and the coal storage facility.

Quarry and landfill sites

In Gollans Bay the quarry site and landfill site are in the same area (Figure 6.3).

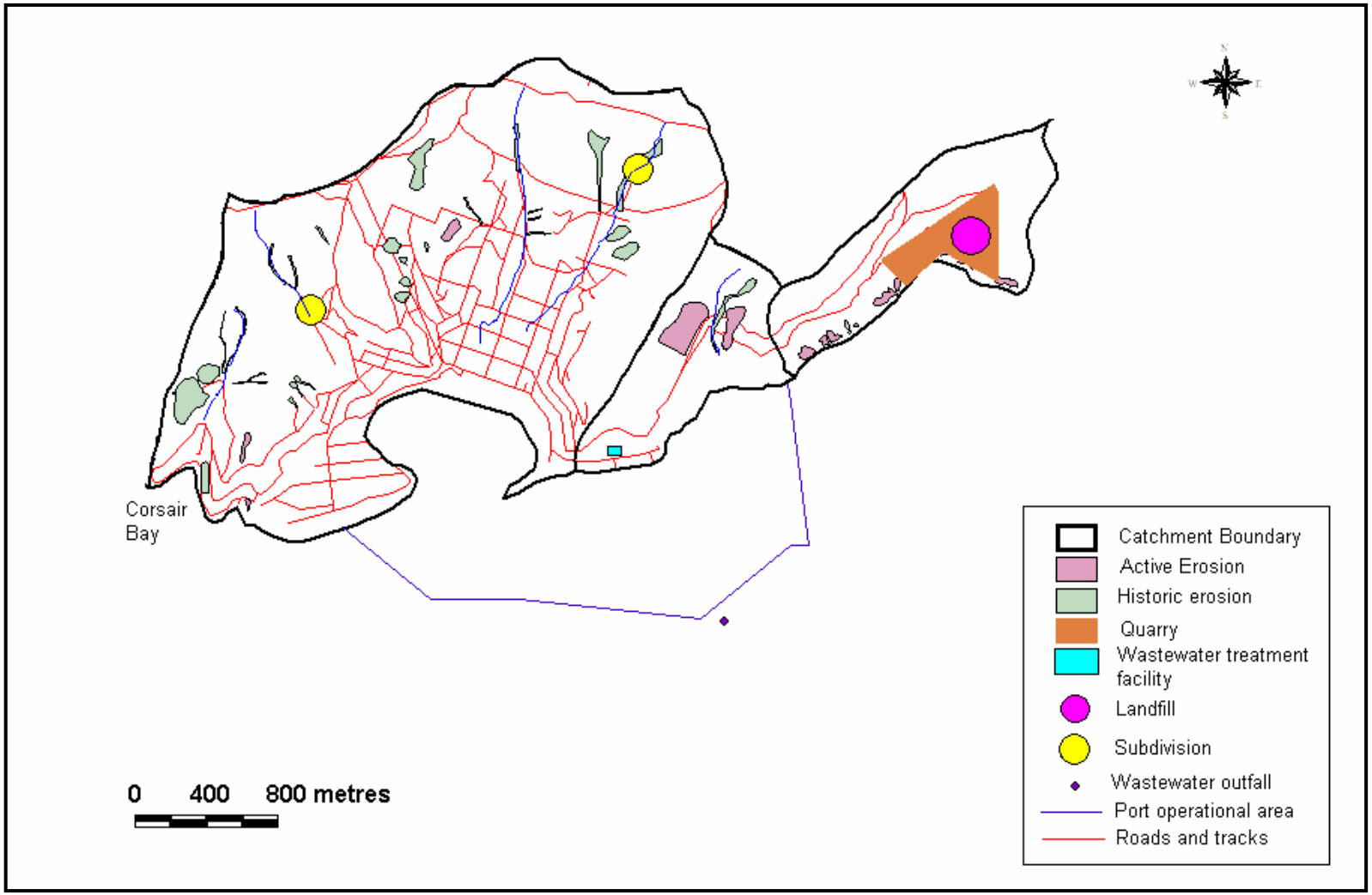


Figure 6.3 Sources of sediment and other contaminants from Gollans Bay, Port Lyttelton and Corsair Bay

Recommended order of management priority for this catchment management area:

1. Subdivisions	2. Streams	3. Roading	4. Active and historic erosion
5. Port Activity	6. Wastewater	7. Landfill	8. Quarry

6.3 Cass and Rapaki bays

Contaminant sources

The potential sediment and other contaminants sources in this management area includes subdivisions, active and historic erosion, streams, roading and wastewater networks.

Subdivisions

In Cass Bay there is a subdivision to the west along Mariners Cove (approx. 12 Lots) and one to the east above the Governors Bay Road (Fig. 6.4). Sediment discharge to road, stream and harbour has occurred from both areas. The site above Governors Bay Road could be an ongoing issue due to the potential size of future development.

Active and historic erosion

There are numerous active erosion signatures in the mid–lower slopes of all three valleys and particularly within Rapaki Valley (Figure 6.4). Historic erosion signatures are present in each valley and particularly along the narrow stream beds. There are also historic erosion surfaces along the coastal margin.

Roading intersects (within 20 m) with more active than historic erosion signatures (Figure 6.4), with some of these intersects being of considerable length. Roading intersects with active erosion along the northern bank of the main road (Governors Bay Road) into and out of both Cass Bay and Rapaki Bay.

Streams intersect (within 20 m) with more historic than active erosion signatures (Figure 6.4). Historic erosion signatures most commonly occur along the narrow streambeds in each of the valleys. Active erosion signatures are intersected by the mid section of the Rapaki stream, and a section of the eastern stream of Cass Bay.

Streams

There are ephemeral streams in each of the valleys. These streams carry a degree of sediment during a moderate rainfall event. The stream that flows through the residential area in Cass Bay has been observed to have a high sediment load with the source of the sediment traced to the subdivision.

Wastewater

The wastewater from the residences in Cass Bay and Rapaki flows to the treatment plant at Lyttelton.

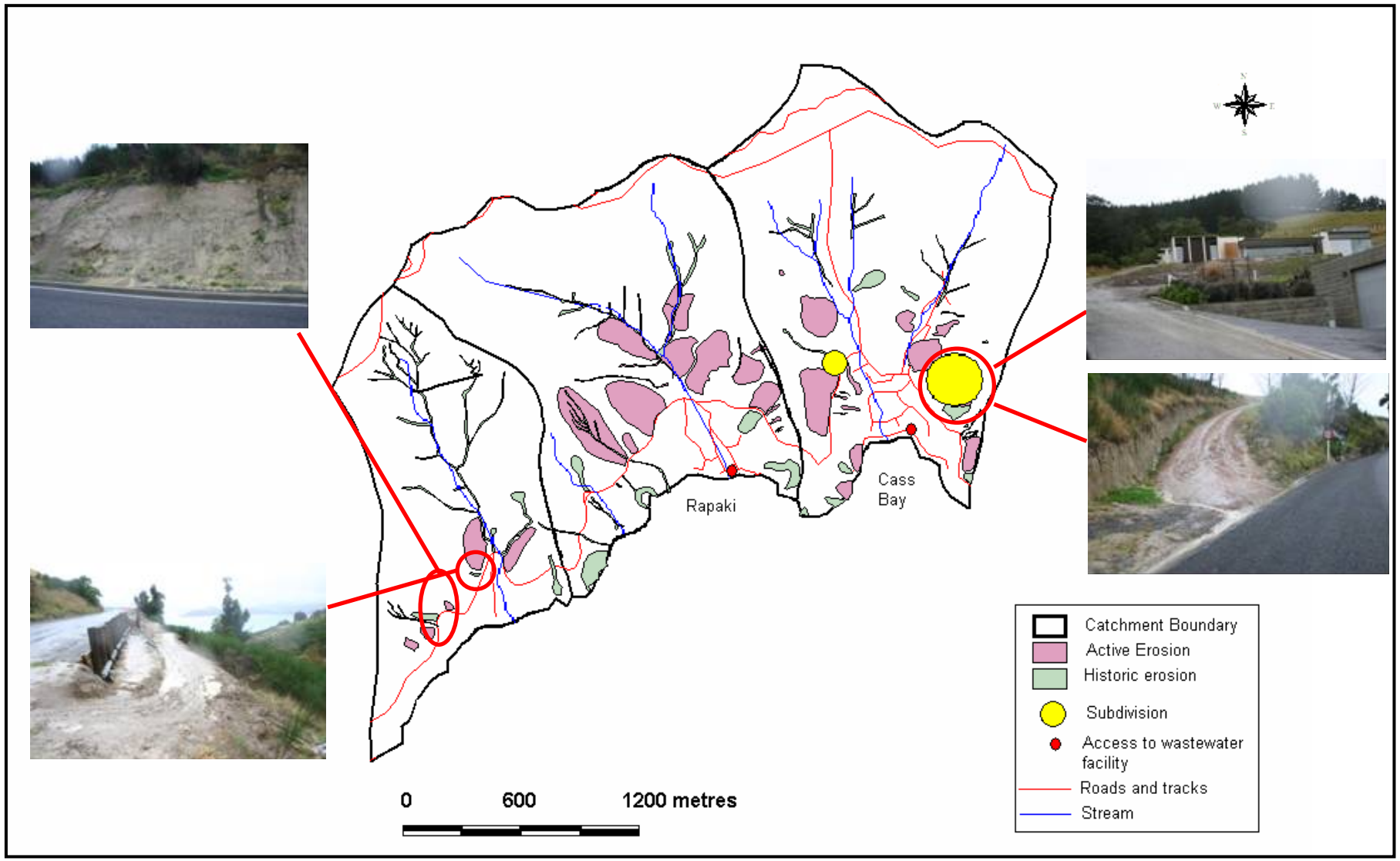


Figure 6.4 Sources of sediment and other contaminants from Cass Bay and Rapaki

Recommended order of management priority for this catchment management area:

1. Subdivisions	2. Streams	3. Roading	4. Active and historic erosion	5. Wastewater

6.4 Governors Bay

Contaminant sources

The potential sediment and other contaminants sources in this management area includes subdivisions, active and historic erosion, streams, roading, wastewater networks and outfall, non-reticulated waste water systems and potential landfill activity.

Subdivisions

The three current subdivisions from north to south (Figure 6.5) are Lighthouse Lane (approx. 30 Lots), Bay Heights and a valley above the Church Bay/Governors Bay Intersection (Figure 6.5). There has been sediment discharge to road, stream and the harbour from each of these subdivisions. Sediment runoff from the Lighthouse Lane subdivision was a major environmental issue for a considerable period of time. The site above the Church Bay/Governors Bay intersection could be an ongoing issue as a significant quantity of sediment was discharged to a downstream weir during the initial vegetation clearing stage.

Active and historic erosion

Active and historic erosion signatures are along and adjacent to stream beds and on some of the exposed slopes. On these slopes the total area of active and historic erosion within this management area are similar. There is a large area of active erosion signature along the northern face of Mansons Peninsula.

Roading intersects (within 20 m) with active and historic erosion signatures along the northern road side cuttings entering Governors Bay from Rapaki, (see photos in Figure 6.5). Streams intersect (within 20 m) with active and historic erosion signatures along the narrow stream beds.

Streams

There are seven streams in this management area with most being ephemeral. All streams carry sediment during a moderate rainfall event. It has been observed that:

- a significant amount of sediment was accumulating at the weir above the road in the stream alongside the Church Bay/Governors Bay intersection.
- two streams to the north of the township receive a significant amount of sediment from road side drainage with more sediment from the road side than from upstream of the road.
- The Bay Height subdivision contributes sediment to the adjacent stream

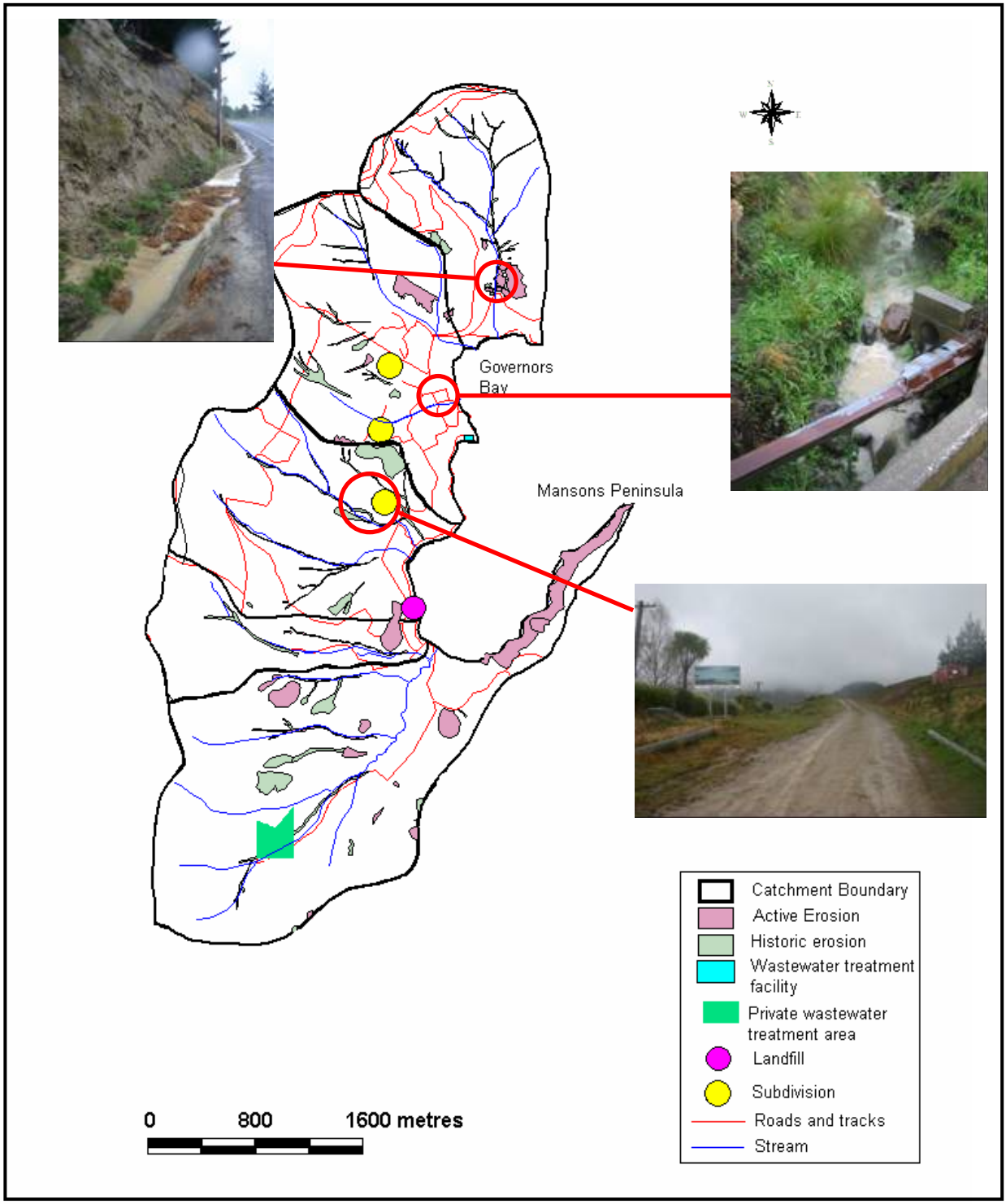


Figure 6.5 Sources of sediment and other contaminants from Governors Bay

Wastewater
There is a public reticulated wastewater system within the main township and a private system at Living Springs southwest of the township. The wastewater from the public system is treated and then discharged into the harbour some distance from shore while the treated wastewater from Living Springs is discharged to land. Private wastewater septic systems are used in non-reticulated areas.

Landfills
Landfill activity occurs at Allendale reserve, but the status of this landfill site is unknown.

Recommended order of management priority for this catchment management area

1. Subdivisions	2. Streams	3. Roading	4. Active and historic erosion	5. Wastewater

6.5 Head of the Bay

Contaminant sources
The potential sediment and other contaminants sources in this management area include active and historic erosion, streams, roading, quarry activity and non-reticulated waste water systems.

Active and historic erosion
Historic and to a lesser degree active erosion signatures occur along and adjacent to stream beds (Figure 6.6). There are large areas of active and historic erosion on exposed faces. In this management area these signatures are typically of tunnel gully erosion. There is a significant area of active coastal erosion occurring along the eastern face of Mansons Peninsula.

Roading intersects (within 20 m) with active erosion signatures occur toward Gebbies Pass, along the road north of Teddington and western road side cuttings climbing over Mansons Peninsula (Figure 6.6). Streams intersect (within 20 m) with active and historic erosion signatures along the narrow stream beds.

Quarry
There is an operational Quarry at the corner of Foleys Road and Governors Bay Teddington Road. In the past sediment from this quarry (site runoff and truck discharge to road) has been observed flowing into nearby roadside drains (photos in Figure 6.6). Sediment control strategies are being developed by the quarry owner.

Streams
The streams in this management area carry sediment during a moderate rainfall event. During moderate rainfall the Foleys Road Stream was highly turbid with the middle stream in this management area the least turbid.

Wastewater
Private wastewater septic systems are used in all dwellings in the catchment management area.

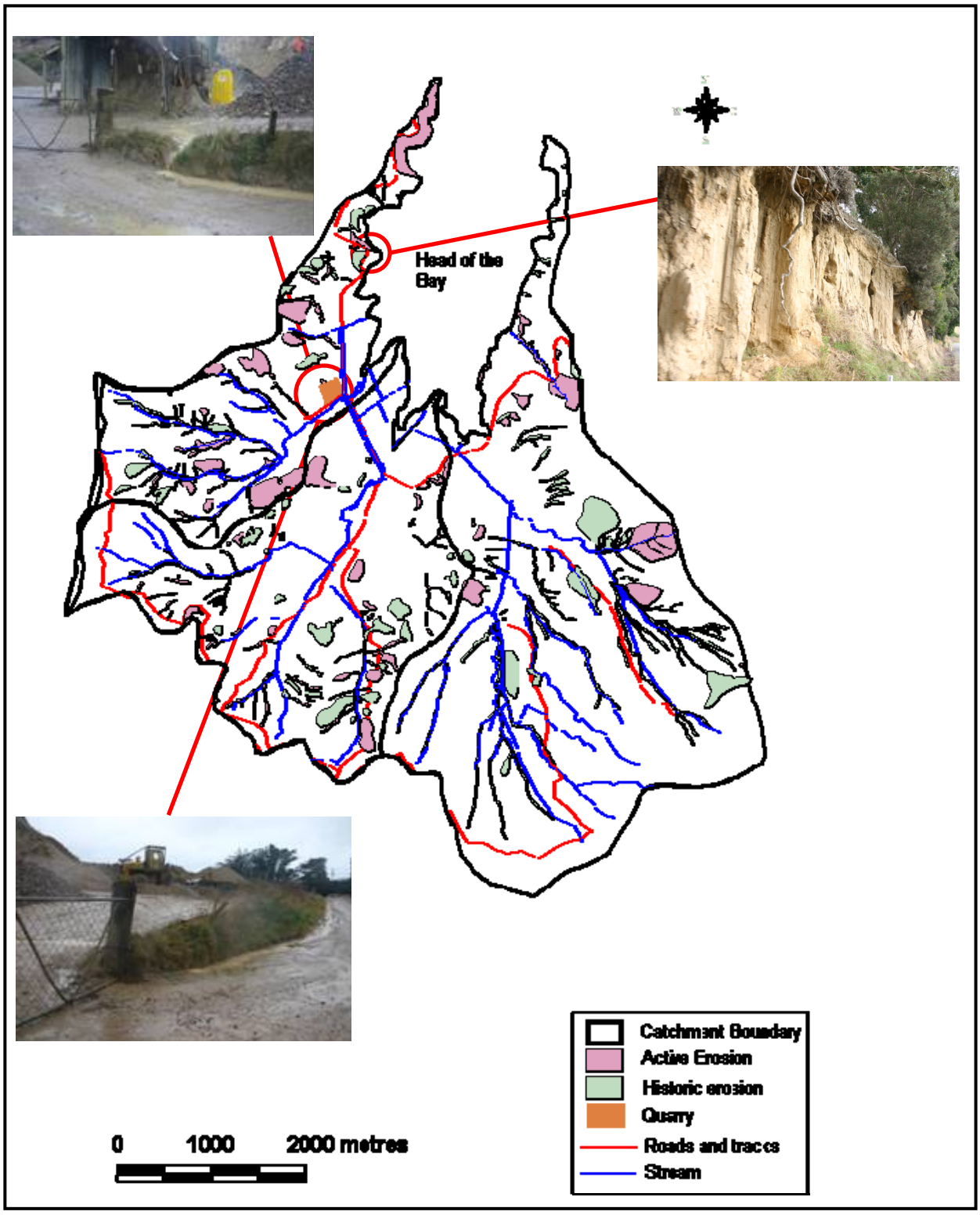


Figure 6.6 Sources of sediment and other contaminants from Head of the Bay

Recommended order of management priority for this catchment management area:

1. Quarry	2. Streams	3. Roading	4. Active and historic erosion	5. Wastewater

6.6 Charteris Bay, Church Bay and Diamond Harbour

Contaminant sources

The potential sediment and other contaminants sources in this management area include subdivisions, active and historic erosion, streams, roading, wastewater networks and outfall and non-reticulated waste water systems.

Subdivision

The three current subdivisions from west to east (Figure 6.7) are at Black Rock (West Church Bay), James Drive (coastal Diamond Harbour) and Stoddart Terrace (uphill in Diamond Harbour township). Black Rock is currently in the preparation stages with sections now up for sale (approx. 40 Lots). James Drive is the largest development (approx. 50 Lots) with many of the houses completed, but there are still some sections to be built on. Stoddart Terrace, is the smallest subdivision (approx. 15 Lots).

Active and historic erosion

Signatures for active and historic erosion are located along and adjacent to stream beds, with more historic than active signatures (Figure 6.7). There are a number of large areas of historic erosion on exposed faces away from the streams, that is, in western/south western areas, above Charteris Bay, in the upper branches of Te Wharau Stream (Charteris Bay) and in Church Gully. The larger areas of active erosion signatures includes northerly facing coastal cliff areas i.e. Quail Island, Black Rock, and around Diamond Harbour as well as some exposed faces away from the streams. The active erosion signatures in this area are quite prominent.

Roading intersects (within 20 m) of active or historic erosion signatures (Figure 6.7) along an extensive area of western Charteris Bay and toward Black Rock. The streams that intersect (within 20 m) active erosion signatures are mainly in behind the Diamond Harbour township. The Te Wharau Stream and its tributaries intersect historic erosion signatures.

Streams

There are streams in all valleys. Te Wharau Stream adjacent to Orton Bradley Park is permanently flowing while the others are ephemeral. During a moderate rainfall event all of these streams carry sediment with Te Wharau Stream having a significant flow and high sediment load.

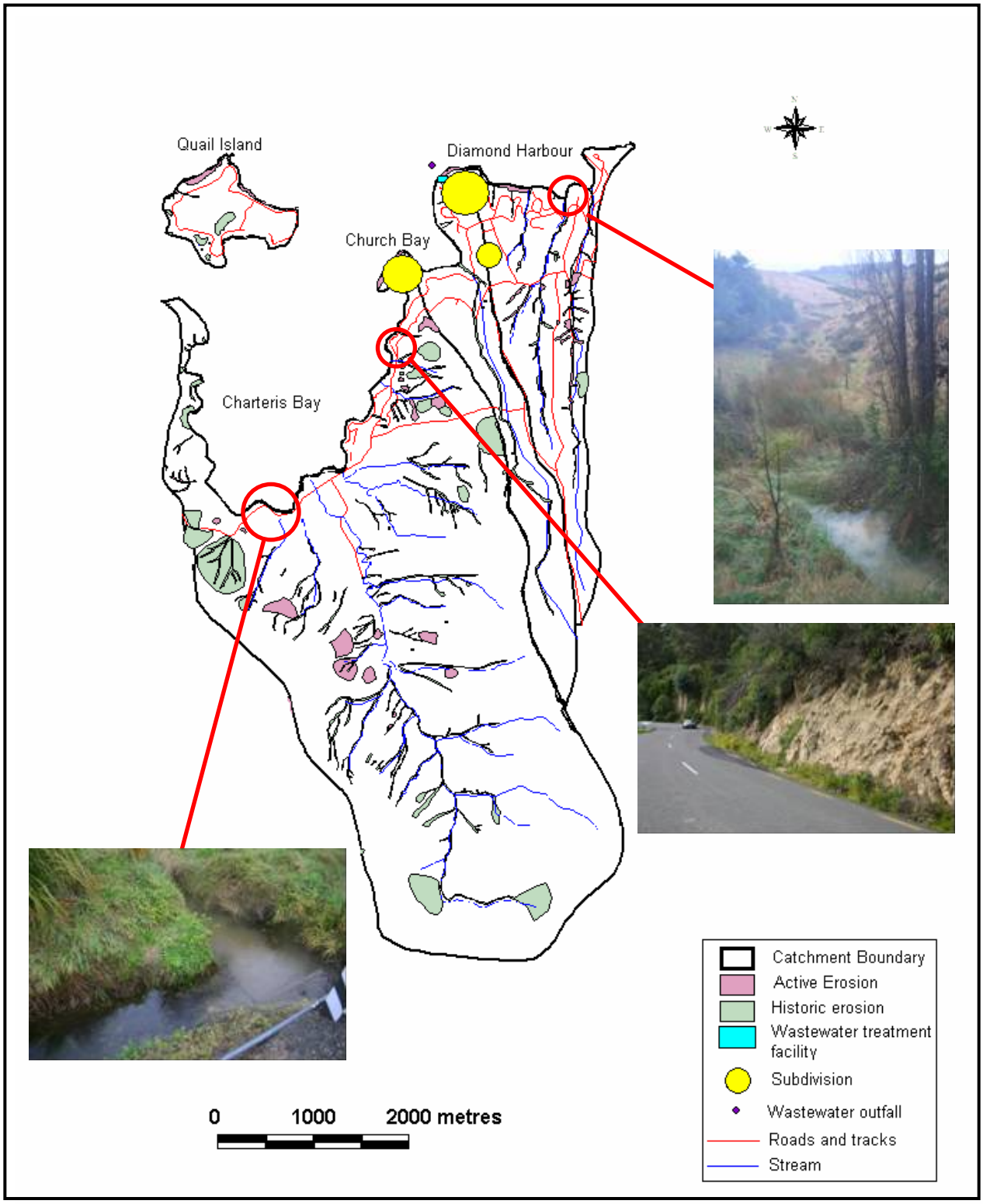


Figure 6.7 Sources of sediment and other contaminants from Charteris Bay, Quail Island and Diamond Harbour

Wastewater
There is reticulated wastewater infrastructure throughout Church Bay and Diamond Harbour. The wastewater is treated at Pauaohinekatau Head (Figure 3.7) and discharged into the harbour approximately 200m from shore. The remaining non-reticulated areas use private septic wastewater systems.

Recommended order of management priority for this catchment management area:

1. Subdivisions	2. Streams	3. Roading	4. Active and historic erosion	5. Wastewater

6.7 Purau, Pile and Deep Gully bays

Contaminant sources
The potential sediment and other contaminant sources in this management area include streams, active and historic erosion, roading and reticulated and non-reticulated waste water systems.

Streams
There are streams in all valleys. The Purau Stream is permanently flowing while the others are ephemeral. During a moderate rainfall event the Purau Stream does carry sediment.

Active and historic erosion
Active erosion signatures are highly visible, on exposed slopes in the east of the management area, and at the very top of Purau Valley, with active coastal erosion in the north east (Figure 6.8). Historic Erosion signatures occur on western exposed slopes and also at the head of Purau Valley. There are also active and historic signatures along and adjacent to stream beds. There area of active and historic erosion signature is greater on exposed slopes than along and adjacent to stream beds.

Roading intersects (within 20 m) an active erosion signature (Figure 3.8) along one road cutting between Diamond Harbour and Purau Bay. The streams in this area intersect (within 20 m) with numerous historic and active erosion signatures (Figure 6.8).

Wastewater
There is reticulated wastewater infrastructure in the Diamond Harbour areas to the North West. The remaining areas are non-reticulated and use private septic systems.

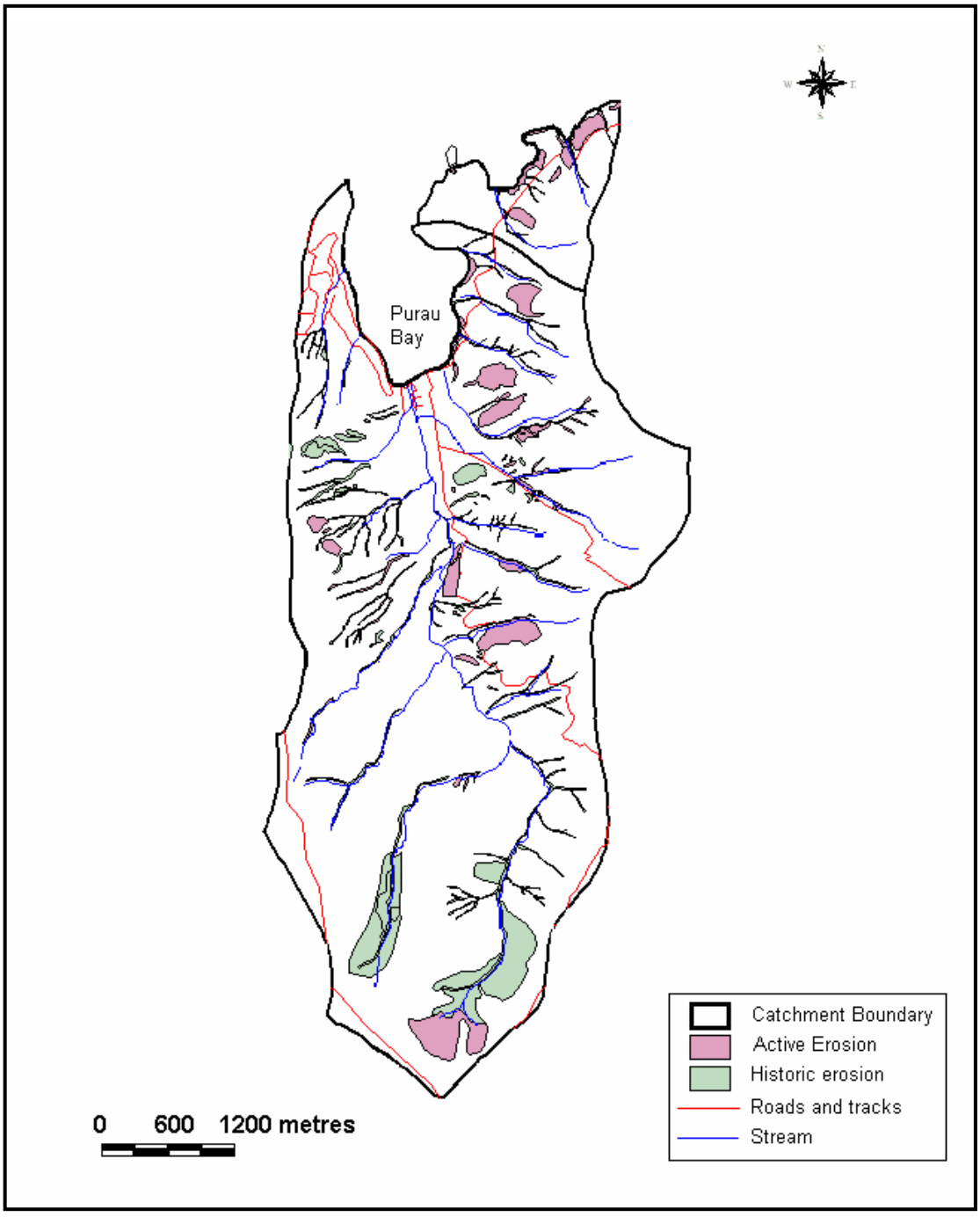


Figure 6.8 Sediment and other contaminant sources from Purau, Pile and Deep Gully bays

Recommended order of management priority for this catchment management area:

1. Streams	2. Roading	3. Active and historic erosion	4. Wastewater

6.8 Camp Bay and Little Port Cooper

Contaminant sources
The potential sediment sources in this management area include active and historic erosion and streams.

Streams
Ephemeral streams occur in the valleys (Figure 6.9).

Active and historic erosion
The active erosion signatures are numerous and large. These active erosion signatures occur along and adjacent to stream beds, on exposed slopes and on coastal faces. Historic erosion signatures predominantly occur on the western slopes of Camp Bay with some areas along and adjacent to stream beds. There are more active than historic erosion signatures in this management area (Figure 6.9).

Roading intersects (within 20 m) active and historic erosion signatures, along a road cutting between Deep Gully Bay and Camp Bay. The streams in this area primarily intersect (within 20 m) with active erosion signatures (Figure 6.9).

Wastewater
All dwellings in the management area use private septic systems.

Recommended order of management priority for this catchment management area:

1. Active and historic erosion	2. Streams

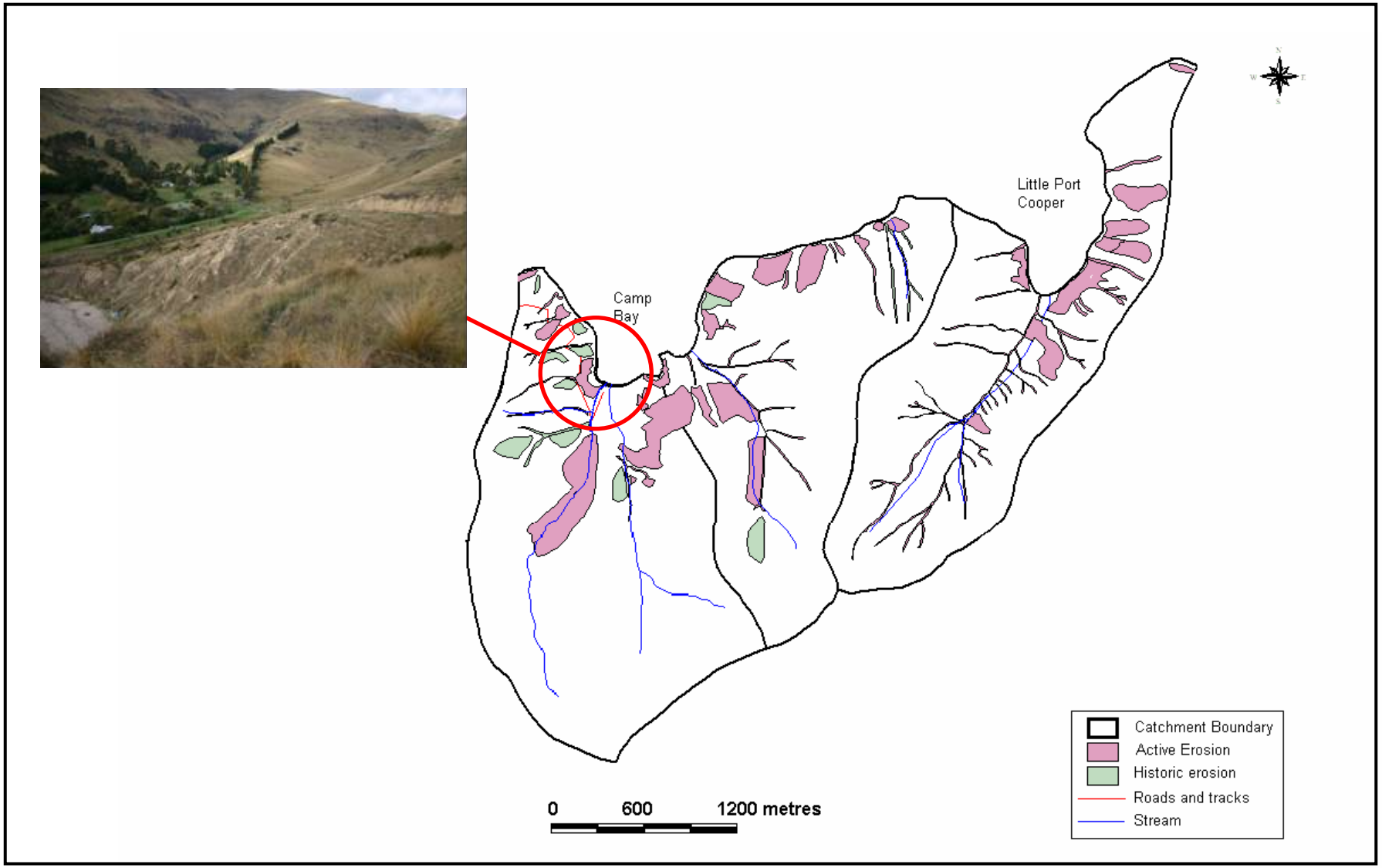


Figure 6.9 Sediment sources from Camp Bay and Little Port Cooper

7 Acknowledgements:

Lyttelton Harbour Issues Group and Akaroa Harbour Issues Working Group are acknowledged for their interest in having a study done for each harbour and for their involvement; Christchurch City Council for their input; Sean Fergus for his research and being author of the draft report; and Lesley Bolton-Ritchie for editing the draft to final stage.

8 References:

Boffa Miskell (2007) Banks Peninsula Landscape Study. Report for Christchurch City Council.

Curtis, (1985). Sedimentation in a Rock Walled Inlet, Lyttelton Harbour, New Zealand. Unpublished PhD Thesis. Department of Geology, University of Canterbury. Christchurch, New Zealand.

Department of Scientific and Industrial Research (DSIR) (1987). Soils of the Downs and Plains, Canterbury & North Otago, NZ, SB Bull. *14* Department of Scientific and Industrial Research. Wellington, New Zealand.

Environment Canterbury (2007). LIR Data Base GIS Resources. Christchurch, New Zealand (2007).

Goff, J. (2005). Preliminary Core Study – Upper Lyttelton Harbour. National Institute of Water and Atmospheric Research Ltd. Christchurch, New Zealand.

Hart, E. H. (2004). Sedimentation in the Upper Lyttelton Harbour: A Report to Environment Canterbury. Environment Canterbury. Christchurch, New Zealand.

Lucas, D., Gray, N., Riley, A., Head, J., deRiddler, L., Meurk, C., Lynn, I. (2005). Indigenous Ecosystems of the Lyttelton Harbour Basin: A Guide to Native Plants, their Ecology and Planting. Governors Bay Community Association, Governors Bay Landcare Group. Governors Bay, Canterbury, New Zealand.

Ministry for the Environment (MfE), New Zealand Association of Resource Management, Ministry of Agriculture and Forestry. (2001). Soil Conservation Handbook. Ministry for the Environment (MfE), New Zealand Association of Resource Management, Ministry of Agriculture and Forestry. Wellington, New Zealand.

Personal Communication. Paul Pritchett, Lyttelton Harbour Issues Group member, 28 April 2008.

Thompson, R. (2003). Effects of Foresty on Freshwater Systems - Review of existing information. Report by Ryder Consulting Ltd for Environment Bay of Plenty, Environment Canterbury, Northland Regional Council, Wellington Regional Council, Dunedin, Otago.

Appendix 1 Zoning

The existing BPDP landuse zoning is compared to the proposed zoning recommendations of the 2007 CCC Banks Peninsula Landscape Study. This comparison identifies where proposed zoning changes could potentially exacerbate existing potential contaminant sources and/or create new ones.

Background
Landscape has been a controversial issue within Banks Peninsula since the public notification of the proposed District Plan (PDP) in 1997. A significant number of submitters opposed or sought modification to land identified as 'Landscape Protection Areas'. Questions were raised over a perceived lack of rigour in establishing these areas. Consequently, a rural task force (RTF) was formed to address these and other issues. Between 1997 and 1999 the RTF focused on the areas of the peninsula requiring environmental protection including management methods. This information was utilised by the Banks Peninsula District (BPD) in plan reviews.

In 2002 the BPD publicly notified "Variation 2'. A decision on Variation 2 was released in June 2005. Two key aspects of the decision were that:

1. uncertainties about proper identification areas were recognised; and
2. there was common ground between the majority of submitters that many parts of the Peninsula exhibit Outstanding Natural Features.

However, this decision was appealed to the Environment Court, and in January 2006 the Court issued a Heads of Agreement establishing the brief for further study.

The study which was subsequently commissioned was required to have a methodology that incorporated the following components: contextual description; landscape description; landscape characterisation; landscape evaluation; and description of assessment criteria informed by relevant Environment Court decisions.

In August 2006 Boffa Miskell Limited were commissioned by the Christchurch City Council to prepare a landscape assessment of the rural parts of the previous Banks Peninsula District (BPD). NOTE: the Banks Peninsula District Council was abolished and merged with Christchurch City Council in May 2006.

The objective of this assessment was:
"To promote the sustainable management of Banks Peninsula landscapes, by managing the use, development and protection of landscapes in a way which enables people and communities to provide for their social, economic and cultural well-being, and for their health and safety, while sustaining the potential of landscapes to meet the reasonable and foreseeable needs of future generations whilst avoiding, remedying or mitigating any adverse effects of activities on landscapes."

2007 CCC Banks Peninsula Landscape Study

Recommendations
There are six recommended zoning classifications for the **Banks Peninsula Rural Zone** within a hierarchy of landscape protection. These six zones along with the suggested permitted/non permitted activities within each are described below.

Important Ridgelines in Visual Amenity Landscapes
(highest level of development restriction)

Desired outcomes:
Avoidance of human modification of these areas and features

Restrictions:
- All activity (non-complying activity)

Outstanding Natural Heritage Area/Coastal
(highest level of development restriction)

Desired outcomes:
Avoidance of modification of these areas and features. It is important to note that working farms are part of outstanding landscapes. Continuation of farming activities in these landscapes is therefore anticipated. Avoidance of skyline buildings.

Restrictions:
- Construction of agricultural buildings (restricted discretionary activity)
- Removal of any indigenous vegetation considered as an Area of Significant Indigenous Vegetation on the planning maps CCC will identify these areas on the planning maps from to up and coming ecological study of the Peninsula (non-complying activity)
- All other activity (non-complying activity)

Coastal Natural Character Landscape

Desired outcomes:
Minimise or avoid additional modification physically and visually. Avoid ribbon development along the coastline.

Restrictions:
- Construction of agricultural buildings (restricted discretionary activity)
- Earthworks(restricted discretionary activity)
- All other activity (non-complying activity)

Heritage Landscape

Desired outcomes:
Avoidance of development which adversely affects the context and surroundings of heritage features by contrasting or undermining the existing landscape pattern.

Restrictions:

- No rules apply- has the effect of an "overlay" on the planning maps which signals that consideration of heritage values would be required as part of any resource consent application within the overlay area. Accordingly, a set of assessment matters would need to be developed, e.g.:
    - The extent to which the proposed activity would undermine or contrast with an existing pattern of landuse or activity in an identified heritage precinct.
    - In a heritage precinct the extent to which the proposed activity would affect the continuity or setting of the landscape.
    - The extent to which the proposed activity would visually or physically encroach upon a heritage feature

Visual Amenity Landscapes

Desired outcomes:
Maintenance of small-scale landuse patterns, sited in harmony with landform. Controlled growth – identify areas capable of absorbing further change in the landscape (e.g., valley floors) with a recommendation to prepare structure plans for rural-residential and settlement growth. Regard to be had to heritage values, context connections, character, natural features, waterways and cultural impacts.

Restrictions:

- In acknowledgement that a significant area of the Peninsula landscape is a working landscape it is considered necessary to balance functionality with landscape sensitivity. Farm buildings which fall within specified criteria are suggested to be a permitted activity (this excludes Outstanding and Coastal Natural Character Landscapes). Suggestions for standards for permitted activity status are as follows:
    - *Height:* 8m
    - *Reflectivity:* Materials within a specific reflectivity range
    - *Colours:* Within a specified range
    - *Size:* Up to 400m^2

  In addition, Council should prepare guidelines and provide some incentives e.g. rates relief, waiver of consent fees for agricultural buildings in the Outstanding and Coastal Natural Character Landscapes or an environmental credit system.

On sites over 40ha

-Agricultural buildings which are not permitted, are controlled activities
-density control of one dwelling per site
-All non-agricultural buildings are controlled activities

On sites under 40ha

-Agricultural buildings which are not permitted (restricted discretionary activity)
-All non-agricultural buildings (restricted discretionary activity)

All sites

-Commercial forestry greater than 2ha are restricted discretionary (Rule not to apply to shelter belts or indigenous vegetation)
-Earthworks (restricted discretionary activity) (but standard/threshold to be lower i.e. more permissive than in Areas of Outstanding Natural Landscape)

Visual Amenity Landscapes Growth Areas

Desired outcomes:
Controlled growth – identify areas capable of absorbing further change in the landscape (e.g. valley floors) and recommend the preparation of structure plans (and later plan changes) for rural-residential and settlement growth. Regard to be had to heritage values, context, connections, character, natural features, waterways and cultural impacts.

Note – growth areas are recommended on the basis of landscape values only. No consideration has been given to servicing, roading and other possible constraints to development, nor the density and character of development that may be appropriate in these areas.

Proposed Zones in the Lyttelton Harbour Catchment
The proposed zoning of the Lyttelton Harbour Catchment is presented in Figure 1.

Proposed **Visual Amenity Landscapes** make up the largest proportion of the catchment and in particular in the mid to upper slopes and some coastal areas.
Proposed **Outstanding Natural Heritage Areas** dominate the majority of all upper slopes and ridgelines apart from the Head of the Bay area. In addition, the Adderley Head area is proposed as Outstanding Natural Heritage Area Coastal.
Proposed **Important Ridge Lines in Amenity Landscape** areas are located along the majority of the ridgeline not determined as Outstanding Natural Heritage Areas.
Proposed **Heritage Landscapes** are located in the coastal Allendale Area to the West, along with coastal and headland areas in Purau Bay to the East, as well as all of Quail Island.
Proposed **Coastal Natural Character Landscapes** are located at the Head of the Bay shoreline, to the North between Cass Bay and Governors Bay, and to the South East including most of the Areas from Pile Bay to the East of Little Port Cooper.

The remaining areas are not included in the study as they are non-Rural Zone are else not part of the study area.

Zones of the Existing Proposed Banks Peninsula District Plan

The existing rural zoning of the Proposed Banks Peninsula District Plan (PBPDP) has one set of respective zone policies and rules associated with land use. This is in contrast to the seven that will be developed from the landscape survey recommendations presented above.

Chapter 19 of the PBPDP focuses on Rural Banks Peninsula and is the most relevant in the context of this report. An important issue covered in this chapter is proposed subdivision activity. As such, the adverse effects of structures, development and activities on landscape character and amenity values have been identified as an issue. This objective emphasis's the importance of protecting landscape character and amenity values. The proposed policies in Chapter 19 aim to maintain and enhance the landscape character and amenity values through: small scale, low-density development in vulnerable areas; protect prominent ridges

skylines from high visibility structures; protect prominent rocky outcrops and natural/indigenous resources/habitats. For details refer to text box below.

CHAPTER 19 THE RURAL ZONE

ISSUE 1
Structures, development and activities can adversely affect the landscape character and amenity values of the Rural Zone.

OBJECTIVE 1
To maintain the landscape character and amenity values of the Rural Zone.

POLICIES
1A. The following qualities or elements contribute to the landscape character and amenity values of the rural environment and are to be maintained and enhanced:
- A generally small scale low density of buildings and residential development in those areas of the District where landscape character and amenity values are vulnerable to degradation. (See also Chapters 12, 13 and 31.)
- Absence of highly visible structures and development on prominent ridges and skylines. (See also Chapters 12, 13 and 31.)
- Prominent rocky outcrops.
- Areas of significant indigenous vegetation and habitat.
- The quality and clarity of water in rivers and streams.
- Indigenous streamside (riparian) and coastal vegetation.
- The ability to sustainably provide for the evolving nature of land based activities.

RULES

Permitted Activities
The following are permitted activities where they meet the standards set out in (chapter 19) Rule 2 and 3, unless otherwise specified as a controlled, restricted discretionary, discretionary or non-complying activity.

a) Farming.
b) Farm accessory buildings and structures.
c) Creation and maintenance of Reserves.
d) Outdoor recreation, which does not involve the commercial use of, motorised vehicles
e) Conservation activities.
f) Home enterprises.
g) The creation of dwellings and accessory buildings.
h) Woodlot forestry
i) Earthworks.
j) The maintenance and repair of roading infrastructure

PBPDP Zones in the Lyttelton Harbour Catchment
The zone designated as rural occurs throughout Lyttelton Harbour Catchment (Figure 2). This zone dominates the south western-south eastern areas but is proportionally less dominant in the northern areas.

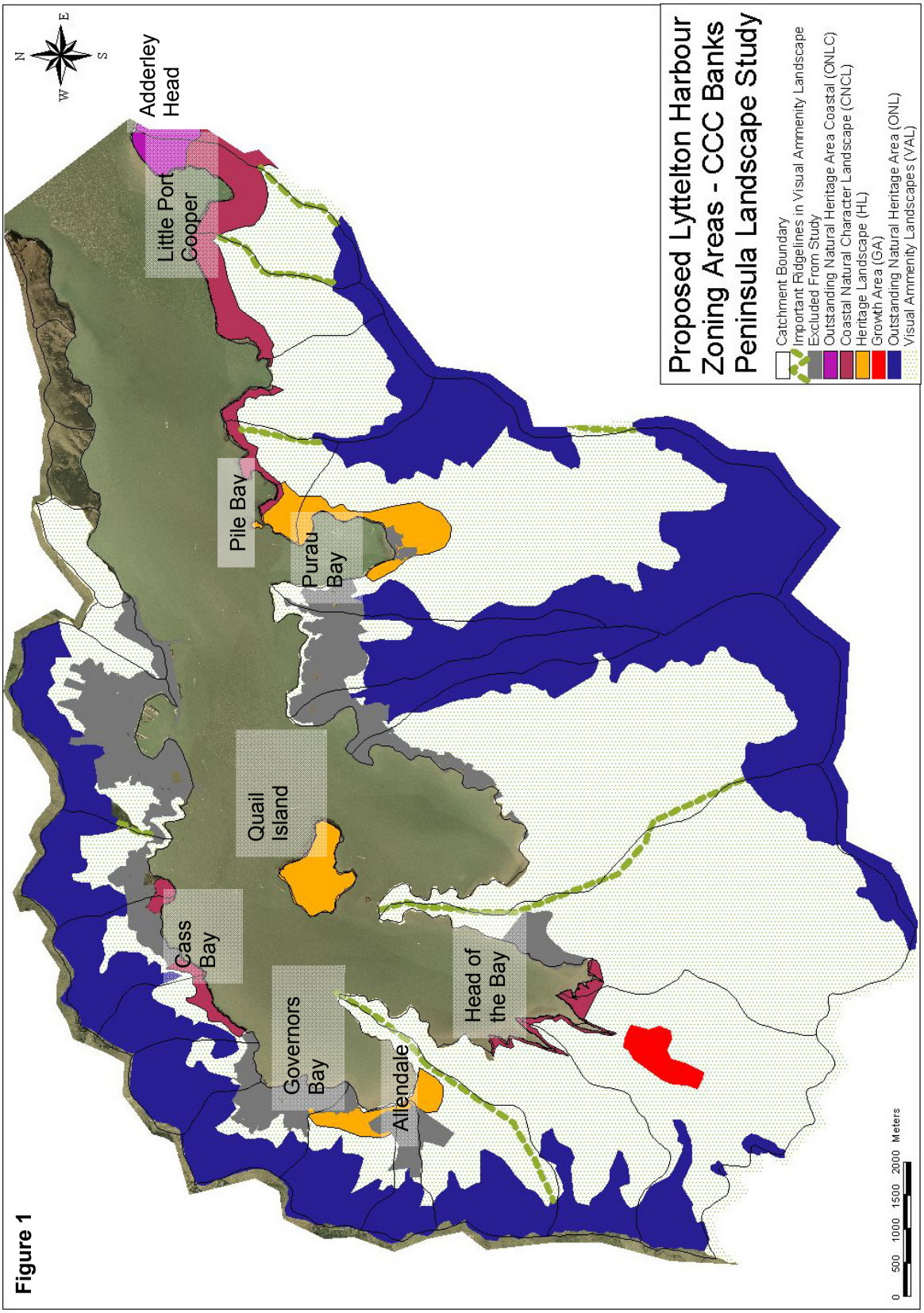
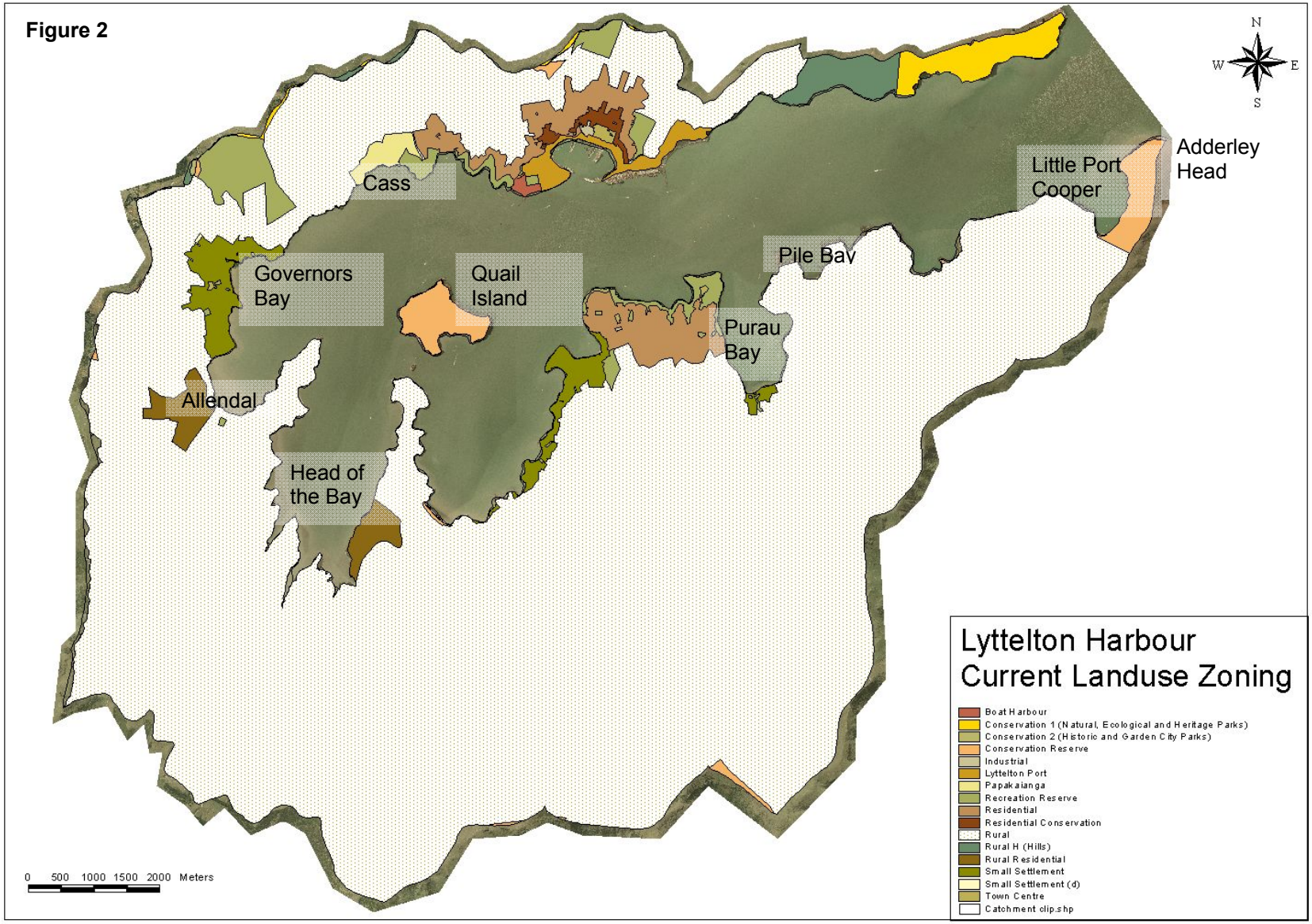

Proposed Lyttelton Harbour
Zoning Areas - CCC Banks
Peninsula Landscape Study
Catchment Boundary
Important Ridgelines in Visual Ammenity Landscape
Excluded From Study
Outstanding Natural Heritage Area Coastal (ONLC)
Coastal Natural Character Landscape (CNCL)
Heritage Landscape (HL)
Growth Area (GA)
Outstanding Natural Heritage Area (ONL)
Visual Ammenity Landscapes (VAL)
N
E
S
W
Adderley Head
Little Port Cooper
Pile Bay
Purau Bay
Quail Island
Cass Bay
Governors Bay
Allendale
Head of the Bay
0 500 1000 1500 2000 Meters

Figure 1

Figure 2


N
W
E
S
Cass
Governors Bay
Quail Island
Allendal
Head of the Bay
Pile Bay
Purau Bay
Little Port Cooper
Adderley Head
0 500 1000 1500 2000 Meters
Lyttelton Harbour
Current Landuse Zoning
Boat Harbour
Conservation 1 (Natural, Ecological and Heritage Parks)
Conservation 2 (Historic and Garden City Parks)
Conservation Reserve
Industrial
Lyttelton Port
Papakaianga
Recreation Reserve
Residential
Residential Conservation
Rural
Rural H (Hills)
Rural Residential
Small Settlement
Small Settlement (d)
Town Centre
Catchment clip.shp

Potential Implications of Proposed Zone Changes

The proposed changes focus on what activities are or are not permitted in specific areas. Unlike the proposed Rural Zone, there is less attention to how the standards of that activity determine its classification; instead activities are more commonly either ruled in or ruled out of the new proposed zones. This reduces the potential for subjective development in particular areas of the proposed Rural Zone (e.g. Outstanding Natural Heritage Areas/Coastal), as clearer boundaries have been established between areas of permitted and non-permitted activities. This is particularly evident for the proposed zones of Outstanding Natural Heritage Area/Coastal, Important Ridgelines in Visual Amenity Areas and Coastal Natural Character Landscape. In these areas urban/subdivision development has been ruled as non-complying.

In Heritage Landscape zones a less regulated, more subjective approach has been developed while there is a more standards based approach for Visual Amenity Landscapes areas. This is more in line with the existing proposed Rural Zoning, although there are less detailed rules associated with specific types of activities. In these proposed zones, there is a greater emphasis on supporting a structured approach development that complements the existing landscape features and patterns. With Heritage Landscape zoning, a specific emphasis has been placed on protecting heritage features from encroachment. With Visual Amenity Landscapes Zoning a more general emphasis has been placed on ensuring developments are in line with the traditional working landscapes of the Harbour Catchment. Farm buildings have been suggested as permitted activities providing they meet specified standards relative to attributes and land area size.

The Visual Amenity Landscape Growth Areas zone is the only explicit zone for residential type development. In the Lyttelton Harbour Catchment the Head of the Bay is the only proposed location for this zone, because it meets the criteria of a location where development can be absorbed.

Overall, the recommended zoning changes appear to clearly specify areas particularly those in prominent locations where types of development are permitted/not permitted. Hence, the proposed zoning changes appear to remove the potential for debate over the impacts of certain proposed activities in these areas. In areas of less visual prominence, recommendations are more in line with those of the existing Rural Zone, in that a more effects based approach is adopted in assessing proposed activity.

Lyttelton Harbour Catchment management areas

The details of the proposed zoning changes in each of the eight catchment management areas are presented here. This includes a description and maps of the existing and proposed zones.

Mechanics, Breeze and Livingstone bays

Existing zoning
The majority of this management area is zoned as (East-West) Conservation, Rural Hills and some Rural (Figure 3).

Proposed zoning
The majority of this management area is outside of that considered in the CCC Banks Peninsula Landscape Study, i.e. the recommendations in the study do not apply to this area.

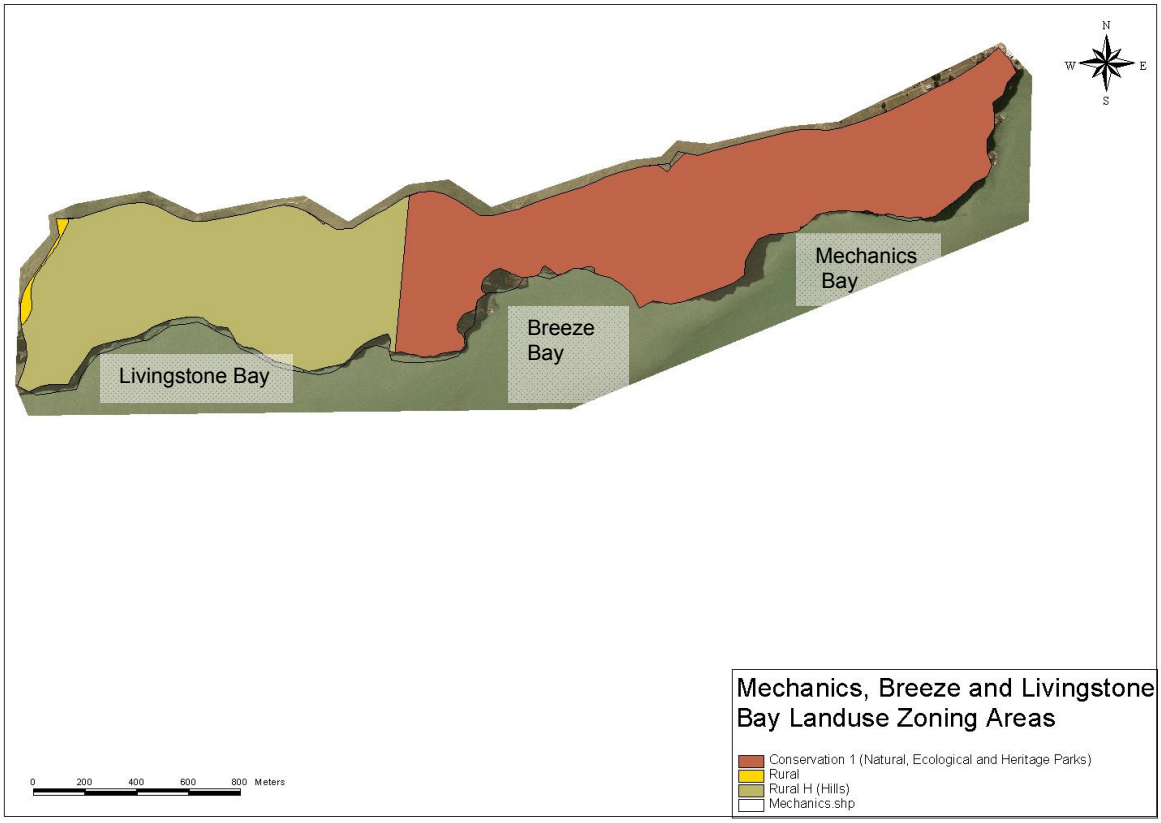


Figure 3 Existing zoning in the Mechanics, Breeze and Livingstone bays (Source: CCC)

Gollans Bay, Port Lyttelton, Corsair Bay

Existing zoning
Within this management area there are eleven different zones (Figure 4).

Proposed zoning
A large proportion of this management area is outside of that considered in the CCC Banks Peninsula Landscape Study, because it is not classed rural (i.e. within the general Lyttelton Township and port operation boundaries).

The following applies to the areas that are currently classed as rural type areas. Emphasis has been placed on maximising protection in the upper catchment and ridgeline areas above Corsair Bay and Lyttelton township. In the lower areas, it is proposed that the existing Rural and Reserve zonings (Figure 4) be replaced by a Visual Amenity Landscape Zoning (Figure 5).

Cass and Rapaki bays
Existing
Within this management area there are seven different zones (Figure 6).

Proposed
The land about and linking Cass Bay and Rapaki Bay residential areas is outside of that considered in the CCC Banks Peninsula Landscape Study, because it is not classed rural.

The following applies to the areas that are currently classed as rural type areas. Emphasis has been placed on maximising protection in the upper catchment and ridgeline areas (Figure 7), through re-zoning to Outstanding Natural Heritage Area. In the lower areas it is proposed that the land be zoned Visual Amenity Landscape while along much of the coastal margin it becomes Coastal Natural Character Landscape.

Note: In certain areas where zoning coverage has been omitted this has been identified as Reserve and not part of the study.

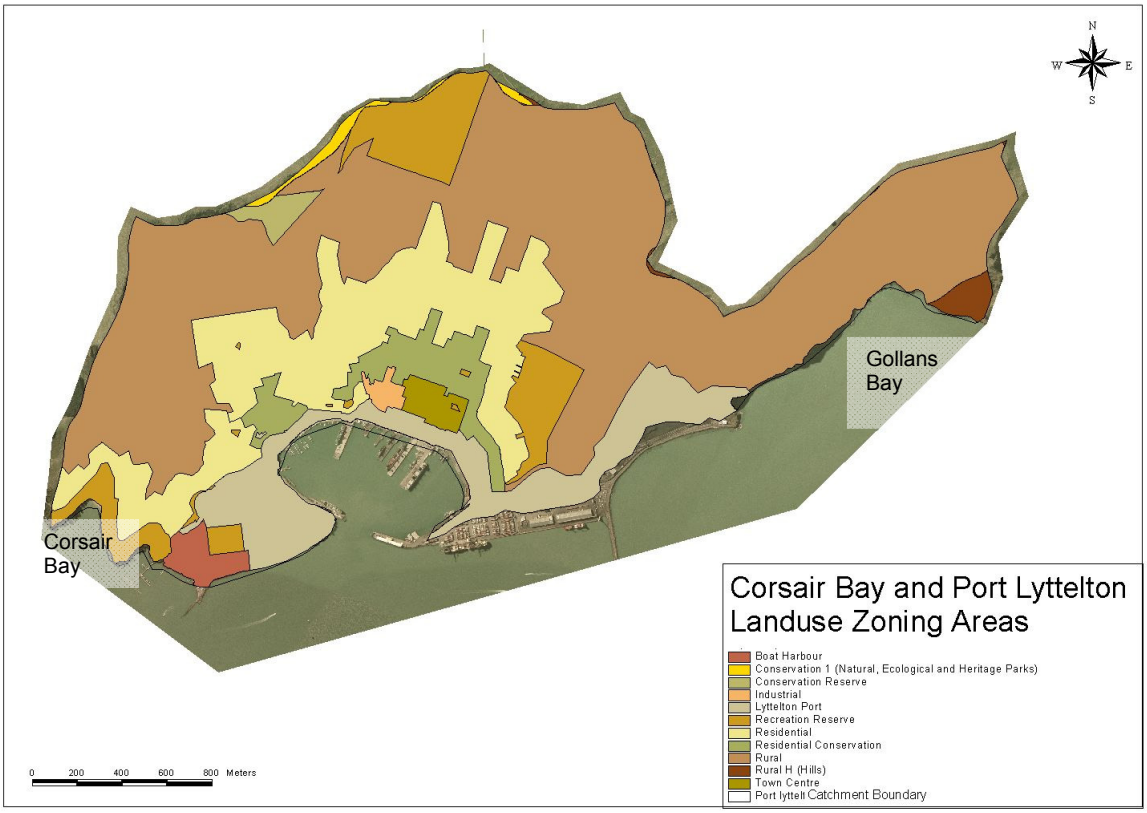


Figure 4 Existing zoning in Gollans Bay, Port of Lyttelton and Corsair Bay (Source: CCC)

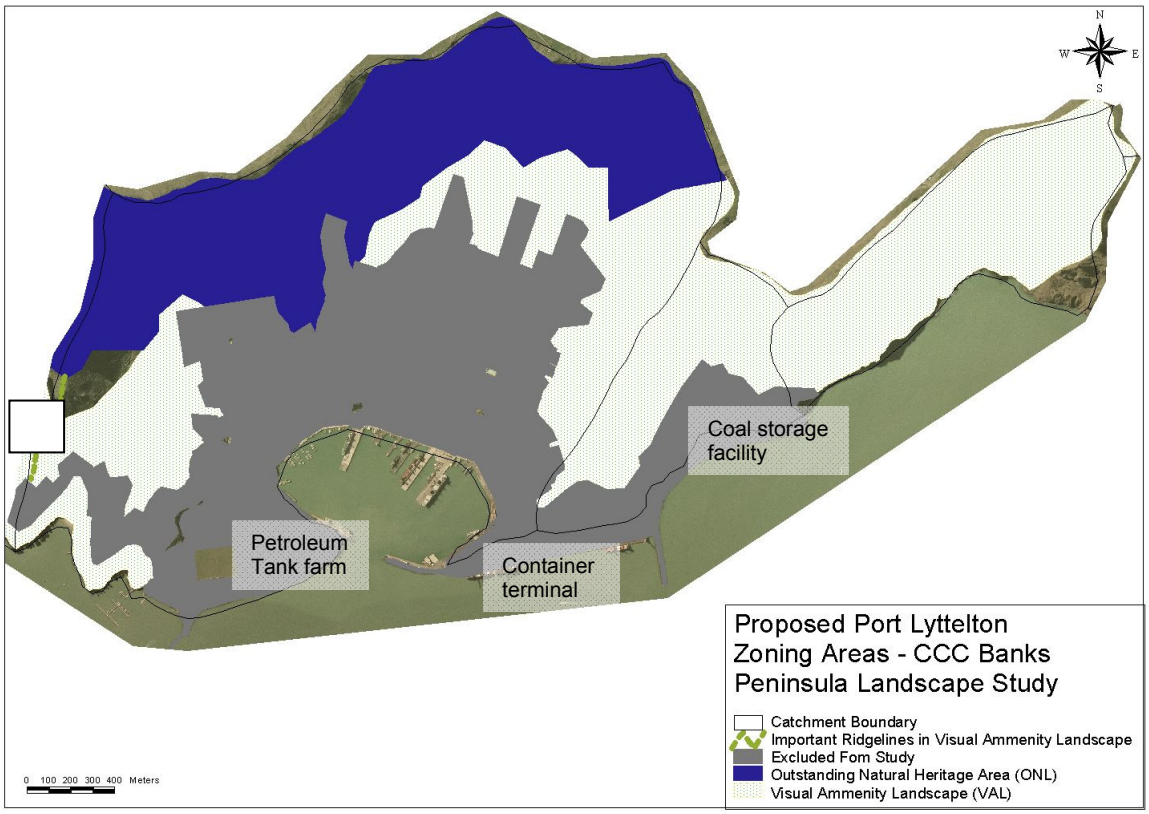


Figure 5 Proposed zoning in Gollans Bay, Port of Lyttelton and Corsair Bay (Source: Boffa Miskell, 2007)

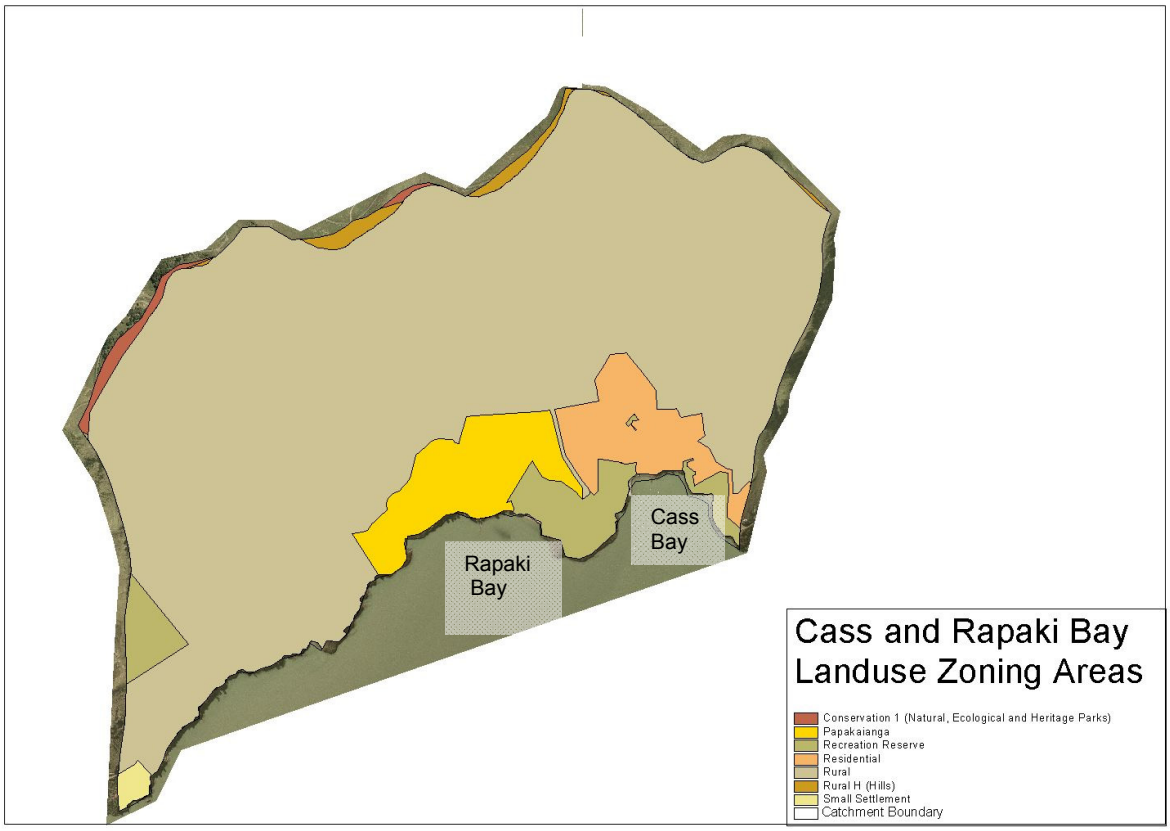


Figure 6 Existing zoning in Cass and Rapaki bays (Source: CCC)

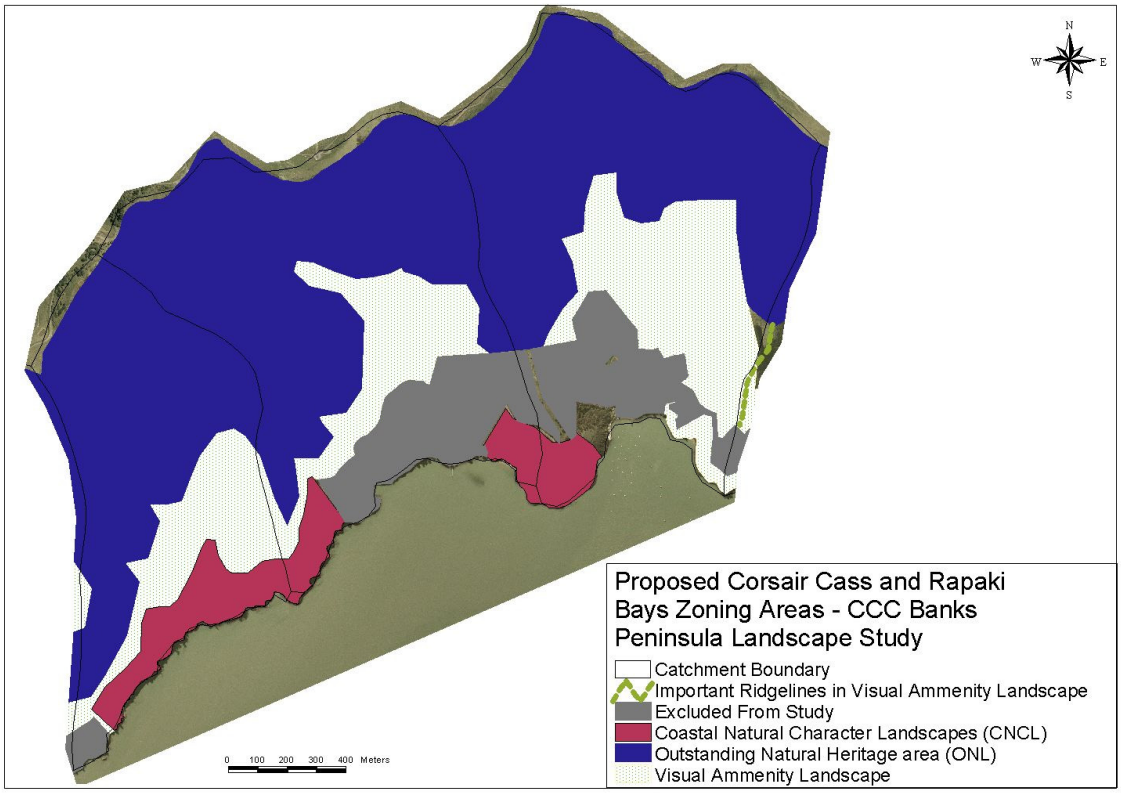


Figure 7 Proposed zoning in Cass and Rapaki bays (Source: Boffa Miskell, 2007)

Governors Bay

Existing
Within this management area there are ten different zones (Figure 8).

Proposed
The township area and rural residential area above Allendale are outside of that considered in the CCC Banks Peninsula Landscape Study, because they are not classed rural.

The following applies to the areas that are currently classed as rural type areas. Emphasis has been placed on maximising protection in the upper catchment and ridgeline areas (including that running down to Mansons Peninsula) through re-zoning to Outstanding Natural Heritage Area (Figure 9). In the lower areas and in some smaller sections of the reserve area to the north east it is proposed that the land be zoned Visual Amenity Landscape. The general area linking the Governors Bay township with the residential area above Allendale may be zoned as Heritage Landscape, this provides greater protection to the landscape than does Visual Amenity Landscape.

Note: In certain areas where zoning coverage has been omitted this has been identified as Reserve and not part of the study

Head of the Bay
Zoning
Existing
Within this management area there are ten different zones (Figure 10).

Proposed
The rural residential areas under current zoning are outside of that considered in the CCC Banks Peninsula Landscape Study, because they are not classed rural.

The following applies to the areas that are currently classed as rural type areas. Emphasis has been placed on maximising protection in the upper catchment and along ridgelines through a re-zoning to Outstanding Natural Heritage Area (Figure 11). In the lower areas it is proposed that the land be zoned Visual Amenity Landscape. Towards Gebbies Pass an area within the proposed Visual Amenity Landscape Zone has been identified as having potential for residential development. A section of coastal margin is proposed Heritage Landscape.

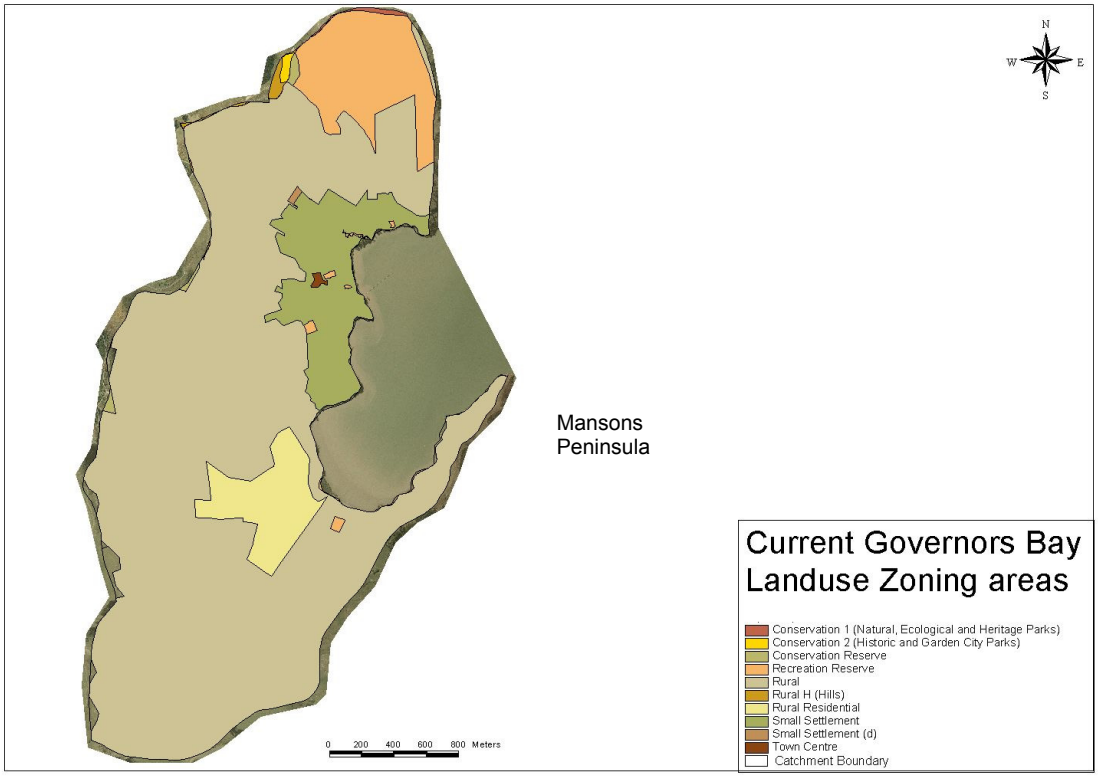


Figure 8 Existing zoning in Governors Bay (Source: CCC, 2007a)

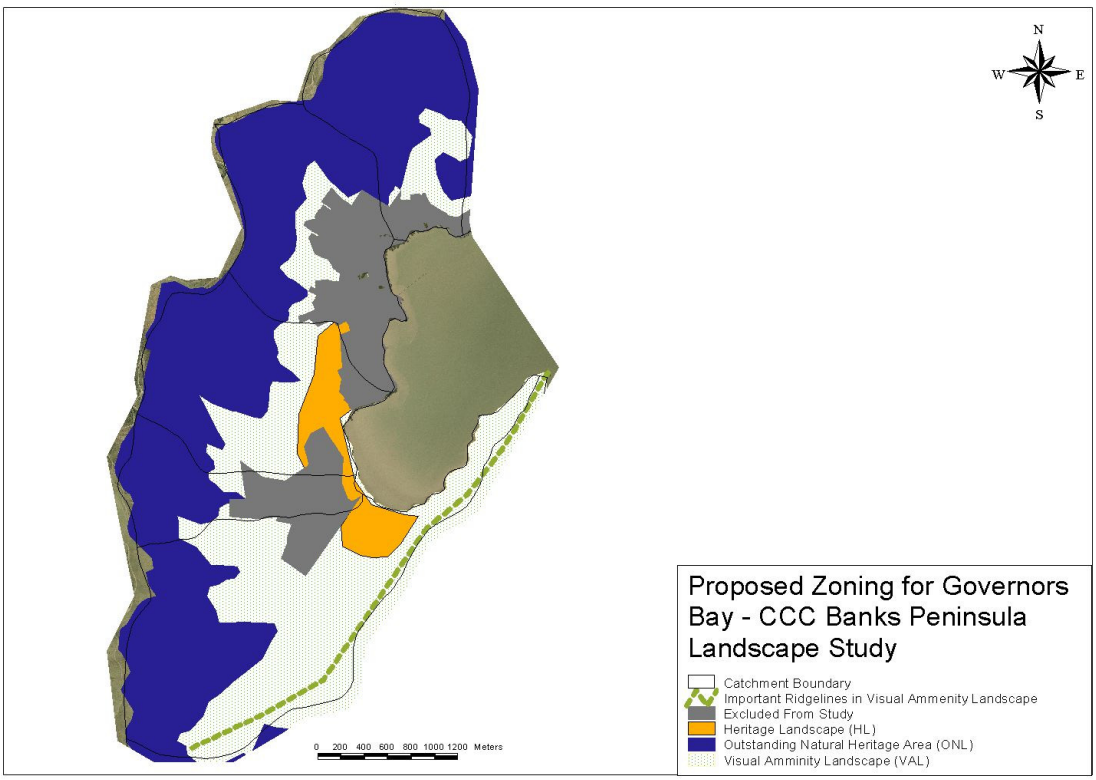


Figure 9 Proposed zoning in Governors Bay (Source: Boffa Miskell, 2007)

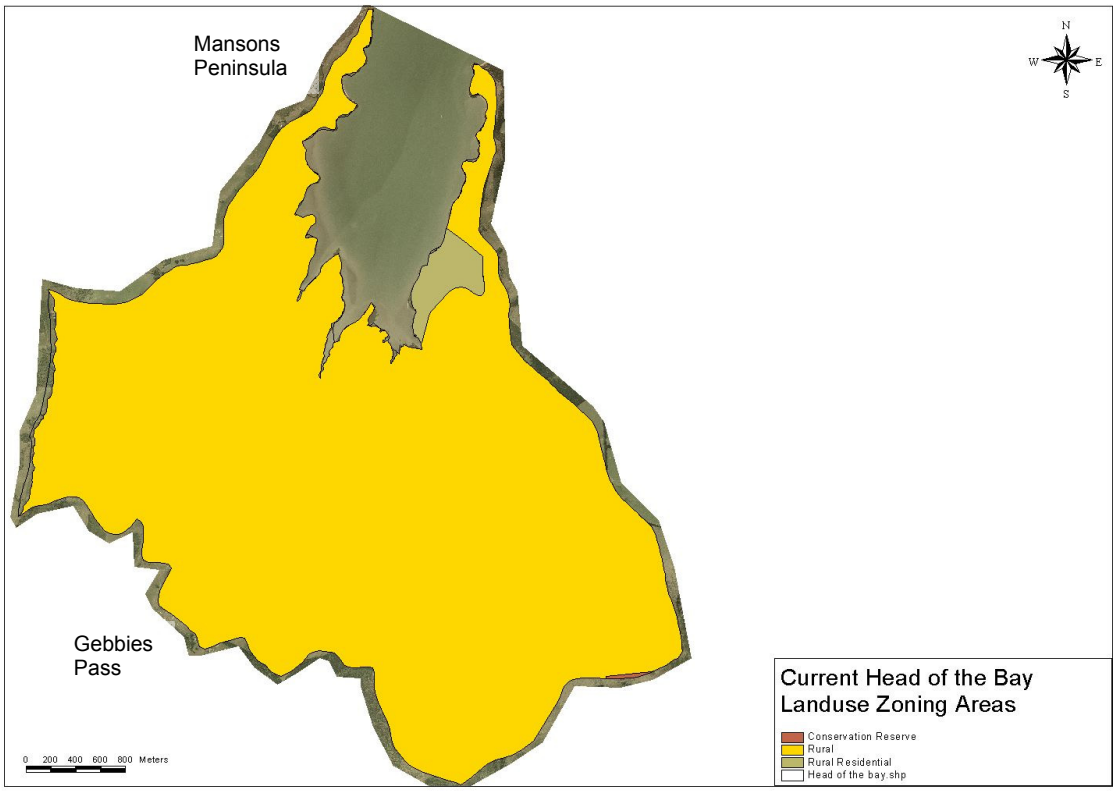


Figure 10 Existing zoning in Head of the Bay (Source: CCC, 2007a)

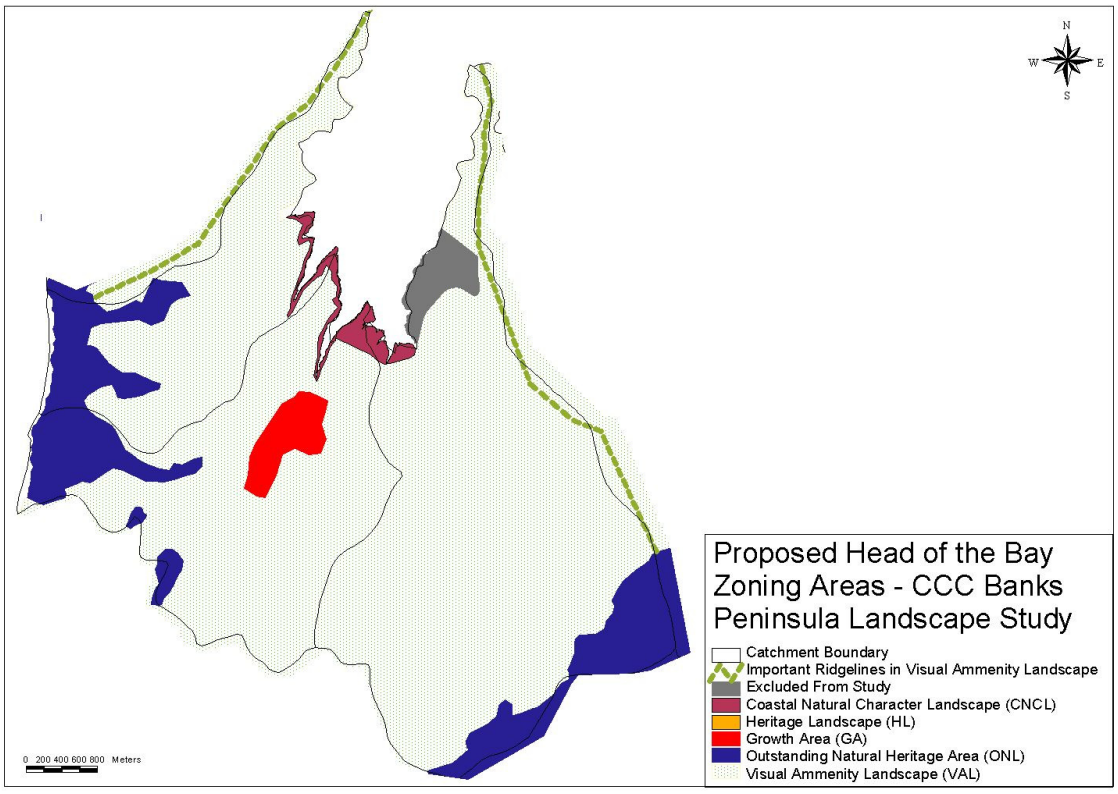


Figure 11 Proposed zoning in Head of the Bay (Source Boffa Miskell, 2007)

Charteris Bay, Quail Island and Diamond Harbour

Existing
Within this management area there are seven different zones (Figure 12).

Proposed
The currently zoned rural residential areas from Charteris Bay through to the Residential area of Diamond Harbour township are outside of that considered in the CCC Banks Peninsula Landscape Study, because they are not classed rural.

The following applies to the areas that are currently classed as rural type areas. Emphasis has been placed on maximising protection in the upper catchment ridgeline area surrounding Diamond Harbour and up to Mt Herbert through a re-zoning to Outstanding Natural Heritage Area (Figure 13). In the lower areas and some smaller sections of the reserve area to the north east along the coast it is proposed that the land be zoned Visual Amenity Landscape. It is proposed that Quail Island changes from Conservation Reserve (Figure 12) to Heritage Landscape (Figure 13).

Purau, Pile and Deep Gully bays

Zoning
Existing
Within this management area there are six different zones (Figure 14).

Proposed
The currently zoned rural residential areas of eastern Diamond Harbour and an area of Purau Bay are outside of that considered in the CCC Banks Peninsula Landscape Study, because they are not classed rural.

The following applies to the areas that are currently classed as rural type areas. Emphasis has been placed on maximising protection in the upper catchment and ridgeline areas through the proposed re-zoning from rural to either Outstanding Natural Heritage Area (for the majority of upper areas), or Important Ridgelines in Visual Amenity Landscapes (parts of the ridgeline in the East of Purau Valley). In the lower areas and the recreation reserve to the north west it is proposed that the land be zoned Visual Amenity Landscape (Figure 15). Much of the coastal area from the western side of Purau to Pile Bay are proposed as Heritage Landscape, while the coastal areas of Pile Bay and Deep Gully Bays are proposed Coastal Natural Character Landscapes.

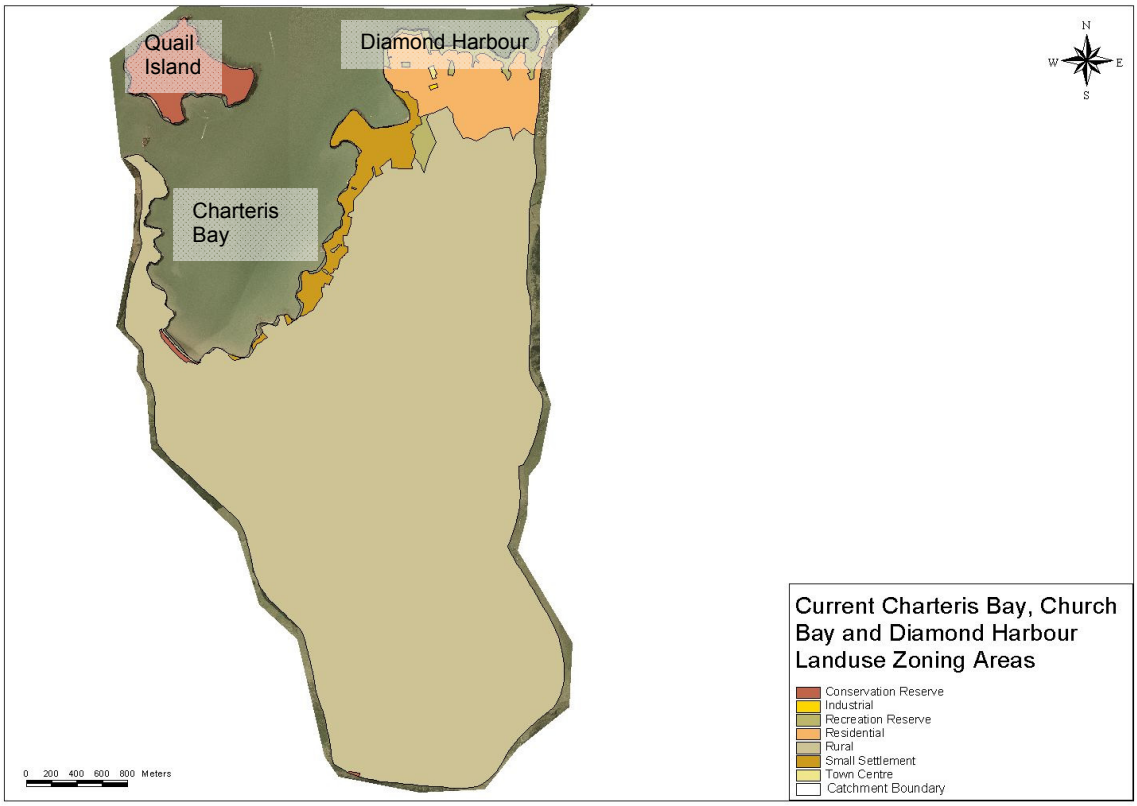


Figure 12 Existing zoning in Charteris Bay, Quail Island and Diamond Harbour (Source: CCC)

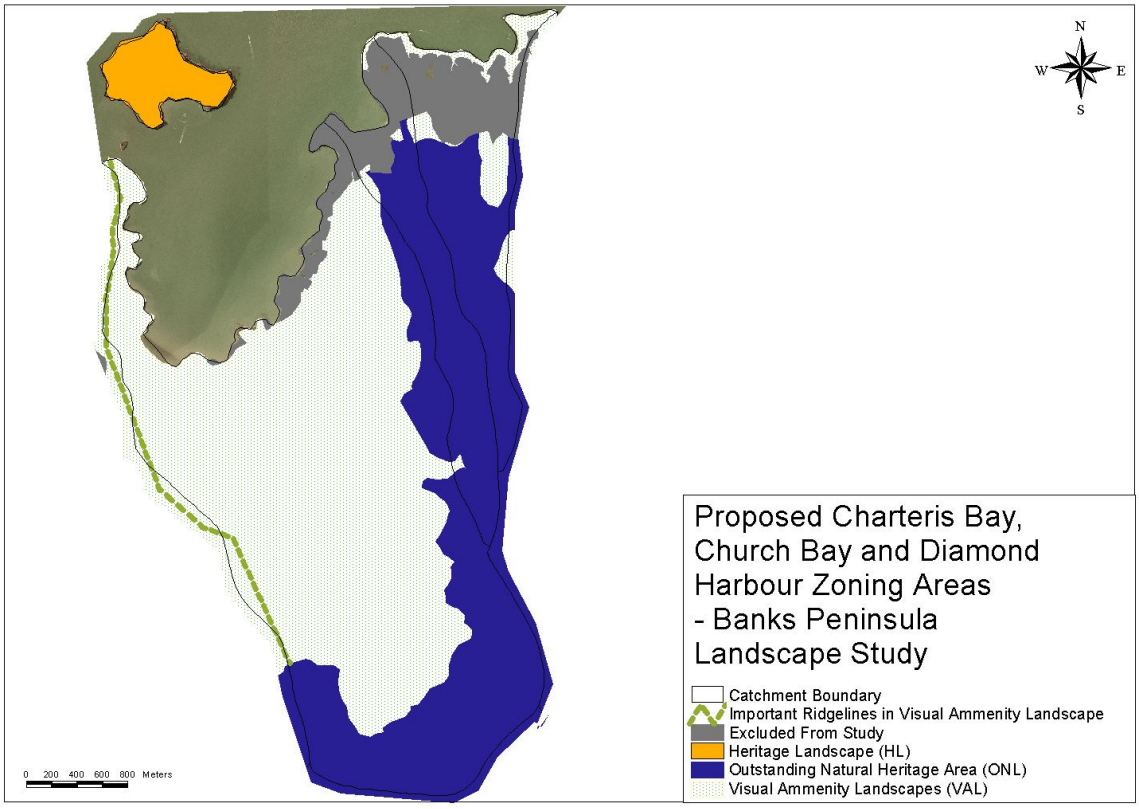


Figure 13 Proposed zoning in Charteris Bay, Quail Island and Diamond Harbour (Source: Boffa Miskell, 2007)

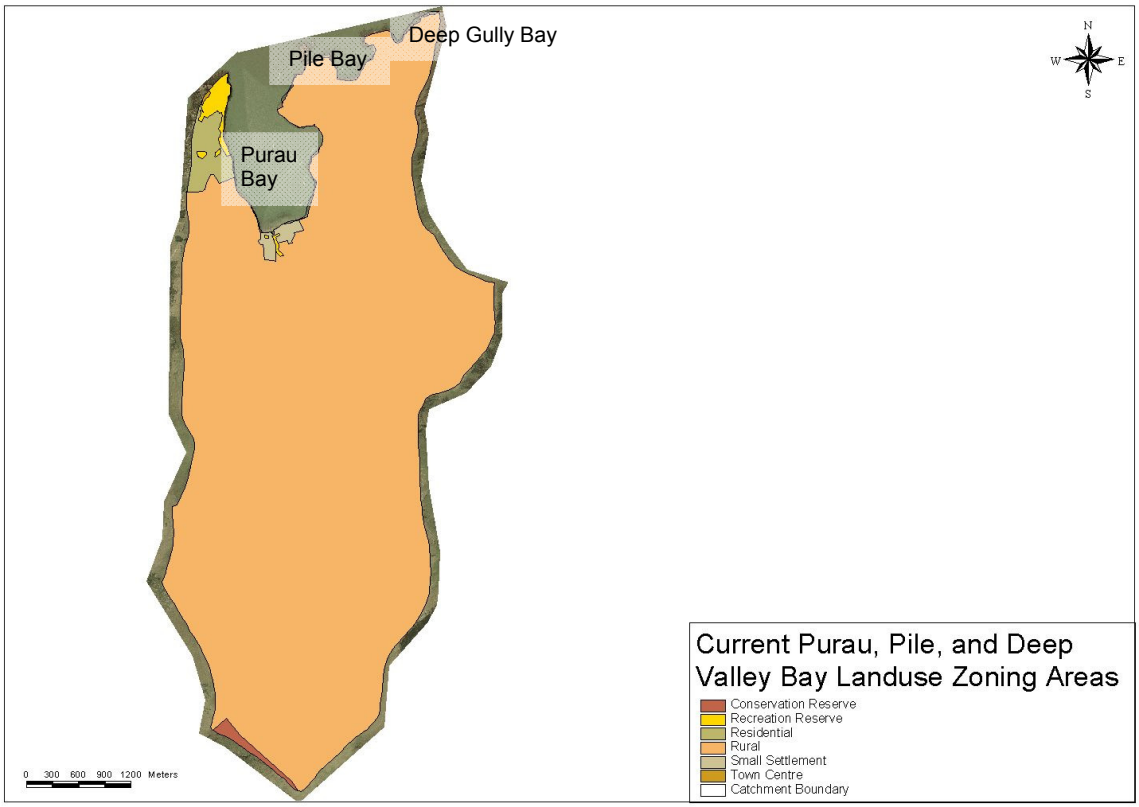


Figure 14 Existing zoning in Purau, Pile and Deep Gully bays (Source: CCC)

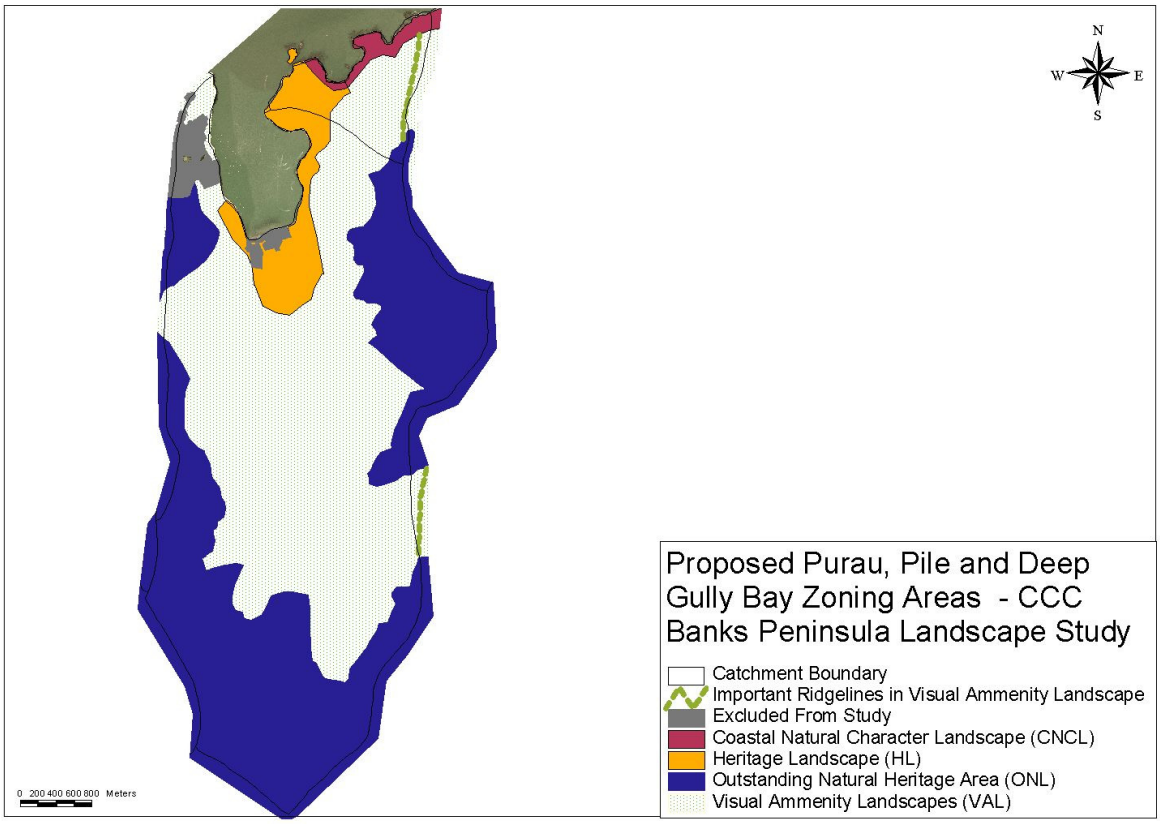


Figure 15 Proposed zoning in Purau, Pile and Deep Gully bays (Source: Boffa Miskell, 2007)

Camp Bay and Little Port Cooper

Existing
Within this management area there are two different zones (Figure 16).

Proposed
Emphasis has been placed on maximising protection in the upper catchment, ridgeline and coastal areas through the proposed re-zoning to either Outstanding Natural Heritage Area (for the majority of upper areas), or Important Ridgelines in Visual Amenity Landscapes (the ridgeline in the East of Camp Bay, the Western and Coastal. In the lower areas, it is proposed that the land be zoned Visual Amenity Landscape (Figure 17).

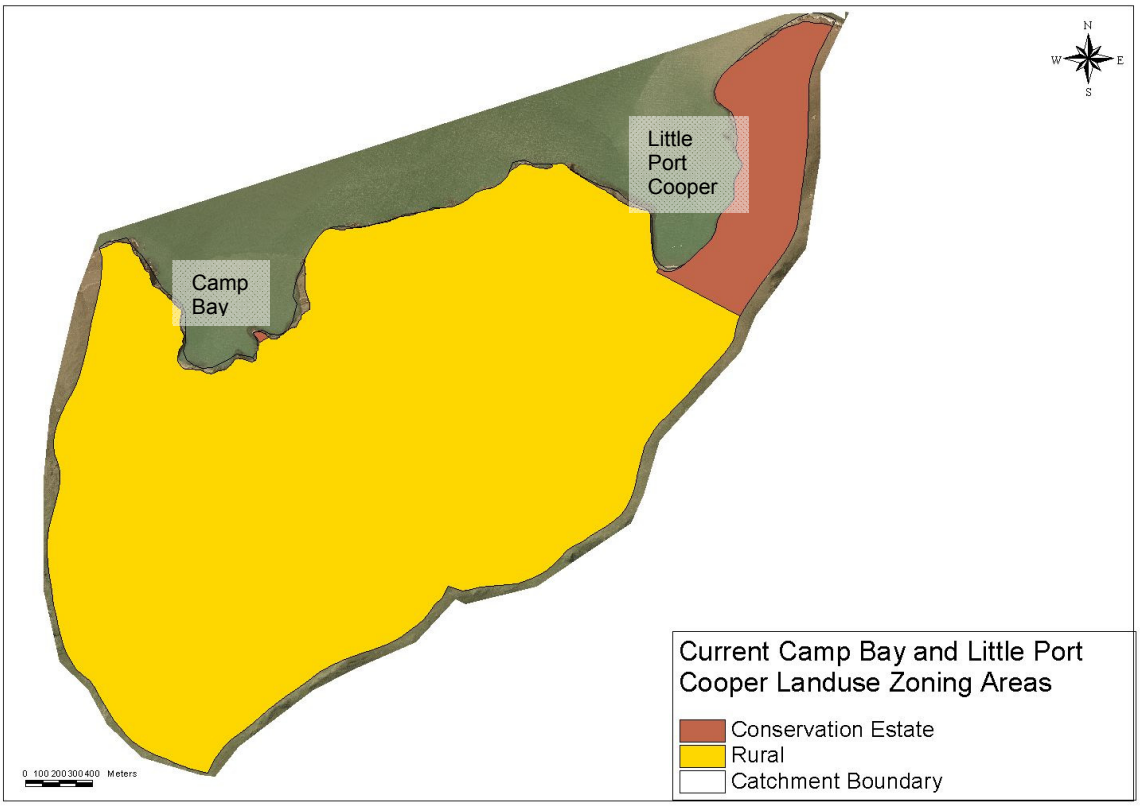


Figure 16 Existing zoning in Camp Bay and Little Port Cooper (Source: CCC)

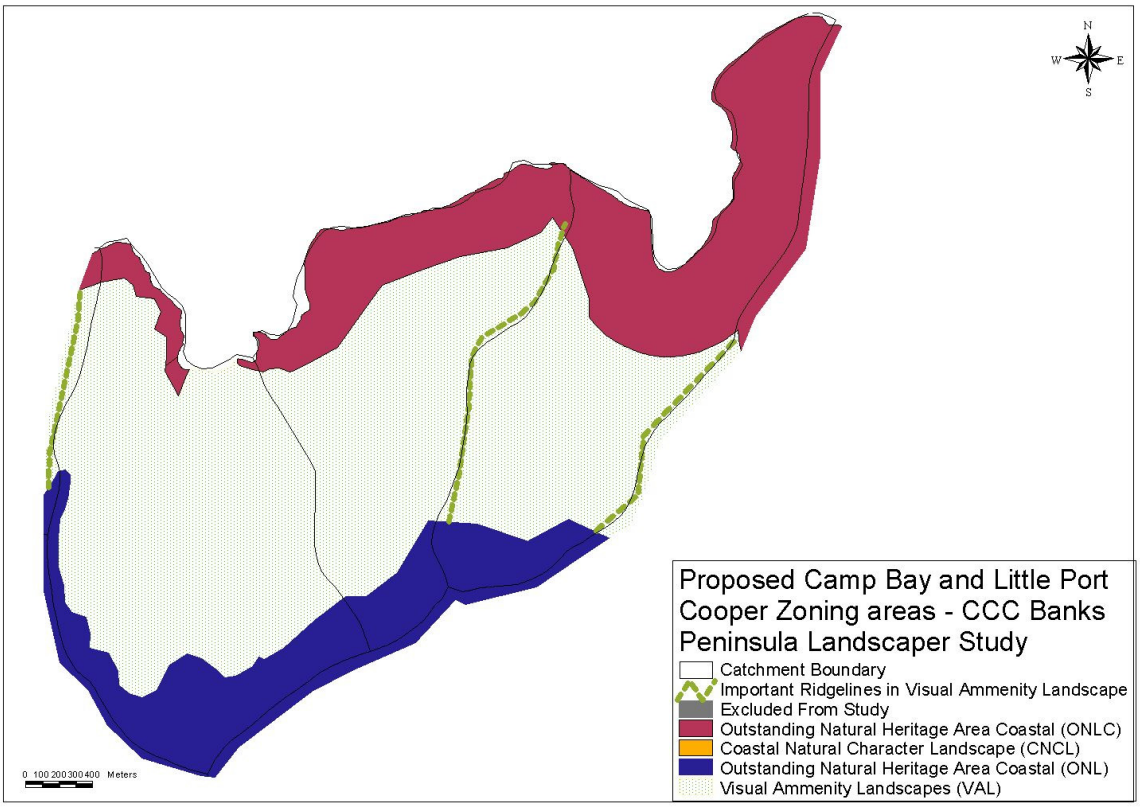


Figure 17 Proposed zoning in Camp Bay and Little Port Cooper (Source: Boffa Miskell, 2007)

Appendix 2

Wastewater treatment facilities in the Lyttelton Harbour Area

Site/Community supplied	Population/ connections	Level of Service	Treatment Process	Disposal Rate/ Disposal Area	Consent Requirements	Design Capacity/ Predicted Needs	Performance	Potential for Upgrades	Issues/ Alternatives
Lyttelton/ Lyttelton, Corsair Bay, Cass Bay, Rapaki	3700/1378	Full reticulation	Screening, extended aeration, UV disinfection, sludge dewatering sludge treatment to Bromley	720m^3/d (av. '04) Lyttelton Harbour	BOD5 : 30g/m^3 S/Solids:30g/m^3 F/C:1000 cfu/100ml Life of consent 1994-2029	4000 connected population (CP) 60 l/s 1080 m3/d **2005** 3700 (CP) ? l/s 720 m^3/d **2020** ~4700 (CP) ? l/s ~915 m^3/d	Suspended solids conditions breached in 2004 due to coal dust infiltration of system causing carry over under certain conditions in clarifier/poor settling	Nutrient removal (N & P) Fine solid filtration Increased disinfection	Excessive suspended solids 2004 (coal dust) High infiltration in sewer network Discharged into the sea Disposal options are being investigated
Governors Bay/ Governors Bay	730/292	Full reticulation	Screening, extended aeration, UV disinfection, sludge treatment to Bromley	230m^3/d Lyttelton Harbour	BOD5 : 30g/m^3 S/Solids:30g/m^3 F/C:1000 cfu/100ml Max permitted discharge 600m^3/d Life of consent 2000-2010	900 (CP) 16 l/s ? m^3/d **2005** 795 (CP) 10 l/s 230 m^3/d **2020** 1300 (CP) 25l/s 360 m^3/d	Within Consent requirements UV upgrades 1999, automatic fine filter screen installed 2004	Nutrient removal (N & P) Fine solid filtration Increased disinfection	Discharged into the sea Disposal options are being investigated
Diamond Harbour/ Diamond Harbour, Church Bay	1000-1500/ 720 (600 Diamond Harbour, 120 Church Bay)	Full reticulation	Screening, extended aeration, UV disinfection, sludge treatment to Bromley	190 m^3/d Lyttelton Harbour	BOD5 : 30g/m^3 S/Solids:30g/m^3 F/C:1000 cfu/100ml Life of consent 2004-2014	2200 (CP) 16 l/s ? m^3/d **2005** 1000-1400 (CP) 10 l/s 190 m^3/d **2020** 3500 (CP) 25l/s 360 m^3/d	-2003/2004 monitoring results exceeded faecal coliform concentrat-ions but complied with other conditions	Nutrient removal (N & P) Fine solid filtration Increased disinfection	Excessive Faecal Coliforms 2003/2004 Discharged into the sea Disposal options are being investigated

Site/Community supplied	Population/ connections	Level of Service	Treatment Process	Disposal Rate/ Disposal Area	Consent Requirements	Design Capacity/ Predicted Needs	Performance	Potential for Upgrades	Issues/ Alternatives
Living Springs	100	Full reticulation	Small aeration plant with storage, dispersion via irrigation	$26m^3$/day maximum discharge Land (hillside site)	$26m^3$/day max. discharge	100 Connected population **2020** ?	?	Upgrade the system as required	? Connect to Governors Bay treatment plant (if that plant is upgraded)
Allendale, Ohinetahi, Teddington	80	No reticulation	Septic tank	Site specific At tank location	Site specific	? **2020** ?	No known problems, but will be localised. Problem can occur due to failure to empty or service, or system age		localised due to failure to empty or service, or problems due to system age most likely On site improvements providing housing densities do not increase significantly --Connect to Governors Bay treatment plant (if that plant is upgraded)
Charteris Bay and Purau	?	No reticulation	Septic tank	Site specific At tank location At tank location	Site specific	? **2020** ?	No known problems, but will be localised. Problem can occur due to failure to empty or service, or system age Increasing population density may mean on site disposal unfeasible for most residents		localised due to failure to empty or service, or problems due to system age most likely On site improvements providing housing densities do not increase significantly Connect to Diamond Harbour treatment plant long term not viable

Christchurch
58 Kilmore Street, PO Box 345, Christchurch

General enquiries: 03 365 3828
Fax: 03 365 3194

Customer services: 03 353 9007
or: 0800 EC INFO (0800 324 636)

Timaru
75 Church Street, PO Box 550, Timaru

General enquiries: 03 688 9069

Fax: 03 688 9067

www.ecan.govt.nz