

Title: The physical geography of Te Awarua-o-Porirua
Whaitua

Purpose: To inform Te Awarua-o-Porirua Whaitua Committee of the
physical geography of the catchment

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The physical geography of Te Awarua-o-Porirua Whaitua

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1. Introduction

Te Awarua-o-Porirua Whaitua (the Whaitua) covers an area of approximately 21,300ha, stretching 28km from Pukerua Bay to Johnsonville (north-south), and 15km from Titahi Bay to Haywards Hill (east-west). The Whaitua boundaries are slightly more extensive than Te Awarua o Porirua Harbour catchment. While most of the Whaitua waterways run to Te Awarua o Porirua Harbour (either Onepoto Arm or Pauatahanui Inlet), others run to the coast.

The topography of the Whaitua is strongly rolling and moderately steep with areas of flatter land at the bottom of the valleys. Undeveloped areas retain many natural characteristics with regenerating vegetation, natural stream channel shape and flows and a variety of habitat types.

A significant geographical feature of the Whaitua is Te Awarua-o-Porirua Harbour (the Harbour) which consists of two main arms being Pauatahanui Inlet (524ha) and Onepoto Arm (283ha) with the harbour entrance and outer harbour facing Cook Strait and the Tasman Sea (640ha). Most parts of the Whaitua drain to the Harbour or the outer harbour, but some catchments also drain to the open coast. The open coast forms 30% of the Whaitua. The Onepoto Arm and Pauatahanui Inlet are both very shallow with maximum depths of 3m (see Appendix 1).

The Harbour is the largest estuary in the lower North Island being 807ha in area and featuring habitats recognised as being regionally and nationally significant including having the highest seagrass coverage of any estuary in the lower North Island. Seagrass is important as both a food source and as shelter for marine life. The Harbour is unique in that unlike most New Zealand estuaries (which empty completely at low tide) the Harbour is mainly subtidal, with 65% of its area remaining underwater at low tide. The Harbour also has one of the largest cockle concentrations in New Zealand and the Pauatahanui Inlet is home to nationally significant bird species including many that are 'declining' such as the pied stilt or 'nationally vulnerable' such as the pied shag.

The landscape of the Whaitua has been greatly modified by settlement. Reclamation of parts of the Harbour (mainly in the Onepoto arm) and streams for transport infrastructure and urban development, modification of stream channels for flood protection and removal of native vegetation cover have resulted in the greatest changes to the landscape. Much of the Harbour edges and stream mouths have been significantly modified by reclamation, earthworks and the building of the railway line and state highways. This has resulted in a loss of important spawning, nursery and feeding grounds for freshwater and marine life. Contamination from stormwater discharges and sediment runoff has meant that many shellfish beds are unsuitable for eating.

2. Geography

2.1 Geology and faults

The Whaitua sits largely on a base of greywacke similar to the rocks that form the Southern Alps and North Island ranges. The base greywacke is overlain with loess (windblown silt), a highly erodible material that is easily dispersed by the wind and therefore contributes to sedimentation of the Harbour.

New Zealand sits between the Australian and Pacific tectonic plates with Porirua City lying on one of the more active parts of this boundary. Due to the high level of faulting, the whole Whaitua has a significant earthquake hazard risk (Gibb & Cox, 2009). The Whaitua sits on top of the subducting¹ Pacific Plate with three major fault lines running in a northeast to southwest direction: the Ohariu, Pukerua and Moonshine Faults (Appendix 2). These fault lines are capable of generating large single event earthquakes with surface ruptures².

The Ohariu Fault is the most active fault in the Whaitua and runs beneath the CBD of Porirua City and is capable of generating high magnitude earthquakes. It is also one of the major earthquake-generating faults in the Wellington region with its most recent significant earthquake being approximately 1,000 years ago. It is expected to cause a surface rupture earthquake every 800-7,000 years. Areas most susceptible to shaking in the Whaitua are swamp land, and unconsolidated alluvial material (river gravels) and coastal areas that have been reclaimed.

Around 22,000 years ago, both the Pauatahanui and Onepoto arms of the Harbour were river valleys. The Porirua CBD area was a swamp, before supporting a forest when the land dried out over time around 9,500 years ago. When the sea level rose around 8,000 years ago, marine waters rapidly filled the former Porirua and Pauatahanui river valleys, which formed drowned river estuaries (the Harbour arms).

2.2 Fossil forest remnants

Beneath the sands of Titahi Bay beach are fossilised tree stumps approximately 35,000 years old, remains of a forest that grew here before the sea rose after the last ice age (100,000-125,000 years ago). Pollen in core samples indicates that the forest was a mix of rimu, totara and kahikatea indicating a warmer climate. When the sea level rose, salt water flooded the trees. Deposited sediment helped to preserve and fossilise the remaining stumps.



Image 1 Titahi Bay Fossil Forest - Source: <http://juliansrockandiceblog.blogspot.co.nz/2013/03/titahi-bay-geology.html>

¹ When one tectonic plate moves under another tectonic plate and sinks as the plates converge.

² Splits in the earth's surface from ground shaking

2.3 Sub-catchments

A catchment is a basin shaped area of land, bound by natural features such as hills or mountains from which water (both surface and underground) flows into streams, rivers, harbours and wetlands³. Large catchments are often made up of smaller sub-catchments which contain tributaries which are smaller feeder streams that empty into larger streams or rivers. In the larger Whaitua there are 12 sub-catchments (Appendix 4).

The main stream draining into the Onepoto Arm of the Harbour is the Porirua Stream which has a catchment size of about 5300ha. This catchment has five sub-catchments being Churton, Paparangi, Porirua, Whitireia and Aotea. While the sub-catchments of Churton, Paparangi and Porirua first drain to Porirua Stream before reaching the Harbour, Aotea and Whitireia have smaller waterways that drain directly to the Harbour. Several of these sub-catchments have little vegetation cover other than pasture grass or residential gardens.

These sub-catchments have a mixed topography with only a small amount of pastoral farming and are significantly urbanised when compared to the Pauatahanui Inlet catchment. There is little natural flood retention within these sub-catchments with increases in hard surfaces (like asphalt) that limit the ability of water to soak into the soil or restriction to the size of the Porirua Stream channel, increasing the flood risk. The Porirua Stream has been significantly shaped by railways, roads and other developments leading to some unnatural bank slopes, particularly in the lower reaches.

The Pauatahanui Inlet catchment covers 109km² and comprises four sub-catchments (Duck Creek, Pauatahanui, Horokiri and Kakaho). These four sub-catchments contain more vegetation cover, plantation forestry and have less residential and industrial development compared to the southern sub-catchments. These northern sub-catchments also have a steeper topography with urban residential development restricted to the southern side of Pauatahanui Inlet (in the Aotea and Duck Creek sub-catchments). Peri-urban⁴ development is found in the flatter areas of the eastern parts of the catchment. Forestry, pastoral farming, native bush and regenerating land dominate in the upper slopes of the Pauatahanui sub-catchment.

The two sub-catchments of Hongoeka and Pukerua drain directly to the Tasman Sea. These sub-catchments have fewer land use pressures but similar stream systems.

2.3.1 Te Awarua-o-Porirua Harbour arms

There are significant geographical differences between the two main arms of the Harbour and their catchments. Onepoto and Pauatahanui arms each have a different orientation and therefore different levels of exposure to coastal processes and dominant weather patterns, with Pauatahanui Inlet facing west, and Onepoto Arm facing northeast. This, coupled with different hydrological systems (only one main stream entering Onepoto Arm (being Porirua Stream) and several flowing into Pauatahanui Inlet), may also influence sediment flushing regimes within the Harbour basins. Both arms differ greatly from the outer harbour which has much fewer land use pressures but similar stream systems. These fundamental geographic differences between the three parts of Te Awarua-o-Porirua Harbour have important implications for future management.

³ Waikato Regional Council

⁴ Lifestyle blocks

2.4 Land cover

When European settlement occurred in the early 1840s the Whaitua was described as being densely covered in impenetrable forest. Between 1850 and 1885 this forest was mostly converted to grazing pasture leading to early hillside and stream bank erosion issues. In the Pauatahanui catchment, at least 66% was originally covered in native bush. However, by the 1940s only 17% of this remained with 83% of the Whaitua covered in grassland (Blaschke, Woods and Forsyth, 2010). Since then, there has been a revival in regeneration (both from planting and natural regeneration) of native bush (now approximately 19%) and grassland has reduced to 59%.

There has also been a significant increase in exotic plantation forestry in the Whaitua which was planted between the 1970s and 1990s. Today, exotic forests cover 13% of the Whaitua (see Appendices 5 and 6).

Today much of the land cover of the Whaitua is grassland, parkland (fields and reserves) and urban areas (see Appendix 6). Other non-urbanised areas include regenerating native forest and scrub (both native and introduced species), pine plantations and old-growth native forest. Small remnant areas of old-growth native forest are scattered within the Whaitua, mainly on the edges, with some areas now protected as public reserves or as open space covenanted areas registered with the Queen Elizabeth II National Trust. Most remnants are smaller than 2 hectares, with a notable exception being Porirua Scenic Reserve above the Spicer Landfill. The pattern of public reserves (parkland) in the Whaitua can also be seen in Appendix 5.

In the Pauatahanui Inlet catchment, urbanisation first occurred at the mouth of Pauatahanui Inlet at Mana in the 1940s with rapid residential development then beginning in Whitby and spreading to Browns Bay and Duck Creek sub-catchments in the 1950s. These suburbs extended into valleys and up hillslopes over the next 60 years. Limited development has also occurred in the hills above the Pauatahanui village in 2004 and there are many life-style blocks in the remaining rural parts of the Pauatahanui sub-catchment.

In the Onepoto catchment, Porirua city was initiated as a satellite suburb to Wellington city with extensive state housing development and motorway expansion beginning in the 1950s (Blaschke, Woods and Forsyth, 2010). Industrial and commercial development began soon after with more housing spreading up into the catchment towards Tawa and Johnsonville.

2.5 Soils and slope

Soils within the Whaitua are mainly sandy or silty loams (fertile soil of clay and sand containing humus in the lowlands); and in the uplands are normally silty loams (see Appendices 7 and 8). The upland, poorer quality soils also tend to be on a steeper topography (see Appendices 2 and 3). These soils have high loess (wind deposited silt) content which means they are highly erodible and mobile particularly when overlying vegetation is removed (see Appendices 9 and 10). These soils easily make their way into streams which can smother biodiversity in both freshwater and marine environments.

A direct result of significant environmental change in the Whaitua over the last century, especially in terms of deforestation to make way for pasture and urban development, has been excessive sedimentation of the Onepoto Arm and Pauatahanui Inlet. It is suggested that accelerated sedimentation rates were a result of significant urban and infrastructure development (including large scale earthworks) beginning in the late 1950s.

While all estuaries naturally fill up with sediment over time, a healthy rate is approximately 1mm per year (Porirua City Council, 2010). Studies have indicated that sedimentation rates from 1974 to 2009 have averaged about 6mm per year in the Onepoto Arm and 9mm per year in the Pauatahanui Inlet (Gibbs and Cox, 2009). A target in the Porirua Harbour and Catchment Strategy is to reduce sedimentation rates to 1mm per year by 2031 (averaged over the whole harbour).

2.6 Climate and hydrology

2.6.1 Climate

The Whaitua is dominated by northerly winds and these bring rain in autumn and winter but also exacerbate dry periods in summer. The mean annual rainfall varies across the Whaitua from 1,000-1,200mm in the west to 1,200-1,400mm in the east, as do sunshine hours with more sunshine in the west than the east, as a result of cloud that forms over Belmont Regional Park under north-westerly conditions. As a comparison, NIWA data shows that most of New Zealand has an average rainfall of between 600 and 1,600mm and 2,000 sunshine hours each year.

2.6.2 Porirua Stream

The Whaitua has a number of streams that either enters the Harbour's Onepoto Arm or Pauatahanui Inlet (Appendix 4). Porirua Stream is one of the largest and most important remaining streams in the Wellington urban area. It's natural values are impacted by urbanisation. The Porirua Stream starts in the southernmost part of the Whaitua in the Churton Park sub-catchment and flows 11km to the Onepoto arm of Porirua harbour. It has many tributaries which are short and steep with well-draining soils so during intense rainfall, the stream can quickly rise to flood peak. The natural flooding potential of the catchment has been exacerbated by a loss of vegetation cover, more land covered in impermeable surfaces like roads and houses, and constriction of the stream into a narrower channel.

The full effects of a functioning catchment were felt on 20 December 1976 when there was an unusually severe rainstorm that affected many parts of the Wellington region including Tawa. This caused damaging flood flows on many watercourses including Porirua Stream. Public and private property was severely damaged by debris travelling downstream causing blockages of culverts and stormwater drains. The local Moore Wilson's store was flooded to depths of between 1m and 1.5m and many private bridges across the Porirua Stream were washing away.

2.6.3 Pauatahanui Stream

Pauatahanui Stream is 2.2km long and is fed from tributaries in the Haywards Hills, Judgeford and Belmont areas. It then flows through the Pauatahanui Inlet Wildlife Refuge and discharges into the Pauatahanui Inlet. Pauatahanui Inlet Wildlife Refuge is the largest relatively unmodified estuarine area in the southern North Island.

2.6.4 Horokiri Stream

The Horokiri Stream flows south into the Pauatahanui Inlet. The upstream catchment is largely pastoral and data collected by Greater Wellington Regional Council shows that the macroinvertebrate index for Horokiri Stream is consistently good with key species that are sensitive to pollution found there. However, this stream will be significantly affected by the construction of the Transmission Gully Motorway.

2.6.5 Taupo Stream and swamp

Taupo Stream drains a catchment of 820ha, much of which is occupied by the Taupo Swamp. Taupo Swamp rises to 20m above sea level at its north end. Its southern end has been drained and developed for industrial use and playing fields, but prior to development the base of the swamp was at least 2m above sea level behind Plimmerton beach. The remaining swamp land is protected by the Queen Elizabeth II Trust, and it is one of the few remaining relatively large flax wetlands in the Wellington region. The swamp is valued by local residents and recognised within Porirua City Council's Northern Growth Area Structure Plan.

3. Bibliography/further reading

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Report prepared by

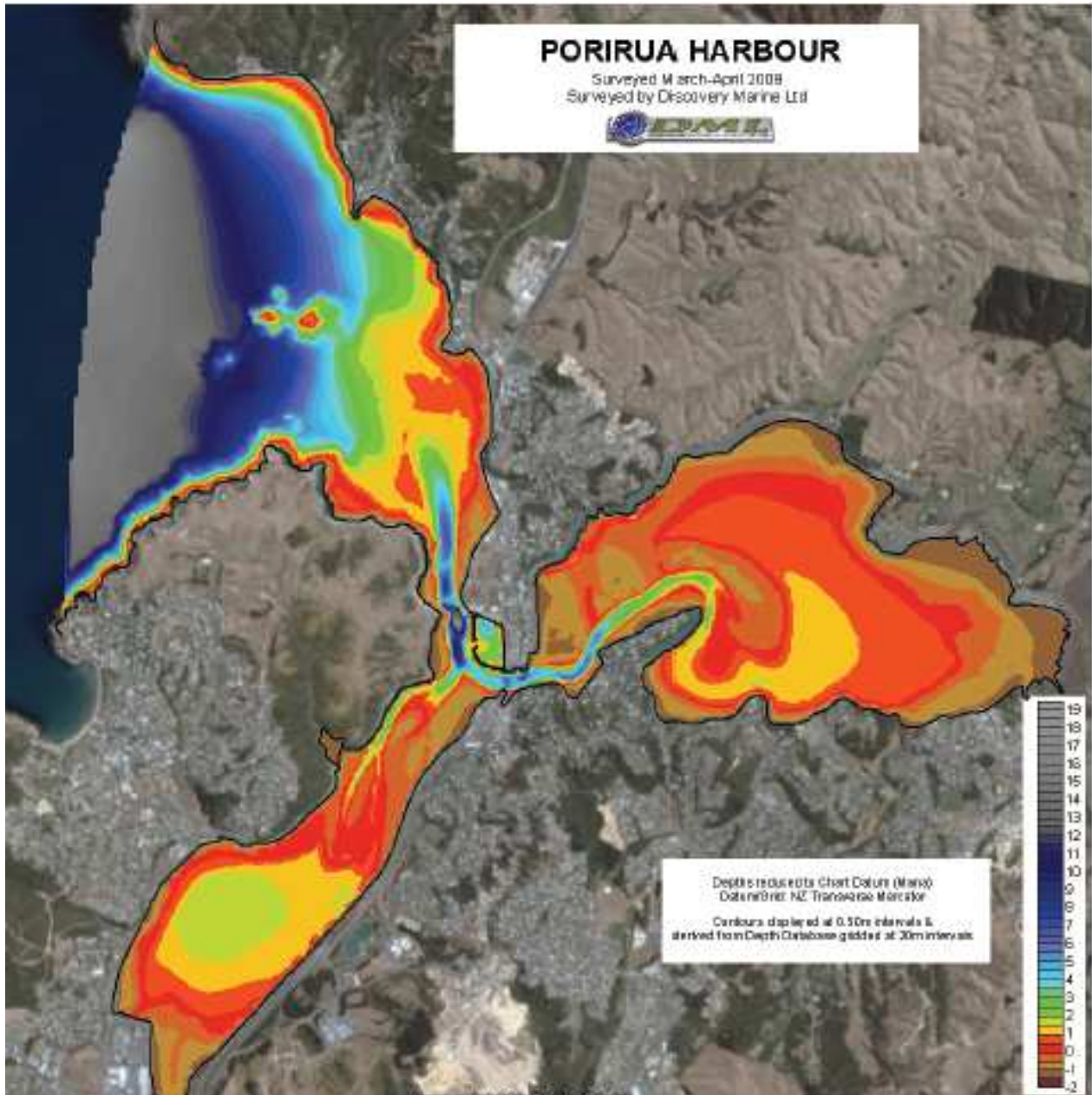
Caroline Ammundsen
18 May 2015

Report approved by

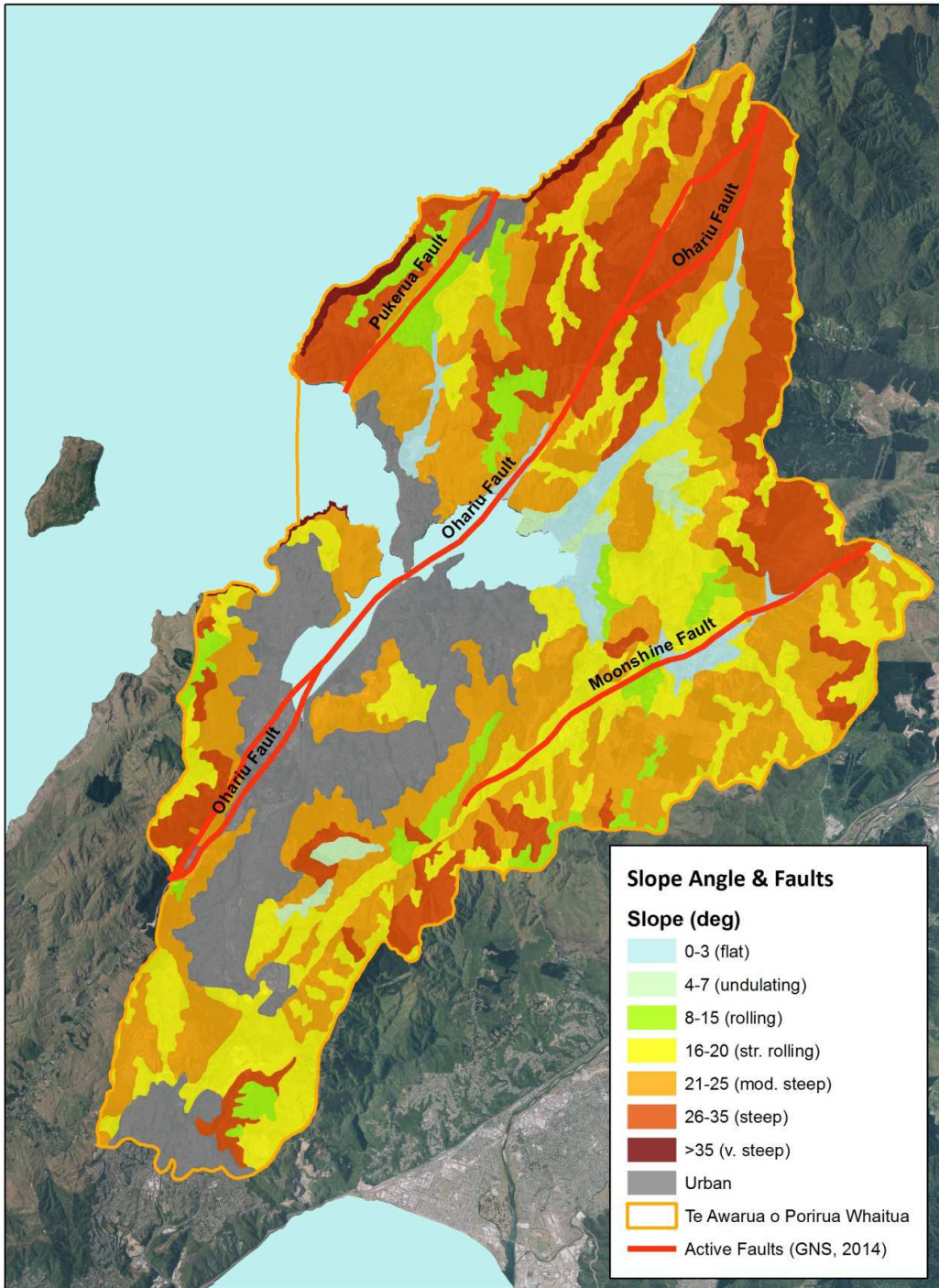
Alastair Smaill
18 May 2015

4. Appendices

Appendix 1 - Bathymetry of Te Awarua-o-Porirua Harbour (PCC, 2009)



Appendix 2 – Slope angle and faults in Te Awarua-o-Porirua Whaitua



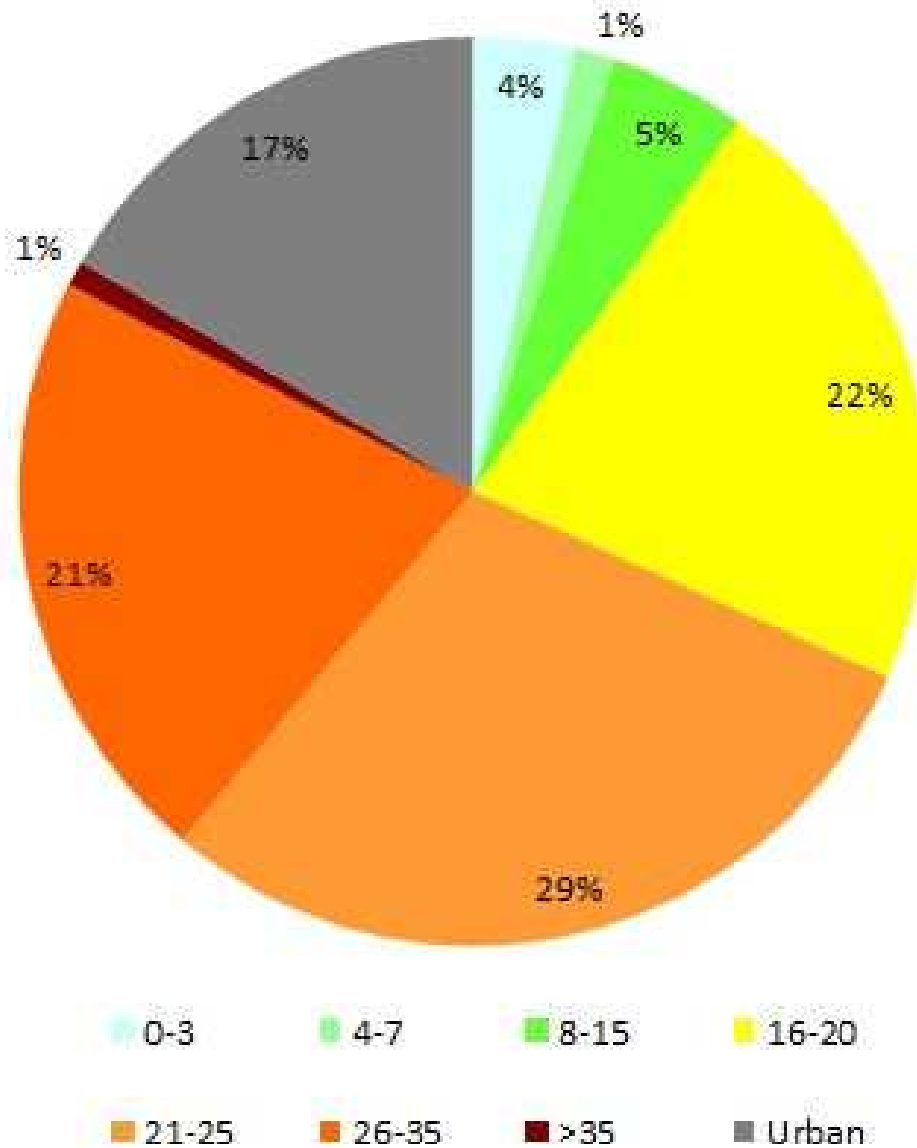
Te Awarua o Porirua Whaitua - Slope

0 1.25 2.5 5 km

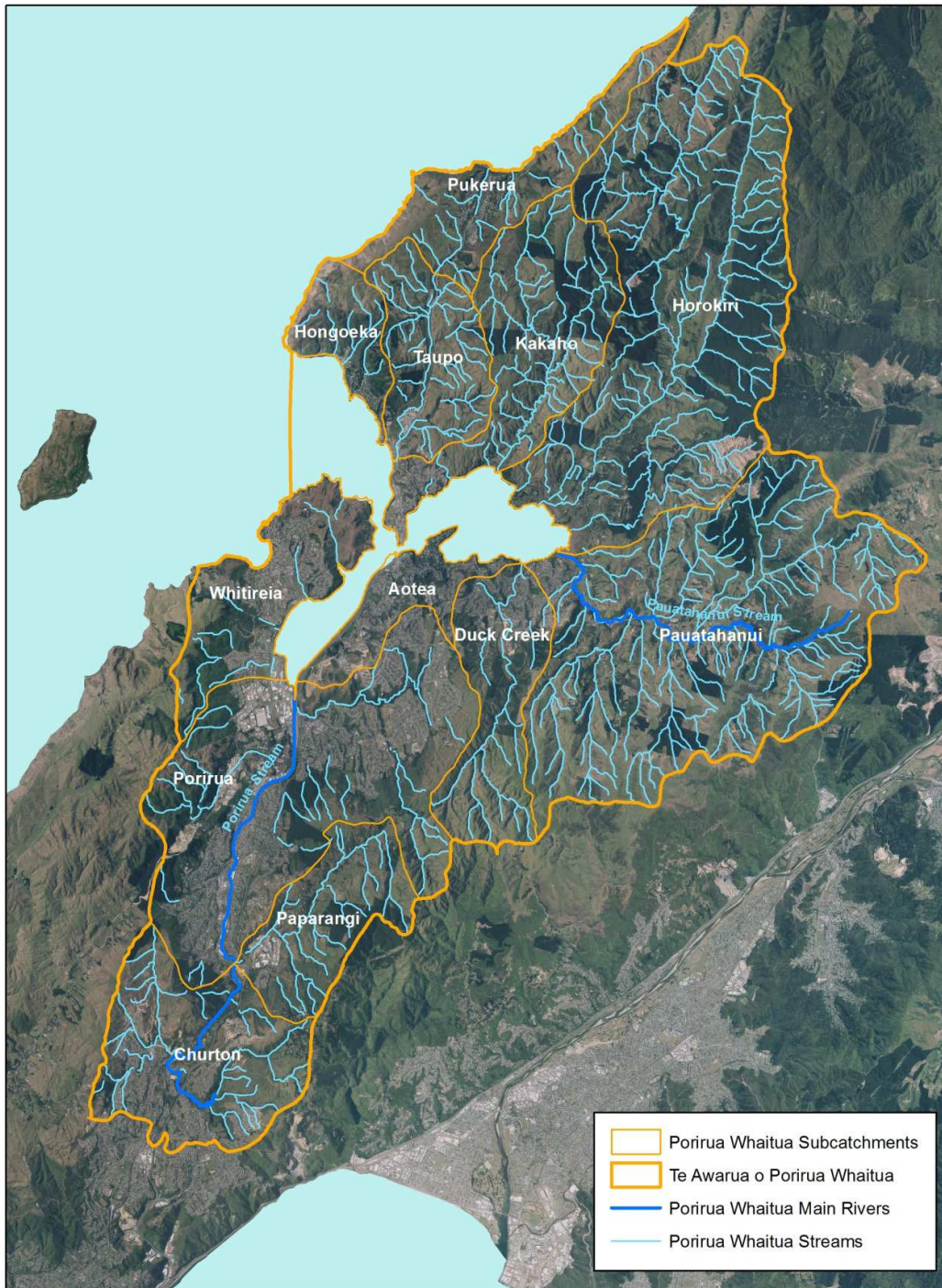
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Appendix 3 – Slope angle % in Te Awarua-o-Porirua Whaitua

Te Awarua o Porirua Whaitua - Slope



Appendix 4 – Sub-catchments and streams in Te Awarua-o-Porirua Whaitua



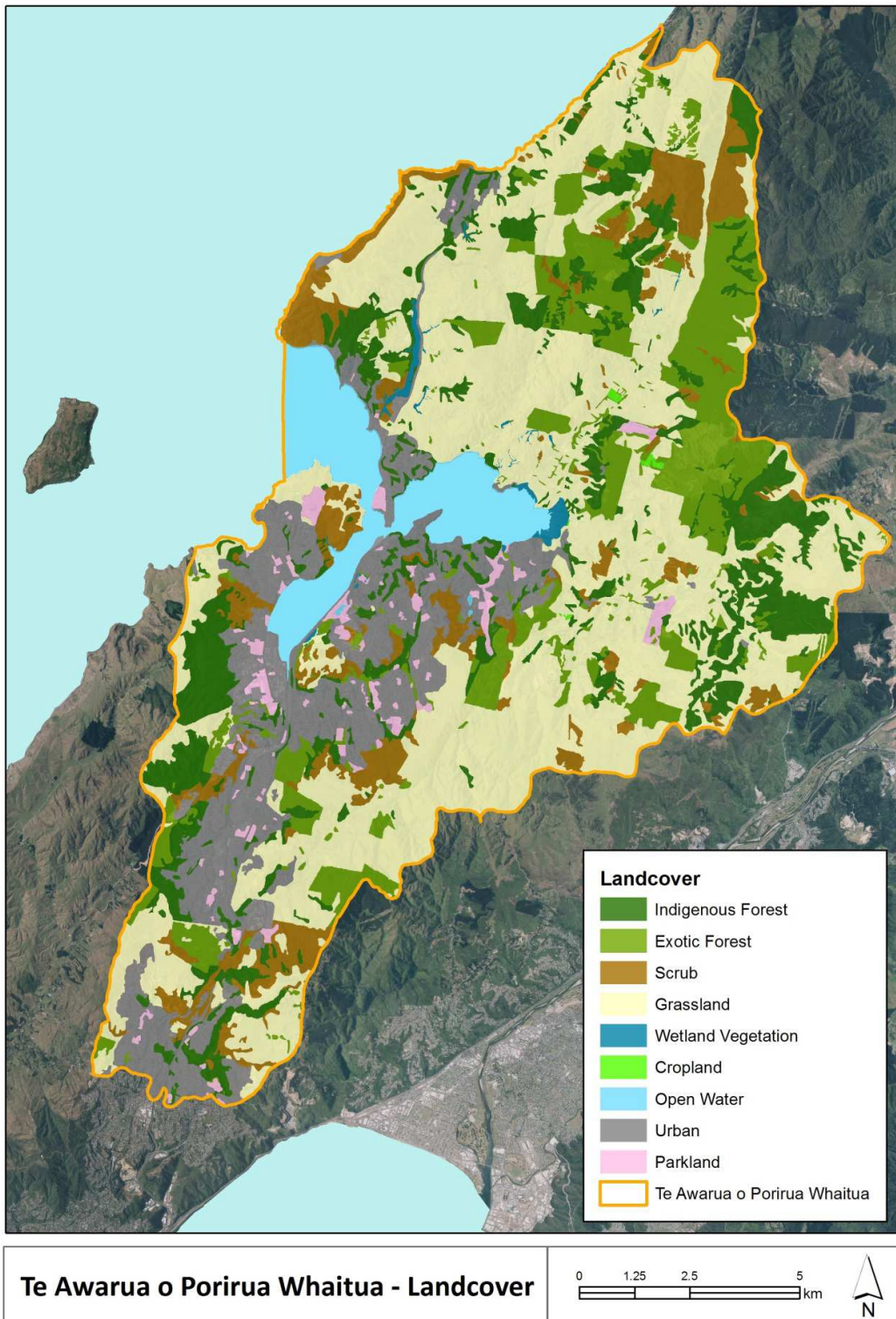
	Porirua Whaitua Subcatchments
	Te Awarua o Porirua Whaitua
	Porirua Whaitua Main Rivers
	Porirua Whaitua Streams

Te Awarua o Porirua Whaitua - Catchment

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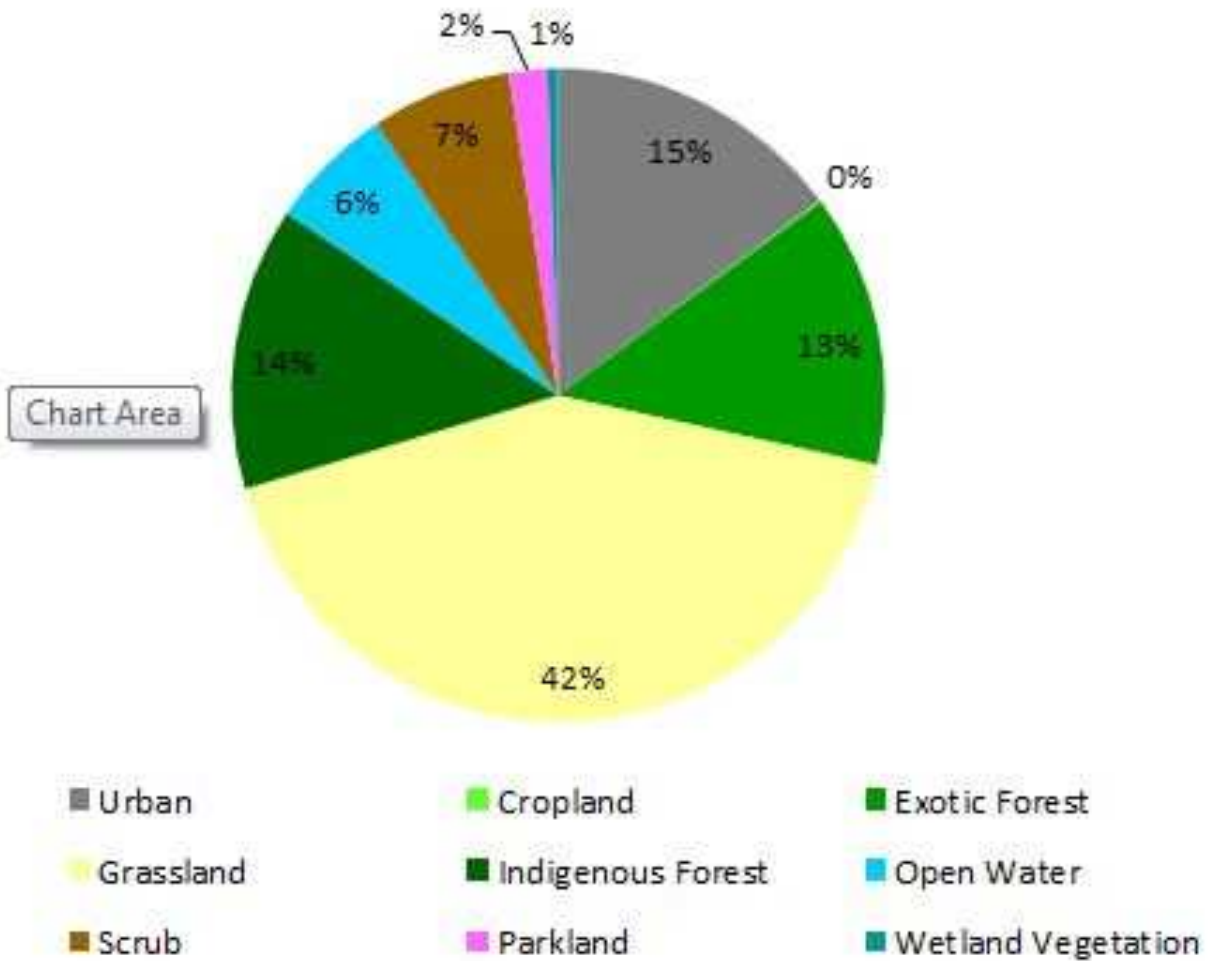
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Appendix 5 – Land cover in Te Awarua-o-Porirua Whaitua

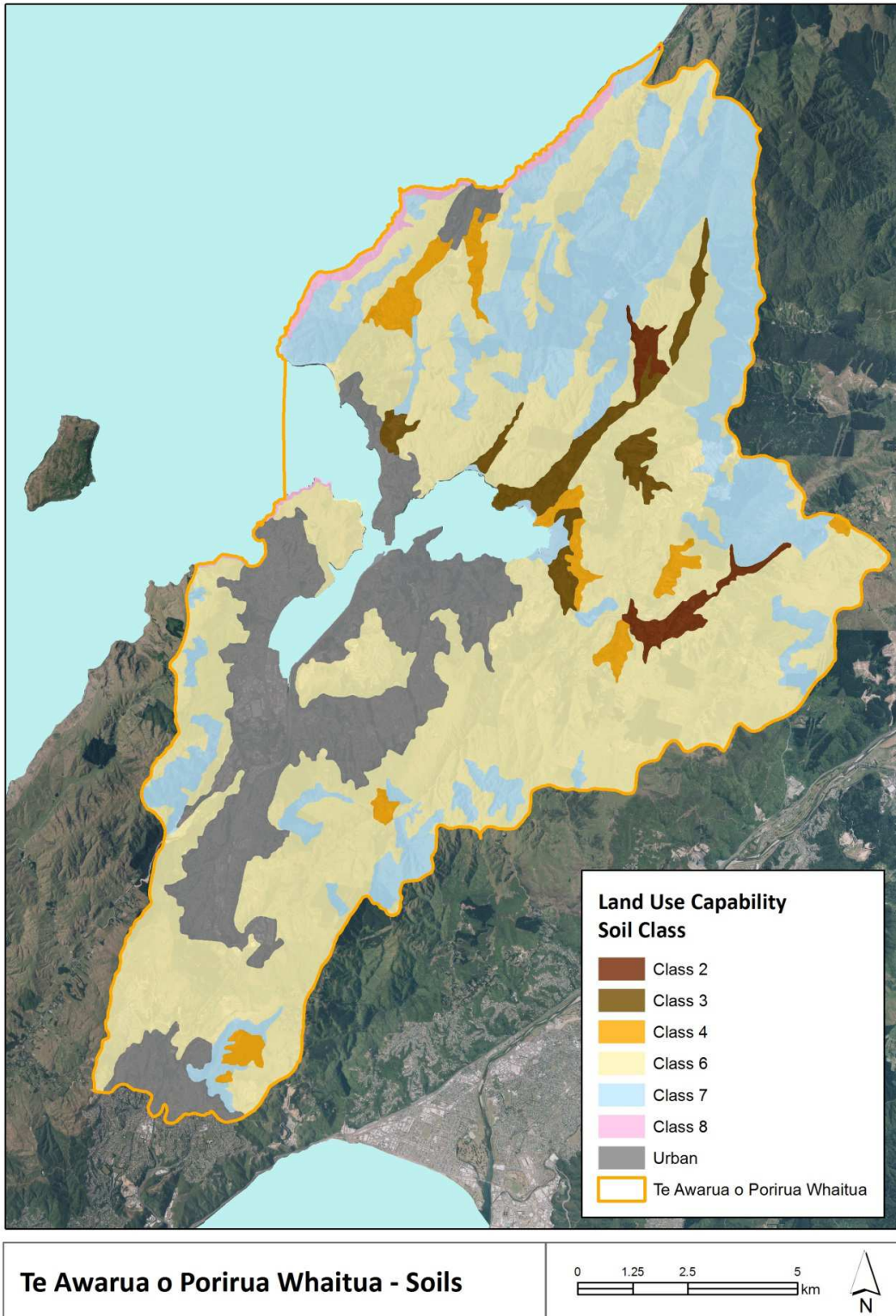


Appendix 6 – Percentage land cover in Te Awarua-o-Porirua Whaitua

Te Awarua o Porirua Whaitua - Landcover

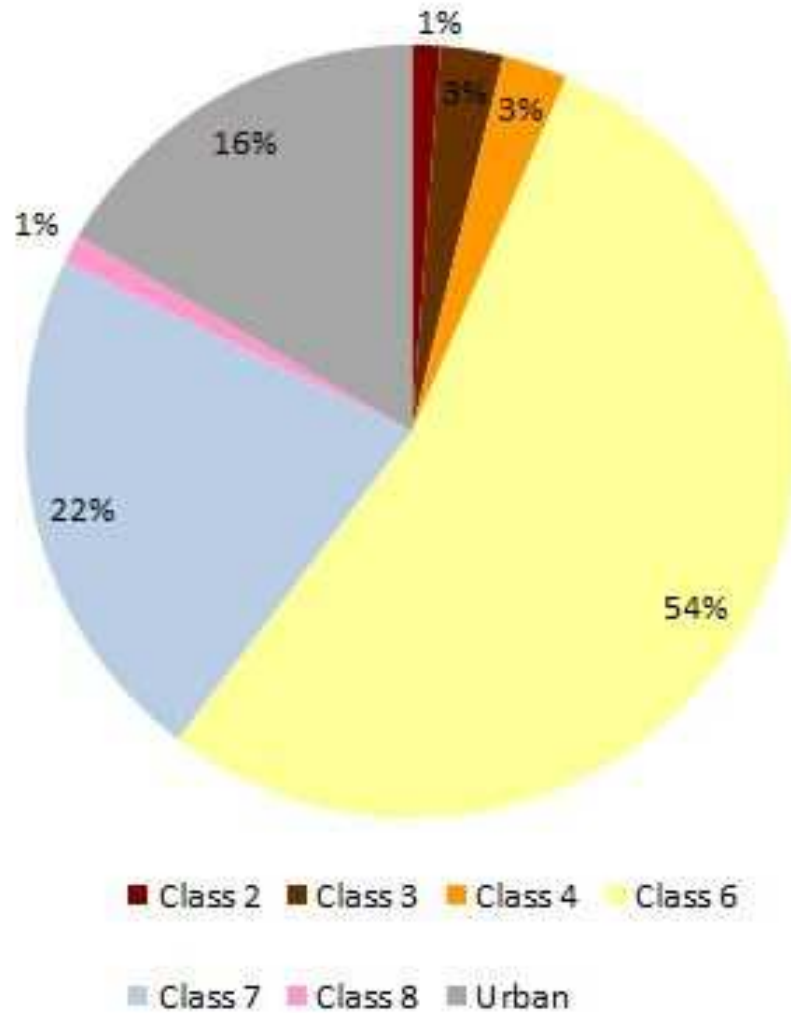


Appendix 7 - Soil classes in Te Awarua-o-Porirua Whaitua

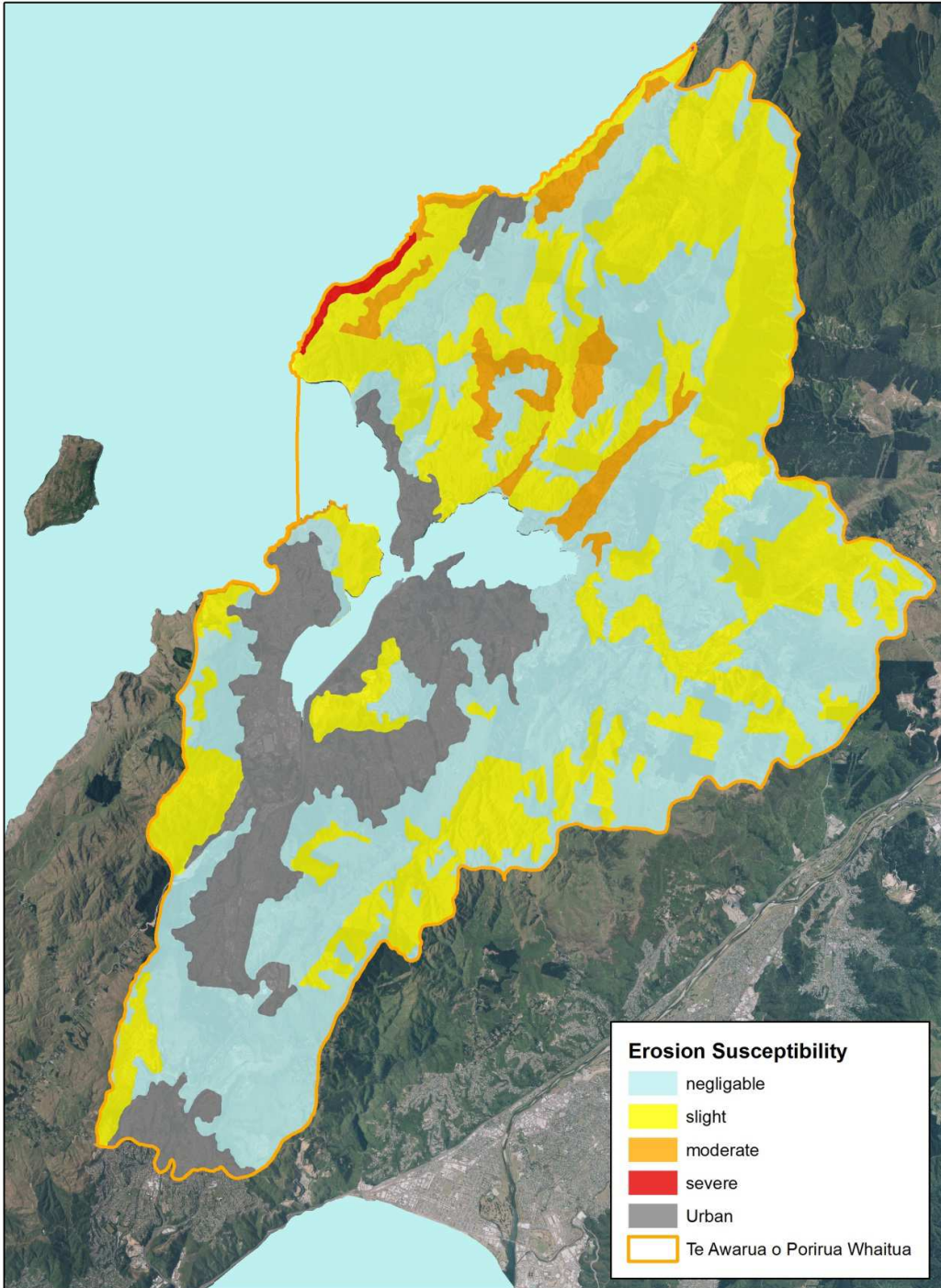


Appendix 8 – Soil class % in Te Awarua-o-Porirua Whaitua

Te Awarua o Porirua Whaitua - Soil Class



Appendix 9 – Erosion susceptibility in Te Awarua-o-Porirua Whaitua



Te Awarua o Porirua Whaitua - Erosion

0 1.25 2.5 5 km



Appendix 10 – Erosion susceptibility % in Te Awarua-o-Porirua Whaitua

Te Awarua o Porirua Whaitua - Slope Susceptibility

