Wellington Water

Wellington Water Stage Two Global Stormwater Discharge Consent

Assessment of Effects on the Environment

June 2023

Our water, our future.

Document Control

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Name	Role	Sign-off Date
David Cameron / Jiajia Liu	Author	21 June 2023
Bram Mulling	Stantec Reviewer	21 June 2023
Emily Greenberg	WWL Reviewer & Project Lead	28 June 2023

Executive summary

The stormwater networks owned by Wellington City Council, Porirua City Council, Hutt City Council, and Upper Hutt City Council are administered for the client councils by Wellington Water Ltd. Stormwater is discharged from these networks into freshwater or coastal water environments.

The purpose of this Assessment of Environmental Effects (AEE) is to provide technical support for an application for resource consent for the discharge of stormwater from the stormwater networks. This AEE forms part of the consent application documentation that covers all information required under Schedule 4 of the RMA. It should be read in conjunction with the Stormwater Management Strategy (SMS) which also forms part of the consent application.

The stormwater networks are located within 35 sub-catchments (or management units) which mostly correspond with stream catchments. The catchments have been modified by varying degrees of urban development, with several having more than 70% of the catchment area serviced by a stormwater network.

Descriptions of the existing environment in each of the 35 sub-catchments are provided. The state of the environment is influenced by multiple contaminant sources and stressors, one of which is the discharge of stormwater from local authority stormwater networks.

The effects of stormwater discharges from stormwater networks on the receiving environment are assessed. In general, the sub-catchments with the longest stormwater network length and highest proportion of stormwater network area (i.e., Evans Bay, Lambton, Porirua, Waiwhetu) had the highest level of adverse effects. The Owhiro Bay and Houghton Bay catchments showed high levels of adverse effects, but this is attributed, at least partly, to landfills within the catchment boundaries. Locations on the Porirua Coast including Plimmerton South Beach and Titahi Bay South also had elevated levels of effect on aesthetic values and recreational values but in both cases faults with the wastewater network are the dominant source of contamination.

The AEE has identified the potential for urban stormwater to cause a 'more than minor' level of adverse effect in the receiving environment in 12 of the 35 sub-catchments. Wellington Water proposes to resolve these adverse effects through a Stormwater Management Strategy (SMS), under the governance of a Collaborative Committee.

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Abbreviations

Enter Abbreviation	Enter Full Name
ADF	Average daily flow
ADWF	Average dry weather flow
$cBOD_5$	Five-day carbonaceous biochemical oxygen demand
CFU	Colony forming units
CMA	Coastal Marine Area
DGV	Default guideline value
FC	Faecal coliform
g/m^3	Grams per cubic metre
L/s	Litres per second
m^3	Cubic metres
mg/L	Milligrams per litre
m/s	Meters per second
pNRP	Proposed Natural Resources Plan
PWWF	Peak Wet Weather Flow
TD	Total dilution
TSS	Total suspended solids
UV	Ultraviolet irradiation
WWTP	Wastewater Treatment Plant

1 Introduction

Wellington City Council (WCC), Porirua City Council (PCC), Hutt City Council (HCC), and Upper Hutt City Council (UHCC) own and maintain a network of pipes and open channels which collect and convey urban stormwater runoff within 35 stormwater sub-catchments. The stormwater networks are administered for the client councils by Wellington Water Ltd (Wellington Water). Stormwater is discharged from these networks into freshwater or coastal water environments, in some cases via land.

Wellington Water was granted resource consent WGN180027[34920] on 30 November 2018 for the discharge of stormwater from the stormwater networks. The consent was granted under Rule R52 of the Natural Resources Plan for the Wellington Region (NRP) for a duration of five years and is referred to as a Stage One Consent under the NRP.

The purpose of this Assessment of Environmental Effects (AEE) is to provide technical support for an application for a Stage Two Consent. The AEE covers the relevant information required under clause 6 (Information required in assessment of environmental effects) and clause 7 (Matters that must be addressed by assessment of environmental effects) of Schedule 4 of the Resource Management Act (RMA).

This AEE forms part of the consent application documentation that covers all information required under Schedule 4 of the RMA. This AEE should be read in conjunction with the Stormwater Management Strategy (SMS) which also forms part of the consent application.

1.1 Definition of stormwater

Stormwater is defined in the NRP as:

"*Runoff that has been intercepted, channelled, diverted, intensified or accelerated by human modification of a land surface, or runoff from the external surface of any structure, as a result of precipitation and including any contaminants contained therein*.

For the avoidance of doubt stormwater excludes discharges associated with earthworks, vegetation clearance, break-feeding and cultivation that are managed under in section 5.3 of the Plan".

Stormwater network is defined in the NRP as:

"The network of devices designed to capture, detain, treat, transport and discharge stormwater, including but not limited to kerbs, intake structures, pipes, soak pits, sumps, swales and constructed ponds and wetlands, and that serves a road or more than one property."

1.2 Generic effects of stormwater discharge on aquatic ecosystem health, recreational use and customary use

In recent decades the effects of urban stormwater on the aquatic environment have been well described both in New Zealand and internationally. These effects can be grouped into the following general types:

- Changes in flow regime
- Channelisation of stream and changes to riparian margins
- Increases in suspended solids

- Increases in toxic substances in the water column and sediments
- Changes to the nutrient regime
- Faecal matter and pathogen effects on human health, recreational use and mahinga kai, and
- Litter.

These types of effect are further described below.

1.2.1 Changes in flow regime

A fundamental characteristic of urban catchments is their high proportion of impervious surfaces. Almost all impervious urban structures, such as roads, carparks, buildings, transport depots, and railways, reduce the area where rainwater can infiltrate into the soil. Runoff rates from these surfaces are very high, far higher than from vegetated surfaces. This results in urban streams having a much higher and faster response to rainfall events than non-urban catchments. It also results in less rainfall infiltration into the ground, and loss of groundwater recharge for many small streams, some of which occasionally dry up (Suren, 2000).

1.2.2 Channelisation and piping of streams

Urban expansion of New Zealand's towns and cities has resulted in a decline in the values of streams draining these catchments (Suren, 2000). The process of urbanisation is almost invariably linked to stream channelisation projects which is one of the most widespread engineering solutions to problems of flooding in urban areas. Channelisation of streams increases their hydraulic efficiency in times of flood, allowing them to drain away excessive water more rapidly. However, channelisation has a profound effect on stream habitat quality, often resulting in decreased biodiversity (and often exacerbates downstream flooding issues).

It is noted that channelisation effects are not caused by the discharge of stormwater per se but rather by modifications of stream channels. As such these effects are outside of the scope of the current consent application, which is for the discharge of stormwater from the local authority stormwater network.

1.2.3 Changes to riparian vegetation

Riparian and in-stream vegetation is an important component of streams, which regulates light and temperature, provides food for invertebrates, shelter for fish, birds and lizards, and spawning habitat for whitebait (McDowell, 1990). Some urban streams are regularly cleared of in-stream and bank-side vegetation to maintain their hydraulic efficiency. Such action degrades in-stream habitat by removing both an important food source and important physical habitat. Collier et al. (2007), however, notes that although some plant cover increases habitat diversity and can provide food, too much can cause ecological problems by impeding water flow, trapping more fine sediments, smothering benthic habitats, and causing wide fluctuations in dissolved oxygen and pH due to plant respiration and photosynthesis. These adverse effects are, however, not caused by the discharge of stormwater and are outside the scope of the current consent applications.

1.2.4 Increased suspended solids

Some of the most severe impacts of urbanisation on stream biota are caused by suspended solids (Suren, 2000). Exposure of soils during development of urban areas can lead to very high suspended solids (SS) concentrations in runoff from developing areas. Concentrations in stormwater can increase 100 to 1000-fold (Williamson, Goff, Mills, & Berkenbusch, 2001). For example, after initial subdivision development, as the urban area fully matures, SS concentrations and loads gradually decrease but this process can take many years and in the intervening period SS can cause the smothering of benthic habitats, especially in small stony streams. Large quantities of fine sediments may also be deposited in estuaries, as evidenced by the gradual sediment accumulation in the Porirua and Wellington harbours. As will be seen later is this report, high SS loads are not particularly a problem of a well-established urban area, but rather are associated with the development of new urban areas, or any activity involving large scale disturbance of soil.

We note also that discharges associated with earthworks, vegetation clearance, and cultivation are excluded from the NRP definition of stormwater and are not within the scope of the current consent applications.

1.2.5 Increase in toxic substances

Urban stormwater in the Wellington area almost invariably contains elevated concentrations of zinc (Zn), copper (Cu) and polycyclic aromatic hydrocarbons (PAH) (Williamson, 2003; KML, 2005; Milne & Watts, 2008; and Stantec, 2022). This is because their sources: tyres and galvanised iron (Zn), brake wear and vehicle wear (Cu), and combustion of fuel and leaked oil (PAH), are ubiquitous in urban areas. Urban stormwater may contain other toxic substances from point sources within the catchment (e.g., spills, disposal of chemicals, ammonia from sewage leaks), or from diffuse sources (e.g., spraying weeds with herbicides).

Concentrations of Cu and Zn in stormwater runoff at many Wellington stream locations can be high compared with both acute and chronic water quality guidelines. Gadd (2016), in a study of urban stream sites in Auckland, Wellington and Christchurch, reported a positive relationship between dissolved Cu and Zn concentrations and urban land cover; higher concentrations of dissolved metals are associated with a higher proportion of urban land use in the catchment. In that study 50% of urban sites in Wellington exceeded the ANZECC (2000) guideline for dissolved Cu (0.0014 g/m^3) and 57% exceeded the guideline for dissolved Zn (0.008 g/m^3). Based on the 2020 to 2022 SMP monitoring results reviewed in the present report 91% of urban stream sites exceeded the ANZG (2018) guideline for dissolved Cu and 83% exceeded the guideline for dissolved Zn

Williamson et al., (2001) concluded that the urban stream environment is probably toxic to some aquatic organisms through both water and sediments. However, many sensitive organisms may have already been affected by flow, temperature, and habitat changes. Due to these factors the adverse effects of urbanisation can occur with as little as 10-20% impervious cover (Wilding, 1996; Suren & Elliot, 2004). Typically, the pollution sensitive taxa disappear (often EPT invertebrate taxa - mayflies, stoneflies & caddisflies) and the invertebrate taxa is dominated by pollution tolerant taxa (e.g., snails, crustacea, worms, midge larvae). In virtually all studies reported in the review of Walsh et al., (2005), sensitive species were either absent or less abundant in streams draining urban areas. That is certainly the case for the Wellington Water SMP sites reviewed in this report.

Many toxicants are associated with the particulate fraction in stormwater which is generally not retained in streams but rapidly flushed through the system into downstream receiving environments. These contaminants therefor pose a risk to aquatic ecosystems in depositional coastal environments such as the Porirua and Wellington Harbours. Cu and Zn are the contaminants of ongoing concern in these environments, but neither are predicted to increase rapidly (Diffuse Sources Ltd, 2014).

Other emerging contaminants of concern include pharmaceuticals, personal care products and polyfluorinated alkyl substances, which are not routinely monitored in stormwater, and which pose an uncertain level of risk in aquatic habitats.

1.2.6 Changes to nutrient regimes

Nutrients in stormwater, such as nitrogen and phosphorus compounds, can either increase or decrease as a result of urbanisation, depending on site specific factors. Forest and native bush have low nutrient yields, so urbanisation increases nutrient loss from the land. However, most cities and towns in New Zealand are built on pastureland. Where this is high production pasture, which receives fertiliser inputs, urbanisation leads to a reduction in nutrient loads, whereas for low production pasture, urbanisation probably leads to little change.

1.2.7 Faecal contaminants

Leaks from the wastewater system via faults or overflows in wet weather can enter streams or coastal waters via the stormwater system, potentially increasing the risk of infection for recreational users of those waters.

Even in areas without sewage leaks or overflows, the microbiological quality of stormwater tends to be poor because of faecal material derived from birds, cats, dogs, rats and other animals present in an urban environment. Pathogens are frequently detected in urban stormwater, but compared with sewage, the occurrence of enteric pathogens is low. Moderate levels of pathogenic organisms that do not require ingestion to infect are also found, and for contact recreation areas affected by stormwater runoff, there is an increased risk of skin, eye and ear infections.

Overall, there is a plausible risk for infection because of the possibility of leaked sewage into the stormwater system. However, there is little epidemiological evidence to support the idea of infection from urban stormwater alone (Williamson, 2001). Stantec (2022) found that close to 100% of urban stream sites monitored between 2020 and 2022 in Porirua, Wellington and the Hutt Valley were placed in the NPS-FM 'E' (red) attribute band for *E. coli*. (i.e., the lowest band).

It is noted that faecal contamination in stormwater caused by wet weather overflows from the wastewater network are *not* the subject of this consent application. These discharges are being addressed in separate consent applications. This current application does however cover wastewater leaks into the stormwater system, incorrect cross connections into the stormwater system, and faecal contaminants derived from stormwater (from dogs, cats, rats, birds, etc, in the urban environment).

1.2.8 Litter

Litter and floatable materials are an issue in urban runoff, both from an aesthetic perspective and because of the impact on habitat quality in the aquatic environment. An unpublished WCC investigation into litter loads discharged from Wellington's Overseas Passenger Terminal culvert suggests that floatable litter is well controlled by street sumps and does not result in significant visual or aesthetic effects in receiving waters. However, non-floatable litter, such as cigarette butts and other organic material, can pass through street sumps and may be discharged to streams and the CMA. While this material is less likely to cause visual or aesthetic effects, benthic ecology surveys (Bolton-Ritchie, 2003) have reported high levels of organic matter in seabed sediments in the immediate vicinity of the large stormwater outfalls at the Overseas Passenger Terminal and Aotea Quay.

More recently, Hutt City Council commissioned a study to quantify urban litter entering the Lower Hutt stormwater system at Petone, Naenae and Taita (Naghibi & Werellagama, 2019). The authors concluded that 83% of total litter by weight is tree leaves, while food wrappers, plastic bags, bottles and cigarette butts made up the balance.

2 AEE Methodology

An assessment of effects on the environment (AEE) is a process for identifying, quantifying and evaluating the potential impacts of defined actions on the environment. It normally includes a description of the receiving environment, assignment of values associated with the receiving environment, a description of the proposed activity which in this case is the discharge of stormwater from local authority stormwater networks, an assessment of actual and potential effects of stormwater discharges on the environment, and a description of how the adverse effects may be avoided, remedied, or mitigated.

2.1 Description of receiving environment

Wellington Water's Stage One consent application, granted in November 2019, defined stormwater sub-catchments contained within WCC, PCC, HCC and UHCC boundaries. These sub-catchments, subject to several boundary changes in the Hutt River catchment, now form the basis for the Stage Two assessment. The description of stormwaters catchment characteristics includes a series of maps and tables detailing:

- catchment areas, boundaries, major stormwater infrastructure and monitoring points,
- piped streams within the network that are of significance to Mana Whenua,
- contaminated land and Hazardous Activities and Industries List (Hail) at a high risk of contributing contaminants to stormwater.

A spatial analysis was conducted by sub-catchment using data sources including the Landcare Research Land Cover Database (LCDB) and Greater Wellington Regional Councils Natural Resource Plan (NRP) schedules of outstanding or significant waterbodies, to support the receiving environment descriptions.

2.1.1 Wetlands

Wetlands listed in NRP Schedule A (outstanding waterbodies - wetlands), and NRP schedule F3 (significant natural wetlands) have been used for this assessment. Wetlands not included in NRP Schedules, but which may nevertheless meet the RMA and/or NPS-FM definition of a natural inland wetland, have not yet been mapped and are not included in this assessment.

Stormwater discharge points were extracted from the Wellington Water Regional Stormwater Node geodata layer. A filter was placed to extract nodes that are labelled as "Outlet" under the "Type"; stormwater discharge points that are primarily associated with infrastructure outside the scope of this consent application have been excluded.

The exclusion of outlets outside the scope of this consent is done based on the following criteria:

1. Ownership: NZTA or private network are excluded.
2. Status: Abandoned and removed networks are excluded.
3. Location and Duration: Sump leads that drain directly to the outlets are excluded.
4. Road culverts are excluded.

Using the above information sources, a visual desktop assessment was undertaken to assess the likelihood that wetlands receive stormwater from a discharge point (outlet), are located within a 100m of a stormwater discharge point or are located downstream of stormwater discharge point(s) while potentially being hydrologically connected to a stormwater discharge point (i.e., has the potential to receive or transport stormwater originating from a stormwater discharge point). Surface water hydrological connectivity has been assessed using aerial imagery, surface water layer and contour lines.

2.1.2 Water quality, sediment quality and aquatic ecology

Wellington Water's Stormwater Monitoring Plan (SMP), finalised in July 2020, was developed as part of the Stage One Consent to guide the collection of information over the consent duration, and to assist with the Stage Two assessment of stormwater and related environmental effects (this document). The monitoring results generated by the SMP provide the bulk of the water quality, sediment quality and aquatic ecology information used in this AEE (the SMP is a collaboration including Wellington Water for most water quality and stream sediment quality monitoring, GWRC for all RWQE water quality and ecology monitoring, GWRC for marine sediment quality and sediment infauna monitoring.

The SMP monitoring sites are listed in Table 2-1 and their locations are shown a series of sub-catchment maps in section 4.

Table 2-1 Sampling sites within each sub-catchment

Sub-catchment	Sampling Sites				
	SMP Fresh water[1]	SMP Coastal water[2]	SMP Stormwater outlet[3]	RWQE Site[4]	Stream/marine Sediment[5]
1. Karori	2			1	1
2. Owhiro Bay	2	1		1	1
3. Island/ Houghton		4	2		
4. Lyall Bay		2	2		
5. East Coast					
6. Evans Bay	3		4		
7. Lambton		6	12 & 1 autosampler		15
8. Kaiwharawhara	3			1	1
9. North harbour	2		2		1
10. Korokoro		1			
11. Speedys					
12. Waiwhetu	2		1 autosampler	1	1
13. Stokes Valley	1			1	1
14. Hulls	1			1	1
15. Lower Hutt South	3	3	4	1	
16. Lower Hutt North			3		
17. Upper Hutt- South	1		3	1	
18. Upper Hutt- North			5		
19. Hutt -Whakatiki					
20. Hutt Akatarawa					
21. Hutt Headwater				1	
22. Hutt Pakuratahi					
23. Hutt Mangaroa					
24. Eastbourne		4			
25. Black Creek	3			1	1
26. Wainuiomata-iti					

Sub-catchment	Sampling Sites				
	SMP Fresh water[1]	SMP Coastal water[2]	SMP Stormwater outlet[3]	RWQE Site[4]	Stream/marine Sediment[5]
27. Wainuiomata					
28. Morton					
29. Taupo		1		1	1
30. Kakaho		3			1
31. Horokiri					
32. Pauatahanui					
33. Duck	2	1			2
34. Porirua	10	2	3 & 2 autosamplers	2	3
35. Porirua coast		3	1		

Notes: 1. SMP freshwater monthly monitoring includes *E. coli*, Cu, Zn, dissolved organic carbon, total hardness, pH, and observations (of oil films, scums, foams, clarity, and odour).

2. SMP coastal water monitoring includes enterococci and observations (of oil films, scums, foams, clarity, odour).

3. SMP stormwater outlet monitoring includes *E. coli*, enterococci, Cu, Zn, and observations (of oil films, scums, foams, clarity, odour). In addition, at selected sites, storm event monitoring is conducted by autosampler; samples tested for a wide range of parameters (as detailed in the SMP report)

4. RWQE monthly monitoring includes water temperature, dissolved oxygen, visual clarity, pH, conductivity, turbidity, TSS, *E. coli*, total ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, total Kjeldahl nitrogen, total nitrogen, total phosphorus, dissolved Cu, dissolved Zn, dissolved calcium, dissolved magnesium, dissolved organic carbon, total hardness, periphyton cover and annual macroinvertebrate community health

5. Stream and marine sediment quality (once during 5 years under SMP) includes a basic soil suite (12 metals), DDT, PAH and total organic carbon.

Other sources of information not included in the table above include GWRC and NIWA (NZ River Maps) for stream flow data, and NIWA for NZ freshwater fish database.

2.2 Catchment Characteristics

A description of stormwater catchment characteristics is an essential part of an assessment of environmental effects of stormwater discharges. It should include stormwater sub-catchment boundaries, sub-catchment area, estimates of impervious area (hard surfaces such as roads, roofs, carparks, driveways, etc), the area serviced by a stormwater network, stormwater network length and number of outlets, piped stream of value to Mana Whenua, and HAIL sites at a high risk of contributing contaminants to stormwater. In combination these factors indicate the level of pressure that the receiving environment is likely to under from stormwater discharges. It is noted that Schedule N of the NRP specifies catchment characteristics that should be addressed in the Stormwater Management Strategy (SMS), many of which are also addressed in this AEE.

2.2.1 Impervious Surface

Impervious surface area is taken from calculations done for the SMS prioritisation. Due to differences in the availability of data from each client council, there are minor differences between the approach taken to calculate impervious surface.

The methodology for calculating the Wellington City and Porirua catchments impervious surface is based on combining two geospatial layers in GIS. First being the geospatial layer generated in 2016 using a predictive model (applying assumed proportions for different property types/land use) primary covering large hardstand area, driveway, and etc on private properties excluding roof area and roads. Second layer is the Land Information New Zealand (LINZ) building roof areas and road generated using LiDAR (light detecting and ranging) imagery, 2021[1].

Whereas the Hutt City Council uses the approach of classifying the impervious surface area by quantifying the area covered by roading and buildings. Hutt City Council used NZ Building Outline Data and the NZ Primary Road Parcels for the calculation[2].

Note, in the absence of the measurement of flows in small urban streams, the proportion of impervious surface in a catchment provides an indication of the degree of modification to the natural flow regime (a greater proportion of impervious surface causes greater disruption to the flow regime).

2.2.2 Stormwater Service Area

Stormwater Service Area is calculated from district plan zoning information. The area serviced by stormwater are zoned as business, industrial, and urban or sub-urban residential. Using this principle, stormwater service areas can be approximated by excluding open space and rural zoning from the catchment.

2.2.3 Stormwater Network Length and number of outlets

The stormwater network length and number of outlets are estimated by excluding stormwater assets not managed by the Wellington Water, for instance stormwater assets managed by NZTA or Wellington Airport.

2.2.4 Piped Streams of significance to Mana Whenua

The identification of piped streams of significant to Mana Whenua is derived by overlaying NRP Schedule B and Schedule C sites with Wellington Water Piped Stormwater Network in ArcGIS. The layer map is then examined by manually inspecting any streams that are highlighted in the Schedules. If a stretch of pipe is in place for any of the stream system in Schedule B or Schedule C map, that instance is counted. Note that this is a preliminary desktop assessment based only on information in the NRP schedules. it is known that other piped streams that are not included in Schedule B or Schedule C are of importance to Mana Whenua, for example: the Kumuototo stream which fed Kumutoto Pā, running underneath Woodward Street. Other examples are streams on south western side of the Onepoto Arm including Hukarito, Urukahika and Mahinawa (Whaitua Te Whanganui-a-Tara Committee, 2021). Further investigation and knowledge from Mana Whenua would be required to identify all such piped streams[3].

2.2.5 SLUR Sites

The Selected Land Use Register (SLUR) for the Wellington Region records details of properties that have, or may have, been used for activities and industries included in the Hazardous Activities and Industries List (HAIL) established by MfE. These include service stations, paint manufacturing plants, landfills, former gasworks and airports, all of which are potential sources of stormwater contaminants. SLUR maps are included for each stormwater catchment in Section 4.

[1] SMS Wellington

[2] Connect Water Memo November 2021 Jess Holland and Sarah Yeo

[3] Reimagining Wellington: Bringing the capital's streams back to life and light | Stuff.co.nz

2.3 Assignment of value and assessment of effects

This assessment of effects methodology is broadly based on the 'Ecological Impact Assessment Guidelines' (EcIA) described by Roper-Lindsay, et al. (2018). It includes the following steps:

1. Assign ecological **value** (and recreational value) to habitats potentially impacted by the stormwater discharges[4]
2. Determine the **magnitude of effect** (spatial scale or extent, temporal scale, duration, timing, uncertainty) from the proposed activity on the environment
3. Ascertain the overall **level of effect** (value x magnitude)
4. Determine the risk of **cumulative effects** over a larger area or longer period
5. Determine an effects management response.

Step 1 in the process comprises assignment of ecological value (Section 3). Although a wide range of metrics and measures are used in the assessment of freshwaters there is no unifying set of attributes used to assign value. Table 2-2 uses a series commonly used habitat and species values to identify 'Negligible' 'Low', 'Moderate', 'High' or 'Very High' categories. It is also noted the EcIA guidelines do not currently include a means of assignment ecological value to marine habitats. Table 2-2 does however include several relevant categories used by Bull & De Luca (2020).

Table 2-2: Assigning value to aquatic species and habitats (from various sources)

Value	Habitat values	Species values
Very high	A reference quality waterbody at or near its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants from human induced activities. Negligible degradation e.g., stream within a mostly native forest catchment.	**Freshwater** Benthic invertebrate community: • Has high diversity, species richness and abundance. • Contains many taxa that are sensitive to organic enrichment and settled sediments. • Has MCI scores typically 130 or greater. • Has high EPT richness and proportion of overall benthic invertebrate community. Fish community is diverse and abundant. No pest or invasive fish species (excluding trout & salmon). Stream channel and banks are unmodified. Riparian vegetation with a well-established closed canopy. **Marine** Benthic invertebrate community typically has very high diversity, species richness and abundance. Habitat unmodified
High	A waterbody with high ecological or conservation value but is no longer reference quality. It has been modified	**Freshwater** Benthic invertebrate community: • Has high diversity, species richness and abundance.

[4] In this case ecological value is determined from the current state of the receiving environment which is affected by a range of modifications and stressors, including stormwater discharges. It would be virtually impossible (and fanciful) to describe the receiving environment as it would be without stormwater discharges from the local authority stormwater network. The approach taken is therefore to assess the extent to which the current state deviates from a reference condition, and to then consider the extent to which that deviation may be explained by stormwater discharges.

	through loss of riparian vegetation, fish barriers, and/or stock access. Slight to moderate degradation e.g., exotic forest or mixed forest/agriculture catchment.	• Contains many taxa that are sensitive to organic enrichment and settled sediments. • Has MCI scores typically 110 or greater. • Has moderate to high EPT richness and proportion of overall benthic invertebrate community. Fish community is diverse and abundant. No pest or invasive fish species (excluding trout & salmon). Stream channel and banks are largely unmodified. Riparian vegetation is well-established. **Marine** Benthic invertebrate community typically has high diversity, species richness and abundance. Habitat largely unmodified
Moderate	A waterbody which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g., high-intensity agriculture catchment.	**Freshwater** Benthic invertebrate community: • Has moderate diversity, species richness and abundance. • Has MCI scores typically 90 - 110. • Has low to moderate EPT richness and proportion of overall benthic invertebrate community. Fish community has moderate diversity and may include pest or invasive species. Stream channel is modified (e.g., channelised) Stream banks may be modified or managed and/or evidence of significant erosion. Riparian vegetation is fragmented. **Marine** Benthic invertebrate community typically has moderate diversity, species richness and abundance. Habitat modification limited
Low	A highly modified waterbody with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g., modified urban stream.	**Freshwater** Benthic invertebrate community: • Has low diversity, species richness and abundance. • Is dominated by taxa that are not sensitive to organic enrichment and settled sediments. • Has MCI scores less than 90. • EPT richness and proportion of overall benthic invertebrate community typically low or zero. Fish communities are low diversity, only 1-2 species, and may include pest or invasive fish species. Stream channel is highly modified (e.g., channelised, lined with artificial surfaces). Stream banks are highly modified or managed and/or evidence of significant erosion. Riparian vegetation is sparse or absent. **Marine** Benthic invertebrate community degraded with low diversity, species richness and abundance. Habitat highly modified

Negligible	Not Threatened Nationally, common locally, poor habitat with few species.	**Freshwater** Nationally or locally common with a negligible ecological function. **Marine** Benthic invertebrate community degraded with very low diversity, species richness and abundance. Habitat extremely modified

Step 2 requires an evaluation of the magnitude of effects on local ecological values based on footprint size, intensity, and duration. The unmitigated 'Magnitude of Effect' that the activity is expected to have on species and ecosystems found in the receiving environment. It is evaluated as being either 'Negligible', 'Low', 'Moderate', 'High' or 'Very High', (Table 2-3) and is assessed in terms of:

a) Level of confidence in understanding the expected effect
b) Spatial scale of the effect (small = tens of meters, medium = hundreds of meters, large > 1km)
c) Duration and timescale of the effect (short = days to weeks, moderate weeks to months, persistent = years or more), and
d) Timing of the effect in respect of key ecological factors.

Table 2-3: Evaluation of magnitude of effects (from Roper-Lindsay et al., 2018)

Magnitude	Determining factors
Very high	Total loss of, or very major alteration to, key elements/features/ of the existing baseline condition, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature.
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.

Step 3 requires the overall level of effect to be determined using a matrix based on the ecological values and the magnitude of effects on these values. Table 2-4 shows the Roper-Lindsay et al. (2018) matrix outlining criteria to describe the overall level of ecological effects. We have used the overall level of ecological effect to determine if effects management is required. Effects assessed as being Moderate, High or Very High warrant efforts to avoid, remedy or mitigate.

Table 2-4: Criteria for determining levels of ecological effects (Roper-Lindsay et al., 2018)

Magnitude of effect	Ecological Value				
	Very high	**High**	**Moderate**	**Low**	**Negligible**
Very high	Very High	Very High	High	Moderate	Low
High	Very High	Very High	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very Low	Very low
Negligible	Low	Very Low	Very Low	Very Low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Step 4 implementation of the effects management hierarchy to avoid, remedy or mitigate potential impacts (Section 7). Where the effects cannot be avoided or adequately mitigated consider biodiversity offsetting.

2.4 Mana Whenua Values

Section 3.3 and Section 6.3 of this AEE attempt to summarise the body of information that is available from various documents about the relationship of Mana Whenua with the receiving environment and about the adverse effect of the stormwater discharge on Mana Whenua values.

Documents that have been reviewed to inform this assessment are:

- Te Awarua-o-Porirua Whaitua Implementation Programme
- Te Awarua-o-Porirua Whaitua Implementation Programme – Ngāti Toa Rangatira Statement
- Schedule B, C3, C4, D1, and D2 of the NRP
- Te Whaitua te Whanganui-a-Tara Implementation Programme
- Te Mahere Wai o Te Kāhui Taiao

3 Overview of stormwater catchments

The region's topography contains many well-defined watersheds and individual catchments. At a high level, there are two major catchments or Whaitua which drain to the two major harbours in the western region, Wellington Harbour (Te Wanganui-a-Tara) and Porirua Harbour (Te Awarua-o-Porirua). The Te Wanganui-a-Tara Whaitua is defined by the western and southern coastal areas, and the ranges to the north and east which bound the Kapiti and Ruamahanga (Wairarapa) catchments. Te Awarua o Porirua Whaitua covers an area that drains into the Porirua Harbour and includes developed areas between Johnsonville and Pukerua Bay.

3.1 Stormwater sub-catchment characteristics

The 35 sub-catchments described in this report mostly correspond with stream catchments, except the Hutt River which is broken into smaller sub-catchments (or management units), and flat coastal areas without significant streams which are combined into 'coastal' catchments.

As indicated in Table 3-1 several of the listed sub-catchments (Hutt Headwater, Pakuratahi, Wainuiomata-iti, and Horokiri) have no reticulated stormwater network and are not affected by stormwater discharges. Others have varying degrees of urban development, with some, including Island/Houghton Bay, Lyall Bay, Evans Bay, and Lower Hutt South, having more than 50% of the catchment area serviced by a stormwater network. The catchment boundaries are illustrated in Figure 3-1.

Table 3-1: The stormwater sub-catchments

Sub-catchment	Total Catchment Area (Km^2)	SW network area (Km^2)	SW Network Area (%)	Impervious Surface Area (%)	SW Network length (km)[5]	Number of storm-water outlets[5]	Piped Stream of significance to Mana Whenua
1. Karori	31.0	3.1	10%	5%	58.5	125	No
2. Owhiro Bay	9.7	2.1	21%	6%	30.9	81	No
3. Island/ Houghton	6.0	4.2	70%	17%	56.2	52	No
4. Lyall Bay	2.8	2.1	73%	34%	26.3	32	No
5. East Coast	2.9	1.1	36%	20%	12.2	30	No
6. Evans Bay	9.5	5.9	62%	25%	102.6	51	No
7. Lambton	13.7	8.5	62%	26%	155.7	92	No
8. Kaiwharawhara	16.6	5.5	33%	10%	83.8	242	Kaiwharawhara
9. North harbour	15.8	7.1	45%	15%	104.4	225	No
10. Korokoro	16.5	0.9	6%	3%	5.7	38	No
11. Speedys	11.7	0.9	8%	6%	7.4	23	No
12. Waiwhetu	19.1	11.5	60%	53%	125.5	157	No
13. Stokes Valley	12.2	6.5	53%	27%	51.4	90	No
14. Hulls	16.7	4.0	24%	21%	35.5	60	No
15. Lower Hutt South	17.9	13.6	76%	59%	168.4	226	No
16. Lower Hutt North	15.8	6.6	42%	27%	57.9	48	No

[5] Estimated, based on methodology described, within the Scope of this Consent

Sub-catchment	Total Catchment Area (Km^2)	SW network area (Km^2)	SW Network Area (%)	Impervious Surface Area (%)	SW Network length (km)[5]	Number of storm-water outlets[5]	Piped Stream of significance to Mana Whenua
17. Upper Hutt- South	28.2	5.8	20%	20%	52.0	55	No
18. Upper Hutt- North	19.2	7.3	38%	32%	85.9	75	No
19. Hutt -Whakatiki	80.2	0.3	0%	<1%	1.7	5	No
20. Hutt Akatarawa	118.1	1.9	2%	<1%	2.2	5	No
21. Hutt Headwater	115.4	0.2	0%	<1%	0	0	No
22. Hutt Pakuratahi	81.2	0.0	0%	<1%	0	0	No
23. Hutt Mangaroa	103.5	0.8	1%	1%	2.9	13	No
24. Eastbourne	14.5	3.2	22%	11%	12.5	38	No
25. Black Creek	18.7	7.6	41%	27%	80.5	165	No
26. Wainuiomata-iti	17.7	0.0	0%	<1%	0	0	No
27. Wainuiomata	60.3	0.9	2%	1%	9.5	15	No
28. Morton	40.5	0.2	1%	<1%	0.7	5	No
29. Taupo	10.6	0.6	6%	9%	5.5	22	No
30. Kakaho	14.8	0.9	6%	3%	14.2	28	No
31. Horokiri	41.0	0.0	0%	2%	0	0	No
32. Pauatahanui	41.5	0.9	2.3%	4%	13.3	35	No
33. Duck	12.0	4.6	39%	15%	72.9	176	No
34. Porirua	66.5	28.5	43%	19%	385.2	610	Hukarito, Urukahika,Mahi nawa
35. Porirua coast	14.4	2.1	15%	10%	22.1	59	No

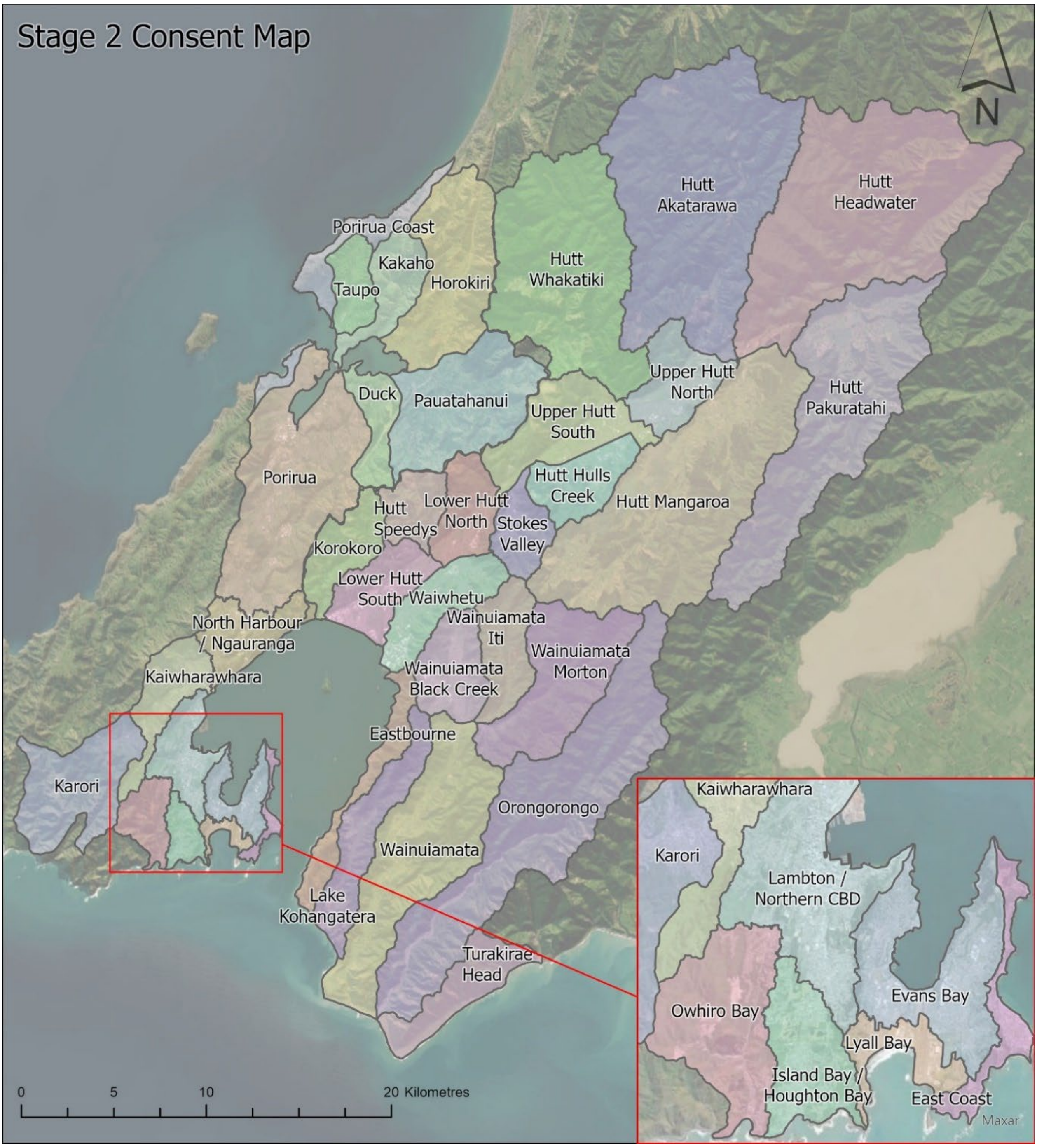

Figure 3-1: Overview of 35 stormwater catchments

3.2 Wetlands

This assessment identifies several wetlands that are hydrologically connected to an urban stormwater discharge *and* located within 100m of the discharge point (Table 3-2). These are: the Hutt River mouth, Taupō Swamp, Pauatahanui tidal flats, Pauatahanui saltmarsh, Duck Creek saltmarsh, Camborne Scarp wetland, Romesdale Lagoon, Papakowhia Bush, Papakowhia Lagoon, Onepoto Arm tidal flats and the Muri Road wetland.

Table 3-2: NRP scheduled wetlands in relation to SW discharges

Catchment	Wetland within sub-catchment					
	Wetland	**Size (ha)**	**NRP Schedule**	**Stormwater discharge directly into wetland**	**Within 100 m of an urban SW discharge point**	**Hydrologically connected to urban SW**
1. Karori	None scheduled in NRP	Not applicable				
2. Owhiro Bay	None scheduled in NRP	Not applicable				
3. Island/Houghton	None scheduled in NRP	Not applicable				
4. Lyall Bay	None scheduled in NRP	Not applicable				
5. East Coast	None scheduled in NRP	Not applicable				
6. Evans Bay	None scheduled in NRP	Not applicable				
7. Lambton	None scheduled in NRP	Not applicable				
8. Kaiwharawhara	None scheduled in NRP	Not applicable				
9. North harbour	None scheduled in NRP	Not applicable				
10. Korokoro	None scheduled in NRP	Not applicable				
11 Speedy	None scheduled in NRP	Not applicable				
12. Waiwhetu	None scheduled in NRP	Not applicable				
13 Stokes Valley	None scheduled in NRP	Not applicable				
14. Hulls	None scheduled in NRP	Not applicable				
15. Lower Hutt South	**Te Awa Kairangi / Hutt River mouth**	**3.2**	**F3**	**yes**	**yes**	**yes**
16 Lower Hutt North	None scheduled in NRP	Not applicable				
17. Upper Hutt South	None scheduled in NRP	Not applicable				
18. Upper Hutt North	None scheduled in NRP	Not applicable				
19. Hutt- Wakatiki	Whakatikei Headwater Swamp	10.44	F3	No	No	No
	Whakarikei Wetland	6.55	F3	No	No	No
20.Hutt Akatarawa	Martin River Wetland	8.43	F3	No	No	No
21 Hutt Headwater	Maymorn Wetlands	13.15	A	No	No	No
	Stock Car wetland	3.1	F3	No	No	No
22.. Hutt Pakuratahi	Ladel Bend Wetland	2.56	F3	No	No	No
23. Hutt Mangaroa	Blue Mountain Bush Swamp Forest	7.72	F3	No	No	No
	Johnson's Road Wetland	0.59	F3	No	No	No
24. Eastbourne	Kohangapiripiri Wetlands	22.3	A	No	No	No
25. Black Creek	Gracefield Scrub / Waiau Wetland	4.01	F3	No	No	No
26. Wainuiomata-iti	Not surveyed 16 (Moore's Valley Wetland)	0.21	F3	No	Yes	Unlikely
27. Wainuiomata	Wainuiomata River Bush A	0.8	F3	No	No	No
	Not surveyed 11 (Curtis Swamp)	0.64	F3	No	No	No
28. Morton	Wainuiomata Waterworks Swamp Lower	4.8	F3	No	No	No
	Skull Gully Wetland	2.9	F3	No	No	No
29. Taupo	**Muri Road Wetland**	**2.1**	**F3**	**Yes**	**Yes**	**Yes**
	Plimmerton Swamp East	3.3	F3	No	No	No
	Taupō Swamp Complex	**31.1**	**A**	**Yes**	**Yes**	**Yes**
30. Kakaho	**Pauatahanui Inlet Tidal Flats**	**466.8**	**A**	**Yes**	**Yes**	**Yes**
	Kakaho Saltmarsh	1.94	F3	No	No	No
	Camborne Scarp wetland	**0.2**	**F3**	**Yes**	**Yes**	**Yes**
31. Horokiri	Swampy Gully (Battle Hill)	1.4	F3	No	No	No
	Kakaho Saltmarsh	1.9	F3	No	No	No

Catchment	Wetland within sub-catchment					
	Wetland	Size (ha)	NRP Schedule	Stormwater discharge directly into wetland	Within 100 m of an urban SW discharge point	Hydrologically connected to urban SW
	Motukaraka Saltmarsh / Ration Point	0.46	F3	No	No	No
	Horokiri Saltmarsh	6.2	F3	No	No	No
	Pauatahanui Inlet Saltmarsh	**37.1**	**A**	**No**	**Yes**	**Yes**
	Pauatahanui Inlet Tidal Flats	**466.8**	**A**	**Yes**	**Yes**	**Yes**
32. Pauatahanui	**Pauatahanui Inlet Saltmarsh**	**37.1**	**A**	**Yes**	**Yes**	**Yes**
	Pauatahanui Inlet Tidal Flats	**466.8**	**A**	**Yes**	**Yes**	**Yes**
33. Duck	**Pauatahanui Inlet Tidal Flats**	**466.8**	**A**	**Yes**	**Yes**	**Yes**
	Duck Creek Saltmarsh	**1**	**F3**	**Yes**	**Yes**	**Yes**
34. Porirua	**Romesdale Lagoon**	**0.68**	**F3**	**Yes**	**Yes**	**Yes**
	Papakowhai Bush	**0.79**	**F3**	**Yes**	**Yes**	**Yes**
	Papakowhai Lagoon	**0.09**	**F3**	**Yes**	**Yes**	**Yes**
	Te Onepoto Wetland	0.51	F3	No	No	Possibly
	Te Awarua o Porirua Harbour (Onepoto Arm) – Tidal Flats	**1.5**	**F3**	**Yes**	**Yes**	**Yes**
35. Porirua coast	**Muri Road Wetland**	**2.0**	**F3**	**Yes**	**Yes**	**Yes**

3.3 Mana Whenua Values

3.3.1 Te Whaitua te Awarua o Porirua

Ngāti Toa has Mana Whenua over Te Awarua o Porirua. Ngāti Toa's rohe is defined as "Mai I Miria te Kākara ki Whitieia, whakawhiti te Moana Raukawa ki Wairau ki Whakatū" ("From the place known as Miri ate Kāraka in the Rangitīkei to Whitireia in Porirua, across the Cook Strait to the Wairau Valley and the Nelson area.") (Te Mahere Wai, 2021). Ngāti Toa's Statutory Acknowledgement recognises that Te Awarua-o-Porirua, including both the Pauatahanui and Onepoto Arms is of 'primary cultural, historical, spiritual, and traditional significance to Ngāti Toa and that the iwi maintains 'an inextricable connection to the area' (Ngāti Toa Rangatira Claims Settlement Act, 2014).

The Harbour

The Porirua Harbour has occupied a central place in the livelihood and identify of Ngāti Toa as a people (Te Awarua-o-Porirua Whaitua Committee, 2019). The natural flows and processes of the harbour are a defining feature of traditional life (NRP, Schedule B). The Statutory Acknowledgement identifies that Ngāti Toa are the kaitiaki of the harbour, its resources and 'countless sacred and historical sites located in the vicinity of the harbour' (Ngāti Toa Rangatira Claims Settlement Act, 2014).

As kaitiaki, Ngāti Toa in turn had the obligation to nurture and protect these water bodies and ensure that they could sustain future generations. These long held connections to the area are reflected in all of the waterbodies within the catchment being identified in Schedule B (Ngā Taonga Nui a Kiwa) of the Natural Resources Plan (Figure 3-2) and are also reflected in the large number of sites of significance to Ngāti Toa that are located around Te Awarua-o- Porirua (Figure 3-3).

The abundance of natural life supported by the harbour provided a wealth of kaimoana (including shellfish such as pipi, pūpū, tuangi, paua, mussels and oysters, kina and a range of fish). The tuangi could be gathered in abundance from the mud flats and was the most highly prized of all shellfish in the area. A sand bank located in the eastern arm of the harbour (Ngā Whatu o Topeora) was an important mahinga kai and site of a storehouse. Kōura, pāua, and kina were all in abundance along the coast. In addition to providing sustenance for Ngāti Toa and manaakitanga to its manuhiri, kaimoana gathered from the harbour was an important commodity for trade and gifts (Ngāti Toa Statement on WIP, NRP).

Despite being damaged by land reclamation, modification, and environmental degradations, the harbour continues to support a variety of endemic wildlife, including threatened and endangered species. This demonstrates Te Manawaroa o te Wai.

In addition to providing an abundance of kai and other resources, numerous sites in and around the harbour foreshore are important as the testament to the history of Ngāti Toa and the history of Aotearoa. Since the settlement of Ngāti Toa's settlement in the region the harbour is recognised for its importance strategically as a part of the trading route (WIP).

Takapuwhahia Pā, located on the southern shores of the Onepoto Arm was an important kainga of Ngāti Toa. Hongoeka, a coastal settlement north of the harbour entrace, is also an important kainga of Ngāti Toa. The Takapuwhahia and Hongoeka are the only traditional settlements of Ngāti Toa within the Porirura region and continue to be sites of significance.

Taupō Pā was the principal residence of Ngāti toa chief Te Pauparaha. Paremata pā and was the residence of Nohorua. Nohorua also had a pā at hongoeka. Te Rangihaata had pā at both Motukaraka and Pauatahanui (Matai-taua Pā).

The Whitireia Peninsula is another area of importance, containing numerous wāhi tapu (sacred sites) and historical sites, including urupā, kainga, pā, middens, pits, terraces (for gardens) and tauranga waka (places of anchorage). The Taupo wetland provides harakeke which is an important commodity for trade and gifts.

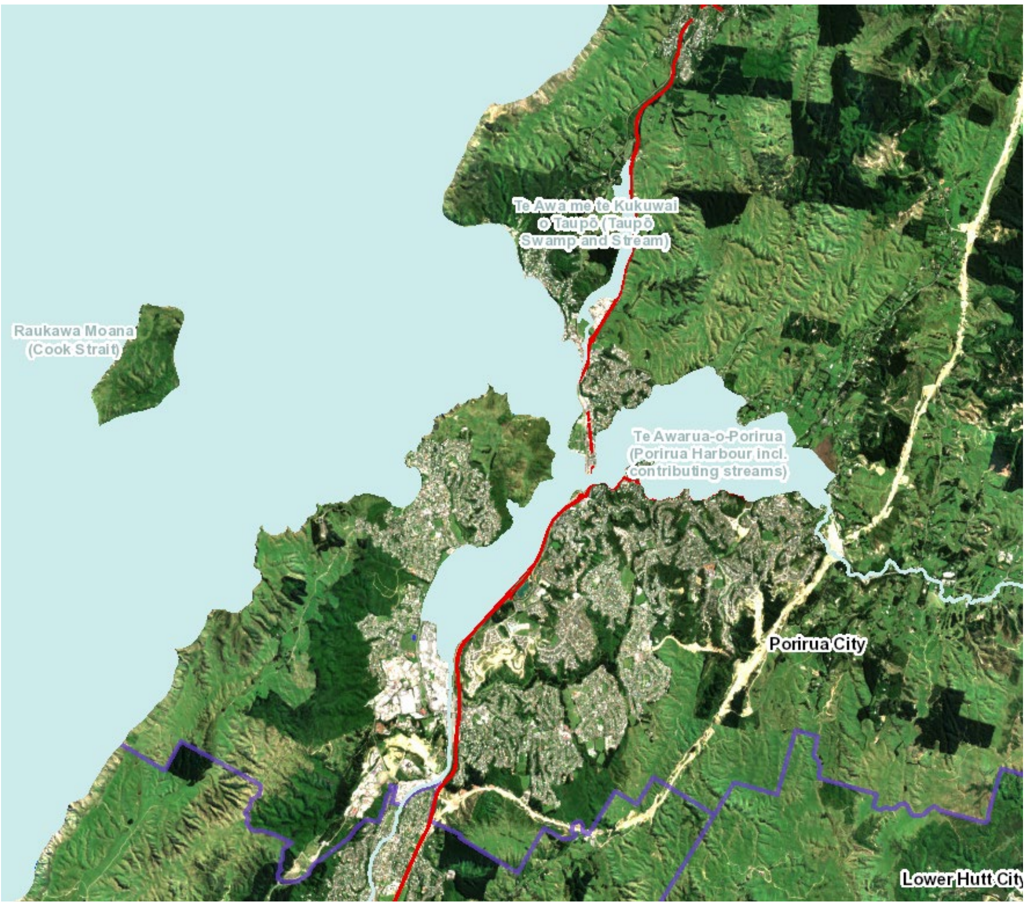

Figure 3-2 Ngā Taonga Nui a Kiwa in Te Awarua-o-Porirua catchment (Source: GWRC online maps)

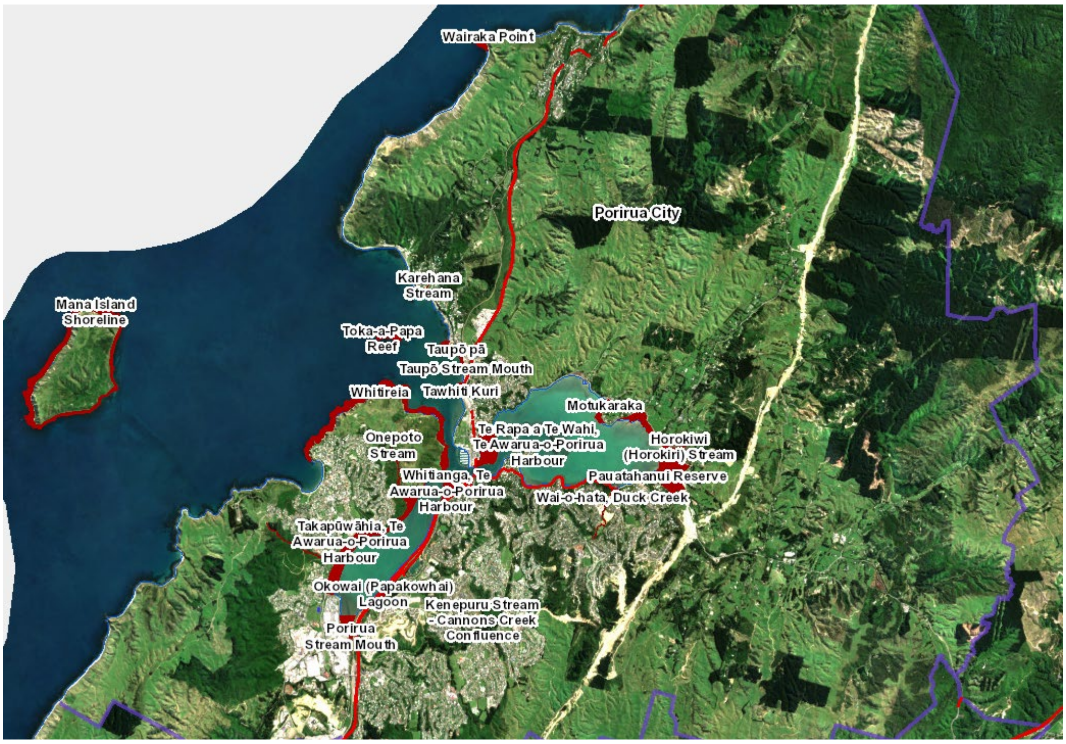

Figure 3-3 Sites of significance to Ngāti Toa Rangatira in Te Awarua-o-Porirua catchment (Source: GWRC online maps)

The Streams

Ngāti Toa's statement on Te Awarua-o-Porirua Whaitua Implementation Programme identifies that the streams which flow into Te Awarua-o-Porirua are greatly valued by Ngāti Toa as mahinga kai and because they are a source of renewal and replenishment for the harbour. The streams traditionally provided a plentiful supply of freshwater fish and tuna and their catchments provided birds, berries and rongoā (medicines).

3.3.2 Te Whanganui a Tara Waitua

Taranaki Whānui and Ngāti Toa Rangatira are the Mana Whenua authority over the Te Whanganui-a-Tara. The takiwā of Taranaki Whānui extends from Pipinui to Remutaka, down to Turakiae, across to Rimurapa and back up to Pipinui. As part of the treaty settlement, Taranaki Whānui has a statutory acknowledgement over Te Awa Kairangi, Te Whanganui -a-Tara (the harbour), the Costal Management Area, and holds significant interests in all waterways within Te Whaitua o Te Whanganui-a-Tara.

Ngāti Toa Rangatira Treaty Settlement with the Crown acknowledges the legitimacy of the customary rights and interests of Ngāti Toa in the area of Te Whaitua o Te Whanganui-a-Tara.

In the Te Mahere Wai, it was stated "Both Taranaki Whānui and Ngāti Toa Rangatira recognise the individual, shared and collective history of both iwi within the Te Whaitua o Te Whanganui-a-Tara."

Hutt River and its āku waiheke[6]

As identified in the Te Mahere Wai and the Whaitua Implementation Plan "Te Awa Kairangi is a taonga and awa tupuna (treasured ancestral river) for Ngāti Toa and Taranaki Whānui." Te Awa Kairangi has much lore, and the awa bear witness to the cultural history of the iwi who lived and

[6] Small water bodies are named and recognised for their individual and accumulated values including habitat and water volume (Proposed District Plan - Wellington City Proposed District Plan)

moved on from this area. The Statutory Acknowledgement from the Port Nicholson Block (Taranaki Whānui Ki Te Upoko o Te Ika) Claims Settlement Act 2009 acknowledge that the Taranaki Whānui has "traditional, cultural, spiritual association with Te Awa Kairangi ", the awa "linked the settlements as well as being a food supply for the pā and kainga along the river." The Ngāti Toa Rangatira Treaty Settlement Act 2014 acknowledges that "The Hutt River (Te Awa Kairangi) is of historical and cultural importance to Ngāti Toa Rangatira", and that "the iwi consider that the river is included within their extended rohe and it is an important symbol of their interests in the Harataunga area". The connection between the awa and Taranaki Whānui and Ngāti Toa is evidenced in Schedule B (Figure 3-4) and Schedule C (Figure 3-5 and Figure 3-6) of the NRP.

Te Awa Kairangi the largest river in the Te Whanganui-a-Tara Whaitua and supported a large variety of native fish, including kokopu, bluegill bully, giant bully, giant kokopu, koaro, piharau, longfin tuna, redfin bully, and shortfin tuna. The awa also navigable by waka and provided access to forest birds, watercress, and numerous other food plants. The abundant native fishery, birds, and food plant resources, together with the rich gardening soil, once supported a large Mana Whenua population.

Like all awa in the Te Whanganui-a Tara Whaitua, Te Awa Kairangi is a place for wānang (learning). Of particular note are pā sites, the repo (wetlands) and their uses for weaving dyes and building materials. The Maraenuku pā and Motutawa Pā on the awa are Schedule C wāhi tapu sites, the battles are all linked to the Ātiawa/Taranaki Whānui stories. Along the awa, sites are maintained for rituals and ceremonies. Many pā were built on the bank of the mainstem and tributaries of Te Awa Kairangi and sustained a full way of life for whanau and provided extensively for manuhiri.

Mana Whenua value Te Awa Kairangi for its manawaroa, despite the excessive land reclamations, modification, and environmental damage the awa has experienced, the awa continue to support a variety of endemic wildlife, including endangered species.

Off the mainstem of Te Awa Kairangi, there many āku waiheke (small streams) in the wahitua with unique value and mana. These includes Speedy's stream, Mangaroa awa and wetlands, Pakuratahi and Akatārawa river systems, Stokes Valley stream, Kororipo stream, Putaputa Stream, Waiwhetu stream, and Moonshine stream.

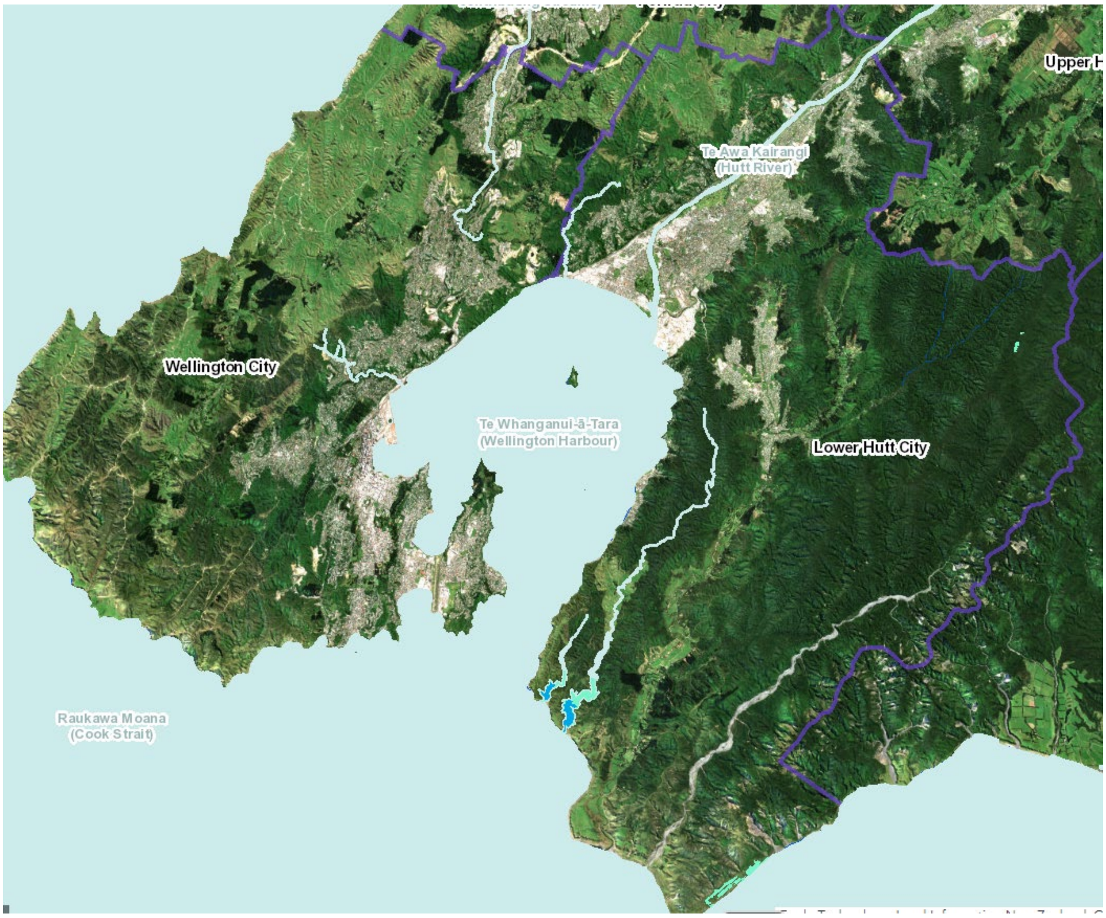

Figure 3-4 Ngā Taonga Nui a Kiwa in Te Whanganui a Tara Whaitua (Source: GWRC online maps)

Figure 3-5 Sites of significance to Ngāti Toa Rangatira in Te Whanganui a Tara Whaitua (Source: GWRC online maps)

Figure 3-6 Sites of significance to Taranaki Whānui ki te Upoko o te Ika a Maui in Te Whanganui a Tara Whaitua (Source: GWRC online maps)

Waiwhetū stream

Waiwhetū Stream arises in the foothills above Naenae and discharges into Te Awa Kairangi near the river mouth which is a Schedule C sites of significance for Taranaki Whānui. The stream has sustained iwi over many centuries and along the stream there were several pā and kainga, with Waiwhetū pā and Owhiti Pā being two important pā on the awa. The urupā at Owhiti are still in use today (Statutory Acknowledgement from the Port Nicholson Block (Taranaki Whānui ki Te Upoko o Te Ika) Claims Settlement Act 2009). Despite being considered the most polluted water in Te Whanganui-a-Tara and being assessed as Wai Kino on the Te Oranga Wai Mana Whenua assessment framework, the stream was a source of tuna, piharau, as well as kokopo and other freshwater species of fish.

Korokoro Stream

Te Korokoro o Te mana (Korokoro Steam) is a Schedule B Ngā Taonga Nui a Kiwa site, it has been used by Taranaki Whānui for sustenance as high-quality drinking water for Pito-one pā (a Schedule C site) located at the mouth of Korokoro stream. The Korokoro stream is renowned for white bait, and its well known for the collection of rongoā both in and around this stream and throughout the valley. The stream and the valley contain sites used for riturals, and the name of the stream which resonates with korero is considered by some iwi to be the throat of the fish of Maui. The stream was integral to day-to-day life of the pā and the valley it run through has high spiritual value to the iwi.

Wellington City Urban Streams

The Wellington urban area is made up of several urban streams including Kaiwharawhara, Ōwhiro, Karori awa.

Te Manga o Kaiwharawhara (including Te Mahanga Korimako Steams) is identified in the NRP as Schedule B Ngā Taonga Nui a Kiwa for Taranaki Whānui. Kaiwharawara is the largest stream in Wellington City and one of the few remaining tributaries that has a relatively natural estuary mouth into the harbour. The stream runs around the west of Te Ahumairangi (Tinakori Hill), where the five streams flow that traditionally sustain the city of Wellington. The stream is of great significance to Te Ātiawa and Ngāti Tama. On its bank there sits the pā of Taringa Kuri a Ngāti Tama Rangatira and the land of Te Wharepouri and Te Puni. The stream is essential to the identity of the Ngāti Tama people who lived there. This is well documented in the Waitangi tribunal report Te Whānganui a Tara me Ona Takiwā. The Kaiwharawhara Pā was located near the stream mouth and remains a significant site for Taranaki Whānui, forming the original gateway into Wellington. This stream and its environs are considered significant to both the history and continued wellbeing of the Mana Whenua.

The Kaiwharawhara Stream also supported a wide range of plants which provided sustenance for whanau. The stream was used as a route to access the western side of Te Ahumairangi and through to the southwest coast for Taranaki Whānui so that fishing villages could be easily reached and supported. The estuary and lagoon beside the stream in early times was used as fishery base and water was used for horticulture. The stream is also a site of wāhi whakarie and was used for rituals such as planting at Puanga/Matariki.

Wellington Harbour

Te Whanganui a Tara (Wellington Harbour) is listed in the NPR as a Taonga Nui a Kiwa to both Taranaki Whānui and Ngāti Toa. Te Whanganui a Tara is one of the eyes of the fish of Maui and is integral to the Aotearoa/iwi creation story which gives the region its name as part Te Upoko o Te Ika a Maui. Te Whanganui a Tara as the most significant identity tohu for Taranaki Whānui, and it is a defining feature of Ngāti Toa settlement in the Wellington area.

The mouth of streams and rivers in the harbour support a variety of fish species, including inanga, tuna, kahawai, piharau, kingfish, terakihi, pātiki, kumukumu, araara, aua, kanae, and hapuku, and shellfish such as pipi. Te Whanganui a Tara also support mahinga kai plant such as karengo (sea lettuce), as well as rongoā. The harbour was important for gathering kai for sustenance of iwi and manuhiri, in addition to providing commodity and access for trade.

Numerous pā were located around the harbour from the West Coast at Pipinui to the south coast at Turakirae via the harbour entrance. The major pā were Te Aro Pā at Lambton Harbour, Kumutoto Pā at Lambton Quay, Pipitea Pā at Thorndon, Kaiwharawhara pā, Ngāuranga Pā, Pito-one Pā at Thorndon, Waiwhetu Pā at the mouth of Te Awa Kairangi with smaller pā and kainga used mainly as site for fishing at the appropriate time of the year.

The harbour was used extensively for travel, and the freshwater sources of the harbour were well known and highly prized by Taranaki Whānui and European traders alike.

The harbour is also of important historical significance, a portion of the Treaty of Waitangi was signed at Port Nicholson by the harbour in April 1840[7].

Wainuiomata

The Wainuiomata catchment is made of many parts. The river originates in the Remutaka ranges, and flows through several forested streams, then joining with a number of smaller rural streams that flow through primarily pastoral land, as well a stream flowing through urban Wainuiomata (Black Creek), before entering the ocean at Wellington's south coast.

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7 Port Nicholson, 29 April 1840 | NZ History, New Zealand history online

Its headwaters in the Remutaka Ranges are considered a source of mauri. The upper reaches of the river are recognised for its abundance of taonga species, including native vegetation and rongoā, such as titoki, makomako, manamana, kawakawa and rangiora.

The small, forested streams of the Wainuiomata and its tributaries, such as Catchpool Stream, are wai tapu, which are sacred places where rituals and ceremonies were practiced by Mana Whenua. The water is wai matua o tūāpapa (virgin water) and tohi (baptism) and cultural immersion take place here. The Wainuiomata River and George Creek are Wai Maori (fresh drinking water sources), both places in which surface water is abstracted for community water supply.

The Wainuiomata River is also valued for its Māori customary and recreational uses. It supports a variety of activities, such as te hī ika (line fishing), te haoika (netting), te hopu tuna (taking eels) and kaukau (swimming).

The mouth of the Wainuiomata River and foreshore are sites of significance to Taranaki Whānui, in addition to being key mahinga kai sites, the estuary of the river contains habitat for native or migratory fish, native birds which are all considered taonga for Mana Whenua.

3.3.3 Te Moana o Raukawa

Ngāti Toa and Taranaki Whānui have a deep connection to the waters of Te Moana o Raukawa, which is considered a Taonga for both iwi due to the immense historical and cultural significance as well as the abundant source of food and other resources. The moana is also significant for the strategic and economic advantages it provides to iwi.

Crown's Statutory Acknowledgement identifies the Taranaki Whānui's coastal marine area extends in the east from the settlement of Mukamukaiti in Palliser Bay. The area proceeds along that coastline towards Turakirae. The moana forms part of Taranaki Whānui's identity and serves as a highway between the Te Ātiawa/ Taranaki Whānui and Te Ātiawa takiwā of Totaranui/ Tory Channel.

Raukawa Moana, including the south and west coast of wellington, is the primary customary fishing resource for Taranaki Whānui. The kaitiaki role for Taranaki Whānui is extensive in this area. Commercial fishing interests of the Iwi based on customary rights are extensive in Raukawa Moana. The Moana is especially known for kōura, pāua, kina, hapuku and many other finfish and serves as a migratory route for whales. Numerous sites of significance for Taranaki Whānui are located along the coast of Te Moana o Raukawa, pā and kāinga were established along the coastline, most of these settlements include urupā, and extensive gardens on adjacent land.

The Ngāti Toa, which share Mana Whenua with Taranaki Whānui over the area from Turakirae to Pipinui point, considered the moana o Raukawa integral to their identity. This is reflected in the Crown's Statutory Acknowledgement, which identifies that Te Moana o Raukawa is of highest significance to Ngāti Toa, holding great traditional and spiritual significance, having been a crucial political and economic asset, an important means of transport, and a rich source of various resources.

The importance and value of Te Moana o Raukawa also stem from its strong connections to the earliest Polynesian explorers, Maui and Kupe, with many place names associated with their stories.

3.4 Contaminant loads in stormwater

3.4.1 Sediment loads

Sediment loads in stormwater runoff from urban areas in Wellington and Porirua cities are relatively low especially when compared with the sediment load from the Hutt River and the Horokiri, Pauatahanui and Porirua streams (Table 3-3, Table 3-4, and Table 3-5). There is limited ongoing green-field development in Wellington City and hence little bare soil, which is the major source of fine sediments in urban areas (Jayaratne et al., 2015). It is noted that construction related sediment discharges are excluded from the NRP definition of stormwater and are not within the scope of the current consent application. This is particularly relevant for the Pauatahanui Inlet where recent construction activities have caused a large increase in sediment loads, while the input from urban stormwater in the Pauatahanui Inlet catchment is negligible (refer to Section 6.8.2).

The Hutt River catchment provides by far the largest sediment load to Wellington Harbour. If this load were to be equally distributed and settled over the whole harbour, it would give a deposition rate of about 1mm/year (for 85 km^2 harbour). However, it is likely that a high proportion of the Hutt River load leaves the harbour during northerly winds (Capacity, 2014). The Porirua Stream provides the largest sediment load to the Onepoto Arm of Porirua Harbour, while the Horokiri, Kakaho and Pauatahanui streams provide relatively large sediment loads to the Pauatahanui Arm.

Table 3-3: Sediment load estimates from storm event monitoring up to 2014 (Capacity 2014)

Catchment	Area (ha)	Annual sediment load (t/year)	Catchment yield (tonnes/ha/year)
Hutt River	61,500	132,000	2.14
Kaiwharawhara Stream	1,680	1,300	0.77
Ngauranga Stream	920	600	0.65
Wellington Harbour urban areas (Lambton Harbour, Kaiwharawhara, North Coast, Evans Bay)	5,650	2,200	0.39

Table 3-4: Sediment load estimates from storm event monitoring 2020 to 2022 (WWL 2022)

Catchment	Area (ha)	Annual sediment load (t/year)	Catchment yield (tonnes/ha/year)
Lambton - Southern CBD	823	558	0.68
Porirua – Porirua Stream (inc. Kenepuru Stream)	5,374	15,100	2.80
Porirua - CBD at Semple Street	167	94	0.56

Table 3-5: Estimated sediment loads and calculated yields by sub catchment for the Porirua Harbour catchment (data from Green, Stevens, & Oliver, 2014)

Catchment	Area (ha)	Annual sediment load (t/year)	Catchment yield (t/ha/year)
Camborne Stream	25	30	1.20
Kakaho Stream	1,246	2,306	1.85
No. 2 Stream	39	56	1.44
Horokiri Stream	3,306	7,131	2.16
Ration Stream	680	2,666	3.92
Collins Stream	63	112	1.77
Pauatahanui Stream	4,168	9,252	2.22
Duck Creek	1030	2,694	2.61
Browns Stream	135	431	3.19
Subtotal Pauatahanui	*10,692*	*24,678*	*2.30*
Papakowhai north	63	49	0.78
Papakowhai south	28	22	0.79

Catchment	Area (ha)	Annual sediment load (t/year)	Catchment yield (t/ha/year)
Aotea Lagoon	42	223	5.3
Okowai Road	52	132	2.54
Kenepuru Stream	1,266	2,257	1.78
Porirua Stream	4,108	8,709	2.12
Semple Street Stream	167	124	0.74
Takauwhaia Stream	347	343	0.99
No 13 Stream Titahi	101	99	0.98
No 14 Stream Onepoto	111	95	0.86
No 15 Stream Te Onepoto	98	146	1.48
Subtotal Onepoto	*6,376*	*12,199*	*1.91*
Overall Total	**17,068**	**36,877**	**2.16**

3.4.2 Heavy metals and PAH Loads

Stormwater loads of zinc (Zn), copper (Cu), lead (Pb) and polycyclic aromatic hydrocarbons (PAH) were calculated for Wellington urban stormwater catchments from event mean concentrations (EMC's) and estimated annual stormwater runoff volumes as part of Wellington's Stage One ICMP programme (Diffuse Sources, 2014; Capacity, 2014; and Jayaratne et al. 2015). The results are summarised in Table 3-6.

More recently, storm event monitoring conducted under the SMP at Porirua CBD, Porirua Stream, and the south Lambton catchment in Wellington CBD has produced EMC's and annual load estimates for a range of contaminants. Annual metal loads calculated from 4 to 6 storm events per site are summarised in Table 3-7. Within both the Wellington and Porirua catchments the metal loads are strongly correlated with impervious area, increasing as the area of paved hard surfaces in the urban area increases (i.e., most of the variation in metal loads is attributed to differences in impervious area). Catchments with the largest impervious area (Porirua, Lambton and Evans Bay) generate the greatest copper and zinc loads. Catchment yields of copper and zinc (kg/ha/year) were highest for the CBD areas of Lambton and Porirua.

Table 3-6: Estimated contaminant loads in stormwater runoff from Wellington urban catchments (data from Diffuse Sources Ltd, 2016)

	Total area (km^2)	Impervious area (km^2)	PAH (g/yr)	Lead (kg/yr)	Copper (kg/yr)	Zinc (kg/yr)	Zinc yield ($kg/km^2/yr$)
Owhiro	9.7	0.58	7.1	19.4	27.1	235	24
Island/Houghton	6.0	1.02	11.9	33	44.1	417	70
Lyall Bay	2.8	1.36	8.1	14.1	27.1	224	80
East Coast	2.9	0.58	4.5	12.7	16.9	162	56
Evans Bay	9.5	2.38	20.2	51.9	75.5	683	73
Lambton	13.7	3.56	66.3	168.4	238.2	2055	150
Kaiwharawhara	16.6	1.66	16	46.6	57.9	597	36
North Harbour	15.8	2.37	27.4	75.4	162.5	937	59

Table 3-7: Estimated metal loads from storm event monitoring, 2020 to 2022 (WWL 2022)

	Total area (km^2)	Impervious area (km^2)	Chromium (kg/yr)	Copper (kg/yr)	Lead (kg/yr)	Nickel (kg/yr)	Zinc (kg/yr)	Zinc yield ($kg/km^2/yr$)
Lambton – Southern CBD	8.23	4.0	30	123	93	22	1578	192
Porirua – Porirua Stream	55.9	15.4	318	518	561	231	4615	83
Porirua - Semple St	1.67	0.33	10	26	10	4	447	268

3.4.3 Nutrient Loads

The results of SMP storm event monitoring from 2020 to 2022 indicates that nutrient loads were higher in the Porirua Stream catchment, which includes a significant area of grazing pasture, compared with the purely urban CBD areas of Lambton and Semple Street (Table 3-7).

Table 3-8: Estimated nutrient loads from storm event monitoring, 2020 to 2022 (WWL 2022)

	Ammonia-N (t/yr)	Nitrate-N (t/yr)	TN (t/yr)	DRP (t/yr)	TP (t/yr)	DOC (t/yr)	TN yield ($t/km^2/yr$)
Lambton – Southern CBD	0.29	8.5	14.1	0.66	2.7	34	0.13
Porirua – Porirua Stream	0.36	39.5	89.4	0.74	11.8	189	1.60
Porirua - Semple St	0.87	0.93	3.4	0.15	0.56	8.5	0.34

4 Current state of receiving environments

This section provides a description of the existing environment in each of the 35 sub-catchments listed in section 3. The state of the environment is influenced by multiple contaminant sources and stressors, one of which is the discharge of stormwater from local authority stormwater networks.

The effects of stormwater discharges from local authority stormwater networks on the receiving environment are assessed in Section 6.

4.1 Karori sub-catchment – Wellington

4.1.1 Description of Existing Environment

Karori Stream is a 3rd order[8] watercourse that flows approximately 10 kilometres from its headwaters in urban Karori to the coastal marine area near Tongue Point on Wellington's south coast (Figure 4-1). The stream has a total catchment area of 30.9 square kilometres, a maximum elevation of 460m asl, and an estimated mean flow of 1200 L/s[9].

The upper stream is urbanised with an extensive stormwater network largely replacing natural headwater streams. Urban Karori is predominantly residential, but with significant commercial and community infrastructure (e.g., supermarkets, shops, schools, swimming pool, service stations, restaurants, and bars.). Closed landfills are located at Futuna Retreat (Friend Street) and Ben Burn Park, but none are currently operating. SLUR sites in the Karori catchment are shown in Figure 4-2 The stormwater network in urban Karori includes 125 outlets to tributaries of Karori Stream.

4.1.2 Current state summary

EMP monitoring is conducted at three freshwater stream sites in the Karori catchment (shown in Figure 4-1). The results of monitoring are attached in Appendices A to S while the current state is summarised below and in Table 4-1:

- Faecal indicator bacteria concentrations were elevated at all three stream sites, none of which achieved objective O18.
- Nutrient concentrations were significantly elevated in the Karori Stream.
- The median concentrations of copper and zinc exceeded the ANZG (2018) default guideline value (DGV) at all three stream sites, indicating that NRP objective 19 is not met for copper or zinc toxicity.
- Karori Stream sediment concentrations of lead and zinc exceeded ANZG (2018) DGVs for sediment quality in aquatic ecosystems.
- The streambed periphyton cover achieved NRP objective O19.
- The macroinvertebrate communities of Karori Stream downstream of the urban edge was degraded and did not meet NRP objective O19.

There is, nevertheless, evidence of improved biodiversity lower in the catchment, including a relatively diverse fish population.

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[8] Strahler stream order

[9] https://shiny.niwa.co.nz/nzrivermaps/

Table 4-1: Current state summary based on monthly sampling (unless stated otherwise)

Water quality	Karori Stream RS18	Karori Stream KAFW1	Karori Stream KAFW2
Observed scums or foams (% of inspections)	No data	<5%	<5%
Observed oils or grease films (% of inspections)	No data	<5%	<5%
Observed change in colour or clarity (% of inspections)	No data	10-30%	10-30%
E. coli (freshwater, NPS attribute state)	E	E	E
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting
Water temperature (Davies Colley et al. 2013)	A	No data	No data
Dissolved oxygen (NPS attribute state)	A	No data	No data
Dissolved reactive phosphorus (NPS attribute state)	D	No data	No data
Nitrate-N (nutrient, ANZG 2018)	Not meeting	No data	No data
Nitrate-N (toxicity NPS attribute state)	B	No data	No data
Ammonia-N (toxicity NPS attribute state)	B	No data	No data
Dissolved Cu (ANZG 2018)	Not meeting	Not meeting	Not meeting
Dissolved Zn (ANZG 2018)	Not meeting	Not meeting	Not meeting
Sediment quality			
Metals (ANZG 2018), one-off sampling under SMP	Not meeting for Pb or Zn	No data	No data
Total of reported PAH (ANZG 2018), one-off sampling under SMP	Meeting	No data	No data
Total DDT isomers (ANZG 2018), one-off sampling under SMP	Meeting	No data	No data
Ecology			
Periphyton (NRP O19)	Meeting	No data	No data
Macroinvertebrate community (NRP O19)	Not meeting	No data	No data
Freshwater fish community (NRP O19)	Meeting	No data	No data

4.1.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 is not achieved for faecal indicator bacteria (FIB) at sites within or immediately downstream of urban Karori.

The NRP biodiversity and aquatic ecosystem objective O19 is achieved for periphyton, indigenous fish, ammonia toxicity, and nitrate toxicity, but is not achieved for macroinvertebrate communities, zinc toxicity or copper toxicity.

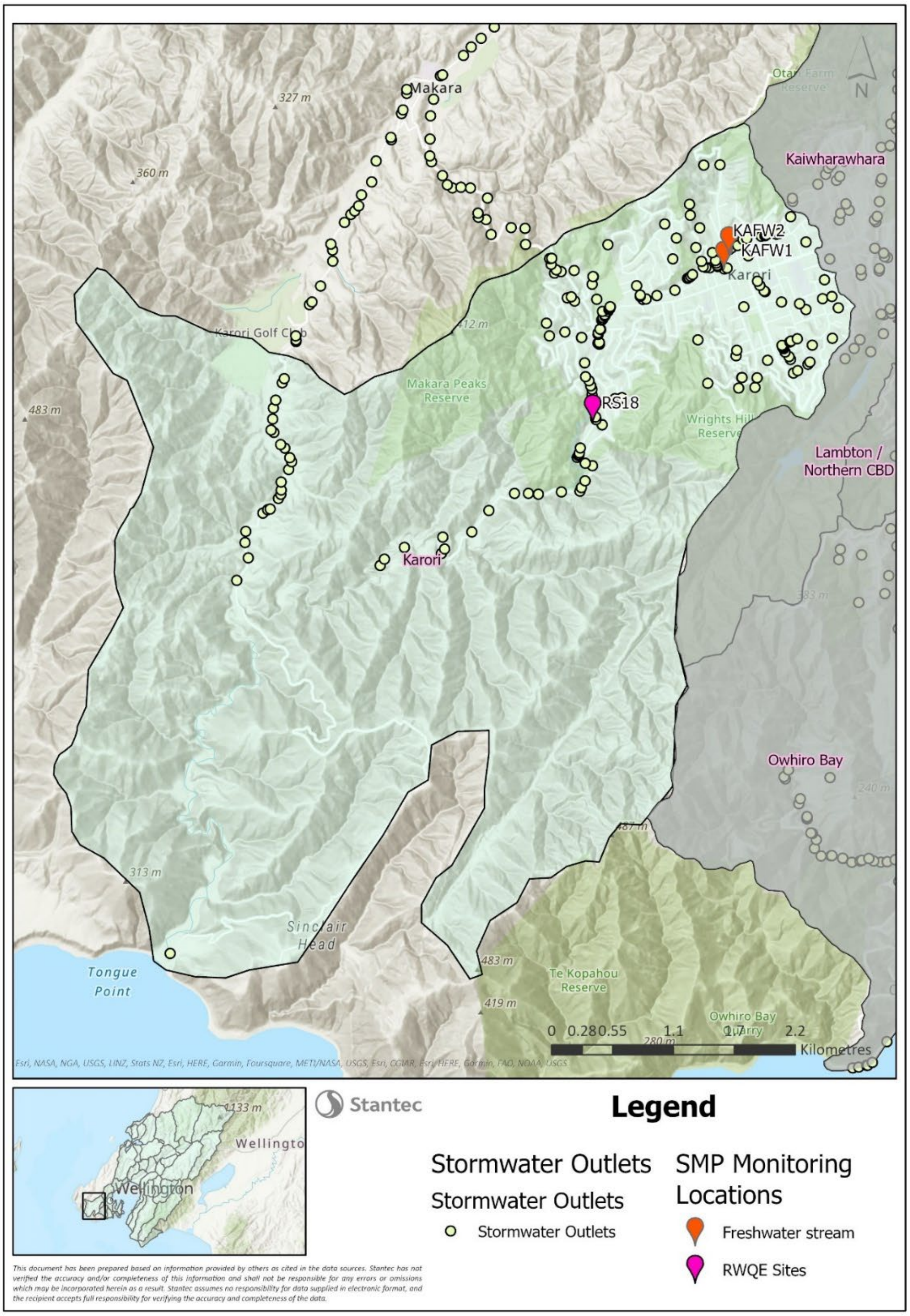


Figure 4-1: Karori Catchment stormwater outlets and SMP sites

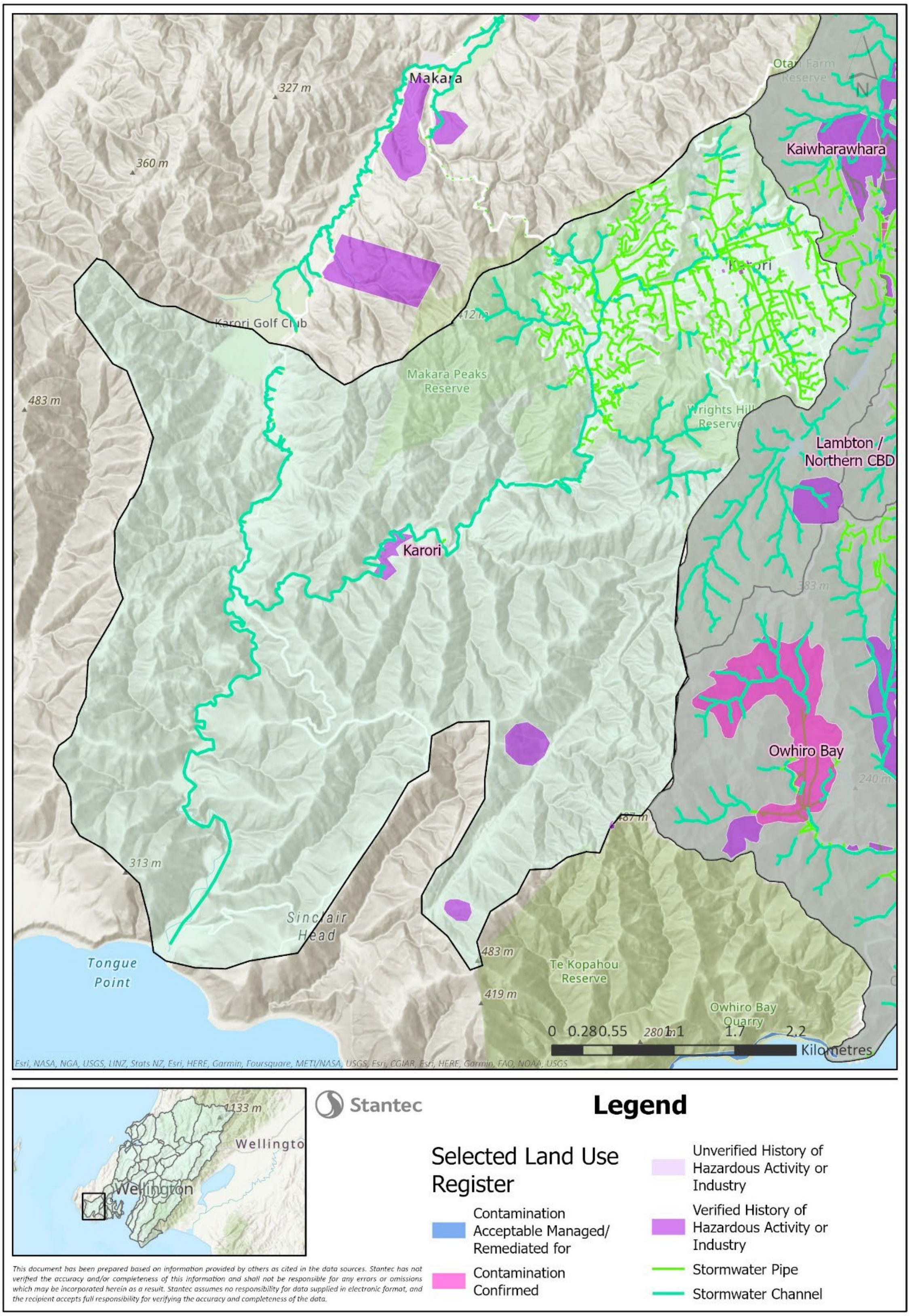


Figure 4-2: SLUR sites in Karori Catchment

4.2 Owhiro catchment

4.2.1 Description of Existing Environment

Owhiro Stream is a 3rd order watercourse which runs approximately 5 kilometres from its headwaters in urban Brooklyn to Owhiro Bay on Wellington's south coast. The stream has a total catchment area of 9.4 square kilometres with a maximum elevation of 400m above sea level, and an estimated mean flow of 240 L/s.

The Owhiro Stream drainage area is predominantly open space with scrubland and gorse land south of Polhill and east of Hawkins Hill, surrounding Southern Landfill. The eastern part of the catchment is largely residential. Industrial activity is clustered around Landfill Road while business properties are concentrated on Owhiro Road and Cleveland Road at Brooklyn. Owhiro Stream has three main tributaries draining Carey's Gully (occupied by Southern Landfill and C&D Landfill), Kowhai Park Gully (occupied by T&T Landfill) and urban Brooklyn (which is largely culverted). Most of the catchment (around 85%) is in gorse scrubland, with 7% urban, 4% pastoral, and 4% bare ground and landfill.

Three active landfill operations are present in the catchment. The Southern landfill is operated by Wellington City Council. It accepts general and green waste and includes a recycling centre. The T&T landfill and the C&D landfill are privately owned, and both operate as "clean fill" operations. The Southern Landfill and T&T landfill occupy a significant area of individual gullies/valley floors and have resulted in the loss of stream habitat and barriers to fish migration. The T & T Landfill has caused water quality problems in the past and is currently working to remedy that situation. SLUR sites are shown in Figure 4-4.

Owhiro Bay lies on the exposed south coast of Wellington, bounded by rocky headlands on either side, while Island Bay, Houghton Bay and Princess Bay lie successively further to the east. Together these areas constitute most of the Taputeranga Marine Reserve.

Owhiro Bay has a predominantly gravel upper beach with a firm sand and gravel lower shore, with little vegetation adjacent to the beach. Visual "aesthetics" are generally good, although there have been intermittent reports of suspended solids and biological growths in Owhiro Stream, which has been mostly associated with landfills in the catchment. The stream forms a small shallow lagoon as it crosses the beach. Discoloration is observed in the beach water after rain. Owhiro Bay is the closest south coast beach to the central city. The sheltered Owhiro Bay boat ramp and car park is on the eastern side of the bay. The area is popular for boating, bathing and sunbathing. A project to restore and protect Owhiro Bay Stream, the only un-piped city stream flowing to the south coast, has been set up by The Friends of Owhiro Stream. The community group has planted more than 8,000 native trees.

4.2.2 Current state summary

EMP monitoring is conducted at three freshwater stream sites and one coastal water in the Owhiro catchment (shown in Figure 4-2). The results of monitoring are attached in Appendices A to S while the current state is summarised below and in Table 4-2:

- Faecal indicator bacteria concentrations were elevated at all three stream sites, and one coastal water site, none of which achieved objective O18.
- Nutrient concentrations were significantly elevated in Owhiro Stream.
- The median concentration of copper was below the ANZG (2018) DGV while the 95th-percentile value exceeded it, indicating that objective O19 is partially met for copper toxicity.
- The median and 95th percentile concentrations of zinc were below the ANZG (2018) DGV indicating that objective O 19 is fully met for zinc toxicity.

- Owhiro Stream sediment concentrations of zinc exceeded ANZG (2018) DGVs for sediments.
- The periphyton and macroinvertebrate communities of Owhiro Stream downstream were significantly degraded and did not meet NRP objective O19.

The stream has, nevertheless retained a moderately diverse fish population.

Table 4-2: Current state summary

Water quality	Owhiro Catchment			
	Owhiro Stream RS64	Owhiro Stream OWFW1	Owhiro Stream OWFW2	Owhiro Bay OWCW1
Observed scums or foams (% of inspections)	>30%	>30%	>30%	<5
Observed oils or grease films	5-10%	5-10%	5-10%	<5
Observed change in colour or clarity	>30%	>30%	>30%	<5
E. coli (freshwater, NPS attribute state)	E	E	E	not applicable
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting	not applicable
Enterococci (coastal water, NRP O18 – 95%ile <500)	not applicable	not applicable	not applicable	Not meeting
Water temperature (Davies Colley et al. 2013)	A	no data	no data	no data
Dissolved oxygen (NPS attribute state)	A	no data	no data	no data
Dissolved reactive phosphorus (NPS attribute state)	D	no data	no data	no data
Nitrate-N (nutrient, ANZG 2018)	Not meeting	no data	no data	no data
Nitrate-N (toxicity NPS attribute state)	B	no data	no data	no data
Ammonia-N (toxicity NPS attribute state)	B	no data	no data	no data
Dissolved Cu (ANZG 2018)	Partially meeting	no data	no data	no data
Dissolved Zn (ANZG 2018)	meeting	no data	no data	no data
Sediment quality				
Metals (ANZG 2018)	Partially meeting	no data	no data	no data
Total of reported PAH (ANZG 2018)	Meeting	no data	no data	no data
Total DDT isomers (ANZG 2018)	Meeting	no data	no data	no data
Ecology				
Periphyton (NRP O19)	Not meeting	no data	no data	no data
Macroinvertebrate community (NRP O19)	Not meeting	no data	no data	no data
Freshwater fish community (NRP O19)	Meeting	not applicable	not applicable	not applicable
Marine ecology (NRP O19)	not applicable	not applicable	not applicable	Meeting

4.2.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 is not achieved for faecal indicator bacteria within Owhiro Stream or Owhiro Bay.

The NRP biodiversity and aquatic ecosystem objective O19 is achieved in Owhiro Stream for indigenous fish, ammonia toxicity, nitrate toxicity, zinc toxicity and is partially met for copper toxicity. However, objective O19 is not achieved for periphyton or macroinvertebrate communities.

An assessment against NRP objective O19 for the marine environment is provided in Table 4-3.

Table 4-3: Assessment of Owhiro Bay against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	A range of measures are monitored by the Department of Conservation (DoC) to determine ecosystem health within the Taputeranga Marine Reserve. The (DoC) 2016 Marine Reserve Report Card identifies the landfills within Owhiro Stream catchment and the closed Houghton Bay landfill site as potential sources of contamination. It notes however that diverse habitats ranging from offshore rocky reefs to rock pools support a wide variety of marine life. Kelp forests provide places for rock lobster, paua and kina to live, as well as many fish. Monitoring has shown that by 2016 blue cod and rock lobster had become more plentiful and larger inside the marine reserve than outside it. On the other hand, the unwanted Asian kelp *Unidaria pinnatifida* was well established in the reserve. The overall assessment is that the objectives in NRP Table 3.8 are very likely achieved. There are, however, ongoing water quality issues associated with contaminant inputs from Owhiro Stream and stormwater outlets at Island Bay and Houghton Bay.			

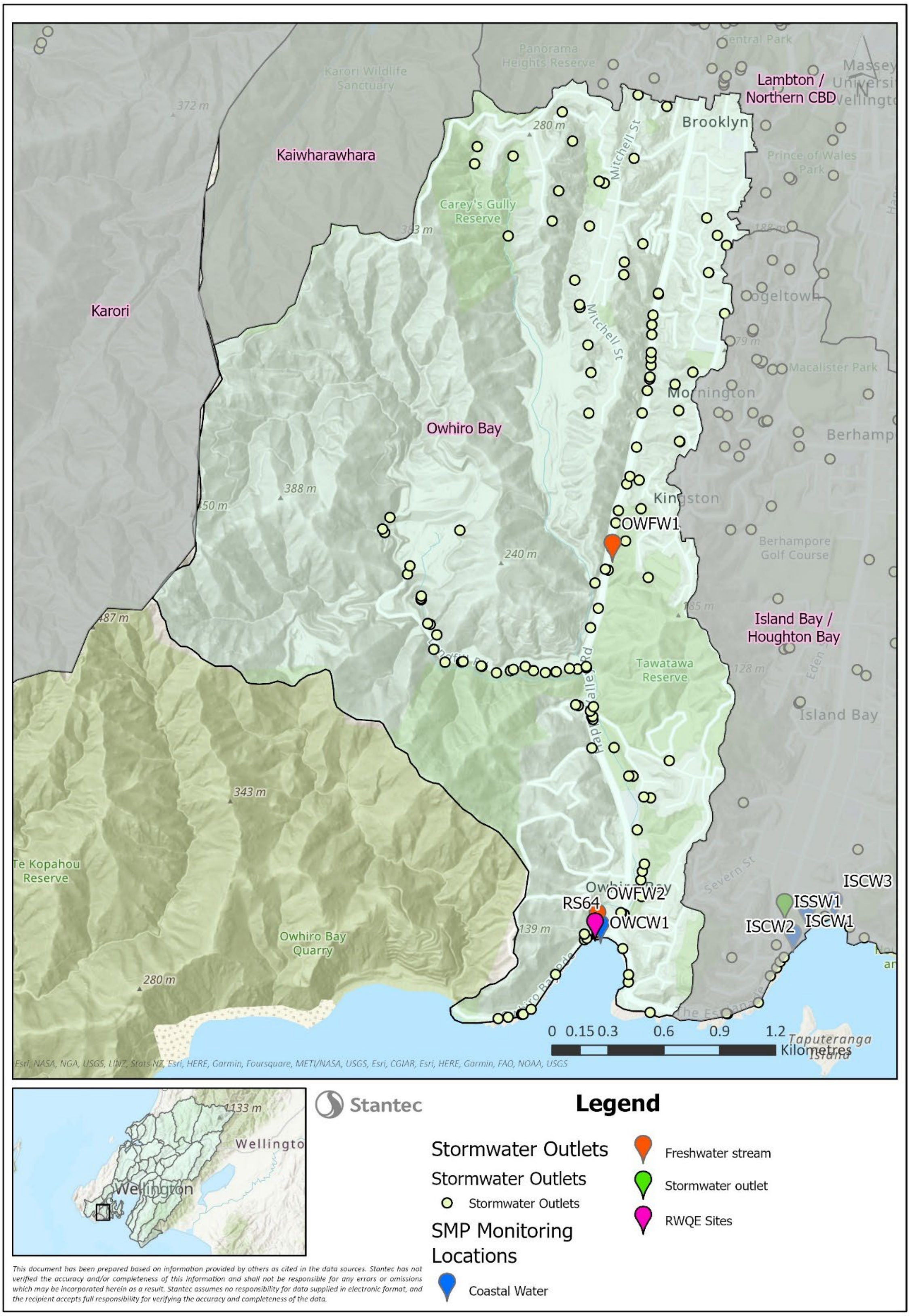


Figure 4-3: Owhiro Catchment stormwater outlets and SMP sites

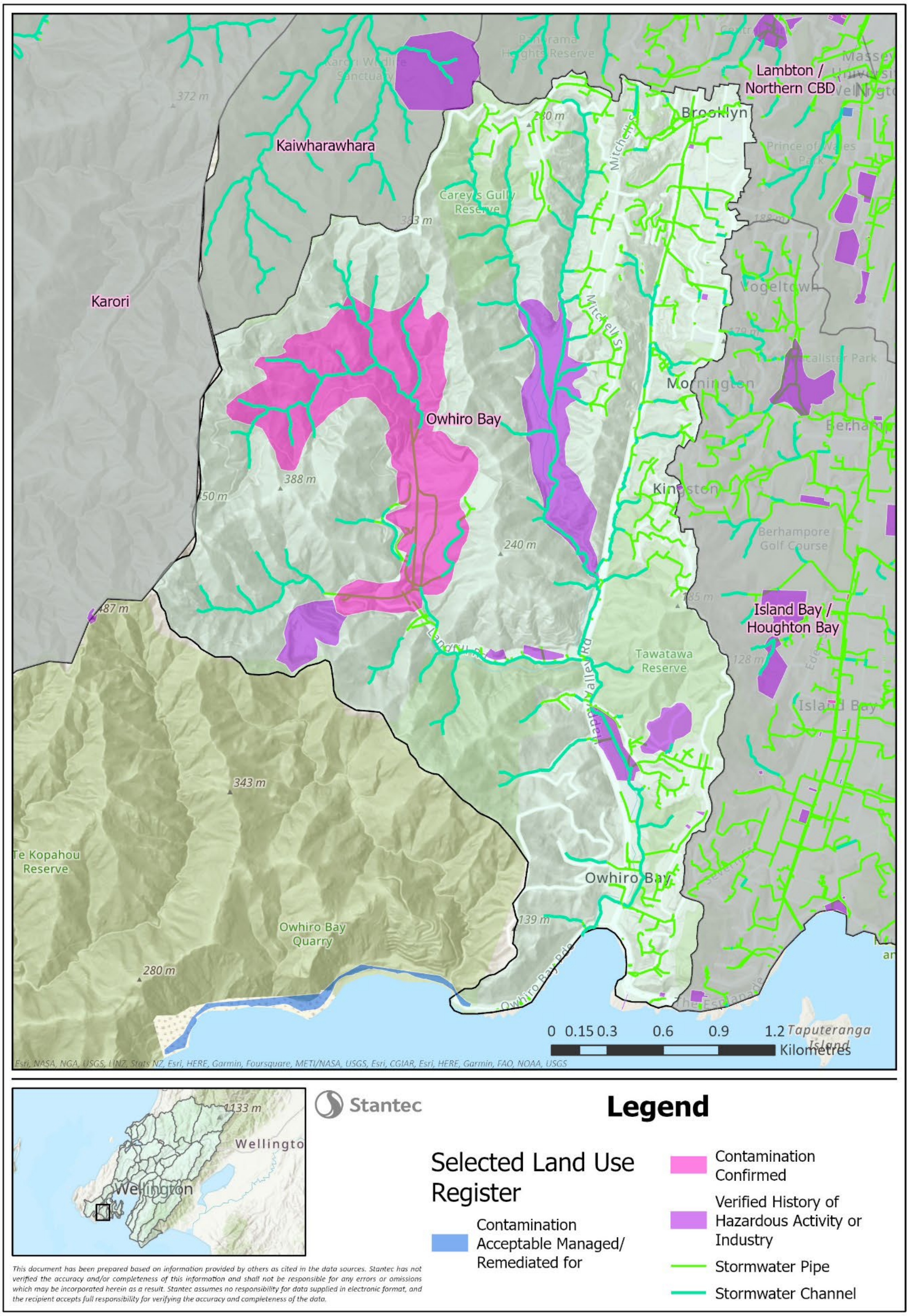


Figure 4-4: Owhiro Catchment SLUR sites

4.3 Island and Houghton bays

4.3.1 Description of Existing Environment

Island Bay has predominantly firm sand, with a small area of rock and gravel near the centre of the beach. Taputeranga Island sites in the middle of the bay, 200m from the beach. Island Bay beach is very popular for boating, bathing, sunbathing, and walking. The Island Bay catchment is heavily urbanised. The stream system that once ran through the area has been completely replaced by a piped stormwater network, with several stormwater outfalls discharging directly into the bay. These stormwater outlets are an intermittent source of poor water quality, especially in wet weather.

Houghton Bay is predominantly a firm sand beach characterised by a steep back dune area extending up to the road. It has a more exposed aspect and is subject to a high energy wave environment. Consequently, it is a popular surf break. A closed landfill in Houghton Bay is an intermittent source of poor water quality in Houghton Bay; leachate from the landfill is discharged into the sewer, but following periods of heavy rain the system can become overwhelmed and overflows into the stormwater drain resulting in the discharge of a highly conspicuous discharge plume in Houghton Bay. (Note, the intermittent discharge of leachate from the landfill to the stormwater system and then Houghton Bay is outside the scope of the current consent and will be consented separately.) Princess Bay is a sheltered beach popular for swimming, sunbathing and picnics.

Island Bay, Houghton Bay and Princess Bay lie within the Taputeranga Marine Reserve.

4.3.2 Current state summary

EMP monitoring is conducted at at four coastal water sites and two stormwater sites in the Island/Houghton catchment (Figure 4-5). The results of water quality, sediment quality, periphyton, macroinvertebrate, and fish community monitoring are attached in Appendices A to Q while the current state is summarised in Table 4-4.

Monitoring results show elevated concentrations of faecal indicator bacteria in coastal water adjacent to Derwent Street, but objective O18 is achieved at all other coastal water sites. The Houghton Bay Culvert was frequently observed to discharge scums, foams, oil/grease films and to cause a change in colour or clarity in receiving waters and is commonly a source of objectionable odours. These effects are at least partly associated with leachate from the closed landfill at Houghton Bay, which normally discharges to the sewer but also overflows into the stormwater system. Concentrations of copper and zinc were elevated in the Houghton Bay and Island Bay culverts however in most cases a 10-fold dilution in receiving waters would be sufficient to achieve ANZG (2018) DGVs.

Table 4-4: Current state summary

	Island, Houghton, Princess Bays					
Water quality	Island Bay Derwent ISCW1	Island Bay Reef ISCW2	Island Bay Surf Club ISCW3	Island Bay Culvert ISSW1	Houghton SW culvert HOSW1	Princess Bay HOCW1
Observed scums or foams (% of inspections)	5 – 10%	<5%	<5%	5 – 10%	>30%	<5%
Observed oils or grease films	<5%	<5%	<5%	5 – 10%	>30%	<5%
Observed change in colour or clarity	<5%	<5%	<5%	5 – 10%	>30%	<5%

Water quality	Island, Houghton, Princess Bays					
	Island Bay Derwent ISCW1	Island Bay Reef ISCW2	Island Bay Surf Club ISCW3	Island Bay Culvert ISSW1	Houghton SW culvert HOSW1	Princess Bay HOCW1
Enterococci (coastal water, NRP O18 – 95%ile <500)	Not meeting	Meeting	Meeting	No data	no data	Meeting
Dissolved Cu (ANZG 2018)	no data	No data	no data	Not* meeting	Not* meeting	no data
Dissolved Zn (ANZG 2018)	no data	No data	no data	Not* meeting	Not* meeting	no data
Ecology						
Marine ecology (NRP O19)	meeting	No data	No data	No data	meeting	meeting

*Note, Cu and Zn are elevated in stormwater but may meet ANZG (2018) receiving water standards after reasonable mixing

4.3.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 is achieved in coastal waters of Island Bay and Princess Bay. Table 4-5 provides an assessment the Island/Houghton Bay coast of against NRP Objective O19.

Table 4-5: Assessment of Island/Houghton Bay against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	A range of measures are monitored by the Department of Conservation to determine ecosystem health within the Taputeranga Marine Reserve. The 2016 Marine Reserve Report Card identifies the landfills within Owhiro Stream catchment and the closed Houghton Bay landfill site as potential sources of contamination. It notes however that diverse habitats ranging from offshore rocky reefs to rock pools support a wide variety of marine life. Kelp forests provide places for rock lobster, paua and kina to live, as well as many fish. Monitoring has shown that by 2016 blue cod and rock lobster had become more plentiful and larger inside the marine reserve than outside it. On the other hand, the unwanted Asian kelp *Unidaria pinnatifida* was well established in the reserve. The overall assessment is that the objectives in NRP Table 3.8 are very likely achieved. There are, however, ongoing water quality issues associated with contaminant inputs from Owhiro Stream and stormwater outlets at Island Bay and Houghton Bay.			

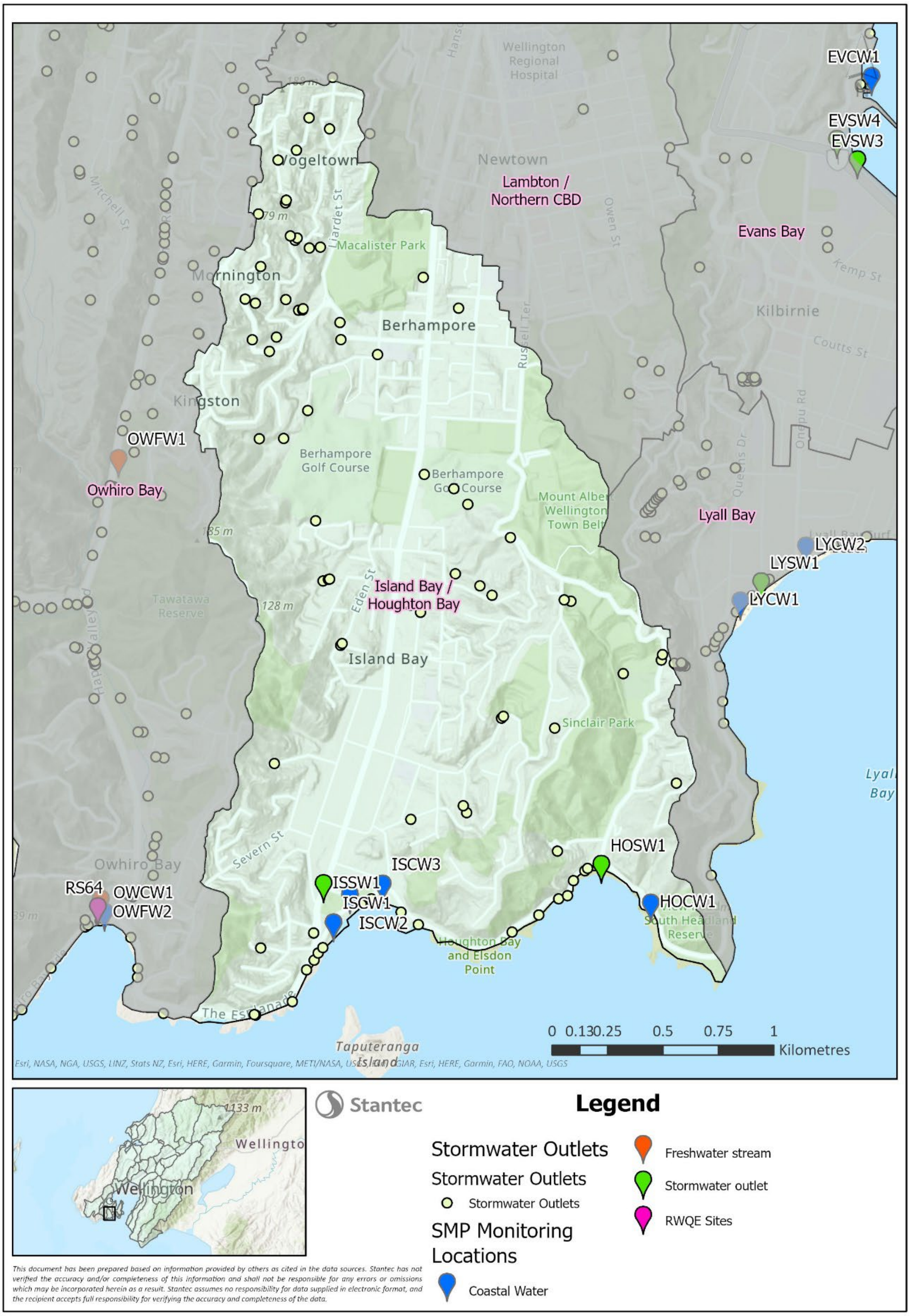


Figure 4-5: Island and Houghton Bay catchments

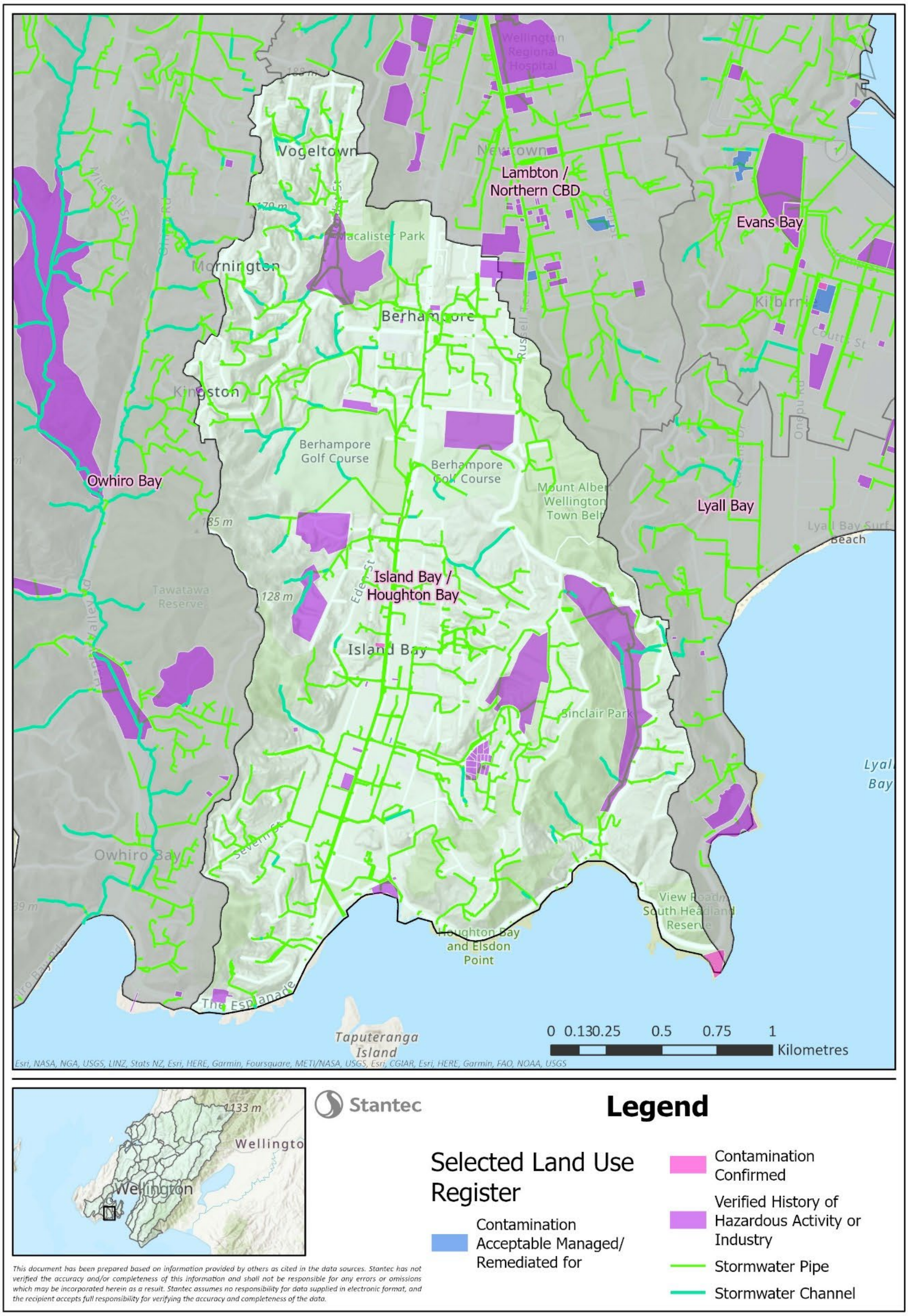


Figure 4-6: Island/Houghton Bay SLUR sites

4.4 Lyall Bay

4.4.1 Description of Existing Environment

Lyall Bay is a semi-circular, large open bay on the Wellington south coast. The Bay is situated between the rocky headlands of Te Raekaihau to the west and Hue te Taka (Moa Point) to the east. The Bay shoals progressively from about 28 m in outer Lyall Bay to the shoreline with steep slopes rising to ridge lines close to the headlands. The Bay is very exposed and can be subject to strong southerly swells and large high energy waves. Waves up to 4.7 m were recorded in September/October 2014 at the southern end of the runway and up to 6.1 m at the entrance to Lyall Bay (James, et al., 2016). Land use in the catchment is predominantly residential with light industry/ commercial as well as the Wellington Airport. The Bay receives stormwater from the Lyall Bay catchment including the area around Wellington Airport and from the Moa Point Wastewater Treatment Plant. Secondary treated ultra-violet disinfected wastewater from this plant is discharged through a 1.87 km pipe to an outfall diffuser just beyond the entrance to Lyall Bay.

Lyall Bay is located outside of Taputeranga Marine Reserve, immediately to the east. It is popular for a wide range of recreational activities including swimming, snorkelling, driving, surfing, wind surfing, kit surfing, surf lifesaving activities, walking, picnicking and sunbathing.

4.4.2 Current State summary

EMP monitoring in the Lyall Bay catchment is conducted at two coastal water sites and two stormwater sites (Figure 4-7). No significant freshwater streams remain in the catchment. The results of coastal water and stormwater monitoring are attached in Appendices A to Q while the current state is summarised in Table 4-6.

Monitoring results show faecal indicator bacteria in coastal water at Lyall Bay are relatively low at most times and that objective O18 is meet. Concentrations of copper and zinc were elevated in the Lyall Bay east and west culverts, however in most cases a 10-fold dilution in receiving waters would be sufficient to achieve ANZG (2018) DGVs.

Table 4-6: Current state summary

Water quality	Lyall Bay West Culvert LYSW1	Lyall Bay East Culvert LYSW2	Lyall Bay Queens LYCW1	Lyall Bay Onepu LYCW2
Observed scums or foams (% of inspections)	10 – 30%	<5%	10-30%	10 – 30%
Observed oils or grease films	<5%	5-10%%	<5%	<5%
Observed change in colour or clarity	10 – 30%	10 – 30%	<5%	<5%
Enterococci (coastal water, NRP O18 – 95%ile <500)	no data	no data	Meeting	Meeting
Dissolved Cu (ANZG 2018)	Not meeting	Not meeting	no data	no data
Dissolved Zn (ANZG 2018)	Not meeting	Not meeting	no data	no data
Ecology				
Marine ecology (NRP O19)	not applicable		Meeting	Meeting

4.4.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 is generally achieved in coastal waters at Lyall Bay. Table 4-7 provides an assessment the Island/Houghton Bay coast of against NRP coastal water Objective O19.

Table 4-7: Assessment of Lyall Bay against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	James et al. (2016) describes a relatively sparse benthic fauna in Lyall Bay which is consistent with the dynamic, exposed, highly mobile fine sand dominated habitat. Macro-algal species associated with rock reef habitat were common off the southern end of airport runway, while crusting and turfing red algae occurred intertidally along most transects except the one off the end of the runway. The transect off the end of the runway was dominated by fine-branched red algae. The authors described moderately diverse fish community in Lyall Bay including 27 species of reef fish, but none that are nationally threatened. Although James et al. (2016) did not specifically address Mahinga kai species, the assessment indicates that all four of the O19 objectives listed above are likely to be met.			

Figure 4-7: Lyall Bay Catchment

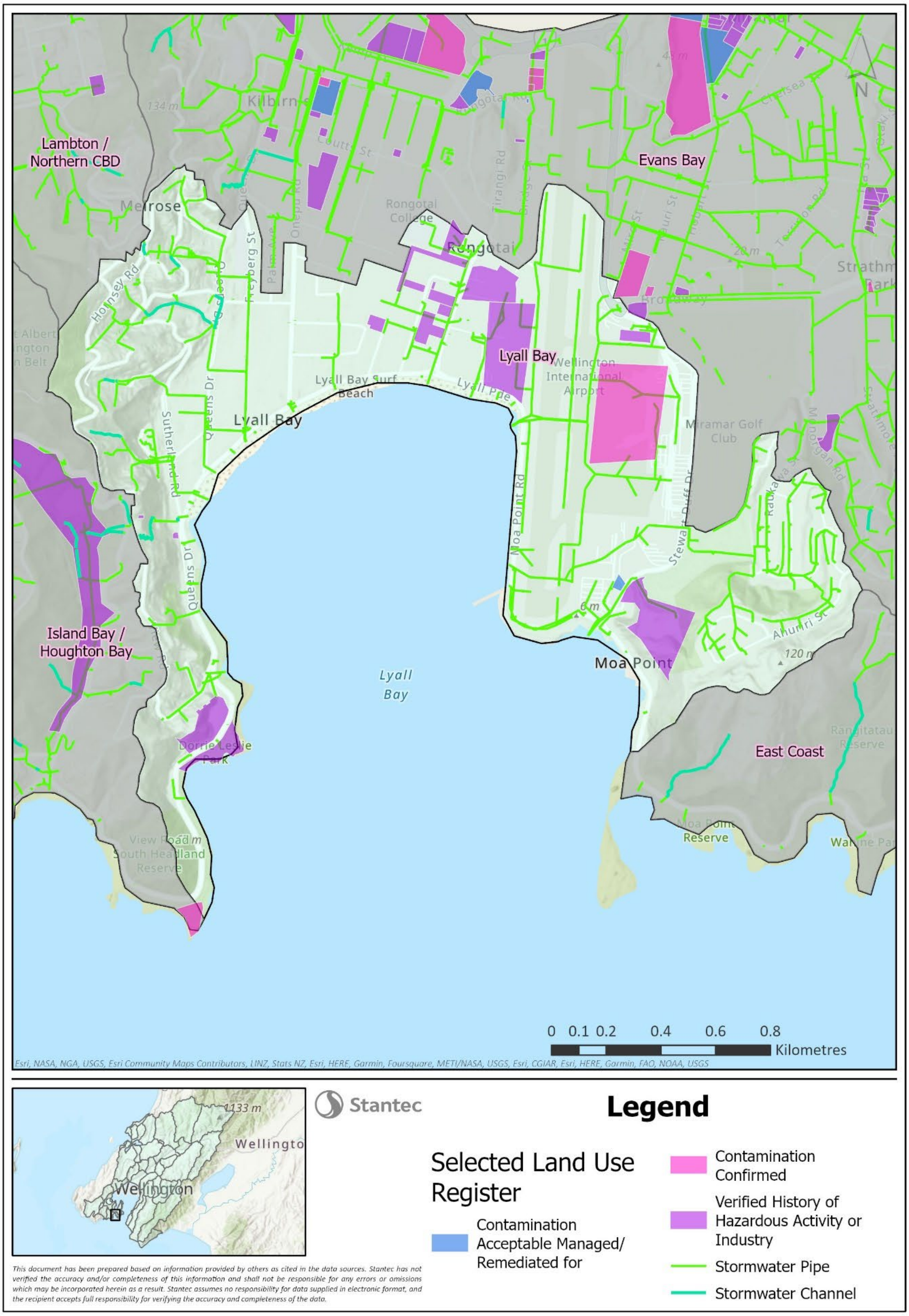


Figure 4-8: Lyall Bay SLUR sites

4.5 Miramar East coast

4.5.1 Description of Existing Environment

The East Coast catchment lies on the eastern side of the Miramar Peninsular, to the east of Wellington City. It includes Seatoun, a residential suburb with scattered small commercial areas. Seatoun Beach has approximately equal areas of gravel and sand; gravel dominant to the southeast and firm sand in the northwest by Worser Bay. To the north and south of Seatoun, most of the coast is open land, with through roads and small pockets of residential land use.

The Seatoun stormwater catchment does not form a single drainage area but rather a series of minor catchments, which have a limited stormwater collection system, or none at all. To the north and south, stormwater discharges through a series of small outfalls along the coast or in overland flow. The southern end of the Miramar Peninsula, from Hue te Taka Point to Point Dorset, consists of very exposed rocky reef, which is subject to extreme wave action and is characterised by dramatic geomorphology with many deep clefts and cuts in the rock (MWH, 2003). The Southeast Coast is suitable for walking, picnicking, watching ships enter and leave the harbour, and admiring the ocean views. Breaker Bay is a picturesque sandy cove and is part of the Oruaiti Reserve. Tracks lead from the beach to the escarpment, cliffs and ridgeline. The Eastern Walkway begins nearby and has excellent views of the harbour entrance and Pencarrow Head.

North of Point Dorset, from Seatoun to Scorching Bay, the coastline varies from rocky shore to sandy beaches. Worser Bay Beach is a large, sandy inner-harbour beach with views of the Orongorongo Range across the harbour, Steeple Rock and Seatoun Beach. In summer, its calm waters make it a popular destination for families, and it is also well- used by the local yacht club. A large area of sand dunes at the southern end of the beach planted with marram and pingao is an attractive feature of the beach. The northern end of the beach is the site of the Worser Bay Lifesaving Club (established in 1910) and the Worser Bay Boating Club (established in 1926). The bay was the site of a pilot station in the 1860s and was given its name after pilot James Heberley's frequent comment that the weather was getting 'worser'. Eventually the bay became known as old Worser's Bay (Diffuse Sources, 2014).

Scorching Bay Beach is a popular sandy inner-harbour bathing beach with a large, grassed area. It is sheltered from the northerly wind. It is a great place to swim, picnic, soak up the sun and watch ships entering and leaving the harbour. Other smaller cobble and pebble beach's include Kau Bay, Mahanga Bay and Karaka Bay. There are many walking opportunities around the coastal road and over Mt Crawford. Point Halswell is a popular dive spot.

4.5.2 Current state summary

Due to the small size of these stormwater catchments, the highly exposed character of the coastal area, and the consistently high coastal water quality reported by GWRC, no SMP water quality monitoring has been conducted in this area.

4.5.3 Assessment against NRP Objective O19

Table 4-8 provides an assessment of the Miramar Peninsula east coast against NRP Objective O19.

Table 4-8: Assessment of Miramar Peninsula east coast against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a	Fish communities are resilient, and their structure, composition and diversity are reflective of a good

		state of aquatic ecosystem health	healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	state of aquatic ecosystem health
Assessment	We have not sighted any marine ecology information relating specifically to Miramar east coastal waters. However, given the relatively small scale of the stormwater network it is unlikely that stormwater discharges would have a notable impact of ecosystem composition or function.			

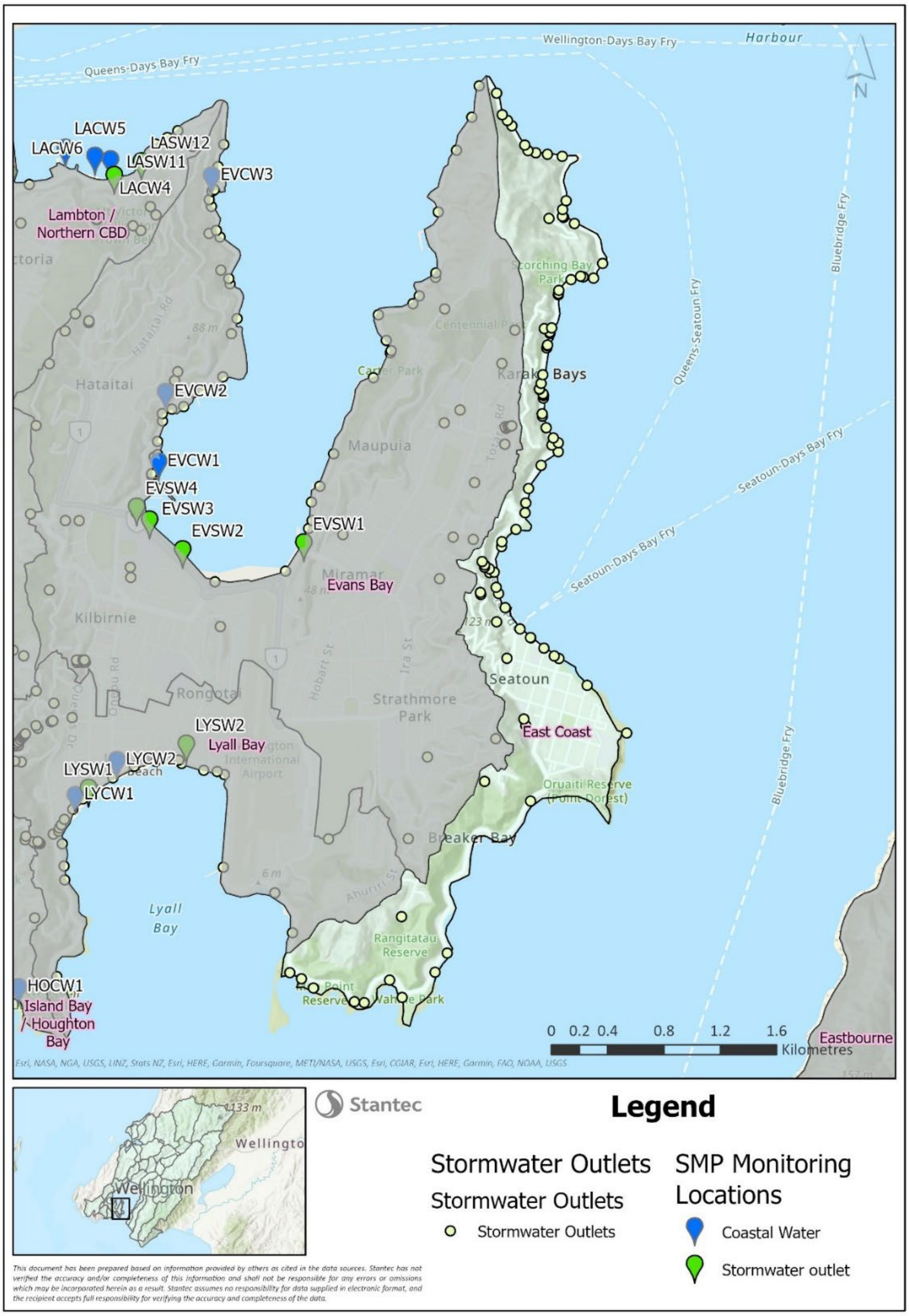


Figure 4-9: Miramar Peninsula East Cast

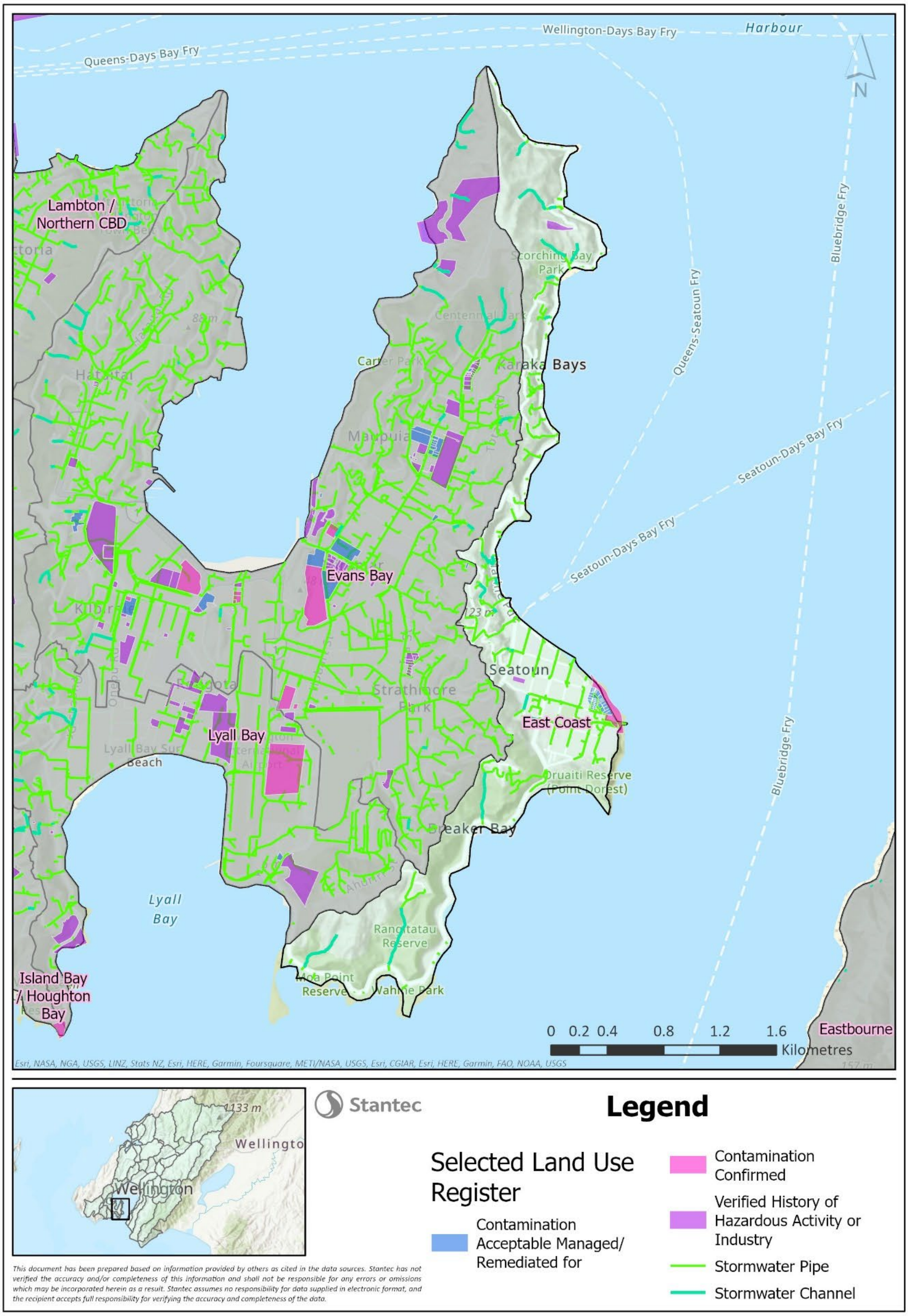


Figure 4-10: Miramar East Coast SLUR sites

4.6 Evans Bay

4.6.1 Description of Existing Environment

Evans Bay is a large, semi-exposed bay within Wellington Harbour. It stretches from Point Jerningham east of Oriental Bay, to Point Halswell below Mount Crawford and has an area of 4.5 km^2. Is a major amenity for Wellington for port and boating activities and for recreation. Evans Bay receives stormwater from the suburbs of Grafton, Hataitai, Kilbirnie, Rongotai, Miramar and Mt Crawford via 10 major stormwater outfalls and numerous smaller outlets. The combined stormwater catchment has an area of 8.52 km^2.

Amenity at the head of the bay is mostly related to boating and shipping, such as port activities, marina, boat launching and kayaking. Secondary contact recreation may occur through these activities and via wading in the shallow waters near the marina. Some passive recreation (walking, viewing) also occurs. In contrast, the outer half of the bay is used for recreational activities involving primary contact – swimming, kite and wind surfing, and scuba/snorkelling, as well as boating and fishing.

4.6.2 Current state summary

EMP monitoring in the Evans Bay catchment is conducted at three coastal water sites and four stormwater sites (shown in Figure 4-11). No significant freshwater streams remain in the catchment. The results of coastal water and stormwater monitoring are attached in Appendices A to Q while the current state is summarised in Table 4-9.

Monitoring results show that faecal indicator bacteria concentrations are relatively low at the three Evans Bay coastal water monitoring sites. Observations of oil and grease films and changes in colour and/or clarity were common at the Miramar and Hataitai culverts outlets but these effects were localised. Discharges from the stormwater culverts contained elevated concentrations of copper and zinc, however in most cases a 10-fold dilution in receiving waters would be sufficient to achieve ANZG (2018) default guideline values.

Several studies have measured chemical contamination in Evans Bay marine sediments. Very high levels of heavy metals (zinc, lead and copper) have been found within 50m Miramar and Kilbirnie outfalls (Pilloto, 1996; Tonkin & Taylor 1996; Bolton-Ritchie, 2003). The relatively sheltered water of Evans Bay allows discharged contaminants to settle, and dispersal processes (such as waves on the shore) are sufficiently weak to allow high levels to remain near the outfalls.

High concentrations of PAH and total petroleum hydrocarbons (TPH) found close to the Miramar outfall may have been partly due to runoff or groundwater contamination from a former gasworks site in Miramar. High levels of PAH have also been attributed to the historical use of coal tar (a by-product of gasworks) for roading adhesive (Ahrens & Olsen, 2007; Depree, 2010). As this material became abraded by road use, it could have been carried by stormwater to the bay. Spillage of petroleum products, perhaps associated with port activities, is also a potential issue.

GWRC's Wellington Harbour marine sediment quality investigations in 2020 include three sites (EB2, WH1B and WH2B) in Evans Bay. Sediments at site WH1B in eastern Evans Bay exceeded the ANZG (2018) DGV for mercury and lead and exceeded ARC amber (an early warning trigger) for copper and zinc. Sediments at WH2B at northern Evans Bay and EB2 in southern Evans Bay exceeded the ANZG (2018) DGV for mercury and ARC amber for lead (see Appendix R). It is likely that mercury and lead are legacy contaminants while copper and zinc continue to be discharged to the marine environment via stormwater runoff. The authors concluded that the high number of exceedances demonstrate that there is reason for concern about contamination in Wellington Harbour sediments. However, arsenic, cadmium, chromium, nickel and total PAH were below concentration DVG's at all sites.

Table 4-9: Current state summary

Water quality	Culverts				Evans Bay		
	Miramar Culvert (EVSW1)	Cobham Culvert (EVSW2)	Kilbirnie Culvert (EVSW3)	Hataitai Culvert (EVSW4)	Evans Bay at Boat Ramp EVCW1	Hataitai Beach EVCW2	Balaena Bay EVCW3
Observed scums or foams (% of inspections)	5 – 10%	5 – 10%	5 – 10%	5 – 10%	5 – 10%	<5%	<5%
Observed oils or grease films	>30%	10 – 30%	10 – 30%	>30%	<5%	<5%	<5%
Observed change in colour or clarity	10 – 30%	10 – 30%	10 – 30%	10 – 30%	<5%	<5%	<5%
Enterococci (coastal water, NRP O18 – 95%ile <500)	no data	no data	no data	no data	Meeting	Meeting	Meeting
Dissolved Cu (ANZG 2018)	Not meeting	Not meeting	Not meeting	Not meeting	no data	no data	no data
Dissolved Zn (ANZG 2018)	Not meeting	Not meeting	Not meeting	Not meeting	no data	no data	no data
Sediment quality							
Metals (ANZG 2018)	Not meeting Pb, Zn, Cu	no data	Not meeting Pb, Zn, Cu	no data	Not meeting Pb or Hg at GW sites WH1B and WH2B		
Total of reported PAH (ANZG 2018)	no data	no data	no data	no data	Meeting Total PAH at GW sites WH1B, WH2B and EB2B		
Ecology							
Marine ecology (NRP O19)	not applicable	not applicable	not applicable	not applicable	meeting	meeting	meeting

Morrisey et al., (2019) described Evans Bay as showing few features, results consistent with a uniform, soft mud substratum. Inshore near Kio Bay and Greta Point coarser sediments including bedrock, boulders and cobbles are observed. Analysis of core samples revealed that the abundance and diversity of animals within sediments was much higher in Evans Bay than in the more homogenous muds of the main harbour.

The intertidal and shallow subtidal Evans Bay contained diverse and abundant assemblages of plants and animals, particularly associated with natural rock reefs compared with artificial substrata such as rip-rap and concrete seawalls. The shallow sandy areas in southern Evans Bay contained numerous horse mussels.

Morrisey et al. (2019) detected red-algal beds in the western and southern parts of Evans Bay. They were most dense and continuous in the southern part, to the east of the marina. Patchier beds were also found along the western side of the bay. Stations progressively further offshore from those where algae were present were surveyed until no algae were present. Red algae (other than drift material) generally occurred in water 5–11 m (unpublished data). Stations south of Greta Point and along the eastern side of the bay were also surveyed but red algae were not present even though water depths appeared suitable in many cases.

The dense algal bed at the south end of Evans Bay is mostly composed of *Adamsiella angustifolia*. A sample of algae (c. 10 L) was collected in this area using a small dredge and *A. angustifolia* was the only species present. However, it is possible that other species occur in the bed. Algal samples were collected by dredge, or remained attached to the frame of the camera, from other parts of the bay. Some of these samples could not be placed in known species based on their morphology and were therefore genetically sequenced. The molecular data revealed three new species belonging to the genera *Stenogramma*, *Griffithsia*, and *Rhodymenia*, and a possible undescribed genus similar to *Callophyllis*. Morrisey et al. (2019) noted that these new species belong to genera in need of taxonomic and molecular reassessment, and it is not surprising to discover this diversity when samples are sequenced. These species are also likely to occur in other localities in Wellington Harbour and further afield.

As part of the 2020 Wellington Harbour subtidal sediment sampling programme, Cummings, et al. (2021b) trialled a benthic health model (BHM) which had previously been used to track the health of New Zealand's intertidal estuarine benthic communities in response to increased lead, copper and zinc contamination ('BHMmetal'). The output from the BHMmetal model is that the majority of the Wellington Harbour sites were categorised as 'good', with only **EB2** (in southern Evans Bay) in the 'moderate' category.

4.6.3 Assessment against NRP Objective O18 and O19

The NRP contact recreation and Māori customary use objective O18 for faecal indicator bacteria is achieved in the three coastal water monitoring sites in Evans Bay. Table 4-10 provides an assessment of Evans Bay of against NRP Objective O19 for coastal waters.

Table 4-10: Assessment of Evans Bay against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health

	Macroalgae	Invertebrates	Mahinga kai species	Fish
Assessment	Morrisey et al. (2019) describe diverse and abundant assemblages of plants and animals in Evans Bay including the *Adamsiella* beds which are recognised in schedule F5 of the NRP as having significant biodiversity values in the coastal marine area. We have not sighted information relating to Mahina kai species or the fish community of Evans Bay. On balance the available information suggests that Objective O19 is at least partially met.			

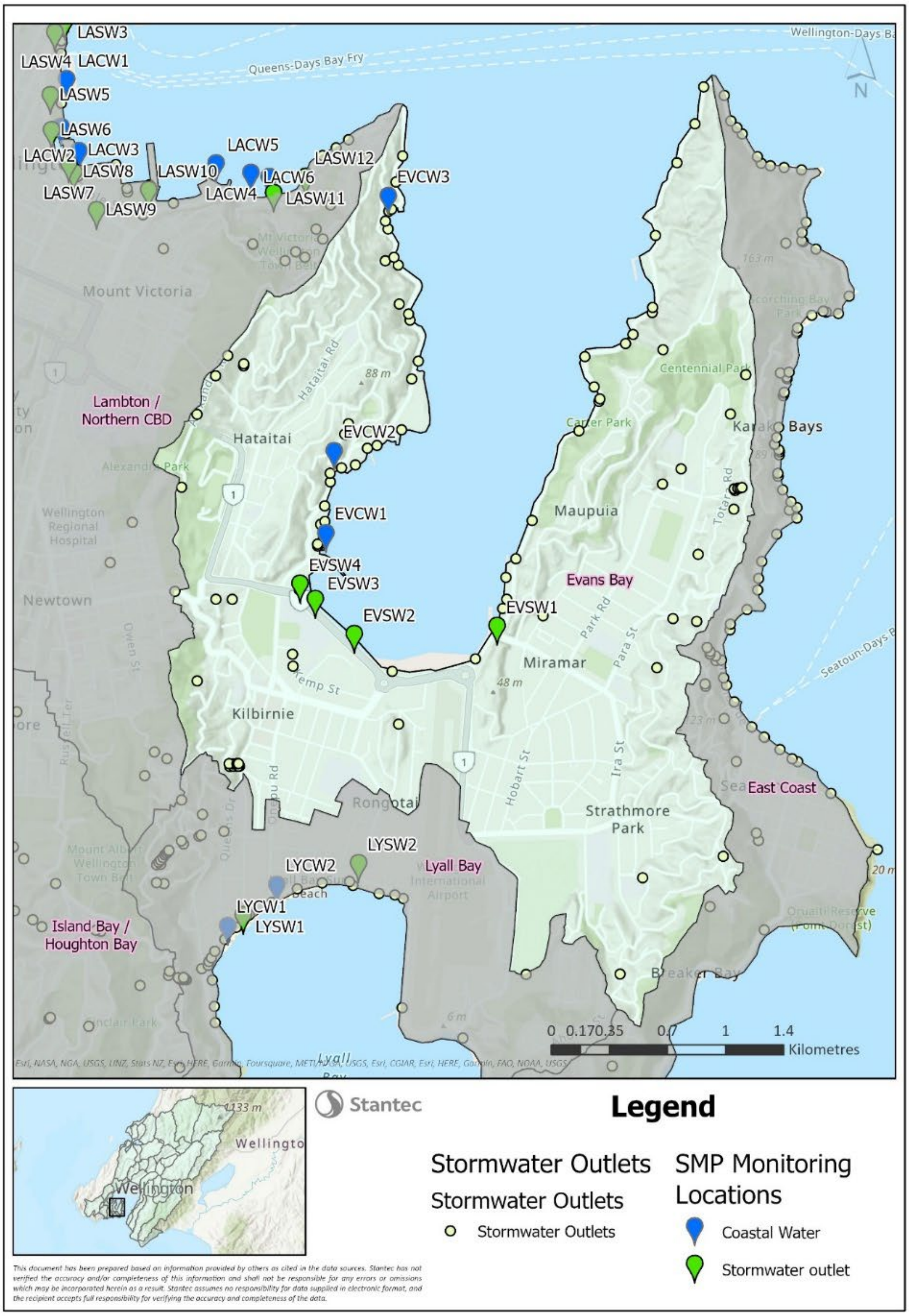


Figure 4-11: Evans Bay Catchment

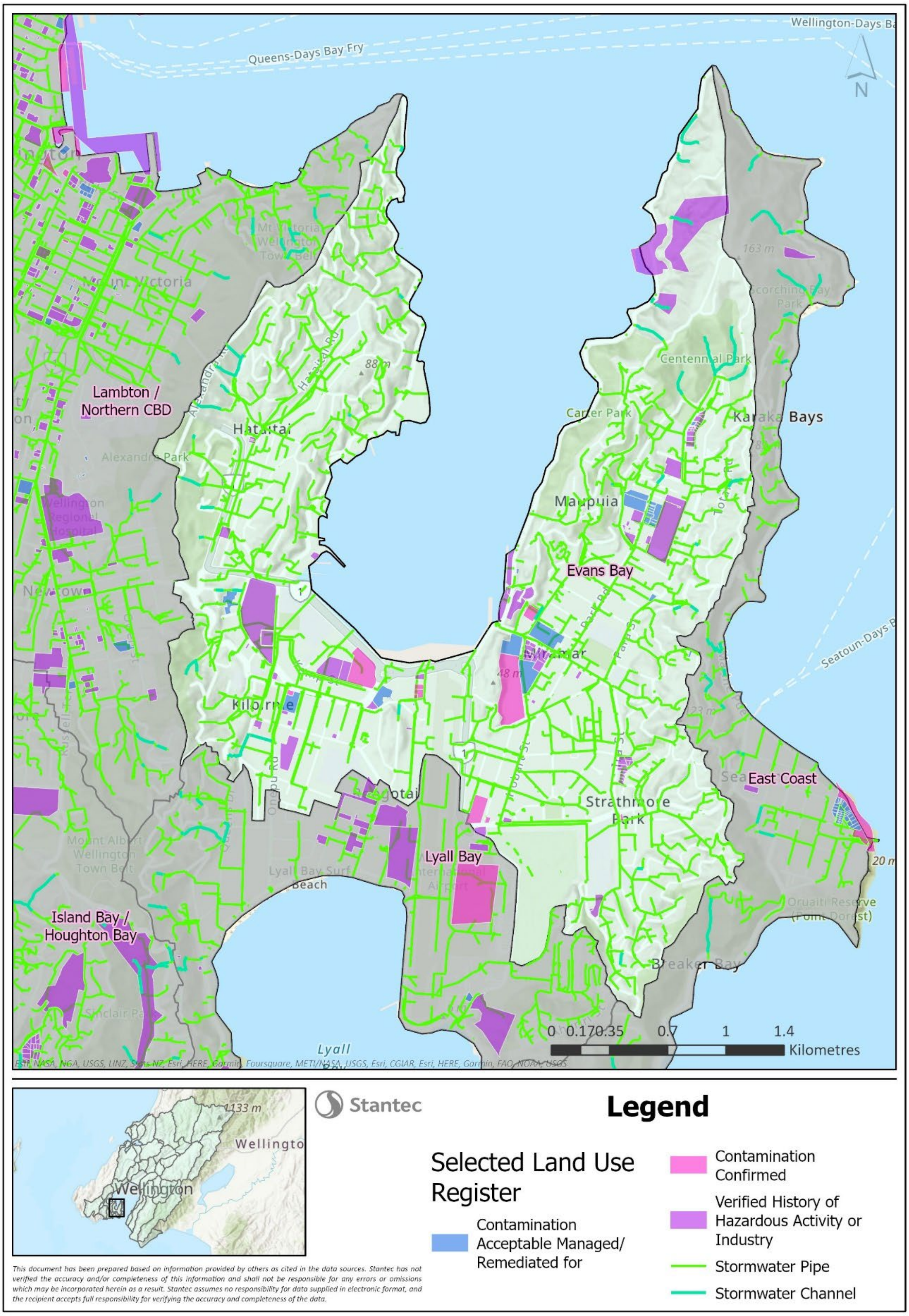


Figure 4-12: Evans Bay SLUR sites

4.7 Lambton Harbour

4.7.1 Description of Existing Environment

Lambton Harbour is located in the north-eastern corner of Wellington Harbour. It stretches from the northern coast along Aotea Quay to Lambton Basin, and the beach front at Oriental Bay. Its commercial amenities include the Port of Wellington, Inter-island ferry terminals, and a large marina. Recreational amenities include the Wellington CBD waterfront, Oriental Bay beaches and boat launching and mooring facilities.

Most of the Lambton Basin shore is accessible to the public and is a major recreational asset for Wellington. Walking, viewing and dinning at cafes and restaurants are popular recreational activities all along the waterfront. Swimming, small boat activities, and fishing also occur in these areas.

4.7.2 Current state summary

EMP monitoring in the Lambton catchment is conducted at six coastal water sites and 12 stormwater sites (shown in Figure 4-13). No significant freshwater streams remain in the catchment, except for headwater fragments. The results of coastal water and stormwater monitoring are attached in Appendices A to R while the current state is summarised below and in Table 4-11.

Monitoring results show that faecal indicator bacteria concentrations were elevated at LACW1 (Waterfront at Shed 6) and LACW3 (Taranaki Street Diver Platform) but were relatively low at the three Oriental Bay sites and at Whairepo Lagoon. Observations of oil and grease films and changes in colour and/or clarity were common at many of the stormwater outlets. Amongst the worst were the Thorndon, OPT, Grass Street, Te Aro, Taranaki and Tory culverts where oil and/or grease films and emission of objectionable odour were observed frequently.

Discharges from almost all 12 large stormwater culverts contained elevated concentrations of copper and zinc, however in most cases a 10-fold dilution in receiving waters would be sufficient to achieve ANZG (2018) default guideline values.

GWRC's Wellington Harbour marine sediment quality investigations in 2020 included four sites **(LB1**, **LB2**, **WH3** and **WH4**) in Lambton Harbour (Cummings, et al., 2021b). A summary of monitoring results is included in Appendix R indicates that sediments at all four sites exceeded the ANZG (2018) DGV for mercury, and three sites also exceeded the DGV for lead. At all sites ARC Amber (early warning) guidelines for copper, zinc, lead and MWH PAH were exceeded. It is likely that mercury and lead are legacy contaminants while copper and zinc continue to be discharged to the marine environment via stormwater runoff. Cummings, et al., (2021b) concluded that this high number of exceedances demonstrate that there is reason for concern about contamination in Wellington Harbour sediments. Arsenic, cadmium, chromium, nickel and total PAH were, however, below concentration guidelines at all sites.

Wear & Gardiner (2001) described the rocky reef communities at Oriental Bay. In total 12 macroalgal and 38 animals were recorded. The high shore was dominated by the littorinid gastropods *Eulittorina cincta* and *E. unifasciata* which were common or very common, and the mid-shore by abundant columna barnacles Chamaesipho, top shells *Melagraphia aethiops*, and limpits Cellana which were common. Towards the lower part of the mid-shore, blue mussels *Mytilus galloprovincialis* were very common, and the cat's eye *Turbo smaragdus* was common. The cobble substrate of the low shore was dominated by barnacles and blue mussel clumps but much of the habitat lacked macroalgae of animal life due to substrate mobility. Brown macroalgae (especially *Carpophyllum maschalocarpum* and *Cystophora* spp.) and red algae (*Corallina officinalis*, *Gigartina* spp.) dominated towards ELWS. The biota beneath cobbles was rich, with dominant and very common gastropod species being *Melagraphia aethiops*, *T. smaragdus*, amphipods and the crab *Petrolisthes elongates*.

Studies of soft sediment benthic communities within Lambton Harbour have shown that communities near the wharves can be strongly disturbed, with very low numbers of benthic species and individuals (Haddon & Wear, 1993; Anderlini & Wear, 1995). Biota becomes rapidly more varied and numerous with increasing distance from the wharf, with species richness, species diversity, and total abundance increasing markedly within 50m from the wharf edge. Diving observations suggested the effects of ship movements appeared to be concentrated within 10 or 15m of the wharf edge. Beyond the immediate vicinity of the wharf, the ecological community was found to be typical of mixed silty/muddy sediments found within Wellington Harbour (Bolton-Ritchie, 2003).

Ecology near four stormwater outfalls in Lambton Harbour studied by Bolton-Richie (2003) showed a “halo” effect, with the sediment ecology showing a strong gradient within the first 10-40m of the outfalls. A greater area of influence may occur but could not be distinguished under the study design (Bolton-Richie, 2003). Diffuse Sources (2014) described these effects as strong but localized biological effects.

As part of the 2020 Wellington Harbour subtidal sediment sampling programme, Cummings, et al. (2021b) trialled a benthic health model (BHM) which had previously been used to track the health of New Zealand’s intertidal estuarine benthic communities in response to increased lead, copper and zinc contamination (‘BHMmetal’). The output is that the majority of the Wellington Harbour sites were categorised as ‘good’, with only EB2 (in southern Evans Bay) in the ‘moderate’ category.

A current state assessment summary for the Lambton Harbour catchment is provided in Table 4-11.

Table 4-11: Current state summary

Water quality	Major SW culverts	Lambton Harbour			Oriental Bay		
	(LASW1 to LASW12)	LACW1	LACW2	LACW3	LACW4	LACW5	LACW6
Observed scums or foams (% of inspections)	5 – 10%	5 – 10%	5 – 10%	5 – 10%	5 – 10%	5 – 10%	5 – 10%
Observed oils or grease films	>30%	5 – 10%	5 – 10%	5 – 10%	<5%	<5%	<5%
Observed change in colour or clarity	10 – 30%	5 – 10%	5 – 10%	5 – 10%	5 – 10%	5 – 10%	5 -10%
Enterococci (coastal water, NRP O18 – 95%ile <500)	no data	Not meeting	Meeting	Not meeting	Meeting	Meeting	Meeting
Dissolved Cu (ANZG 2018)	Not meeting	no data	no data	no data	no data	no data	no data
Dissolved Zn (ANZG 2018)	Not meeting	no data	no data	no data	no data	no data	no data
Sediment quality							
Metals (ANZG 2018)	no data	Not meeting Hg at four GW sites or Pb at three GW sites					
Total of reported PAH (ANZG 2018)	no data	Meeting Total PAH					
Ecology							
Marine ecology (NRP O19)	Not meeting	Not meeting			Meeting		

4.7.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 for faecal indicator bacteria is achieved at four of the six coastal water monitoring sites in Lambton Harbour. Table 4-12 provides an assessment of Lambton Harbour against NRP Objective O19.

Table 4-12: Assessment of Lambton Harbour against NRP Objective O19, Table 3.8

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	The studies referenced above indicate a relatively poor condition of the ecological community in Lambton Harbour near wharves and major stormwater outlets, which likely does not meet the O19 objective. However, community health is much improved outside of these areas. (It is noted that some of these studies were conducted more than 20 years ago).			

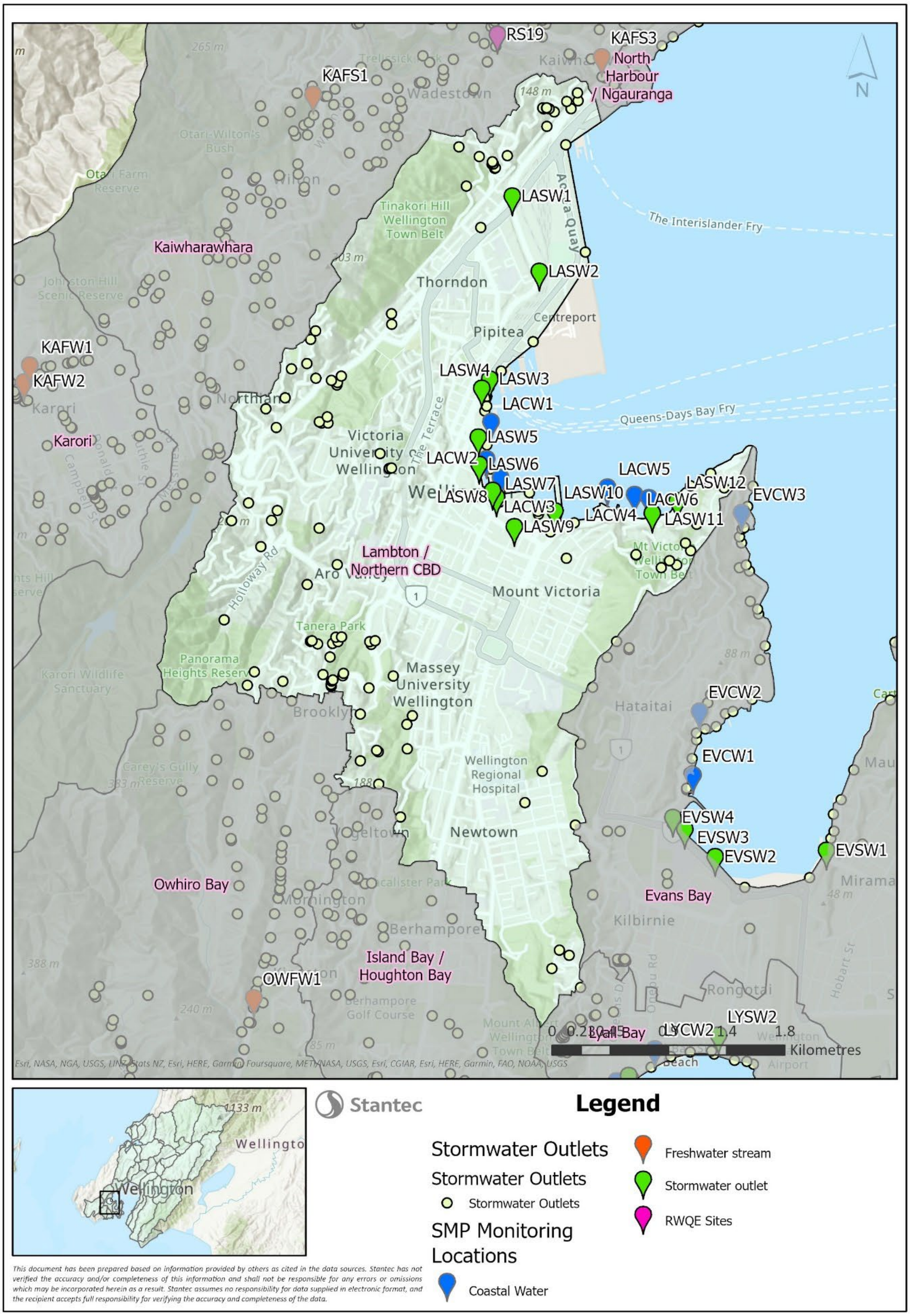


Figure 4-13: Lambton Catchment

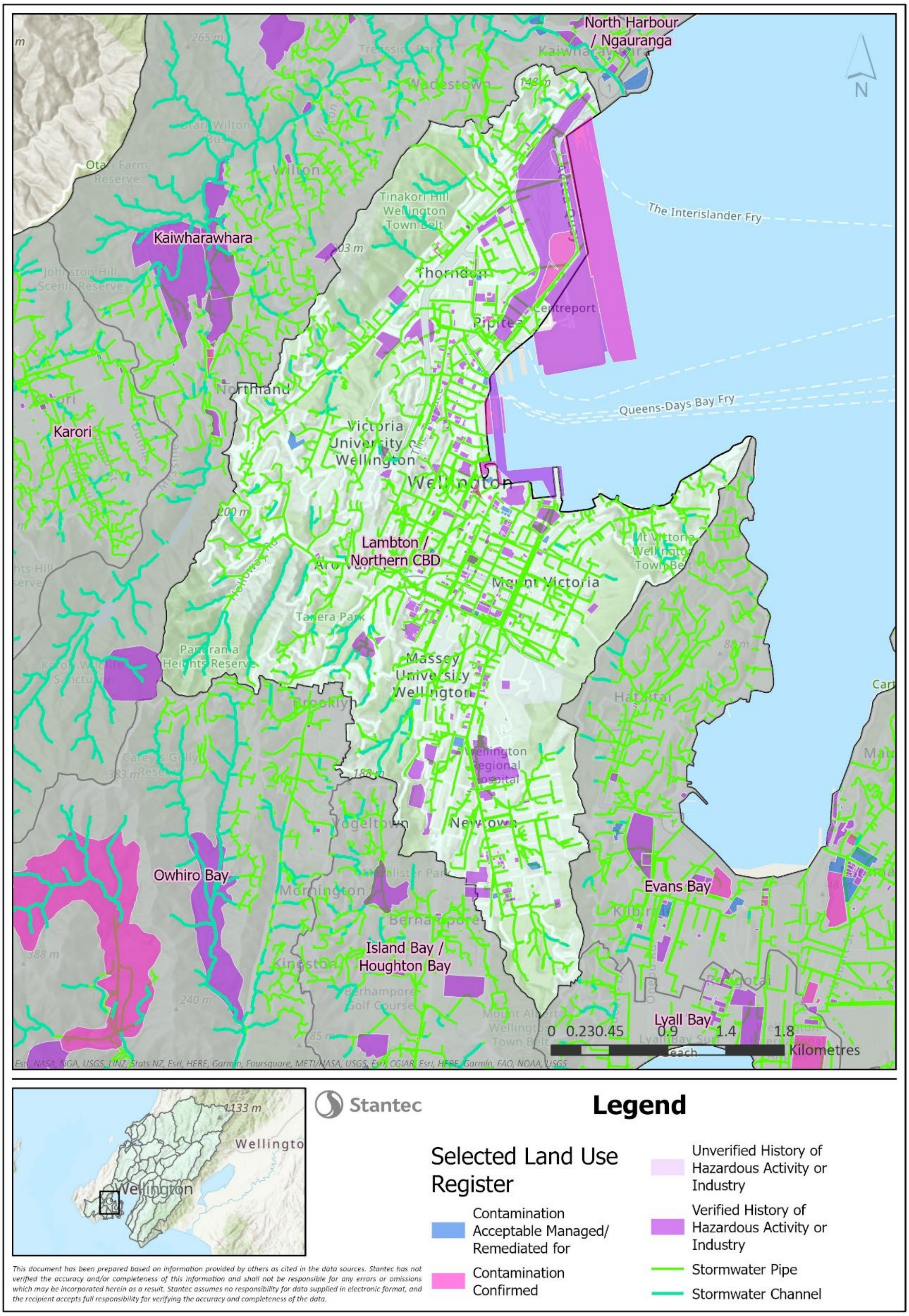


Figure 4-14: Lambton Catchment SLUR sites

4.8 Kaiwharawhara catchment

4.8.1 Description of Existing Environment

Kaiwharawhara Stream is a 4th order watercourse that runs approximately 11 kilometres from its headwaters in the Zealandia Wildlife Sanctuary to the coastal marine area in Wellington Harbour at Kaiwharawhara. The stream has a total catchment area of 16.7 square kilometres, of which nearly 39% is in urban land cover and an estimated 18% has impervious surfaces. The stream has an estimated mean flow of 350 L/s. Its catchment includes parts of urban Karori (including Karori Cemetery), Wilton, Wadestown, Ngaio and Khandallah, as well as an industrial/commercial area near the Stream mouth at Kaiwharawhara. The stream passes through two water supply reservoirs and is then piped under disused landfills at Ian Galloway Park and Appleton Park. Additional disused landfills are located at Anderson Park, Otari Plant Museum and Creswick Terrace Park.

4.8.2 Current state summary

EMP monitoring in the Kaiwharawhara is conducted at three freshwater sites (shown in Figure 4-15). The results of stream monitoring are attached in Appendices A to R while the current state is summarised below in Table 4-13, which indicates the following:

- Faecal indicator bacteria concentrations were elevated at all four stream sites, none of which achieved objective O18.
- Nutrient concentrations were elevated in the lower Kaiwharawhara Stream.
- The median concentration of copper exceeded the ANZG (2018) DGV in the lower Kaiwharawhara Stream, and the median concentration of zinc exceeded the DGV in the Koromiko tributary (Ngaio), indicating that neither site would meet objective 19 for toxicity.
- At all other sites the median values for copper and zinc were below the DGV while the 95% percentile values were above the DGV, indicating partial achievement of the O19 toxicity objective for copper and zinc.
- Kaiwharawhara Stream sediment concentrations of lead and zinc exceeded ANZG (2018) DGVs for sediments.
- The periphyton and macroinvertebrate communities of the lower stream did not meet NRP objective O19.

GWRC's Wellington Harbour marine sediment quality investigations in 2020 includes two sites (AQ1 and AQ2) offshore of Kaiwharawhara Stream mouth, and three sites (WH5, WH9, WH10) offshore between Kaiwharawhara and Ngauranga (Cummings, et al., 2021).

Sediments at sites AQ1, AQ2, WH5, WH9, and WH10 all exceeded the ANZG (2018) DGV for mercury, and ARC amber guideline for lead. Sites AQ1 and AQ2 also exceeded the ARC amber guideline for HMW PAH. It is likely that mercury and lead are legacy contaminants. Arsenic, copper, cadmium, chromium, nickel, Zinc and total PAH were, however, below concentration guidelines at these sites.

Boffa Miskell (2022) provide a description of the marine ecology of the coastal area at Kaiwharawhara in an AEE prepared for the KiwiRail proposed Ferry Terminal. A dive survey indicated that *Macrocycstis pyrifera* was present but was patchy and sparse with most of the plants not reaching the surface, about 1m or less tall, or juvenile thalli. The density of *M. pyrifera* was estimated at 1 plant per m^2 or less. Most *M. pyrifera* plants were detected at a water depth of 2-4m. The most abundant species observed was *Carpophyllum maschalocarpum* (not threatened) which forms an almost continuous belt 5m offshore.

As part of the 2020 Wellington Harbour subtidal sediment sampling programme, Cummings, et al. (2021b) trialled a benthic health model (BHM) which had previously been used to track the health of New Zealand's intertidal estuarine benthic communities in response to increased lead, copper and zinc contamination ('BHMmetal'). The output from the BHMmetal model is that the majority of the Wellington Harbour sites were categorised as 'good', with only EB2 (in southern Evans Bay) in the 'moderate' category.

Table 4-13: Current state summary

Water quality	Kaiwharawhara Stream at Otari (KAFS1	Koromiko Stream at Cummings (KAFS2)	Kaiwharawhara Stream at Ngaio Gorge (RS19	Kaiwharawhara Stream u/s Hutt Road (KAFS3)
Observed scums or foams (% of inspections)	10 – 30%	10 – 30%	no data	10 – 30%
Observed oils or grease films	5 - 10%	5 - 10%	no data	5 - 10%
Observed change in colour or clarity	10-30%	10-30%	no data	10-30%
E. coli (freshwater, NPS attribute state)	E	E	E	E
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting	Not meeting
Water temperature (Davies Colley et al. 2013)	no data	no data	B	no data
Dissolved oxygen (NPS attribute state)	no data	no data	A	no data
Dissolved reactive phosphorus (NPS attribute state)	no data	no data	C	no data
Nitrate-N (nutrient, ANZG 2018)	no data	no data	Not meeting	no data
Nitrate-N (toxicity NPS attribute state)	no data	no data	B	no data
Ammonia-N (toxicity NPS attribute state)	no data	no data	B	no data
Dissolved Cu (ANZG 2018)	Partially meeting	Partially meeting	Partially meeting	Not meeting
Dissolved Zn (ANZG 2018)	Partially meeting	Not meeting	Partially meeting	Partially meeting
Sediment quality	no data	no data	no data	no data
Metals (ANZG 2018)	no data	no data	Not meeting for Pb or Zn	no data
Total of reported PAH (ANZG 2018)	no data	no data	Meeting	no data
Total DDT isomers (ANZG 2018)	no data	no data	Meeting	no data
Ecology				
Periphyton (NRP O19)	no data	no data	Meeting	no data
Macroinvertebrate community (NRP O19)	no data	no data	Not meeting	no data
Freshwater fish community (NRP O19)	no data	no data	Meeting	no data

4.8.3 Assessment against NRP Objective O18 and O19

The NRP contact recreation and Māori customary use objective O18 is not achieved for faecal indicator bacteria at any of the Kaiwharawhara Stream sites.

The NRP biodiversity and aquatic ecosystem objective O19 is achieved for periphyton, indigenous fish, ammonia toxicity, and nitrate toxicity, but is not achieved for macroinvertebrate communities, zinc toxicity at one site and or copper toxicity at one site. Table 4-14 provides an assessment of against NRP Objective O19 for coastal waters.

Table 4-14: Assessment of Wellington Harbour at Kaiwharawhara against Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	The available information suggests that Objective O19 may be met in respect of macroalgae and invertebrates but there not sufficient information to determine compliance with the objectives for mahinga kai and fish.			

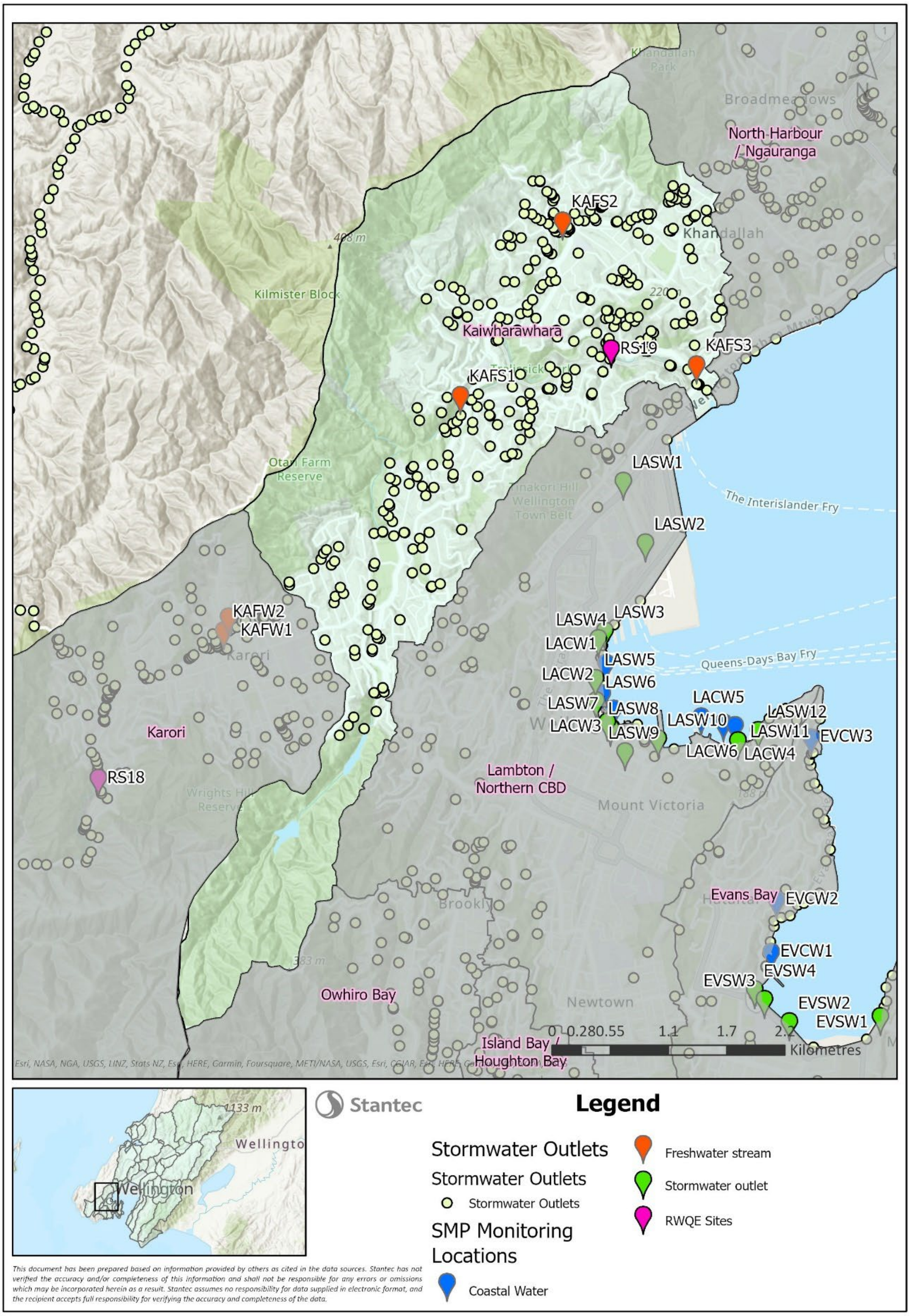


Figure 4-15: Kaiwharawhara Catchment

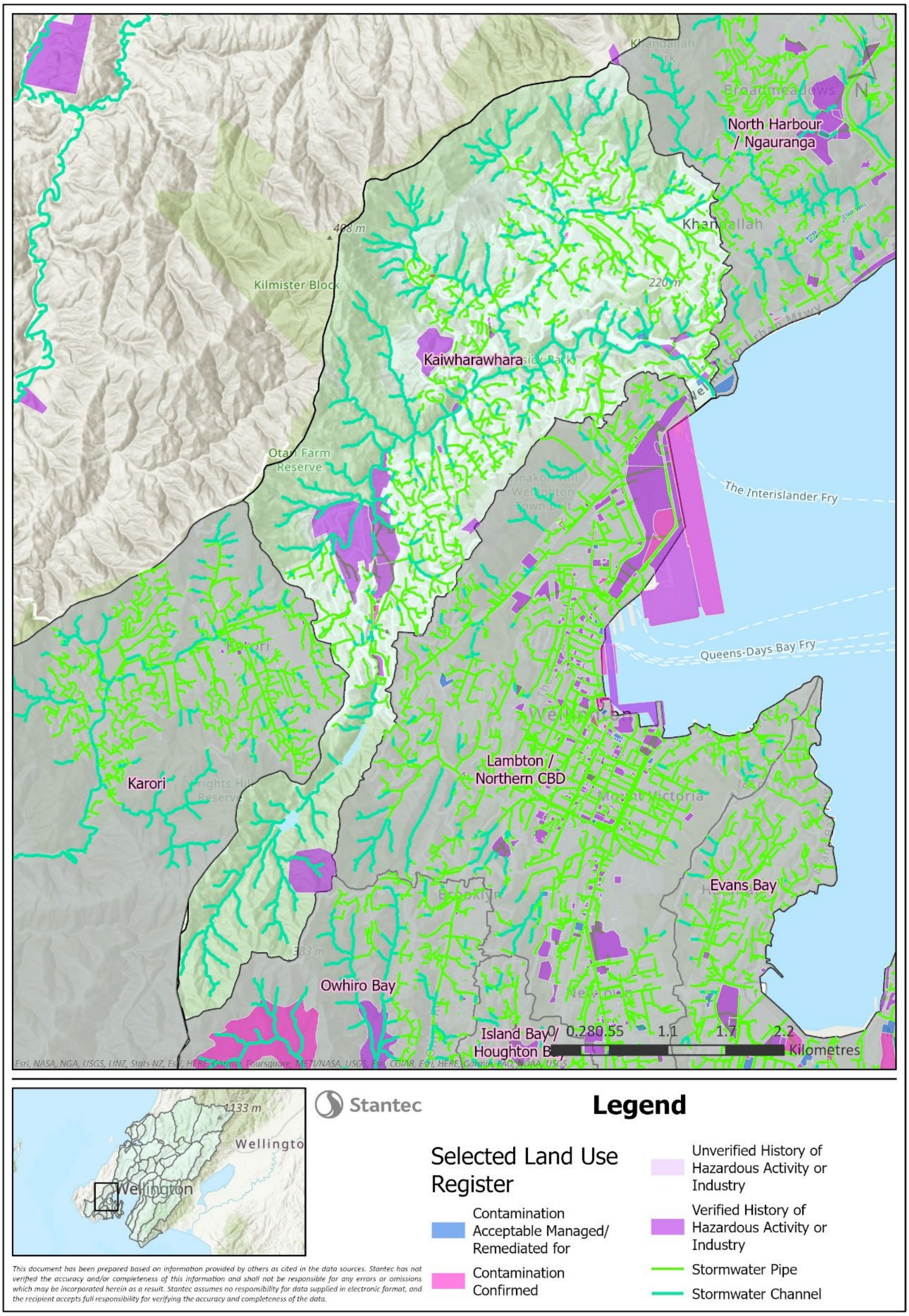


Figure 4-16: Kaiwharawhara catchment SLUR sites

4.9 North Harbour

4.9.1 Description of Existing Environment

The north harbour catchment lies between Kaiwharawhara Stream to the southwest and Korokoro Stream to the northeast. It includes two watercourses: the Ngauranga Stream (also known as Waitohi Stream), which is described below, and Horokiwi Stream which is a minor watercourse carrying mostly rural runoff.

Waitohi Stream is a 3rd order watercourse which has its headwaters in Khandallah, Johnsonville and Newlands, running approximately 4km to Wellington Harbour at Ngauranga. The stream has a total catchment area of 9.5 square kilometres of which an estimated 31% has impervious surfaces. The catchment is heavily urbanised, predominantly in residential land use, but including commercial and light industry premises, including the Kiwi Point Quarry and Taylor Preston Abattoir. No landfills are currently operating in the catchment, however, a closed landfill at Raroa Park operated from 1961 to 1971. The catchment is bisected by the Wellington to Porirua motorway (State Highway 1). The stream has an estimated mean flow of 215 L/s.

The north harbour coastline is straight, rocky, and exposed and has limited access due to the proximity of SH1, SH6 and the main trunk railway. It includes approximately 5 ha of reclaimed land at Kaiwharawhara. The main amenity values along the shoreline are boating, fishing, water skiing and rowing, all of which can be accessed via a boat ramp at the west end Petone Beach.

4.9.2 Current state summary

EMP monitoring in the North Harbour catchment is conducted at two freshwater sites and two stormwater sites (shown in Figure 4-17). The results of stream monitoring are attached in Appendices A to R while the current state is summarised below and in Table 4-15:

- Faecal indicator bacteria concentrations were elevated at both stream sites, neither of which achieved objective O18.
- The median concentration of copper and zinc exceeded the ANZG (2018) DGV at both stream sites indicating that neither site would meet objective O19 for toxicity.
- Waitohi Stream sediment concentrations of zinc exceeded ANZG (2018) DGVs.

Table 4-15: Current state summary

Water quality	Newlands at Gorge (NOSW1)	Tyers Stream at Gorge (NOSW2)	Waitohi Stream mid (NOFW1)	Waitohi Stream Lower (NOFW2)
Observed scums or foams (% of inspections)	10 – 30%	5-10%	10 – 30%	10 – 30%
Observed oils or grease films	<5%	<5%	<5%	<5%
Observed change in colour or clarity	10 – 30%	10-30%	10 – 30%	10 – 30%
E. coli (freshwater, NPS attribute state)	No data	No data	E	E
E. coli (freshwater, NRP O18 – 95%ile < 540)	No data	No data	Not meeting	Not meeting
Dissolved Cu (ANZG 2018)	No data	No data	Not meeting	Not meeting
Dissolved Zn (ANZG 2018)	No data	No data	Not meeting	Not meeting
Sediment quality				
Metals (ANZG 2018)	No data	No data	No data	Not meeting
Total of reported PAH (ANZG 2018)	No data	No data	No data	Meeting
Total DDT isomers (ANZG 2018)	No data	No data	No data	Meeting
Ecology				
Freshwater fish community (NRP O19)	No data	No data	No data	Meeting

4.9.3 Assessment against NRP Objective O18

The NRP contact recreation and Māori customary use objective O18 is not achieved for faecal indicator bacteria at any of the Waitohi Stream monitoring sites.

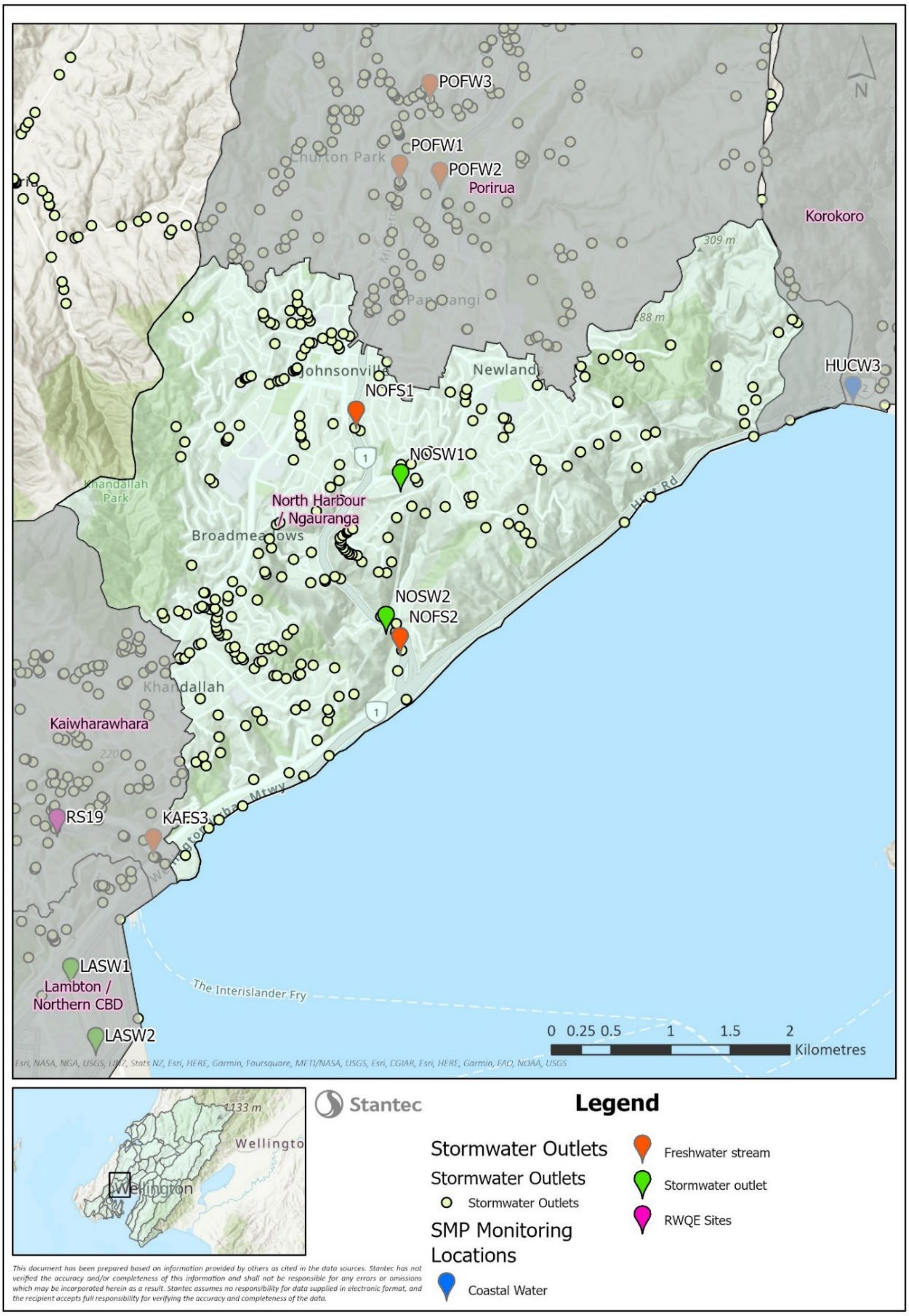


Figure 4-17: North Harbour Catchment

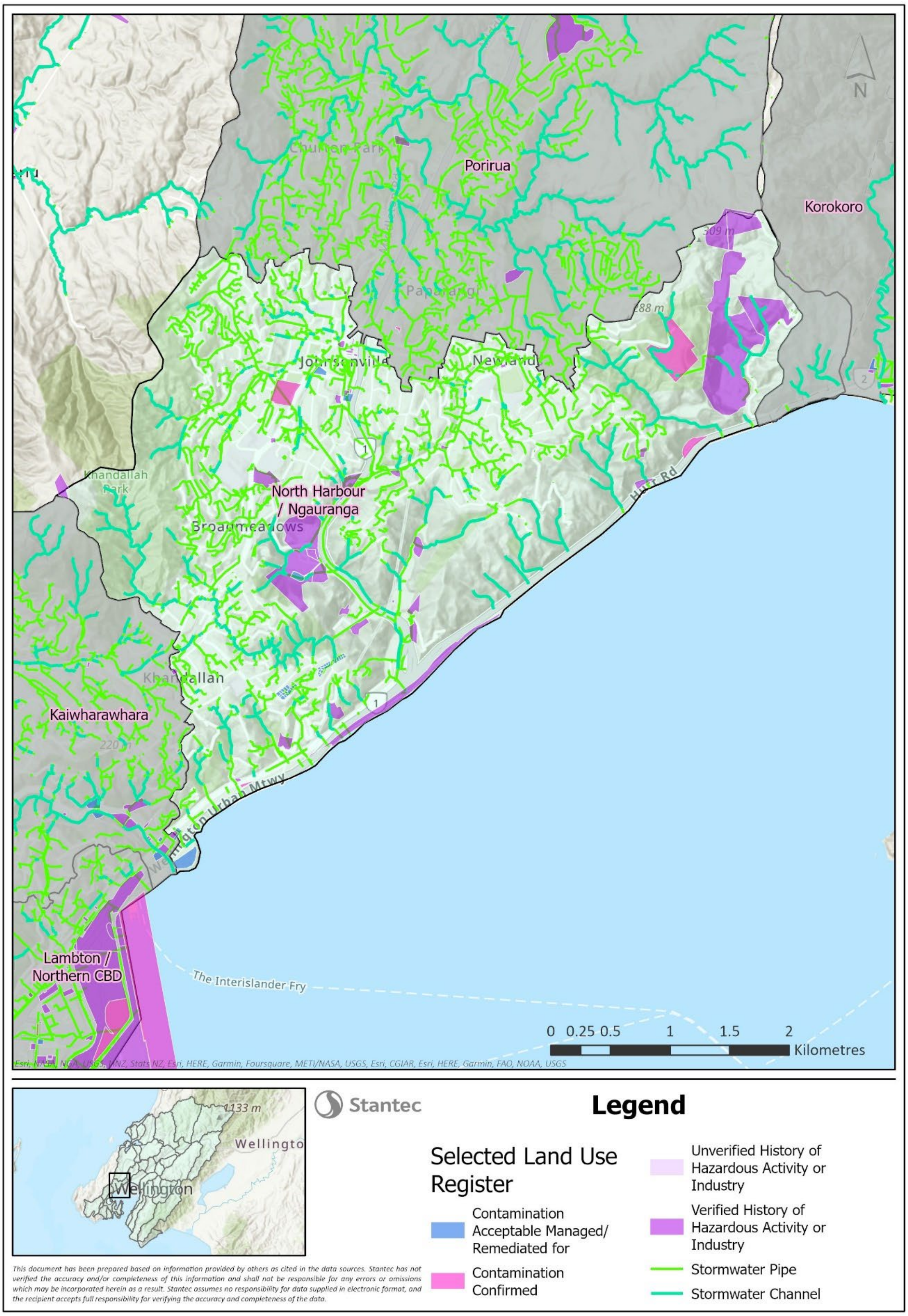


Figure 4-18: North harbour SLUR sites

4.10 Korokoro Stream

4.10.1 Description of Existing Environment

The Korokoro Stream is a 3rd order watercourse which runs approximately 7.8 km from its headwaters to Wellington Harbour. It drains a moderately sized catchment with a total area of 15.7 km^2 situated within Belmont Regional Park on the western hills of the Hutt Valley. Most of the catchment is in regenerating and mature indigenous forest and scrub, including the last significant stand of rimu-rata-tawa-kohekohe in the southwest of the Wellington Region. Only the lower reach near the stream mouth is affected by urban development, with an estimated 3% of the catchment area having impervious surface. The stormwater network has a total length of 5.7 km and includes 38 stormwater outlets.

4.10.1 SMP monitoring

Due to the small area of urban development and very limited stormwater system within the Korokoro Catchment no SMP monitoring is conducted in this area.

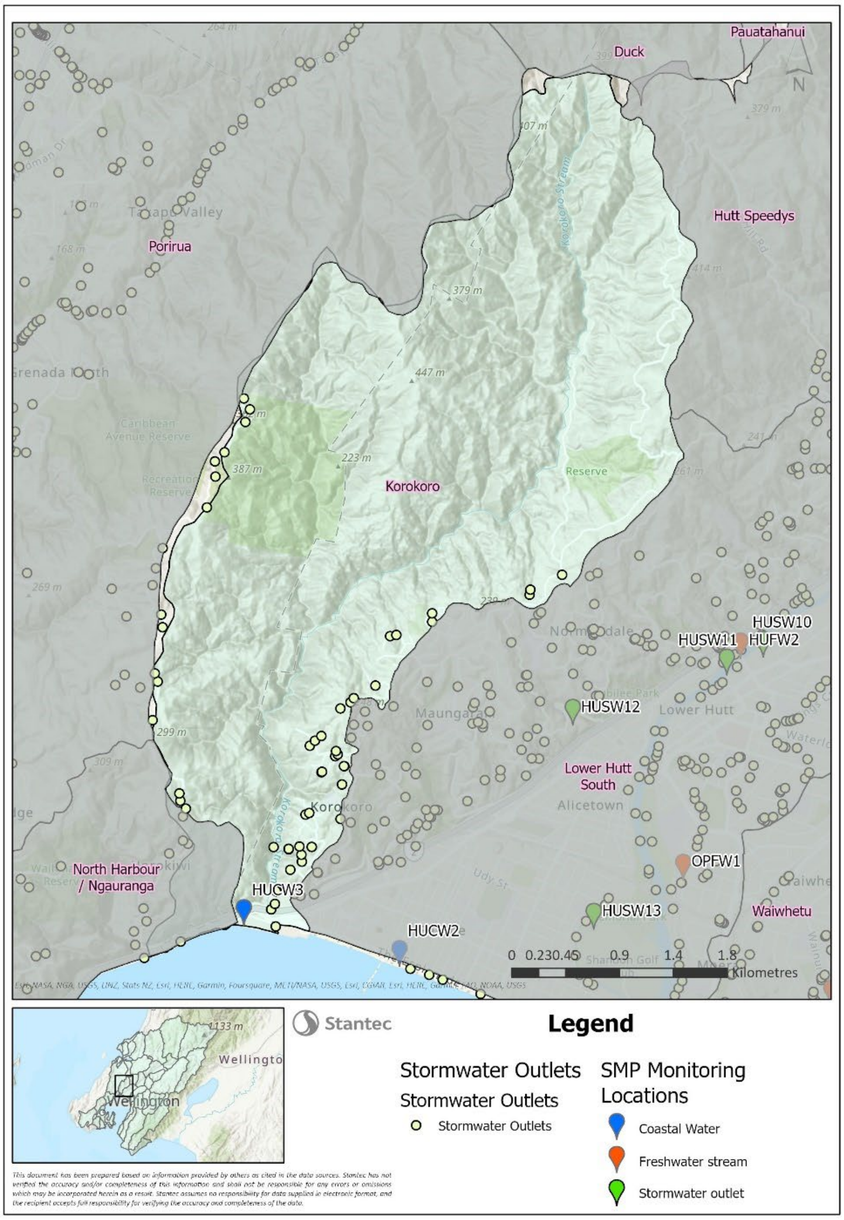


Figure 4-19: Korokoro Catchment

4.11 Speedys Stream

4.11.1 Description of existing environment

Speedy's Stream drains a small steep forested catchment on the western side of the Hutt River valley adjacent to the suburb of Kelson. It joins the Hutt River on its true right bank immediately downstream of the Kennedy Good Bridge. The catchment has an area of 11.7 km^2 of which 6% is impervious surface. The stormwater network has a total length of 7.4 km and 23 stormwater outlets.

4.11.2 SMP Monitoring

Due to the small area of urban development and very limited stormwater system within the Speedy's Catchment no SMP monitoring is conducted in this area.

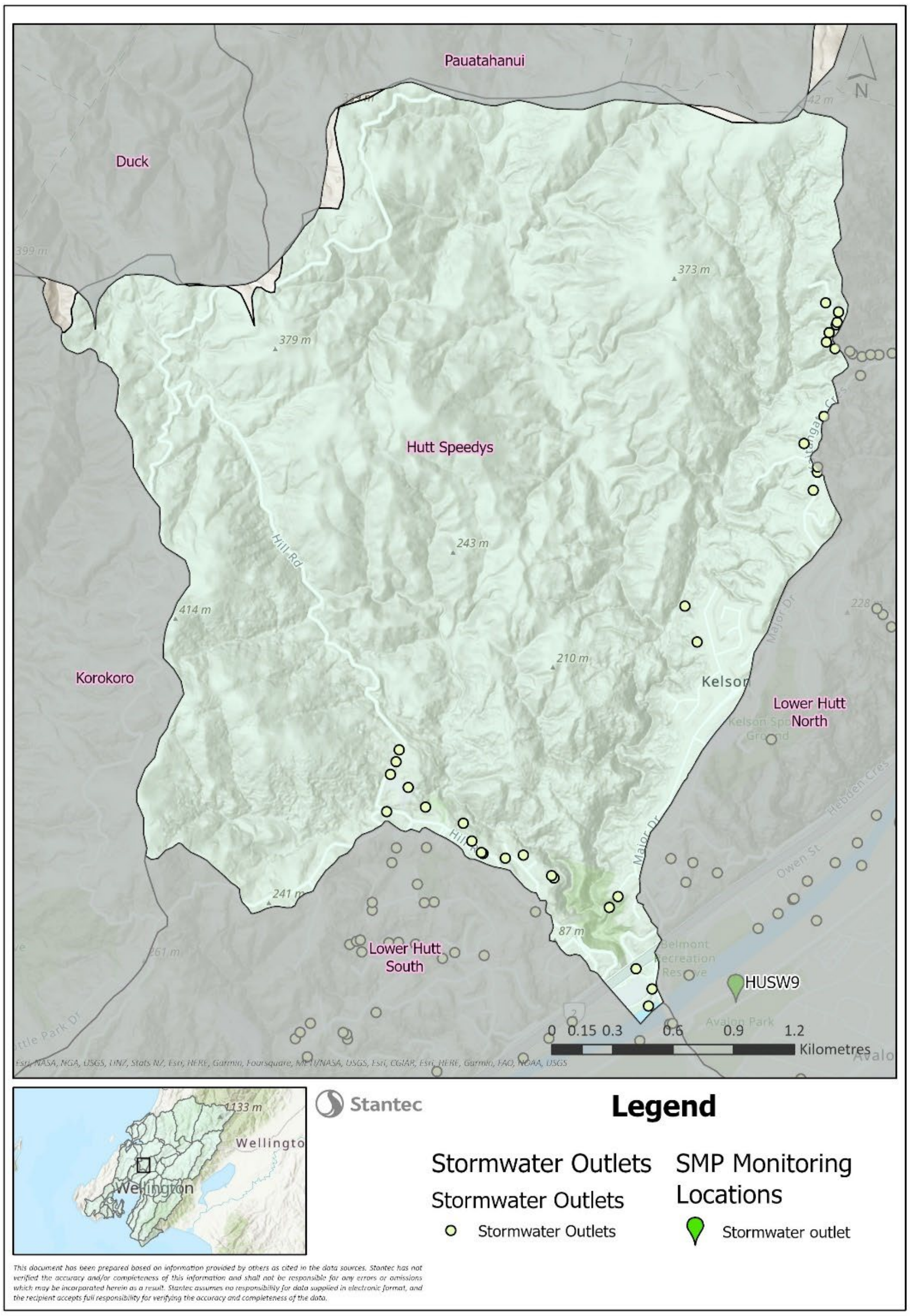


Figure 4-20: Speedy's catchment

4.12 Waiwhetu/Stokes/Hulls

4.12.1 Description of Existing Environment

Waiwhetu Stream

The Waiwhetū Stream is a low elevation 4th order watercourse which runs for 9.4km from the bush covered Eastern Hutt Hills, through urban areas of Naenae, Epuni, Waterloo, Waiwhetū and Gracefield, to its confluence with the Hutt River Estuary at Seaview. It has a total catchment area of about 18.6 km^2 of which approximately 53% is in urban land-use, 42% is in indigenous forest, exotic forest and scrub, and the balance is in low productivity pasture. The stream has a stony bed in its upper reaches and in part of the estuarine reach, but for most of its length the stream bed is soft and muddy.

Extensive urban development in the catchment has modified the streams flow regime, resulting in rapid response to rainfall with high peak flows and low base flows. The estuarine zone extends approximately 2km upstream of the Hutt River confluence, with saline conditions occasionally recorded upstream as far upstream as the Wainui Road Bridge.

Historically the lower estuarine reach was situated within a much wider area of saltmarsh and low-lying wetland at the Hutt River mouth, although the Waiwhetū Stream Estuary would have had relatively small areas of intertidal flats and saltmarsh. However, over the last 100 years the stream corridor and estuary has been extensively modified by flood protection works, reclamation, and removal of the natural vegetated margin. Over the same period the Waiwhetū Stream has received an extensive range of contaminant inputs from stormwater runoff, industrial discharges, and sewage overflows. Sediments in the lower reaches of the stream have historically been highly contaminated with heavy metals.

GWRC's River Water Quality and Ecology (RWQE) monitoring indicates that copper and zinc frequently exceed ANZG (2018) trigger values in the water column, and that the macroinvertebrate community in the lower stream is in poor condition. The community includes no sensitive EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae).

During 2015 HCC established a water quality monitoring site in the estuarine reach of Waiwhetū Stream at Seaview Road, downstream of the industrial area of Gracefield, which was sampled once each month for 12 months, on the outgoing tide (Cameron, 2016). The results show that ANZG (2018) trigger values were consistently exceeded for zinc, occasionally exceeded for copper, but not exceeded for lead, mercury, cadmium, chromium, nickel, or arsenic.

An extensive programme of contaminated sediment remediation was undertaken in the lower reaches of the stream by GWRC and HCC during 2009. Robertson & Stevens (2012) reported that while the remediation and flood control works within the estuary have resulted in some improvements to habitat, and a very significant removal of contaminated sediment, overall, there has been limited improvement to the ecological quality of the estuary, which continues to be rated poorly in terms of eutrophication, sedimentation, toxicity and habitat loss.

Stokes Valley Stream

Stokes Valley Stream begins as a relatively natural watercourse in regenerating bush in the upper valley but once it enters the valley floor it becomes channelised, straightened and is enclosed by culverts at several locations, including the reach passing under the Stokes Valley Shopping Centre. The stream re-surfaces downstream of the shopping centre at Bowers Street but is contained within a concrete lined channel (Figure 3-4). The Tui Glen tributary stream, also contained within a concrete lined channel, joins Stokes Valley Stream approximately 700m downstream of Bowers Street, the confluence marking the upper extent of the application area. The stream runs a further 300m through the concrete channel to a stilling basin at the Stokes Valley Road Bridge. Beyond Stokes Valley Road the stream bed substrate takes on a more natural character of cobbles, gravels and fine sediment. It retains, however, a straightened 'engineered' channel with sloping grassed banks throughout the lower reach to its confluence with the Hutt River.

Hulls Creek

The Hulls Creek catchment covers an area of 1,658 hectares including the low-lying hills of the Blue Mountains, Pinehaven, Trentham, Wallaceville, Heretaunga and Silverstream. The urban area covers approximately 43% of the total catchment. Hulls Creek is a 3rd order stream which runs approximately 5.5 km from its headwaters to its confluence with the Hutt River.

In its upper catchment, Hulls Creek receives runoff from scrub and indigenous forest as well as the Rimutaka Prison farm. Just below the prison farm a tributary draining the northern catchment, which includes the Trentham Racecourse, a golf course, the old General Motors factory and areas of pastoral farming, enters the stream. The mid catchment is drained by the Pinehaven Stream which is dominated by plantation forestry and scrub in its headwaters and urban residential areas in its middle and lower reaches.

The lower catchment is drained by Tip Stream which includes the Silverstream Landfill in its headwaters and indigenous forest and scrub in its lower reaches. Pastoral and urban land use in the upper and middle reaches of the Hulls Creek catchment has resulted in significant channel modification in many places. Much of the northern tributary and part of the main Hulls Creek channel between the northern tributary confluence and the former Central Institute for Technology (CIT) site have been integrated into UHCC's stormwater network. These reaches have been straightened and are concrete lined over much of their length. In urban areas some parts of Hulls Creek and its tributaries have been piped entirely.

4.12.2 Current state summary

EMP monitoring is conducted at three freshwater sites in the Waiwhetū Stream, and at one site each in Stokes Valley Stream and Hulls Creek (shown in Figure 4-21). The results of stream monitoring are attached in Appendices A to R while the current state is summarised below and in Table 4-16.

Monitoring results show that faecal indicator bacteria concentrations were elevated at all five stream sites and did not achieve objective O18. Frequent observations were made at all sites of scums, foams, and changes in visual clarity or colour.

Nutrients concentrations were significantly elevated at all sites, as were water column concentrations of copper and zinc. Stream sediment concentrations of lead and zinc were significantly elevated in the Waiwhetū Stream. These factors contributed to the poor condition of the macroinvertebrate and fish communities in the Waiwhetū Stream.

Table 4-16: Current state summary

Water quality	Waiwhetu Stream (WAIWFW1, WAIWFW2, RS57)	Stokes Valley Stream (STFW1)	Hulls Creek (PIFW1, RS57)
Observed scums or foams	10 – 30%	>30%	10 – 30%
Observed oils or grease films	10 – 30%	<5%	<5%
Observed change in colour or clarity	>30%	10 – 30%	5 – 10%
E. coli (freshwater, NPS attribute state)	E	E	E
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting
Water temperature (Davies Colley et al. 2013)	C	A	D
Dissolved oxygen (NPS attribute state)	A	A	A
Dissolved reactive phosphorus (NPS attribute state)	D	D	C

Nitrate-N (nutrient, ANZG 2018)	Not meeting	Not meeting	Not meeting
Nitrate-N (toxicity NPS attribute state)	A	A	A
Ammonia-N (toxicity NPS attribute state)	B	B	B
Dissolved Cu (ANZG 2018)	Not meeting	Not meeting	Not meeting
Dissolved Zn (ANZG 2018)	Not meeting	Not meeting	Not meeting
Sediment quality			
Metals (ANZG 2018)	Not meeting (for Pb and Zn)	Meeting	Meeting
Total of reported PAH (ANZG 2018)	Meeting	Meeting	Meeting
Total DDT isomers (ANZG 2018)	Meeting	Meeting	Meeting
Ecology			
Periphyton (NRP O19)	no data	no data	no data
Macroinvertebrate community (NRP O19)	Not meeting	no data	no data
Freshwater fish community (NRP O19)	Not meeting	meeting	meeting

4.12.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 is not achieved for faecal indicator bacteria (FIB) at any of the Waiwhetū Stream, Stokes Valley Stream or Hulls Creek monitoring sites. The NRP biodiversity and aquatic ecosystem objective O19 is not achieved in Waiwhetū Stream for copper toxicity, zinc toxicity, macroinvertebrate communities, or fish community.

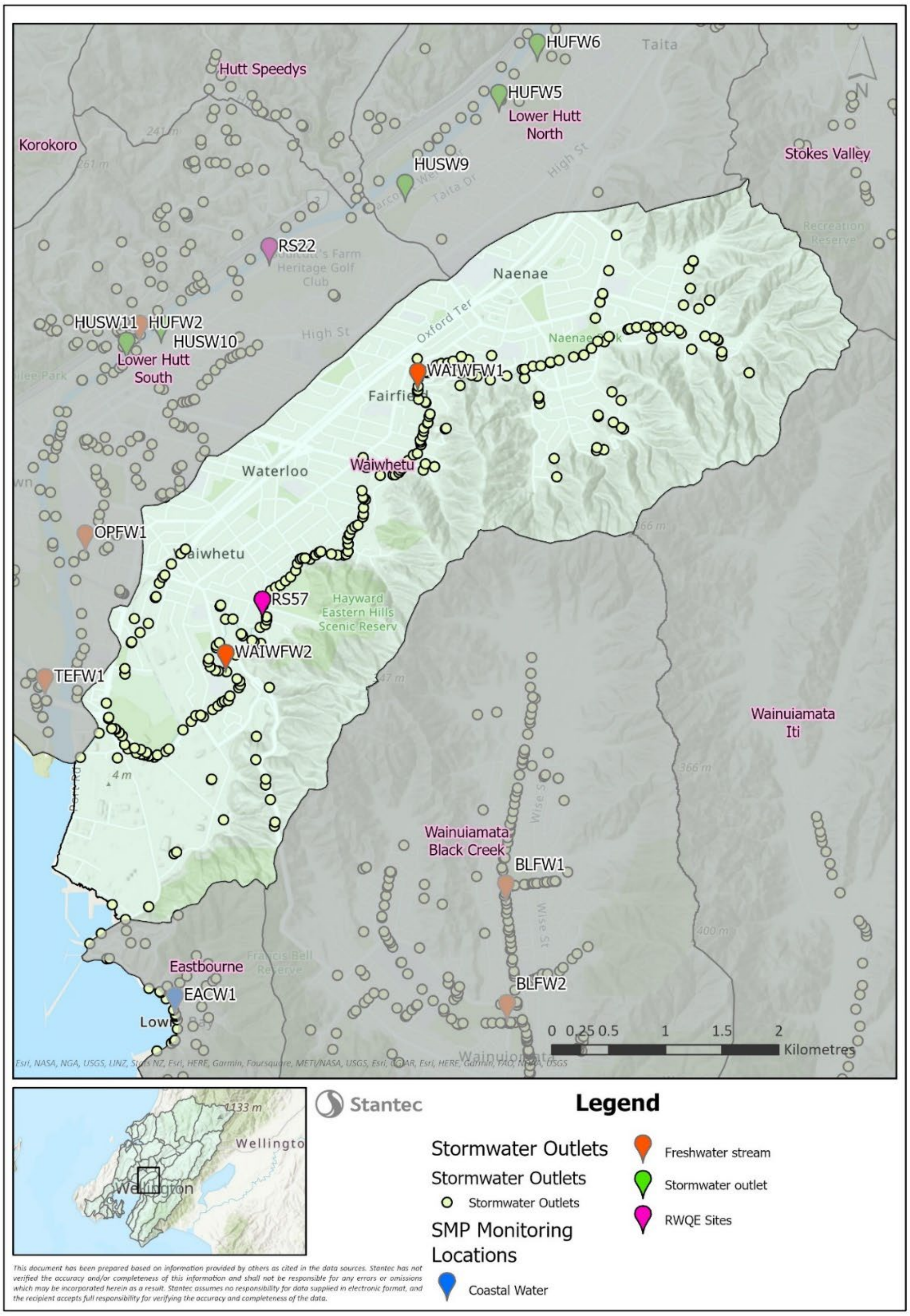


Figure 4-21: Waiwhetū Catchment

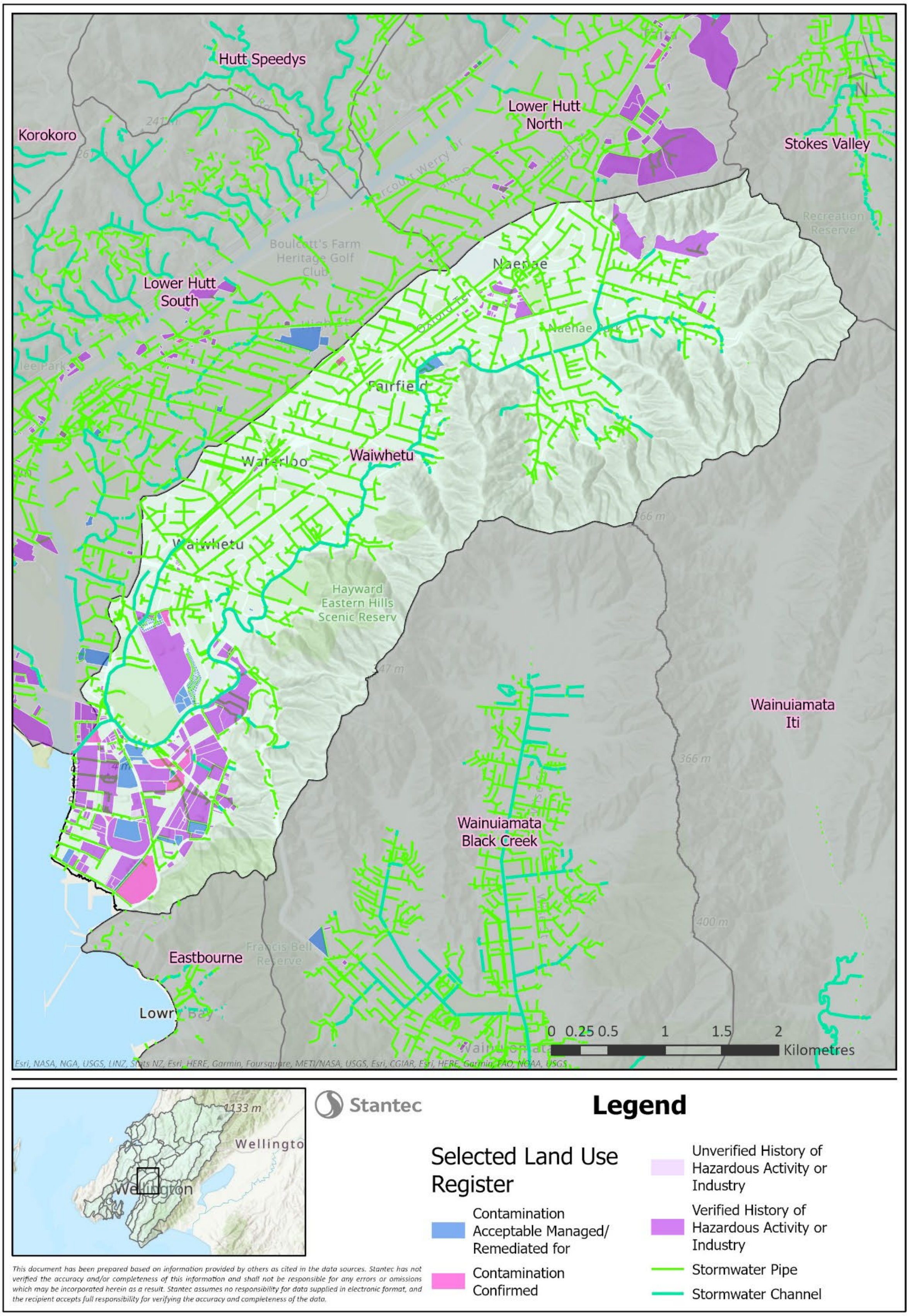


Figure 4-22: Waiwhetū Catchment SLUR sites

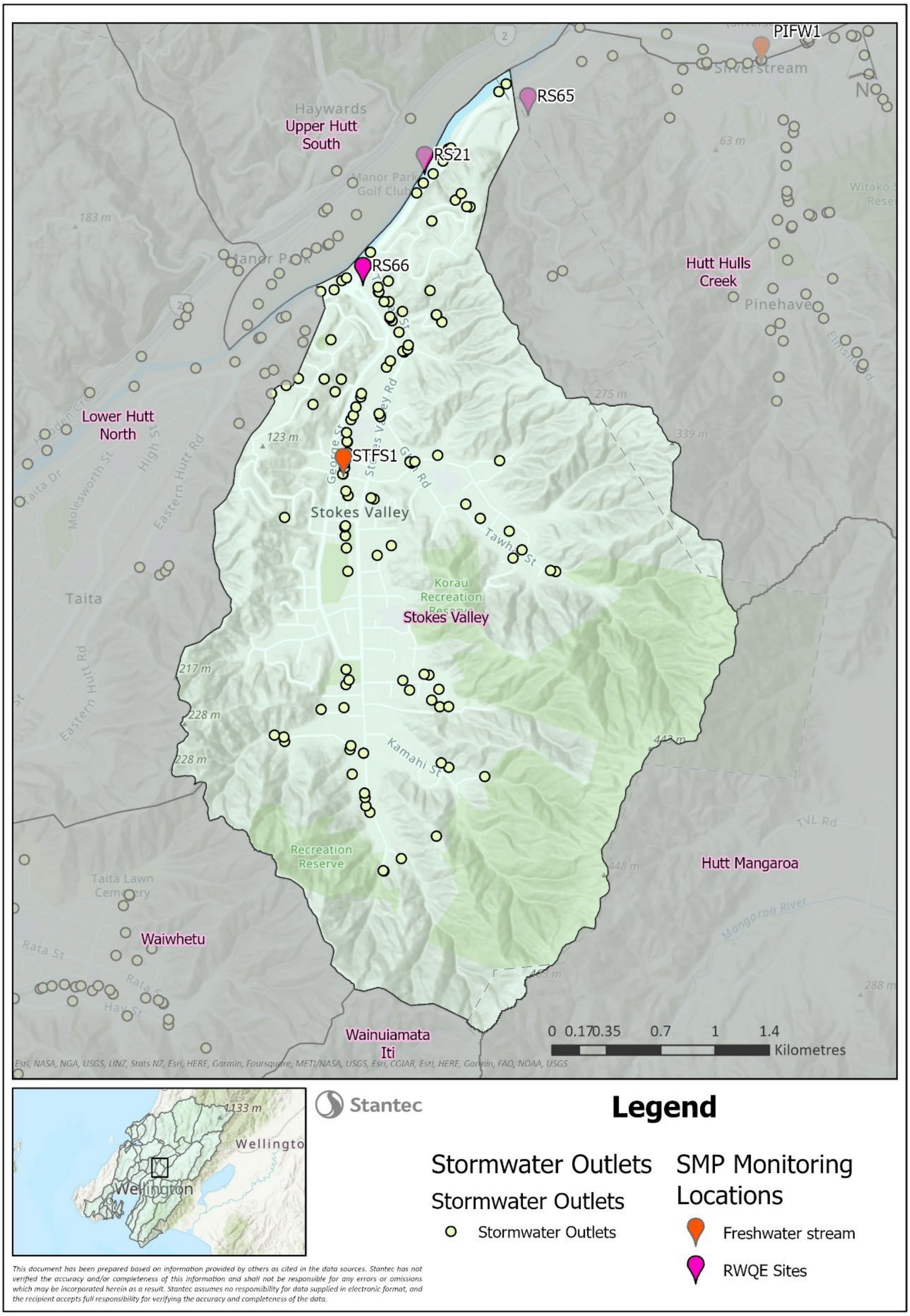


Figure 4-23: Stokes Valley Catchment

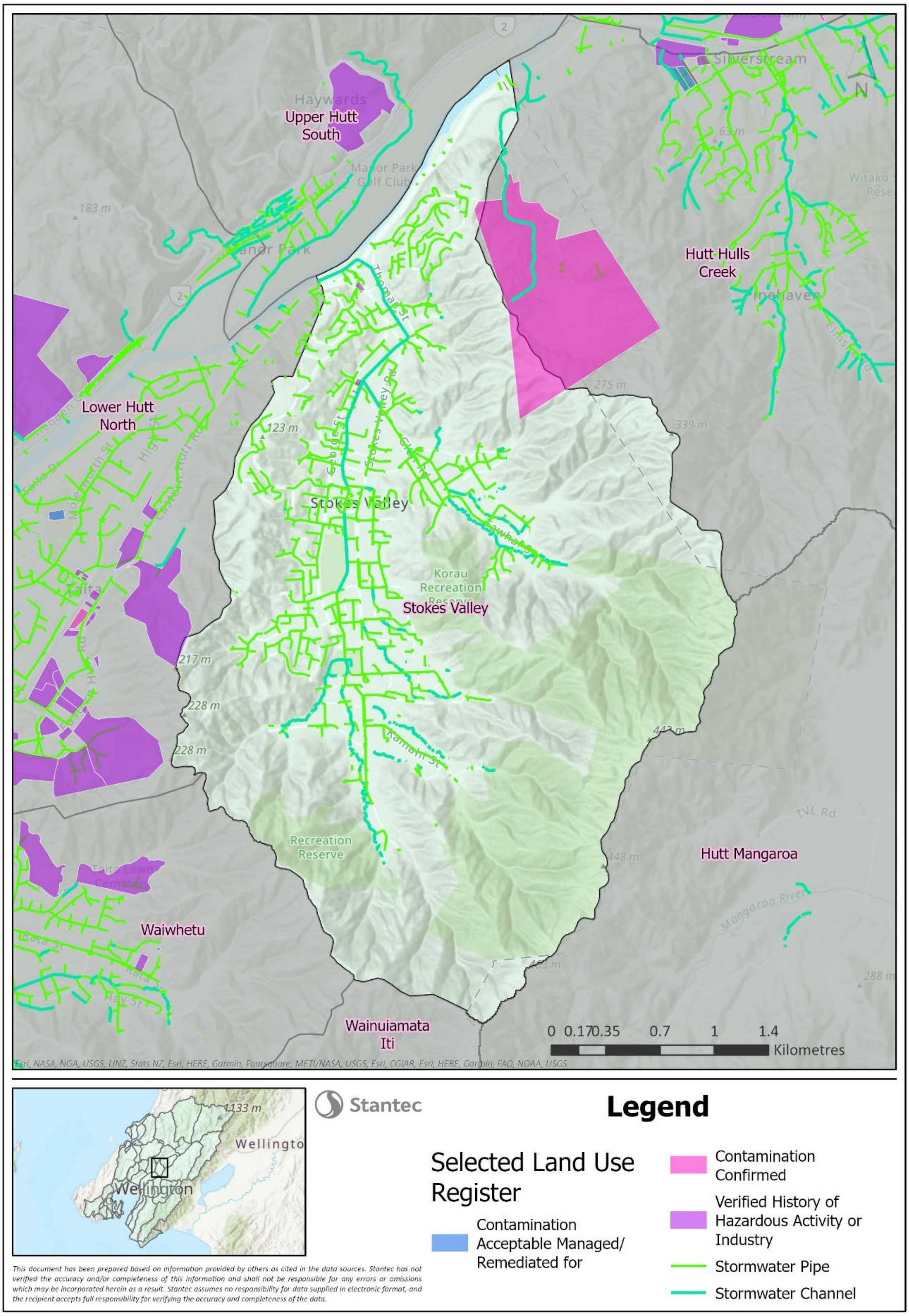


Figure 4-24: Stokes Valley Catchment SLUR sites

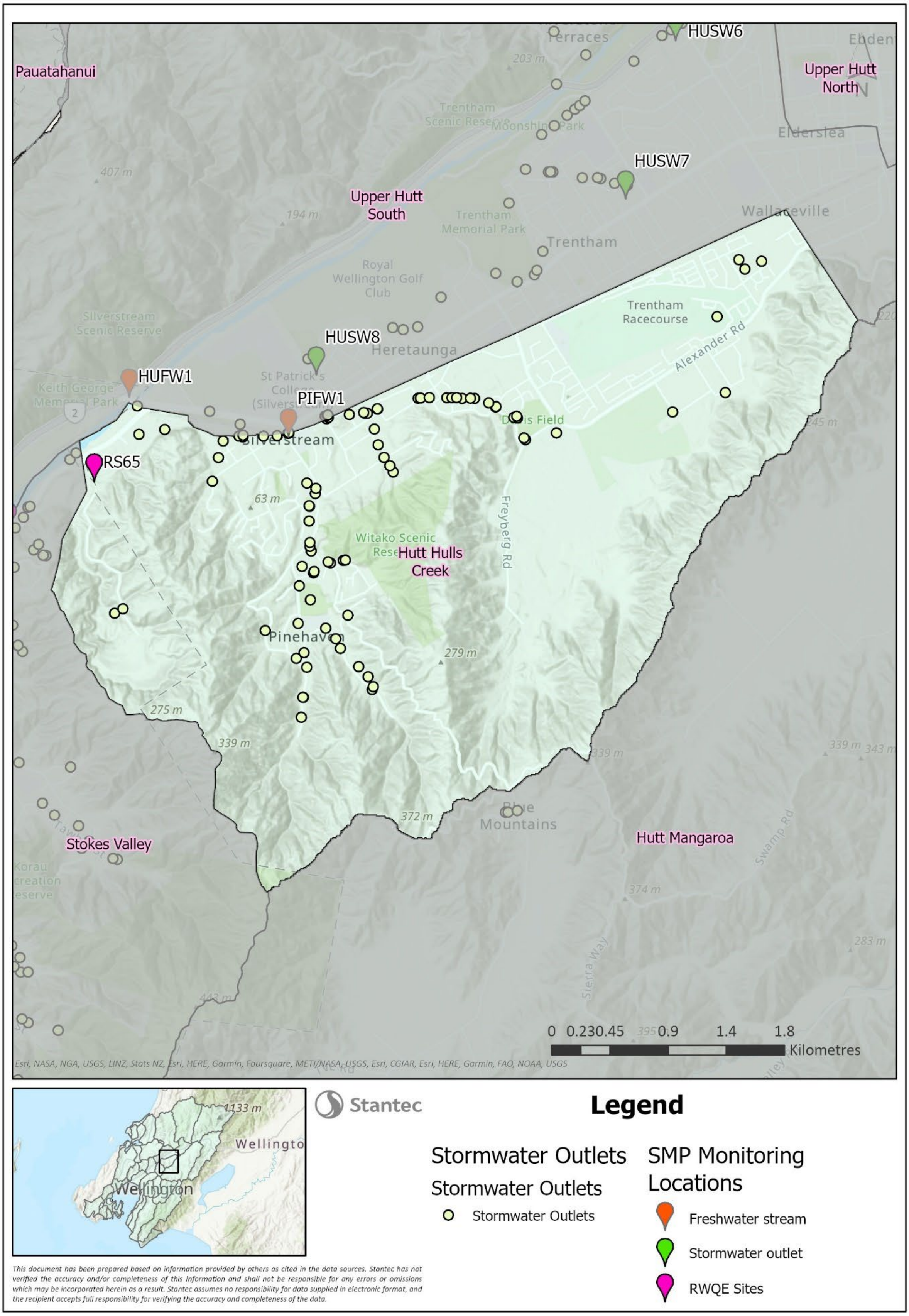


Figure 4-25: Hulls Catchment

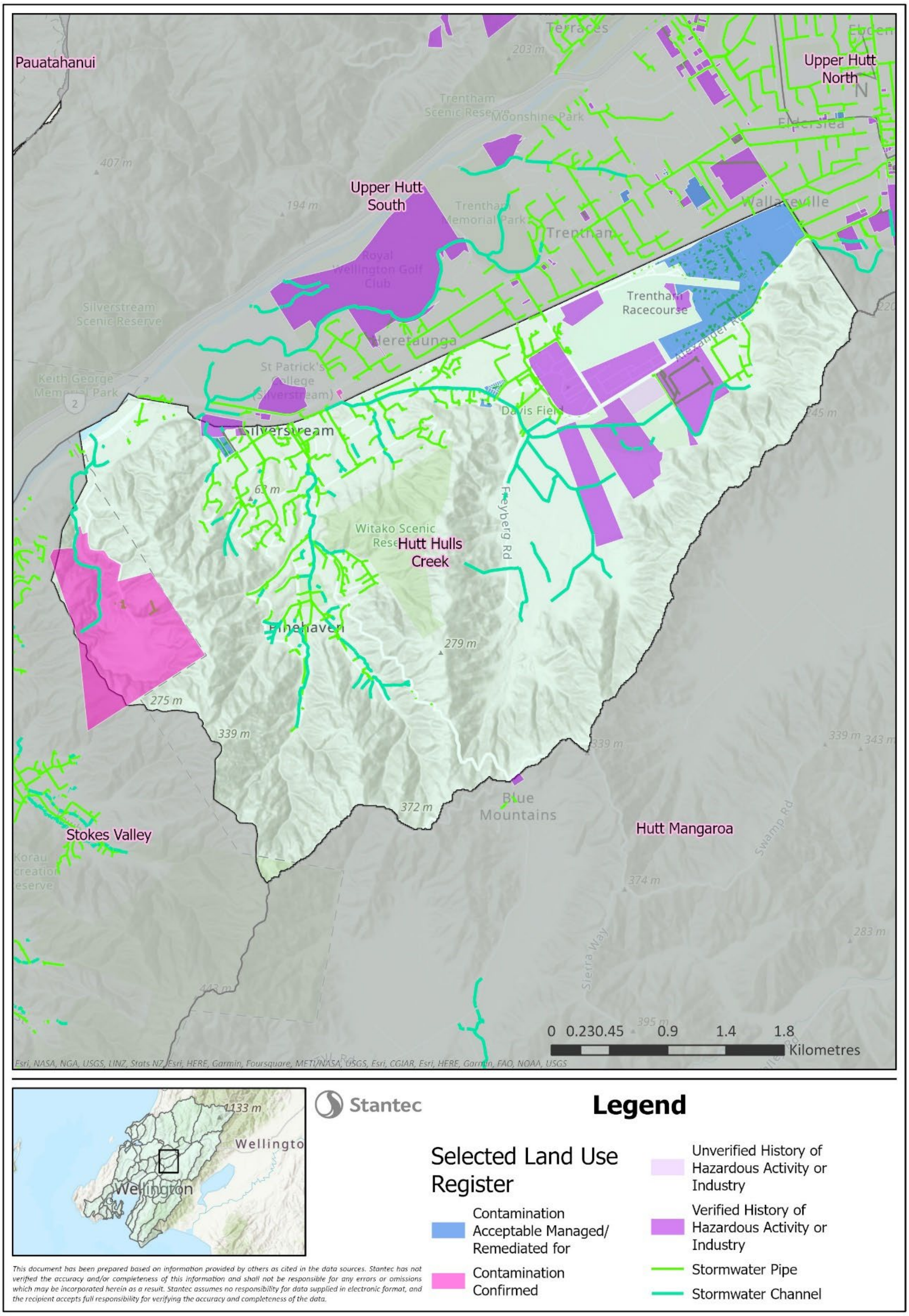


Figure 4-26: Hulls Catchment SLUR sites

4.13 Hutt River (Lower Hutt South & North, Upper Hutt South & North, Hutt Headwaters)

4.13.1 Description of Existing Environment

Te Awa Kairangi / Hutt River is the largest watercourse in the Wellington Harbour catchment. It is a steep gravel-bearing river which originates in the indigenous forest covered slopes of the southern Tararua Ranges and flows approximately 55 km to Wellington Harbour at Seaview. It has a catchment area of 655 km^2 of which 66% is in indigenous forest and scrub, 13% is in exotic forest, 11% is in pasture and 8% is in urban land use. It has a median flow of approximately 12.6 m^3/sec at Birchville. Its main tributaries are the Pakuratahi, Mangaroa, Akatarawa and Whakatiki Rivers (described in section 4.17). The bed gradient reduces at Kennedy Good Bridge, and again at the Ewen Bridge as the river approaches Wellington Harbour. The gravel bed load material drops out along this reach, from about Belmont, and in the Harbour adjacent to the river mouth.

The Hutt River has a long history of flood protection and river control works which have resulted in channel widths far less than their natural state, constrained by extensive bank protection with rock and willow, as well as local bedrock confinement (Hudson, 2010). Floods no longer shape the river as they once did, and lateral channel and off-channel connectivity is spatially limited. The Hutt River and its tributaries have a significant degree of interaction with underlying groundwater resources which influence surface flow along its length (Keenan, Thompson, & Mzila, 2019).

The Hutt Estuary is a 3km long "tidal river mouth" type estuary which drains into Wellington Harbour at Petone. It has been extensively reclaimed and modified, and the banks clad with large rip-rap boulders. Saltwater extends up to 3km, nearly as far as Ewen Bridge, and well upstream of the Waione Street Bridge.

The estuary is highly modified from its original state. In 1909 it was much larger and included several large lagoon arms and extensive intertidal flats and saltmarsh vegetation. Between 1900 and 1960 most of the intertidal flats and lagoon areas were re-claimed and the estuary was trained to flow in one channel between rock rip-rap lined banks. The terrestrial margin, which was originally vegetated with coastal shrub and forest species, was replaced with urban and industrial land-use (Robertson & Stevens, 2011).

As a result of these modifications the Hutt Estuary now has low habitat diversity. High value habitats such as tidal flats, saltmarsh and sea-grass beds are virtually absent. Instead, the estuary is dominated by lower value, sub-tidal sands and muds and artificial sea walls (Robertson & Stevens, 2011).

The mid-lower estuary, below the Waione Street Bridge, is dredged to a maximum depth of about 4 meters below the water level by GWRC to manage the flooding risk during high river flows. Wear (2011) described the sediments in the extraction zone as essentially anoxic and the benthic biota as "depauperate" and of low ecological value. Nevertheless, parts of the estuary outside of the extraction zone, including the western mudflat embayment and the intertidal flats upstream of the bridge, are important areas for juvenile flatfish and significant feeding/refuge areas for wading and non-wading birds (Wear, 2011; Stevens & Robertson, 2014; McArthur, Small, & Govella, 2015). Wear (2011) described the intertidal biota inhabiting the south-eastern flood protection wall as typical of that occurring elsewhere in Wellington Harbour.

Since 2010, Greater Wellington Regional Council has undertaken annual State of the Environment (SOE) monitoring in Hutt Estuary to assess trends in intertidal sediment deposition and macroalgae growth. The 2020/2021 sediment monitoring report concluded that the sedimentation rate over the past 10 years shows an overall trend of deposition, which has increased over the last 5 years (Roberts, 2021). The author observed that most recent sediment accrual is sand dominated with a relatively low mud content, comparable to previous years.

The 2020 macroalgae survey report calculated a 'moderate' macroalgal quality rating, reflecting the widespread presence, but generally low biomass and absence of entrainment, of intertidal macroalgae in the estuary, with growths not causing significantly degraded intertidal sediment conditions (Stevens & Forrest, 2020). The authors concluded that the consistent widespread cover of opportunistic green macroalgae throughout the intertidal estuary strongly suggests elevated catchment nutrient inputs (from both water column, sediment and groundwater sources) are driving the observed growths.

4.13.2 The Waiwhetū Aquifer groundwater resource

The Waiwhetū Aquifer is a natural underground water system located beneath the Hutt Valley and Wellington Harbour. It is generally located between 20m and 70m below ground level and is recharged mostly by Hutt River water seepage from a 5km stretch downstream of Taita Gorge where unconfined conditions prevail. The reported mean residence time for groundwater abstracted at the Waterloo Bore Field has been 3-7 years.

Water sourced from the Waiwhetū Aquifer is drawn from eight bores located along the "Knights Road spine", collectively known as the Waterloo Bore field. The Waterloo Bore Field is the primary source of water for the Hutt City and forms part of the supply network for Wellington City, supplying an average total of 74,000 and 81,000 customers, respectively.

Prior to April 2017, water from the bore field was delivered to the reticulated network without treatment, via the Waterloo Water Treatment Plant. The aquifer's natural filtration processes and confined environment had been relied upon to remove or inactivate (disable) waterborne pathogens. In almost four decades of monitoring before 2017 water samples had never returned a positive *E. coli* result. The bores and aquifer were assessed as meeting the requirements for secure status under the New Zealand Drinking Water Standard (DWSNZ).

Shortly after the Kaikoura earthquake in December 2016 an increasing trend of faecal indicator bacteria was detected within the bore field, indicating that the aquifer was more vulnerable to contamination than previously assumed. This led to a decision in 2017 to manage the contamination risk by providing UV treatment and chlorination at the Waterloo WTP. This provides protection against microbial contaminants; however, the water supply remains vulnerable to chemical contamination and aquifer disturbances.

A recent assessment of the risks to the Waiwhetū Aquifer prepared by Wellington Water (Wellington Water Ltd, 2023) found that the Aquifer is not sufficiently protected and that the risks are likely to increase in the future. These risks are broadly categorised as contaminant sources, activities that create/exacerbate contaminant pathways and/or water availability risks. Increasing urban intensification in the Lower Hutt Valley, increasing water demand and climate change could all place additional pressure on the Waiwhetū aquifer water supply.

Stormwater discharges are a potential source of contamination. Stormwater mobilises contaminants from roads, carparks, roofs, etc, delivering these to the waters of Te Awa Kairangi or its tributaries from where a proportion of the flow may enter the aquifer. The risk associated with an intermittent stormwater discharge is, however, relatively low compared to other sources because of the large dilution achieved in the river on route to the aquifer. By contrast a dry weather chemical spill may enter groundwater with minimal dilution and with far greater potential for a damaging impact on the aquifer, particularly in the case of an undetected long-term leak (for instance from an underground fuel tank).

Wellington Water (2023) made several recommendations to improve the security of the Waiwhetū Aquifer water supply. The authors recommended that:

- Stricter controls of activities within source water risk management areas be implemented, including piling, excavations, and drilling investigations.
- A more coordinated approach be adopted for source water risk management between Wellington Water, GWRC and HCC, including sharing of information around high-density urban development, hazardous activities, chemical storage, and contaminated sites.
- Additional studies be completed to understand groundwater dynamics and contaminant pathways and potential risks in the Waiwhetū aquifer and wider Lower Hutt Valley aquifer system.

4.13.3 Stormwater management areas

The SMP defines the mainstem of the Hutt River as a single catchment extending from Wellington Harbour to the Hutt headwaters in the Tararua Ranges. The stage 2 stormwater consent and SMS have adjusted the boundaries to provide five smaller management units as shown in Table 4-17.

Table 4-17: Management units for the Hutt River mainstem

Number	Sub catchment Name	Monitoring sites		
		Stormwater	Freshwater Stream	Coastal water
15	Lower Hutt South	HUSW10, HUSW11, HUSW12, HUSW13	RS22, HUFW2, OPFW1, TEFW1	HUCW1, HUCW2, HUCW3
16	Lower Hutt North	HUSW8, HUSW9	HUFW5, HUFW6	none
17	Upper Hutt South	HUSW4, HUSW5, HUSW6, HUSW7	RS21, HUFW1	none
18	Upper Hutt North	HUSW1, HUSW2, HUSW3	None	none
19	Hutt Headwaters	none	RS20 (near Te Marua Lakes)	none

4.13.4 Current state summary

EMP monitoring is conducted at the stormwater, freshwater stream and coastal water sites listed in Table 4-17 (shown in Figures 4-27 to 4-36). The results of SMP monitoring are attached in Appendices A to R while the current state of these watercourses is summarised below and in Table 4-18.

Water quality was high in the upper reaches of the Hutt River but decreased in a downstream direction, especially in respect on faecal indicator bacteria and nitrate nitrogen concentrations. By contract, concentrations of dissolved copper and zinc remained low at all mainstem monitoring locations. A slight to moderate downstream deterioration is evident in respect of periphyton and macroinvertebrate communities, corresponding with increased nutrient concentrations.

Faecal indicator bacteria concentrations were elevated at all minor tributary sites and at the three coastal water sites on Petone Beach.

GWRC's Wellington Harbour marine sediment quality investigations in 2020 include three sites (WH13, WH15 and WH17) located immediately seaward of the Hutt Valley. Sediments at site WH15 and WH17, which are located close to the mouth of Hutt River, did not exceed any ANZG (2018) DGV or ARC amber/red criteria for any contaminant tested. These are the only two sites in the study with no guideline exceedances. Sediments at site WH13, which is located further away from the Hutt River mouth, exceeded ANZG (2018) DGV for mercury and ARC amber for lead but no other exceedances were recorded. The relatively low concentration of contaminants normally associated with urban stormwater runoff is likely due to the small proportion of the Hutt River catchment in urban land-use and the high load of sediment discharged by the river that are sourced from other, non-urban land uses.

Since 2010, Greater Wellington Regional Council has undertaken annual State of the Environment (SOE) monitoring in Hutt Estuary to assess trends in intertidal sediment deposition and macroalgae growth. The 2020/2021 sediment monitoring report concluded that the sedimentation rate over the past 10 years shows an overall trend of deposition, which has increased over the last 5 years (Roberts, 2021). The author observed that most recent sediment accrual is sand dominated with a relatively low mud content, comparable to previous years.

The 2020 macroalgae survey report calculated a 'moderate' macroalgal quality rating, reflecting the widespread presence, but generally low biomass and absence of entrainment, of intertidal macroalgae in the estuary, with growths not causing significantly degraded intertidal sediment conditions (Stevens & Forrest, 2020). The authors concluded that the consistent widespread cover of opportunistic green macroalgae throughout the intertidal estuary strongly suggests elevated catchment nutrient inputs (from both water column, sediment and groundwater sources) are driving the observed growths.

A baseline assessment and characterisation of intertidal and subtidal habitats at Petone Beach was conducted in January 2018 by GWRC as part of wider survey of Wellington beaches (Stevens 2018). Petone Beach consisted of sandy to coarse gravel sediments, with no visible biological growths (e.g. sea lettuce, microalgal mats) or other obvious symptoms that might indicate enriched or otherwise degraded conditions. The only macroalgae evident were small amounts of drift material along parts of the high-tide strand-line. Fine organic detritus and salps were conspicuous along the low-tide strand-line and adjacent shallows. Overall, while the infauna density was highly variable, when considered together with other sediment indicators, Petone Beach was judged to be in "very good" or "good" condition (Stevens 2018).

As part of the 2020 Wellington Harbour subtidal sediment sampling programme, Cummings, et al. (2021b) trialled a benthic health model (BHM) which had previously been used to track the health of New Zealand's intertidal estuarine benthic communities in response to increased lead, copper and zinc contamination ('BHMmetal'). The output from the BHMmetal model is that all Wellington Harbour sites in the vicinity of the Hutt Valley were categorised as 'good'.

Table 4-18: Current state summary – Te Awa Kairangi

Water quality	SW culverts to Hutt River (HUSW1 to HUSW13)	Minor tributaries (OPFW1,TEFW1, HUFW5, HUFW6)	Hutt River Headwaters (RS20)	Hutt River -Upper Hutt (HUFW1, RS21)	Hutt River-Lower Hutt (HUFW2, RS22))	Wellington Harbour at Petone (HUCW1, HUCW2, HUCW3)
Observed scums or foams (% of inspections)	5 - 10%	10 – 30%	no data	<5%	5 - 10%	10 – 30%
Observed oils or grease films	5 - 10%	5 - 10%	no data	<5%	<5%	<5%
Observed change in colour or clarity	>30%	10 – 30%	no data	10 – 30%	10 – 30%	10 – 30%
E. coli (freshwater, NPS attribute state)	no data	D	A	B - D	D - E	Not applicable
E. coli (freshwater, NRP O18 – 95%ile < 540)	no data	Not meeting	Meeting	Meeting 1/2	Not meeting	Not applicable
Enterococci (coastal water, NRP O18 – 95%ile <500)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not meeting
Water temperature (Davies Colley et al. 2013)	no data	A	A	A - D	D	no data
Dissolved oxygen (NPS attribute state)	no data	A	A	A	A	no data
Dissolved reactive phosphorus (NPS attribute state)	no data	A	A	A	A	no data
Nitrate-N (nutrient, ANZG 2018)	no data	no data	Meeting	Not meeting	Not meeting	no data
Nitrate-N (toxicity NPS attribute state)	no data	no data	A	A	A	no data
Ammonia-N (toxicity NPS attribute state)	no data	no data	A	A	A	no data
Dissolved Cu (ANZG 2018)	no data	Not meeting	no data	Meeting	Meeting	no data
Dissolved Zn (ANZG 2018)	no data	Not meeting	no data	Meeting	Meeting	no data
Sediment quality						
Metals (ANZG 2018)	no data	no data	no data	no data	no data	Meeting
Total of reported PAH (ANZG 2018)	no data	no data	no data	no data	no data	Meeting
Ecology						
Periphyton (NRP O19)	Not applicable	no data	Meeting	Meeting 1/2	Not meeting	Not applicable
Macroinvertebrate community (NRP O19)	Not applicable	no data	Meeting	Meeting	Meeting 1/2	Not applicable
Freshwater fish community (NRP O19)	Not applicable	no data	Meeting	Meeting	Meeting	Not applicable
Marine ecology (NRP O19)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Meeting

4.13.5 Assessment against NRP Objective O18 and O19

The NRP contact recreation and Māori customary use objective O18 was achieved for faecal indicator bacteria in the upper reaches of the Hutt River and partially achieved in the middle reaches, but not achieved in the Lower Hutt Reach. Nor was O18 achieved at three Petone Beach coastal water sites.

The NRP biodiversity and aquatic ecosystem objective O19 was fully achieved in the upper reaches of the Hutt River, but further downstream adjacent to Lower Hutt was not achieved for periphyton and was only partially achieved for macroinvertebrate communities.

An assessment against NRP Objective O19 for coastal waters is provided below in Table 4-19.

Table 4-19: Assessment of Hutt Estuary and Petone coast against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	Stevens & Forrest (2020) gave the Hutt Estuary intertidal macroalgae community a 'moderate' quality rating and noted that algae growths are not causing significantly degraded intertidal sediment conditions. There is, however, evidence of organically enriched and anoxic subtidal conditions in the estuary downstream of Waione Bridge, resulting from excessive nutrient driven macroalgae growth (Wear 2011; Stevens, et al., 2016). While the infauna density at Petone Beach was highly variable, when considered together with other sediment indicators, Petone Beach was judged to be in "very good" or "good" condition, based on the rating system used. High numbers of juvenile pipi recorded probably support the more extensive pipi bed that is anecdotally reported to be present in the deeper subtidal (Stevens 2018). The information reviewed here leads to an overall conclusion that NRP Objective O19 is not fully met in Hutt Estuary, but is met at Petone Beach.			

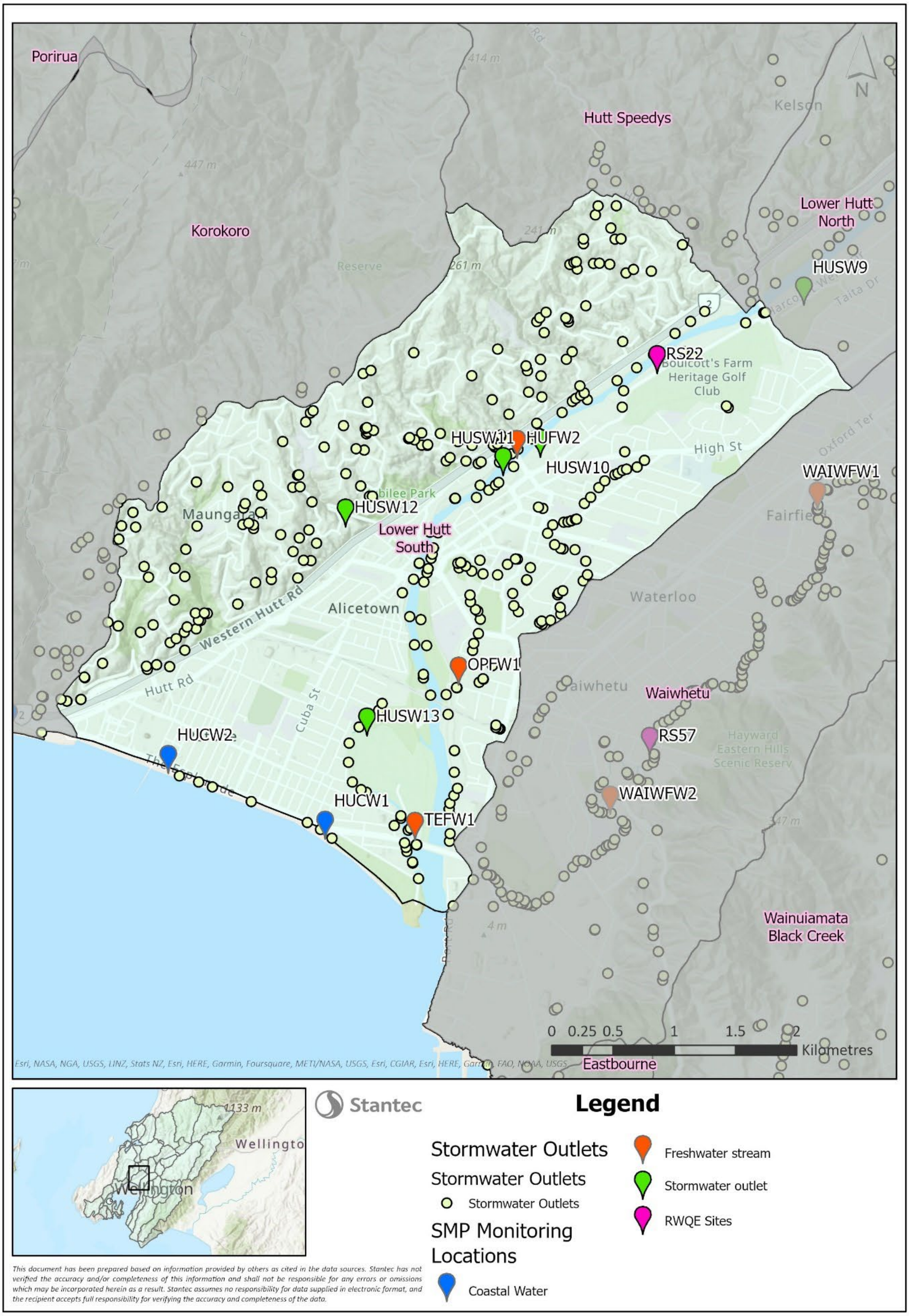


Figure 4-27: Lower Hutt South catchment

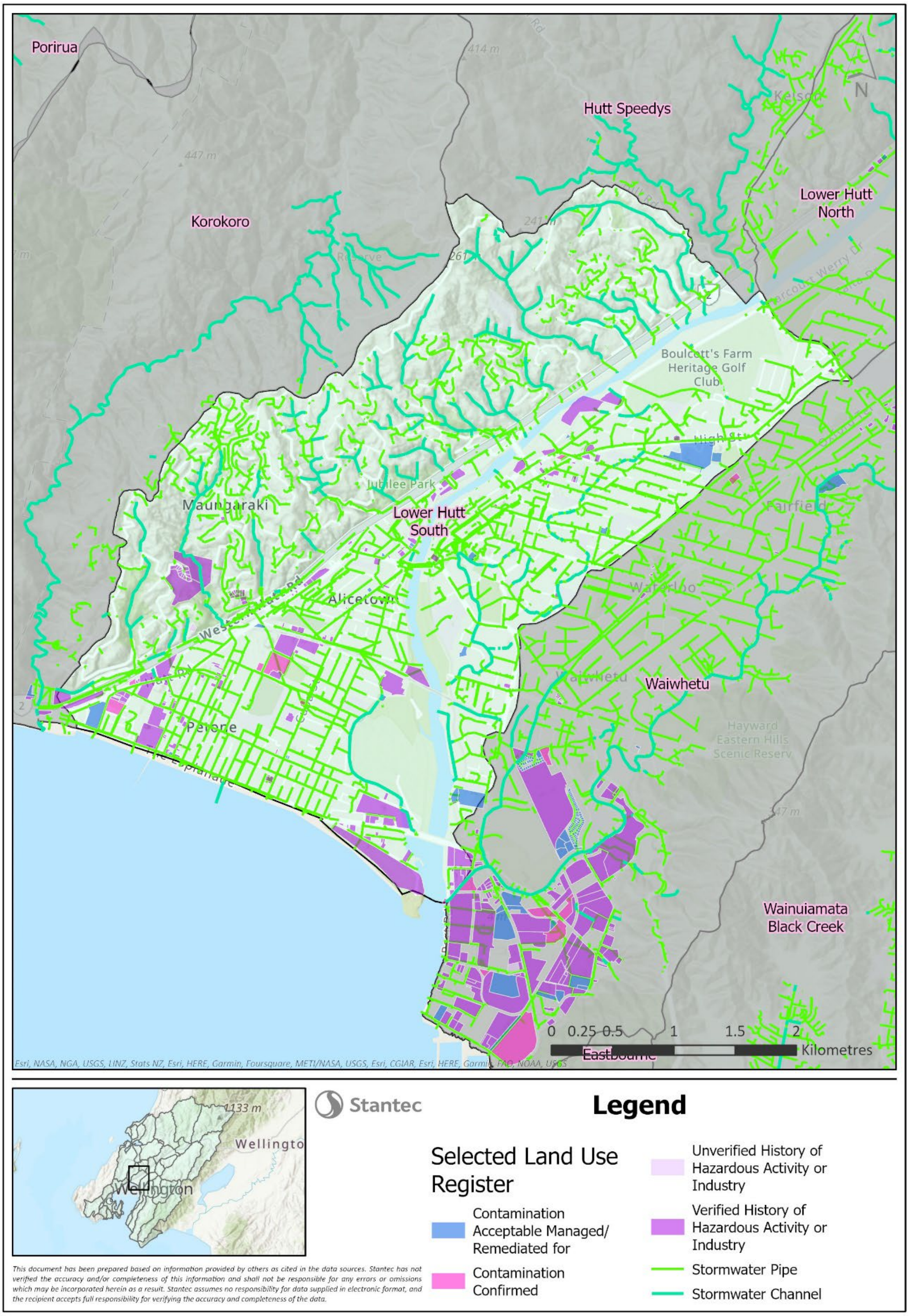


Figure 4-28: Lower Hutt South Catchment SLUR sites

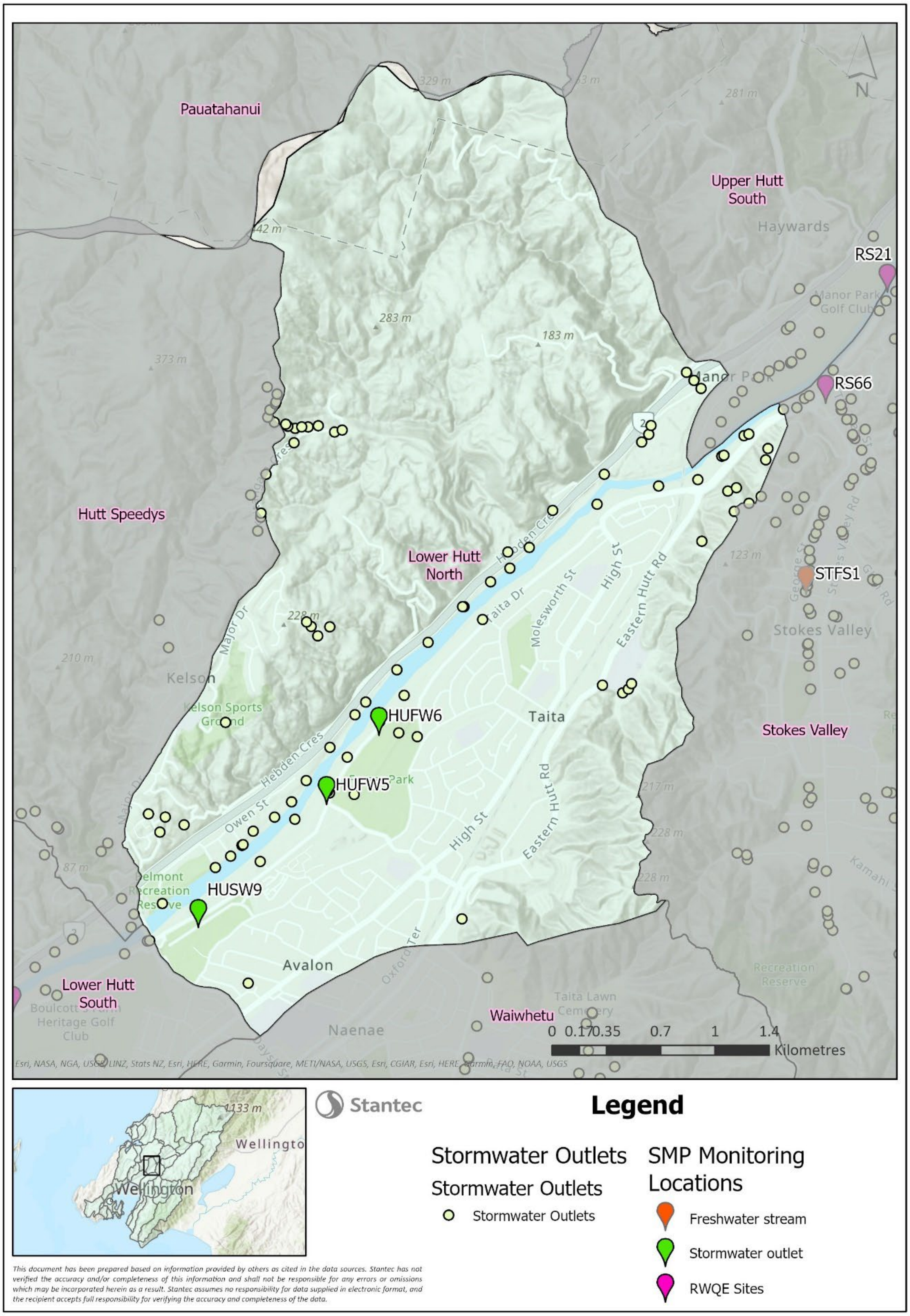


Figure 4-29: Lower Hutt North catchment

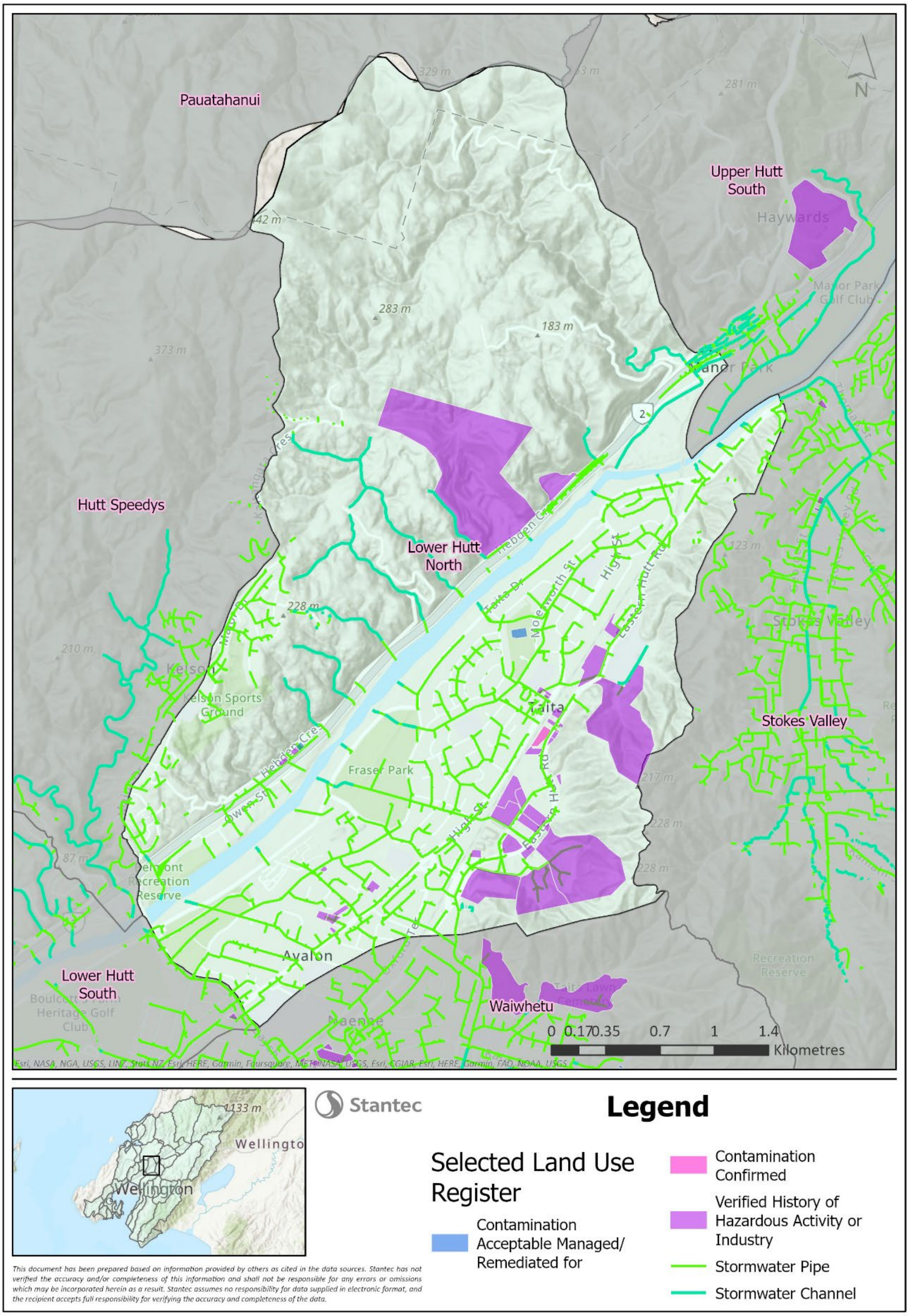


Figure 4-30: Lower Hutt North SLUR sites

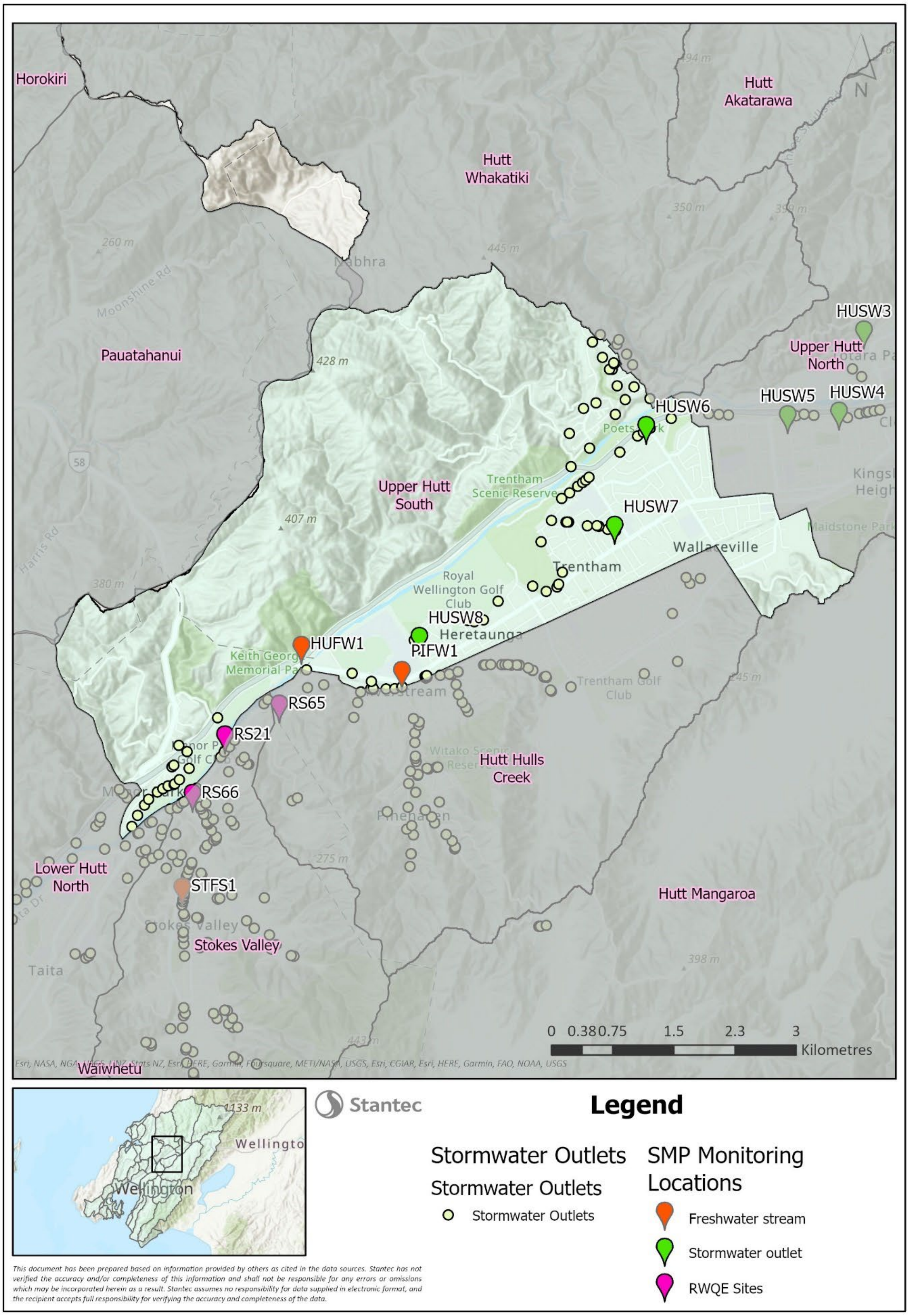


Figure 4-31: Upper Hutt South catchment

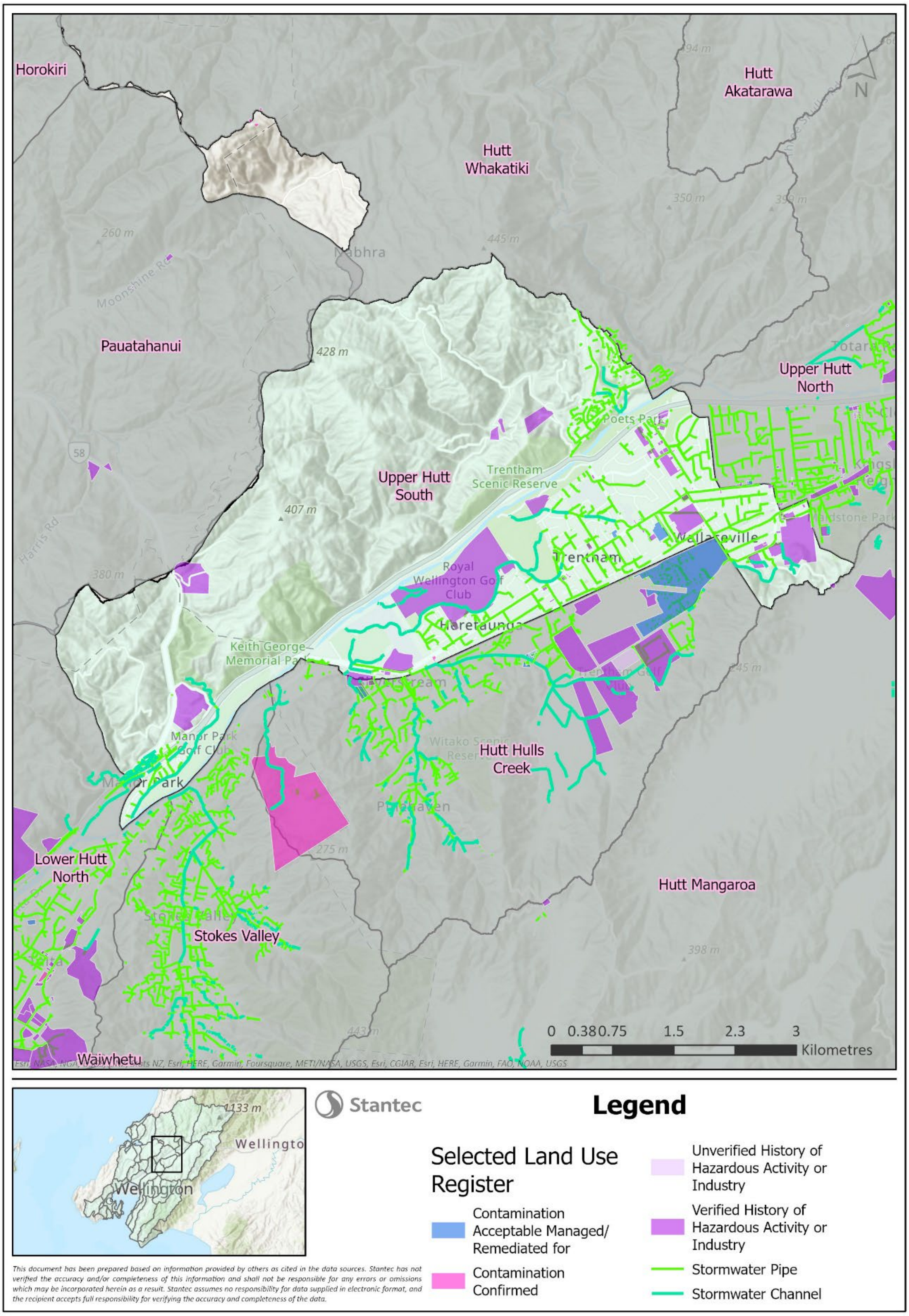


Figure 4-32: Upper Hutt South SLUS sites

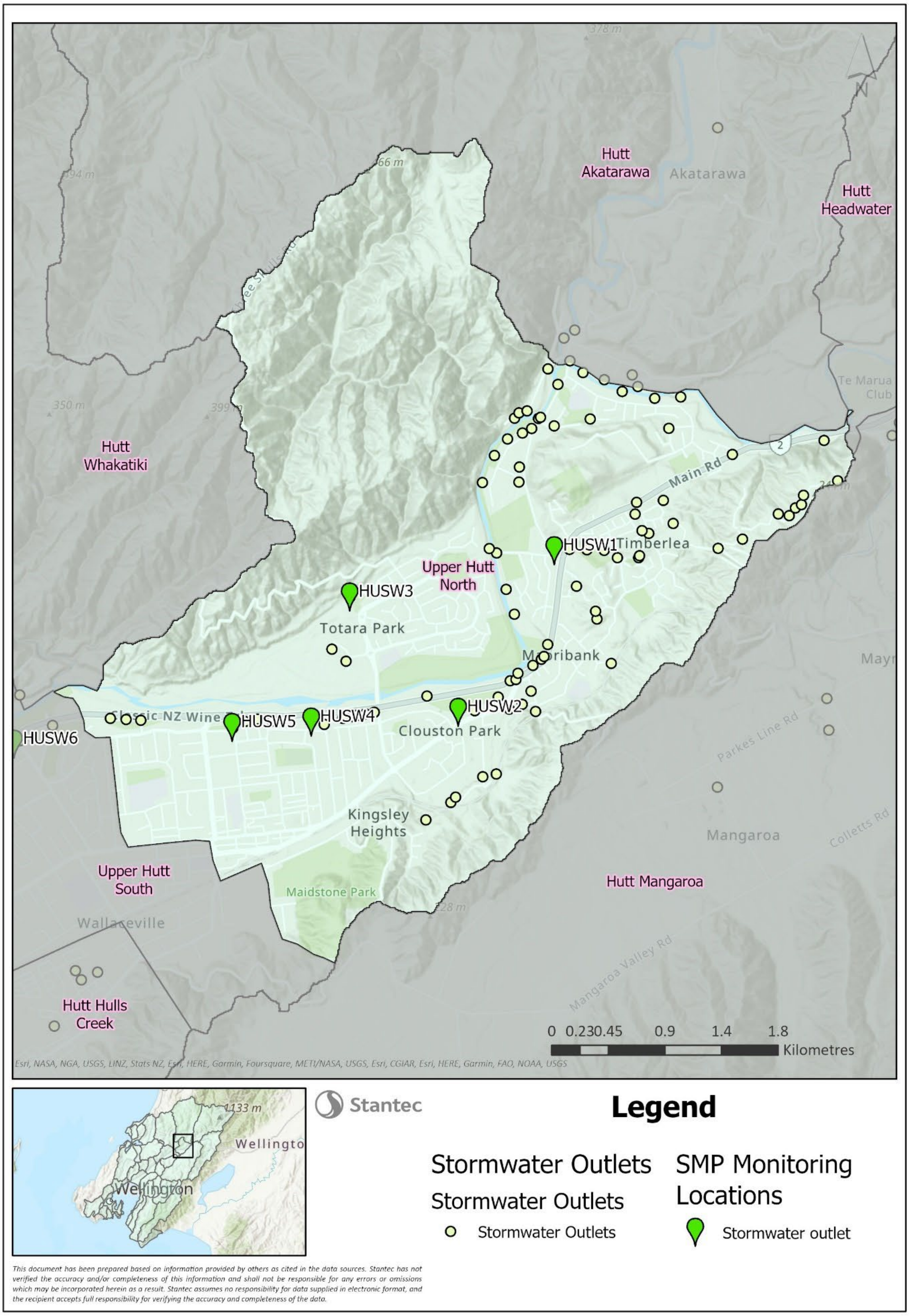


Figure 4-33: Upper Hutt North catchment

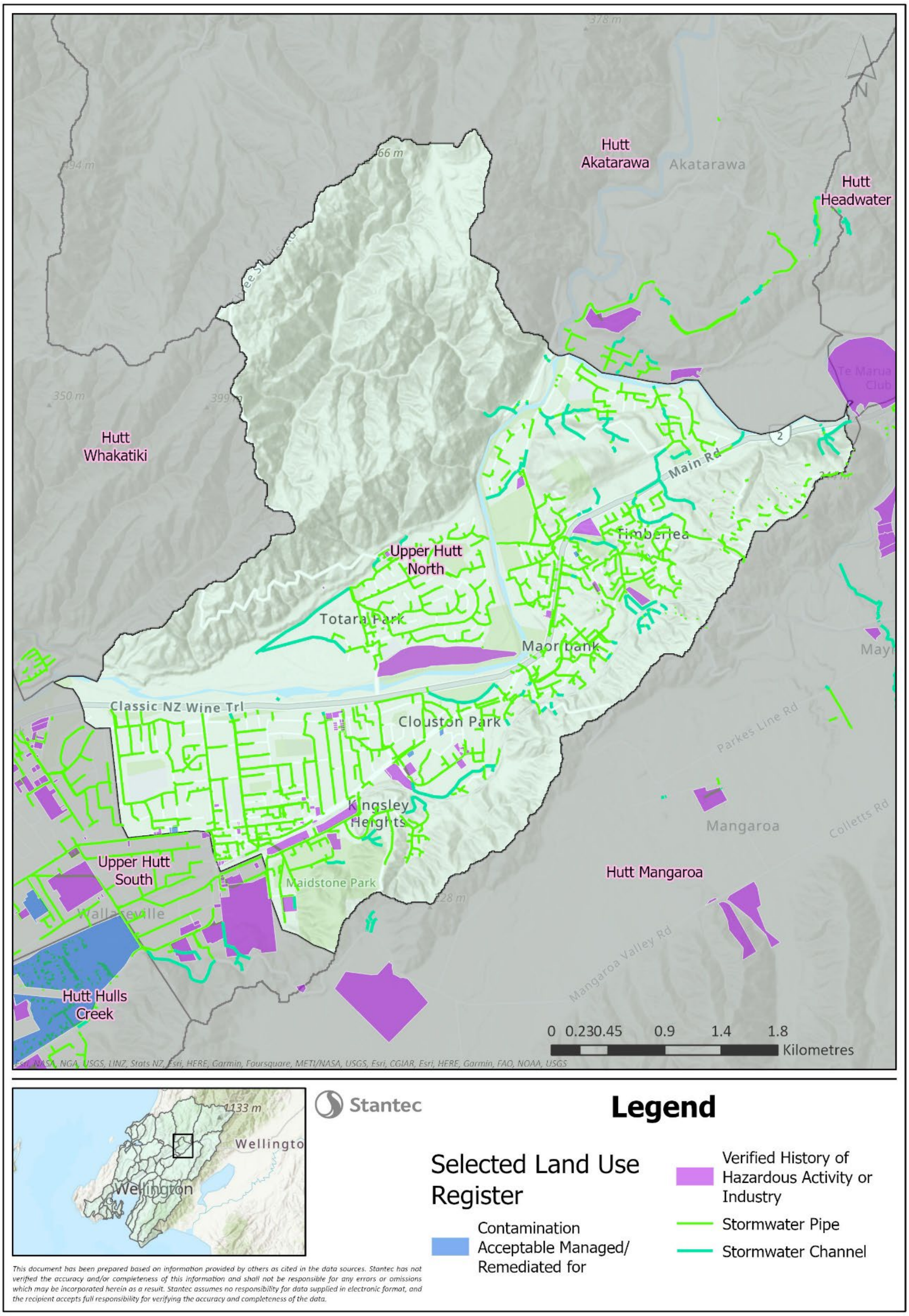


Figure 4-34: Upper Hutt North SLUR sites

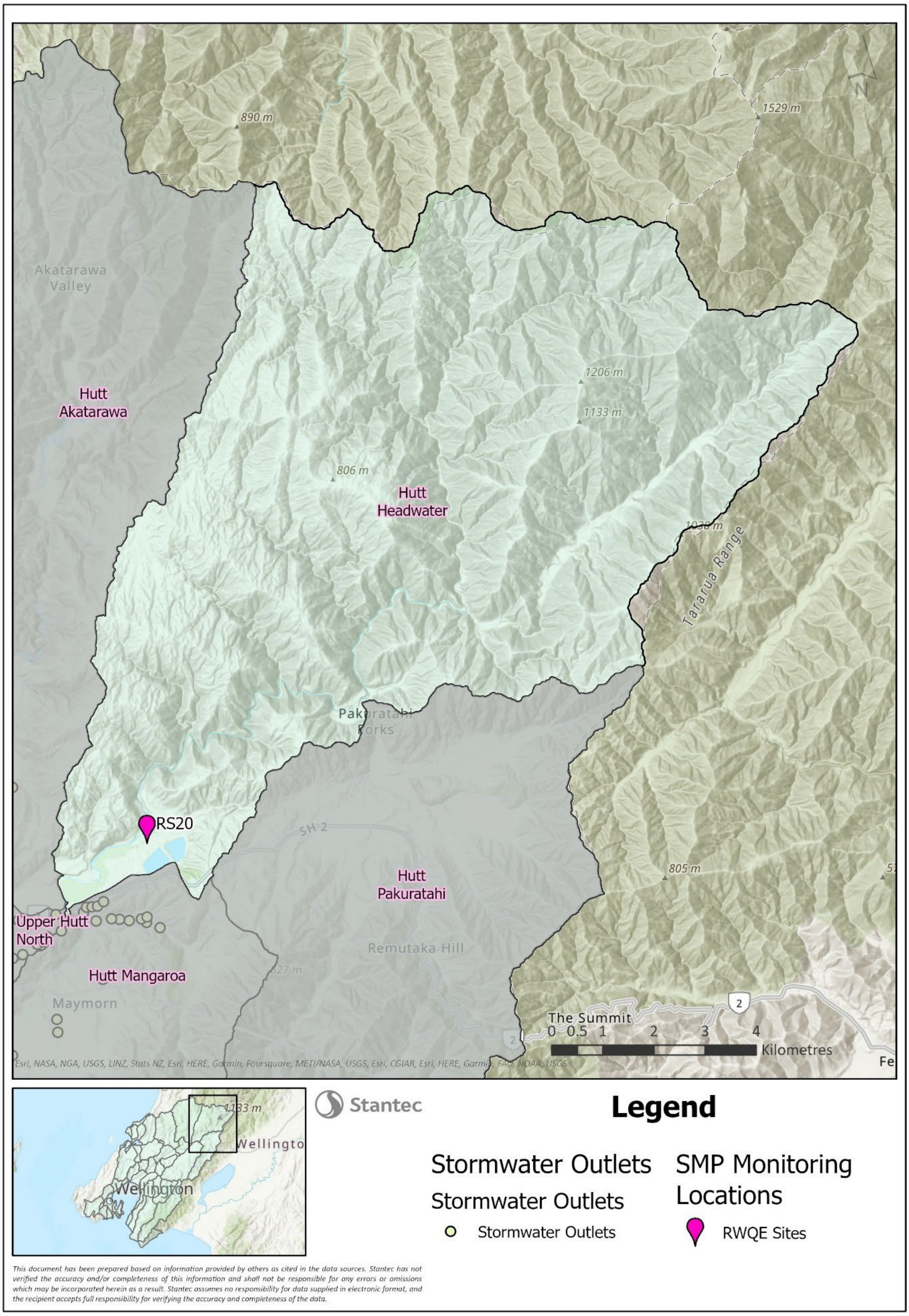


Figure 4-35: Hutt Headwaters

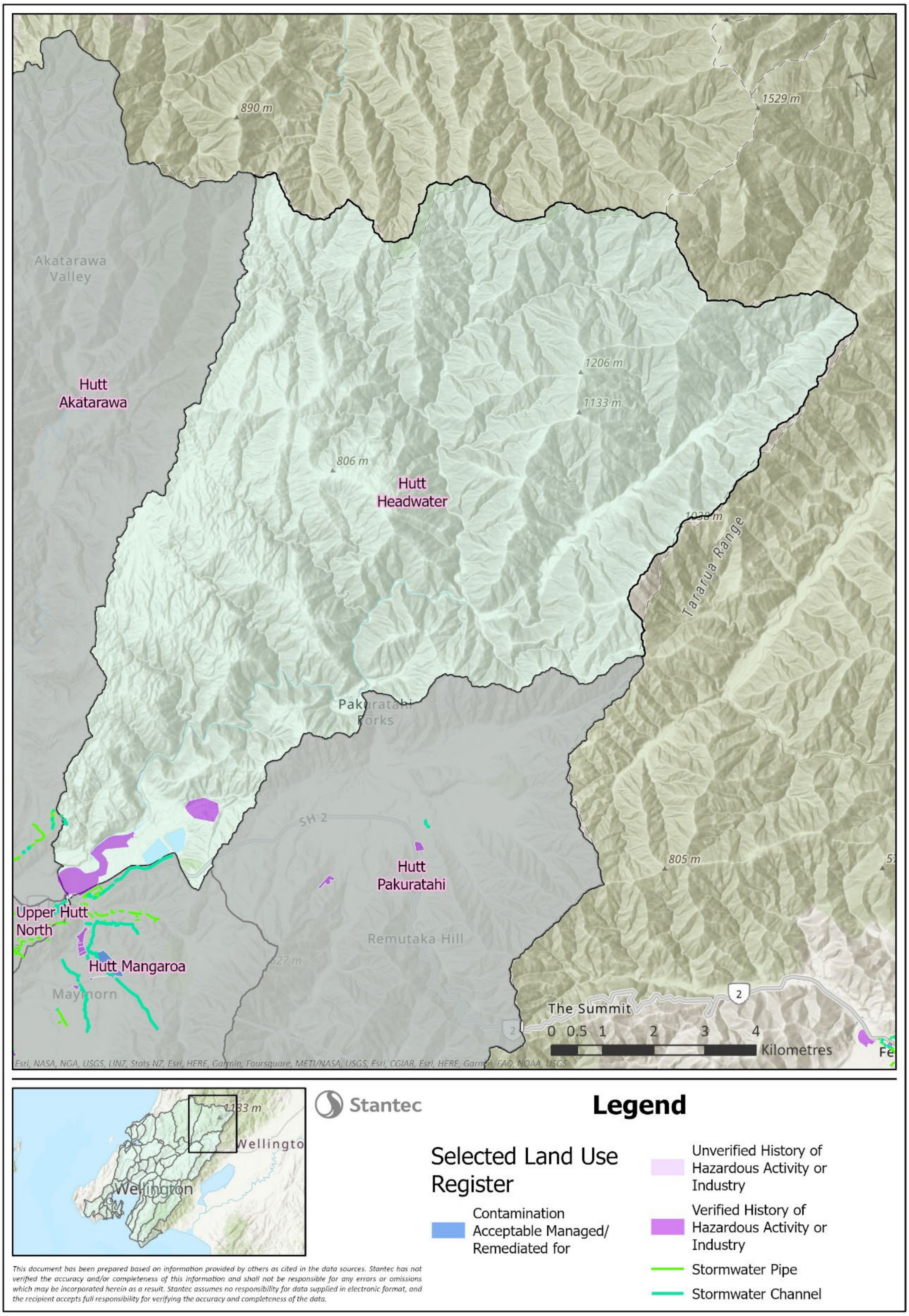


Figure 4-36: Hutt Headwater Catchment SLUR sites

4.14 Hutt tributaries (Whakatikei, Akatarawa, Pakuratahi and Mangaroa rivers)

4.14.1 Description of existing environment

Whakatikei River

The Whakatikei River flows into the Hutt River near Riverstone at Upper Hutt. It is situated on the north-western part of the Hutt Catchment between the Akatarawa and Horokiri rivers and has a total catchment area of 81.8 km^2. It drains a moderately steep catchment predominantly of indigenous forest and scrub (68%) and with significant areas of pine plantation forestry (23%). Very little urban development has occurred in this catchment which has <1% impervious surface, an estimated 1.7km of stormwater network and 5 stormwater outlets.

The New Zealand Freshwater Fish Database (NZFFD) for the period 2012 to 2022 includes records for four species of freshwater fish in The Whakatikei River including two species with an 'At Risk, Declining' conservation status (Dunn, et al., 2017). The calculated Fish Index of Biotic Integrity (F-IBI) for Whakatiki River is 48 which gives an NPS Attribute State of A and meets the NRP Objective O19 for fish (refer to Appendix A for details).

Akatarawa River

The Akatarawa River flows into the Hutt River at Birchville near Upper Hutt. It is situated on the northern part of the Hutt Catchment, between the Whakatikei and Waikanae catchments. It drains a steep catchment of approximately 116 km^2, predominantly of indigenous forest and scrub (84%) and with significant areas of pine plantation forestry (14%). Very little urban development has occurred in this catchment which has less than <0.1% impervious surface, an estimate 2.2 km of stormwater network length and 5 stormwater outlets.

The New Zealand Freshwater Fish Database (NZFFD) for the period 2012 to 2022 includes records for five species of freshwater fish in The Akatarawa River including three species with an 'At Risk, Declining' conservation status (Dunn, et al., 2017). The calculated Fish Index of Biotic Integrity (F-IBI) is 50 which gives an NPS Attribute State of A and meets the NRP Objective O19 for fish (refer to Appendix A for details).

Pakuratahi River

The Pakuratahi River flows into the Hutt River at Kaitoke north of Upper Hutt. It is situated on the northern part of the Rimutaka Range adjacent to the Mangaroa catchment. It drains a steep catchment of just over 81 km^2, predominantly in indigenous forest and scrub (80%) with some production pasture and pine production forestry (7%). The Pakuratahi catchment has very little urban development and less than 0.1% impervious surface. The is no stormwater network in this catchment.

The New Zealand Freshwater Fish Database (NZFFD) for the period 2012 to 2022 includes records for six species of freshwater fish in the Pakuratahi River including three species with an 'At Risk, Declining' conservation status (Dunn, et al., 2017). The calculated Fish Index of Biotic Integrity (F-IBI) for is 52 which gives an NPS Attribute State of A and meets the NRP Objective O19 for fish (refer to Appendix A for details).

Mangaroa River

The Mangaroa River flows into the Hutt River at Te Marua north of Upper Hutt. It is situated on the western side of the Rimutaka Range, adjacent to the Pakuratahi River. It drains a broad low gradient valley with a total area of 104 km^2, which is predominantly indigenous forest and scrub (53%) with substantial areas of production pasture (31%) and pine plantation forestry (14%). Very little urban development has occurred in this catchment which has less than 2% urban land-cover and an estimated 0.01% impervious surface.

The New Zealand Freshwater Fish Database (NZFFD) for the period 2012 to 2022 includes records four species of freshwater fish in the Mangaroa River including one species with an 'At Risk, Declining' conservation status (Dunn, et al., 2017). The calculated Fish Index of Biotic Integrity (F-IBI) is 46 which gives an NPS Attribute State of A but does not meet the NRP Objective O19 for fish (refer to Appendix A for details).

4.14.2 SMP monitoring

Due to the small area of urban development and very limited stormwater system within the Whakatikei, Akatarawa, Pakuratahi and Mangaroa catchments no SMP monitoring has been conducted in these areas.

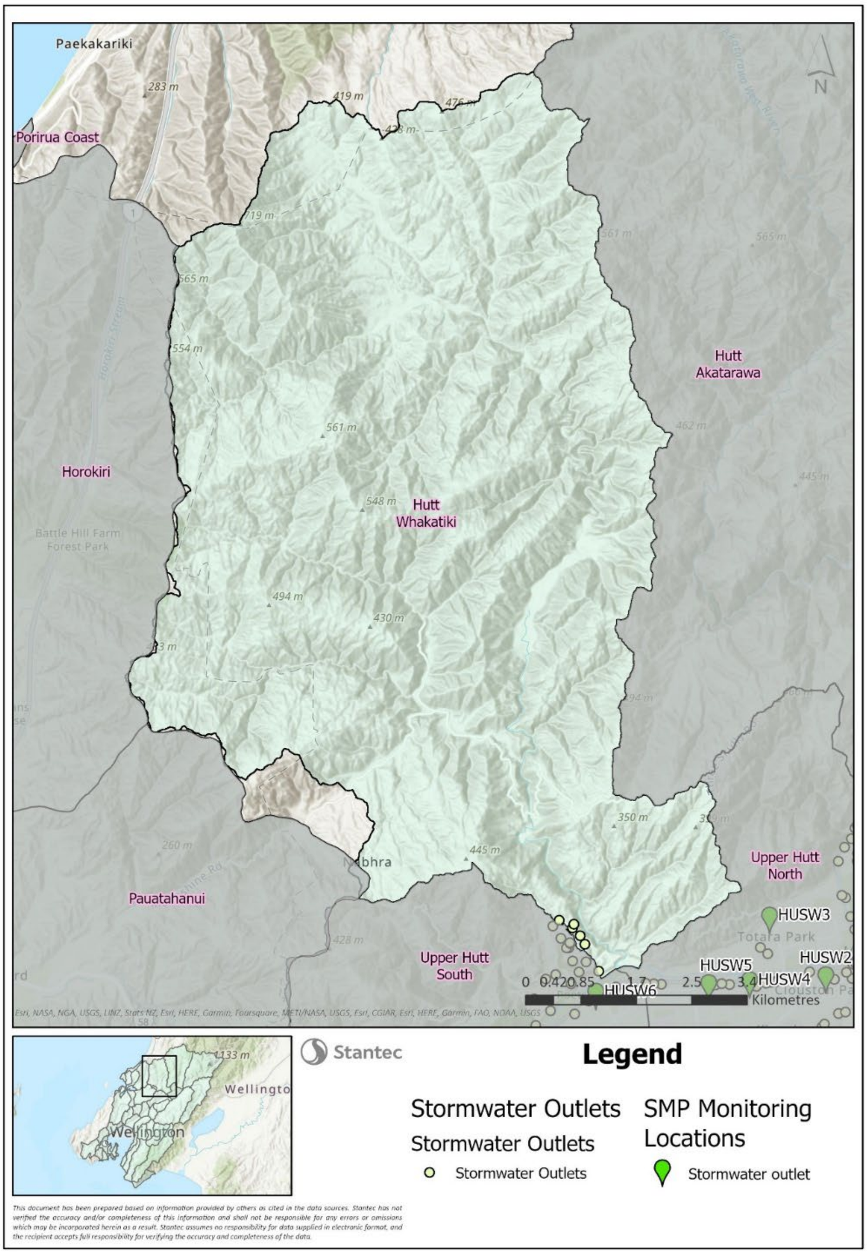


Figure 4-37: Whakatikei Catchment

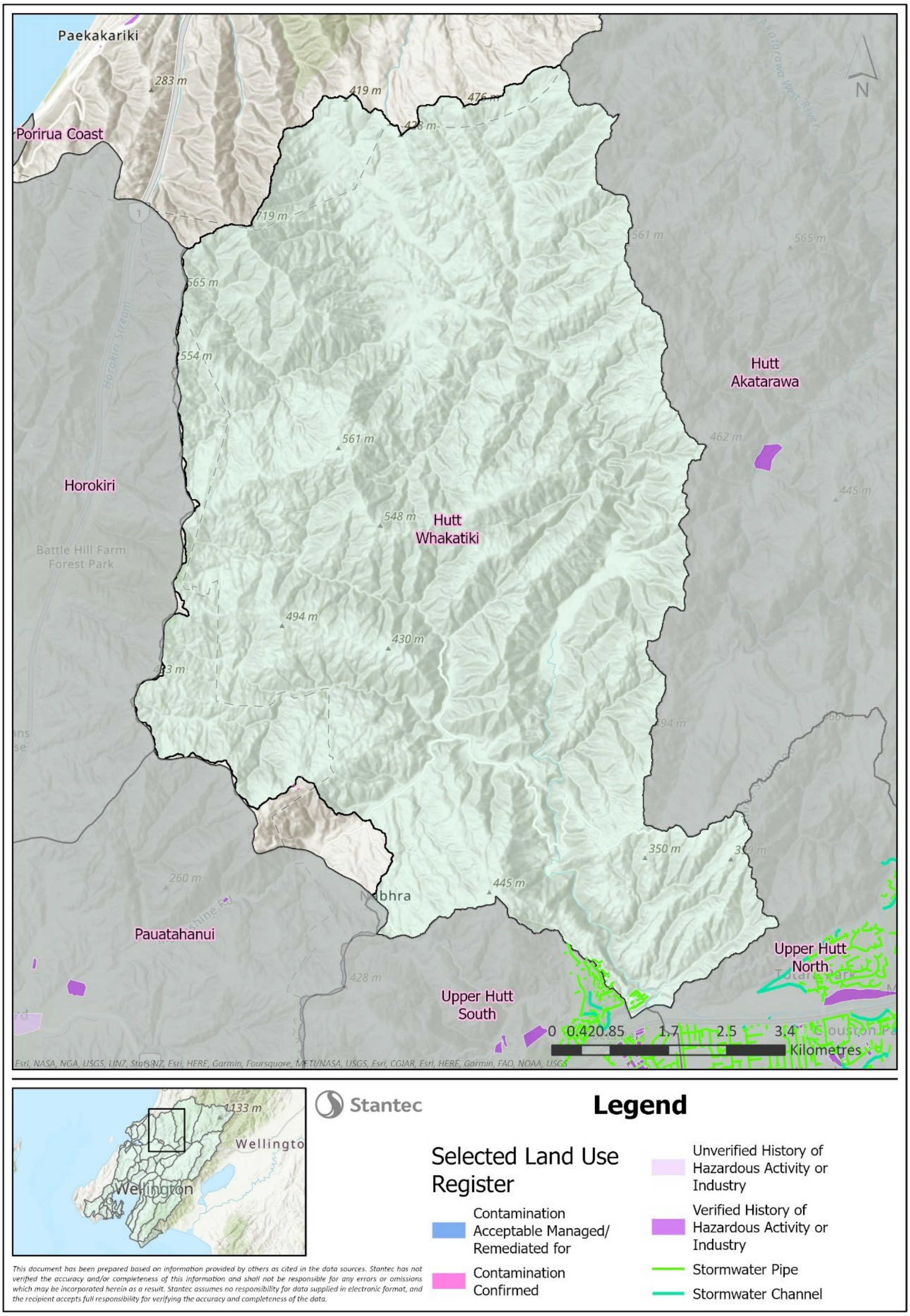


Figure 4-38: Whakatikei Catchment SLUR sites

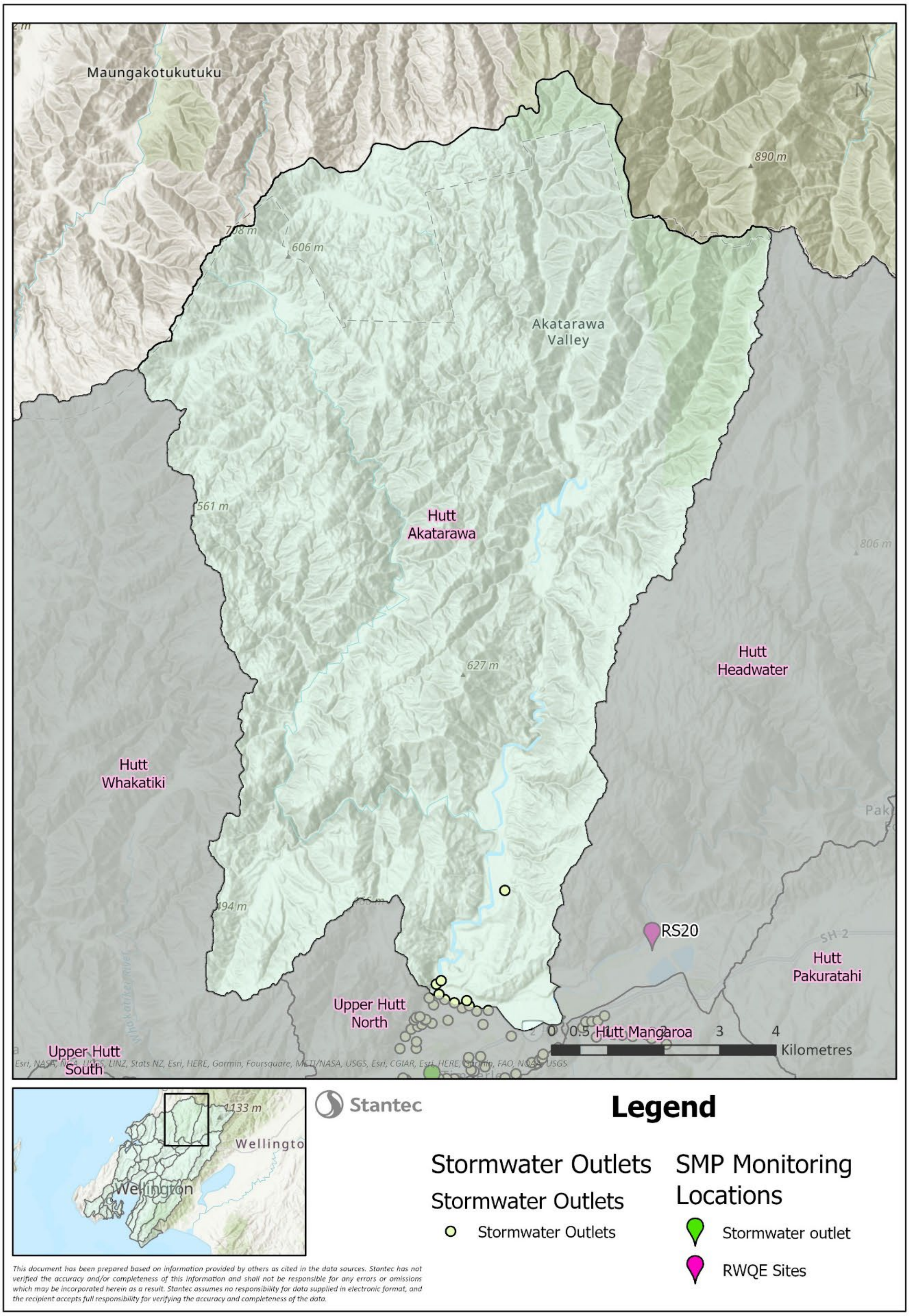


Figure 4-39: Akatarawa Catchment

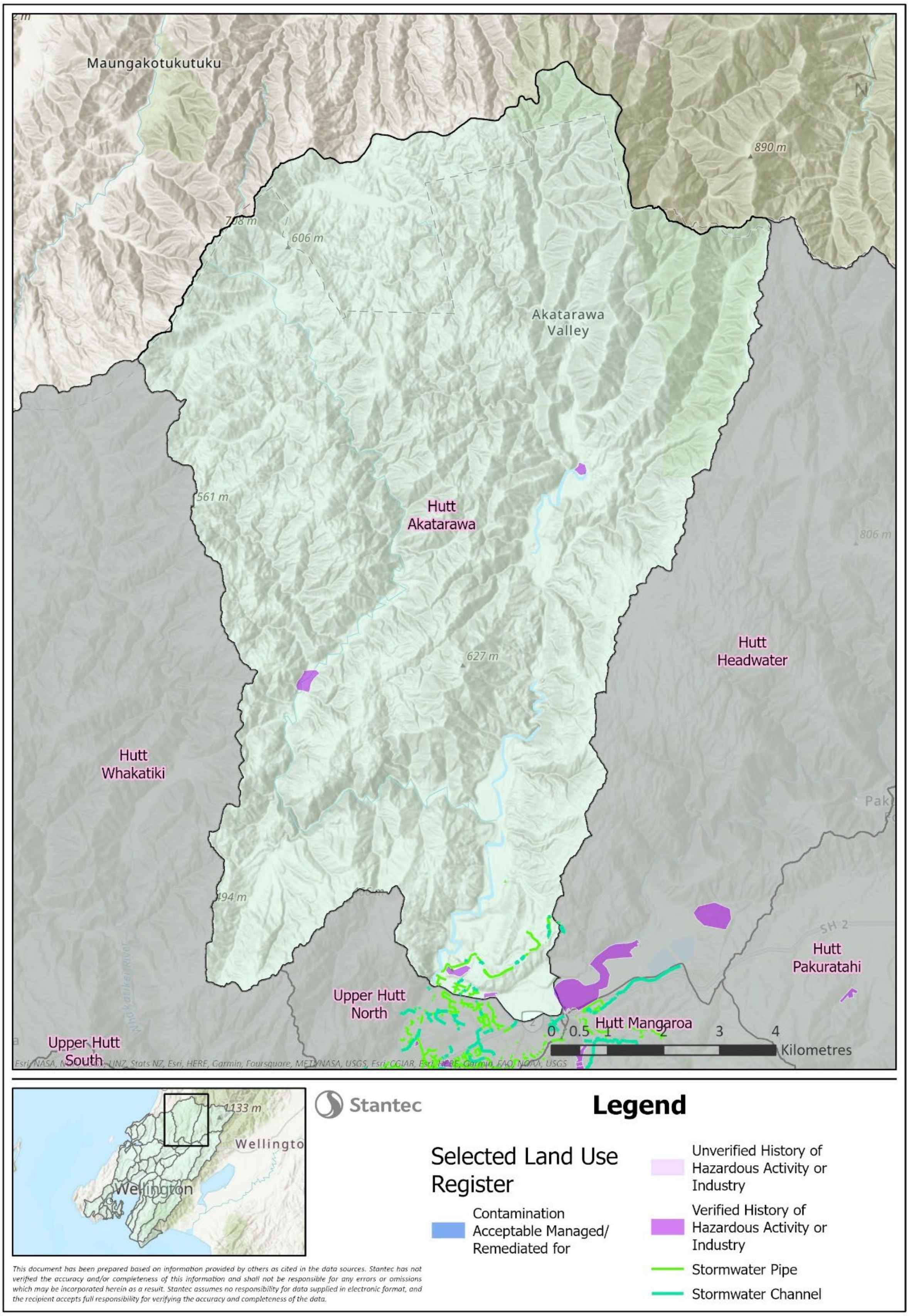


Figure 4-40: Akatarawa Catchment SLUR sites

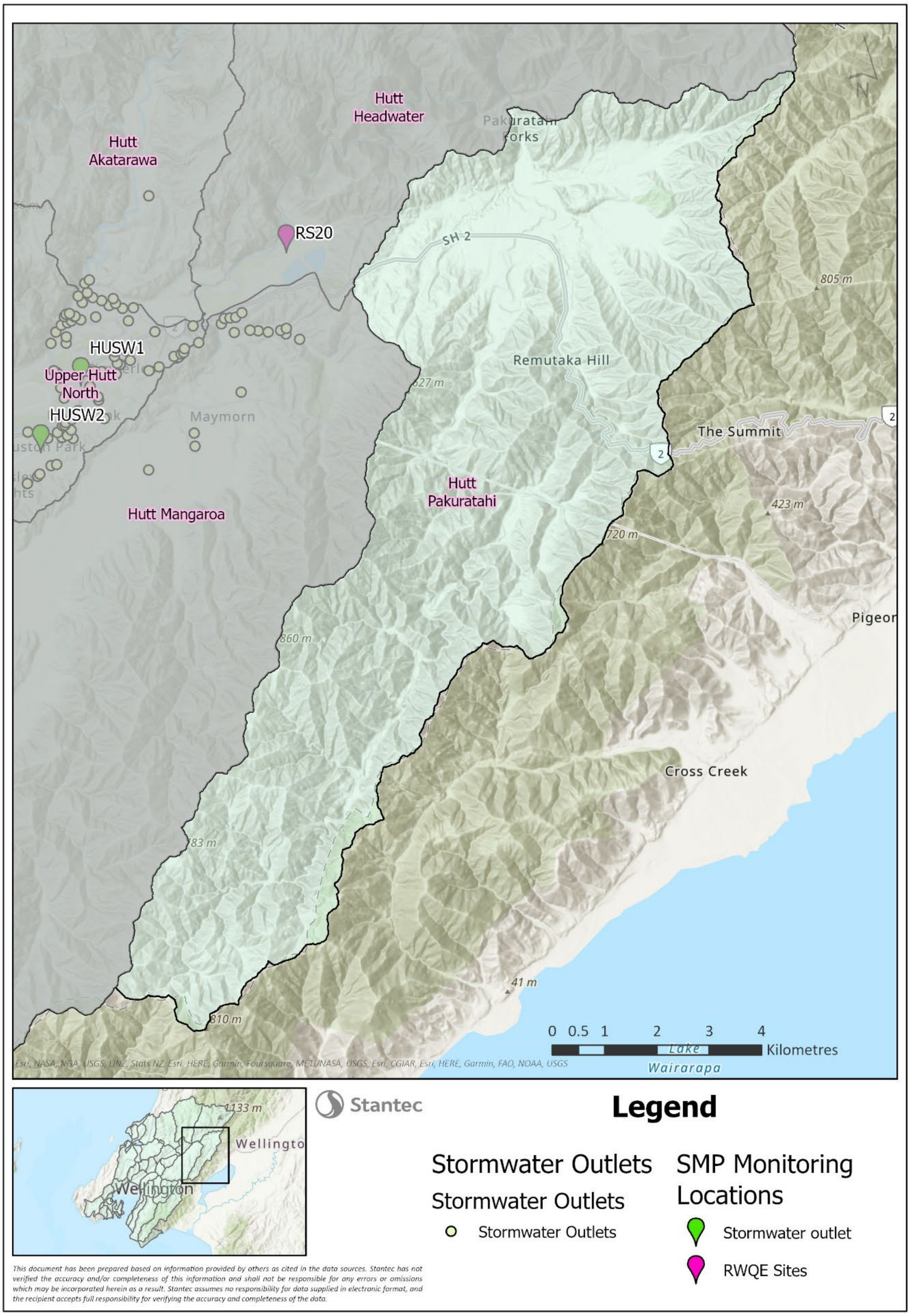


Figure 4-41: Pakuratahi Catchment

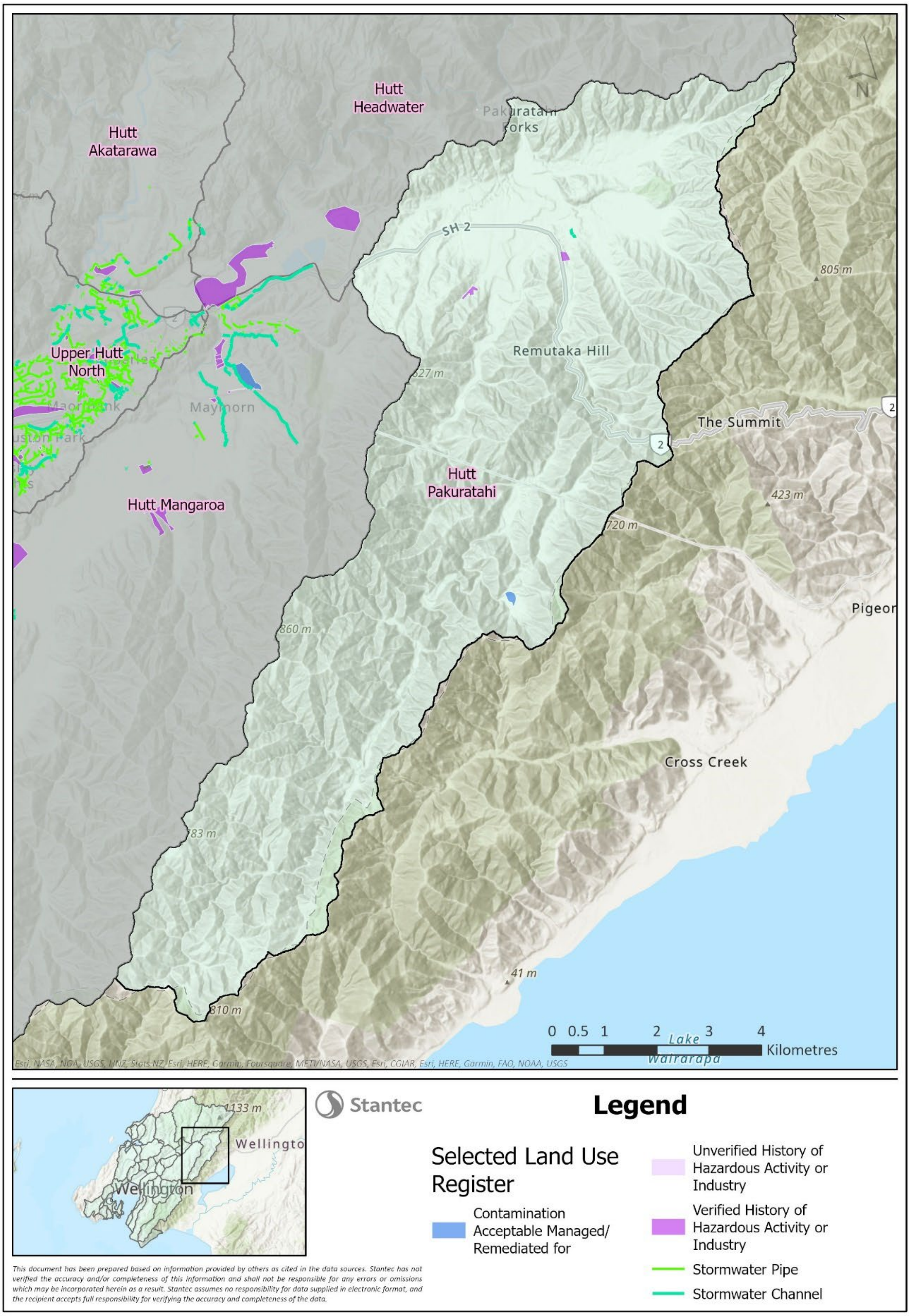


Figure 4-42: Pakuratahi SLUR sites

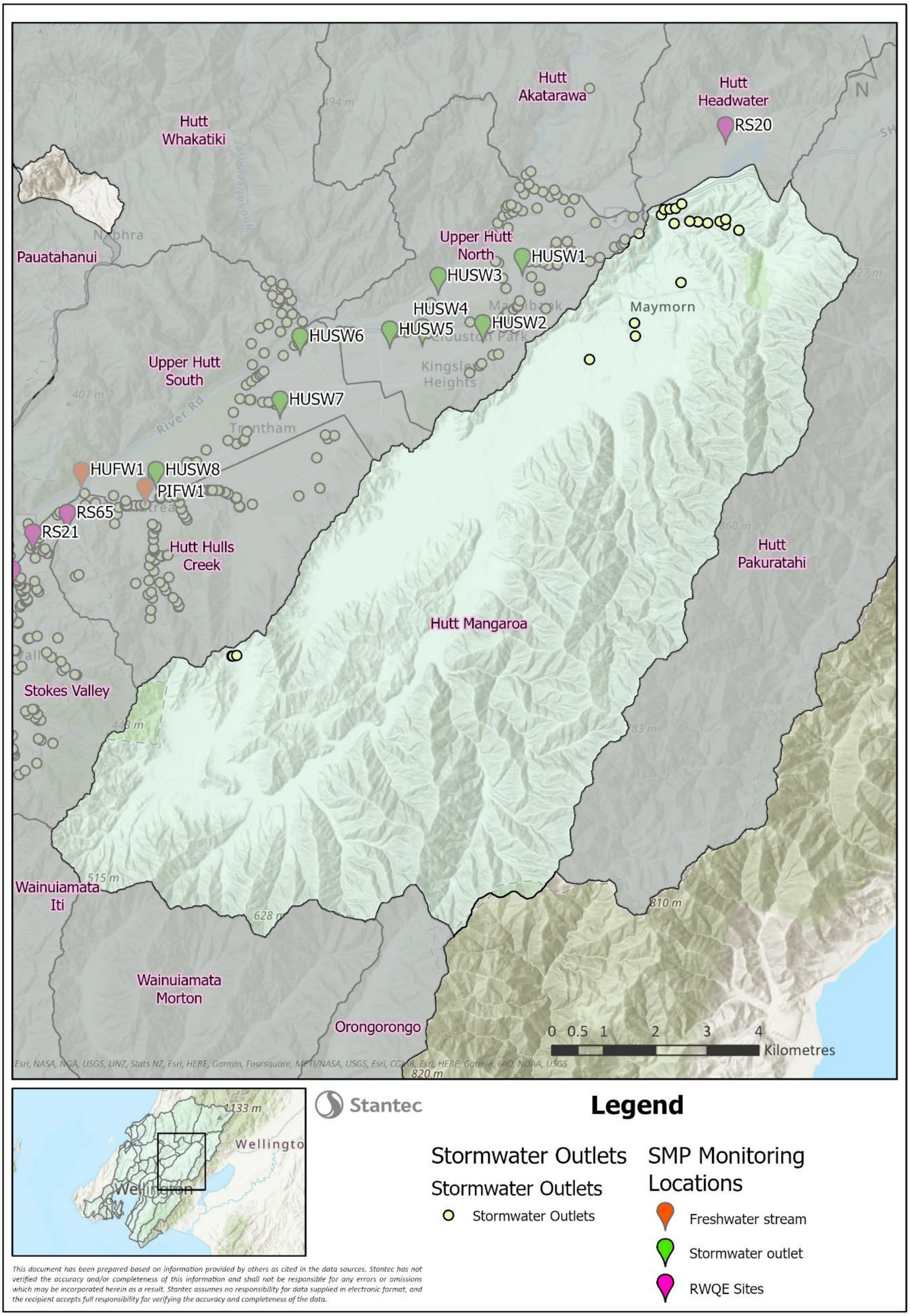


Figure 4-43: Mangaroa Catchment

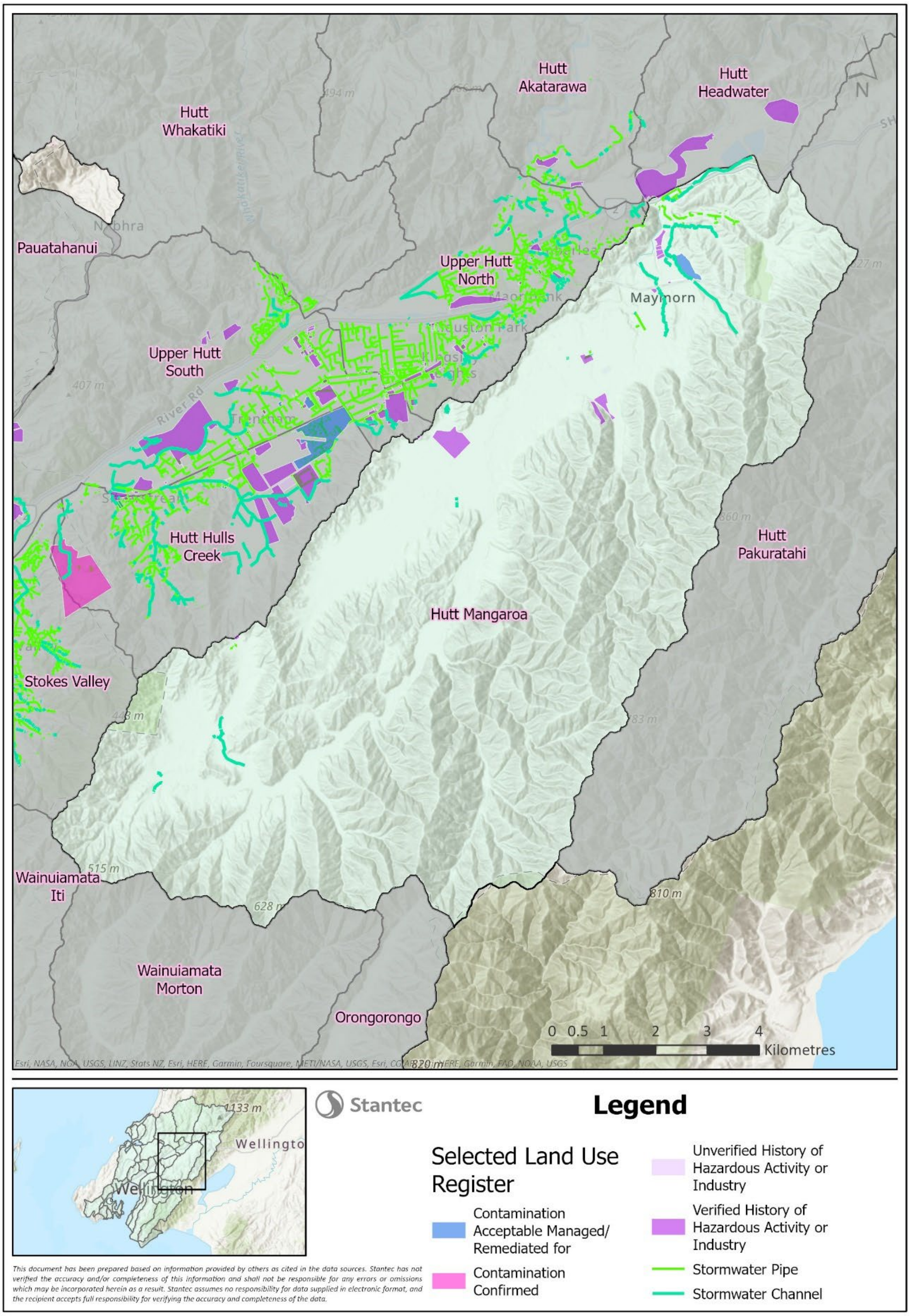


Figure 4-44: Mangaroa Catchment SLUR sites

4.15 Eastern Bays

4.15.1 Description of Existing Environment

The Eastern Bays of Wellington Harbour include a series of small seaside catchments at Sorrento Bay, Lowry Bay, York Bay, Days Bay, Rona Bay, and Robinson Bay. These locations are popular recreation areas enjoyed by a wide range of people engaged in a variety of activities including bathing, surfing, wind/kite surfing, sailing, walking, and sunbathing.

During heavy rain events coastal water quality can be influenced by discharges from local stormwater networks and by the discharge from the Hutt River. The latter can form a visible plume extending all along the Eastbourne Coast to the entrance to Wellington Harbour.

4.15.2 Current state summary

EMP monitoring along the Eastern Bays is conducted at four coastal water sites (shown in Figure 4-45). No freshwater stream monitoring is conducted under the EMP. The results of coastal water and stormwater monitoring are attached in Appendices A to Q while the current state is summarised in Table 4-20.

Faecal indicator bacteria concentrations were elevated at the Lowry Bay coastal water site and did not achieve objective O18 at that location. Objective O18 was however achieved at the Days Bay, Rona Bay and Robinson Bay sites.

Intertidal habitats along the eastern side of Wellington Harbour include estuary, sandy beaches and rocky shores. Moderately sheltered and sheltered rocky reef habitat is found on outcrops between Pt Howard and Eastbourne, with firm sandy beaches and gravel field at Petone, Lowry Bay, York Bay, Mahina Bay, Days Bay and Eastbourne. South of Eastbourne, the rocky reef is moderately exposed, becoming very exposed south of Inconstant Point (EHEA 1998).

McMertrie & Brennan (2016) observed that the intertidal community composition of the Eastern Bays was as expected for this general location (lower North Island) and rocky shore habitat and is similar to the rocky shore communities found elsewhere in Wellington Harbour. No taxa that are indicative of significant nutrient enrichment or fine sediment input were present in any great abundance, with exposure and substrate seeming to be the main factors influencing the communities of this area.

A summary of the current state assessment for the Eastern Bays is provided below.

Table 4-20: Current state summary

Water quality	Lowry Bay (EACW1)	Days Bay (EACW2)	Rona Bay (EACW3)	Robinson (EACW4)
Observed scums or foams	<5%	<5%	5 – 10%	5 – 10%
Observed oils or grease films	<5%	<5%	<5%	<5%
Observed change in colour or clarity	10 – 30%	5 – 10%	5 – 10%	5 – 10%
Enterococci (coastal water, NRP O18 – 95%ile <500)	Not meeting	Meeting	Meeting	Meeting
Ecology				
Marine ecology (NRP O19)	Meeting	Meeting	Meeting	Meeting

4.15.3 Assessment against NRP Objective O18 and O19

The NRP contact recreation and Māori customary use objective O18 was not achieved for faecal indicator bacteria at Lowry Bay but was achieved at Days Bay, Rona Bay, and Robinson Bay.
An assessment against the NRP coastal water objectives is provided below.

Table 4-21: Assessment of Petone and East Harbour intertidal areas against NRP O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	The intertidal community composition of the Eastern Bays was as expected for this general location (lower North Island) and rocky shore habitat and is similar to the rocky shore communities found elsewhere in Wellington Harbour. No taxa that are indicative of significant nutrient enrichment or fine sediment input were present in any great abundance, with exposure and substrate seeming to be the main factors influencing the communities of this area (McMertrie & Brennan, 2016). The information reviewed here leads to an overall assessment that NRP Objective O19 is met.			

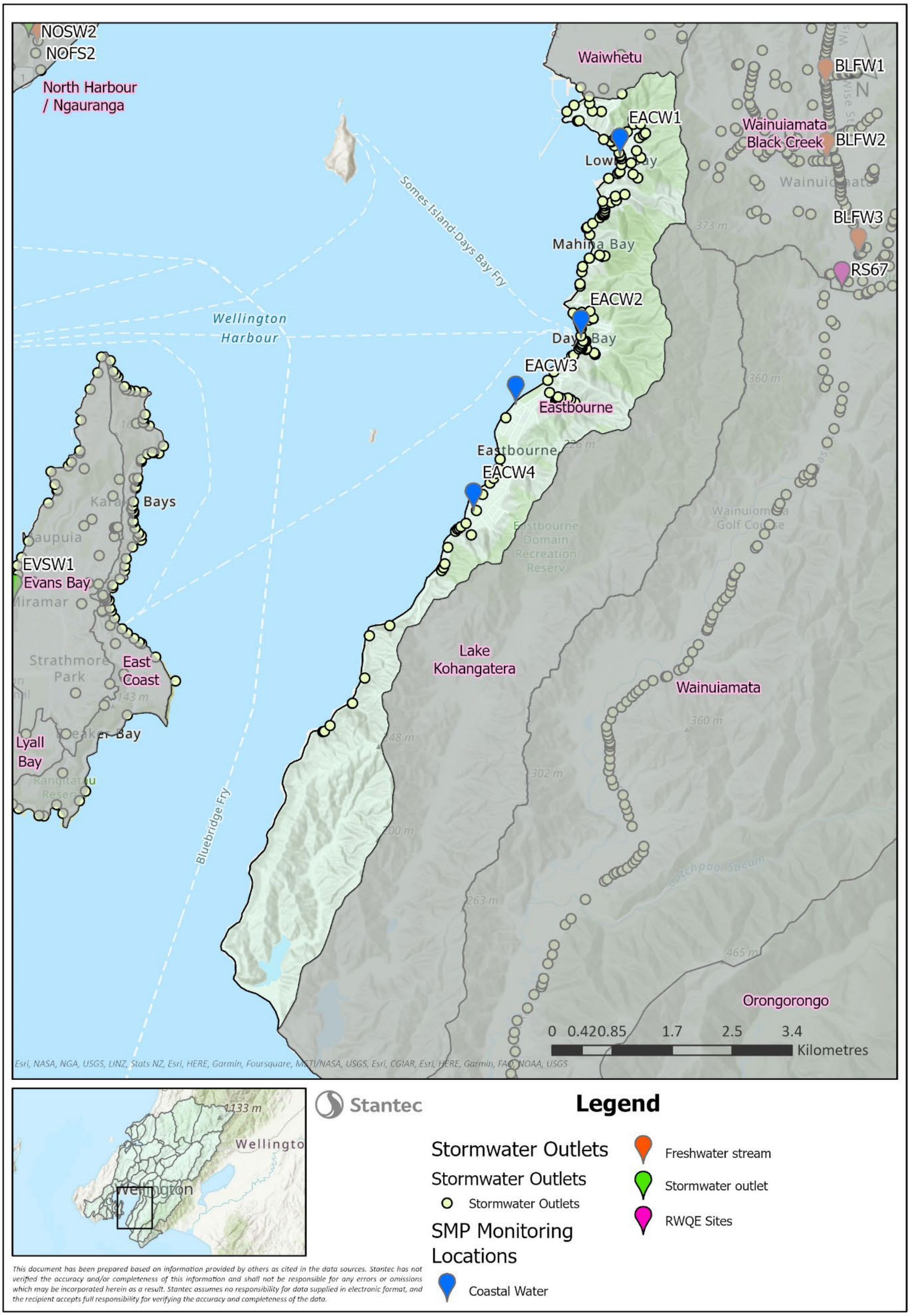


Figure 4-45: Eastbourne catchment

4.16 Wainuiomata

4.16.1 Description of Existing Environment

Black Creek

Black Creek is a 3rd order urban stream (4th order in the lower reach) with a total catchment area of 16.8 square kilometres. It runs through urban Wainuiomata and has been straightened, channelised and in places piped in an effort to manage flooding. Several of the channels are concrete lined for erosion protection. Bank vegetation and shade is limited over most of its length. It has a relatively coarse substrate which provides some hydraulic heterogeneity but, overall, the quality of stream habitat is poor.

Wainuiomata River

The Wainuiomata River is a 5th order watercourse which originates in a native forest catchment of the southwestern Rimutaka Ranges and flows southwest for a distance of approximately 38 km to Cook Strait, east of Bearing Head. Wainuiomata catchment shares a drainage divide with the Orongorongo catchment where elevations reach 800m in altitude. The catchment has a total area of 134 km^2 and has a hard-sedimentary geology and a cool-wet climate. While the upper catchment is steep the riverbed gradient is uniform downstream of the Wainuiomata Water Treatment Plant, dropping 5m per km in the upper part of the Wainuiomata Valley, then flattening to 2m per km near the coast.

The main tributaries of the Wainuiomata River are Skull Gully Creek, Sinclair Creek, George Creek, Wainuiomata-iti Stream, Black Creek and Catchpool Stream. The upper catchment is reserved for water supply and retains 100% indigenous forest cover. Water is taken at two locations by 'run of the river' intake galleries, one on the mainstem of the upper river and the other on Georges Creek.

Two decommissioned water supply dams are located on the upper river. Although neither is now used for water supply, the lower dam continues to form a large impoundment, which has been developed as a wetland. Downstream of the water supply area the river enters the long narrow Wainuiomata Valley, bounded by the Rimutaka Ranges to the east and the Eastbourne foothills to the west. Land use includes plantation forestry, low productivity pasture, scrub and with approximately 6% under urban land-cover and an estimated 2% of the catchment is impervious surface (Wellington Water, 2017).

4.16.2 Current state summary

EMP monitoring is conducted at four sites on Black Creek (shown in Figure 4-46). The results are attached in Appendices A to Q while the current state is summarised below and in Table 4-22:

- Faecal indicator bacteria concentrations were elevated at all four stream sites, none of which achieved objective O18.
- Nutrient concentrations were elevated in the lower reaches of Black Creek.
- The median concentration of copper was below the ANZG (2018) DGV while the 95th percentile exceeded it, indicating objective O19 is partially achieved for copper.
- The median concentration for zinc exceeded DGV indicating that the O19 toxicity objective is not achieved for zinc.
- Black Creek sediment concentrations of zinc exceeded ANZG (2018) DGVs.
- The periphyton and macroinvertebrate communities of the lower stream were significantly degraded and did not meet NRP objective O19.

Table 4-22: Black Creek current state summary

Water quality	Black Creek at Rowe (RS67)	Black Creek at Edmonds (BLFW1)	Black Creek at Fitzherbert (BLFW2)	Black Creek at Moohan (BLFW3)
Observed scums or foams (% of inspections)	No data	5 - 10%	5 - 10%	>30%
Observed oils or grease films	No data	<5%	<5%	<5%
Observed change in colour or clarity	No data	5 - 10%	5 - 10%	>30%
E. coli (freshwater, NPS attribute state)	E	E	E	E
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting	Not meeting
Water temperature (Davies Colley et al. 2013)	B			
Dissolved oxygen (NPS attribute state)	B			
Dissolved reactive phosphorus (NPS attribute state)	D			
Nitrate-N (nutrient, ANZG 2018)	Not meeting			
Nitrate-N (toxicity NPS attribute state)	A			
Ammonia-N (toxicity NPS attribute state)	B			
Dissolved Cu (ANZG 2018)	Not meeting			
Dissolved Zn (ANZG 2018)	Not meeting			
Sediment quality				
Metals (ANZG 2018)	Not meeting for Zn			
Total of reported PAH (ANZG 2018)	Meeting			
Total DDT isomers (ANZG 2018)	Meeting			
Ecology				
Periphyton (NRP O19)	Not meeting			
Macroinvertebrate community (NRP O19)	Not meeting			
Freshwater fish community (NRP O19)	Not data			

4.16.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 was not achieved for faecal indicator bacteria at any of the four sites in Black Creek.

The NRP biodiversity and aquatic ecosystem objective O19 was not achieved for periphyton or macroinvertebrate communities. The NRP fish objective was not assessed due to lack of data.

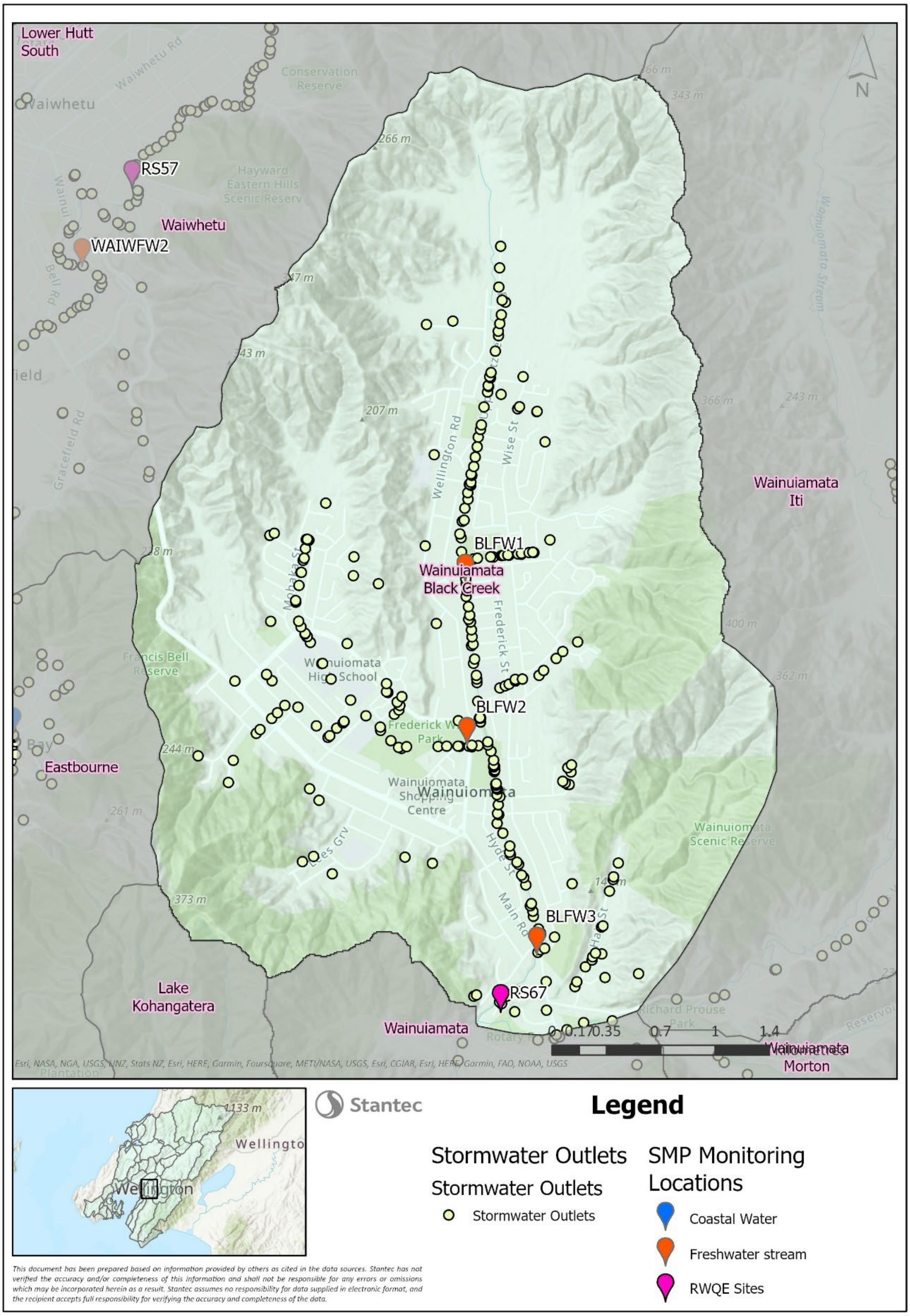


Figure 4-46: Black Creek Catchment

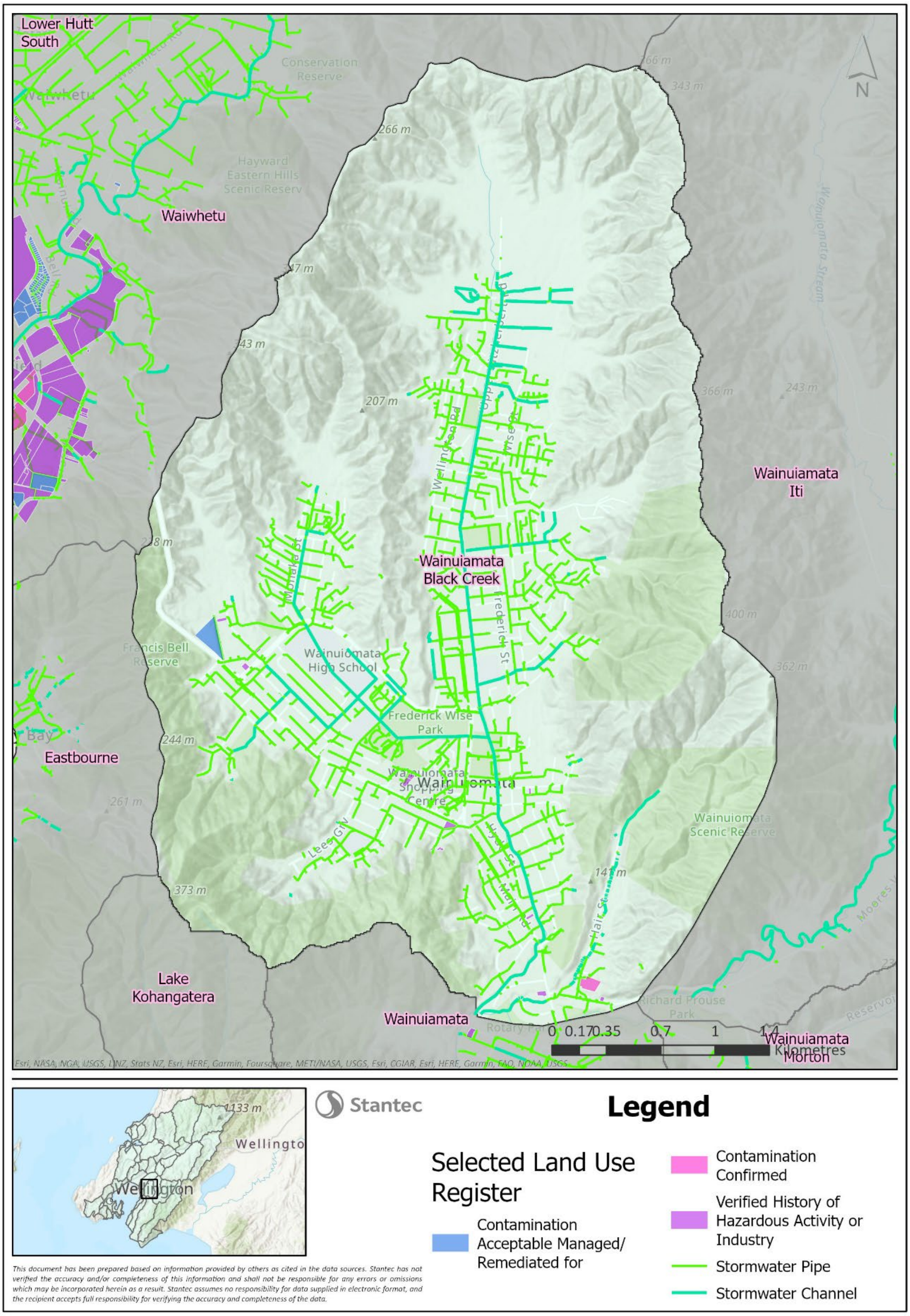


Figure 4-47: Black Creek SLUR sites

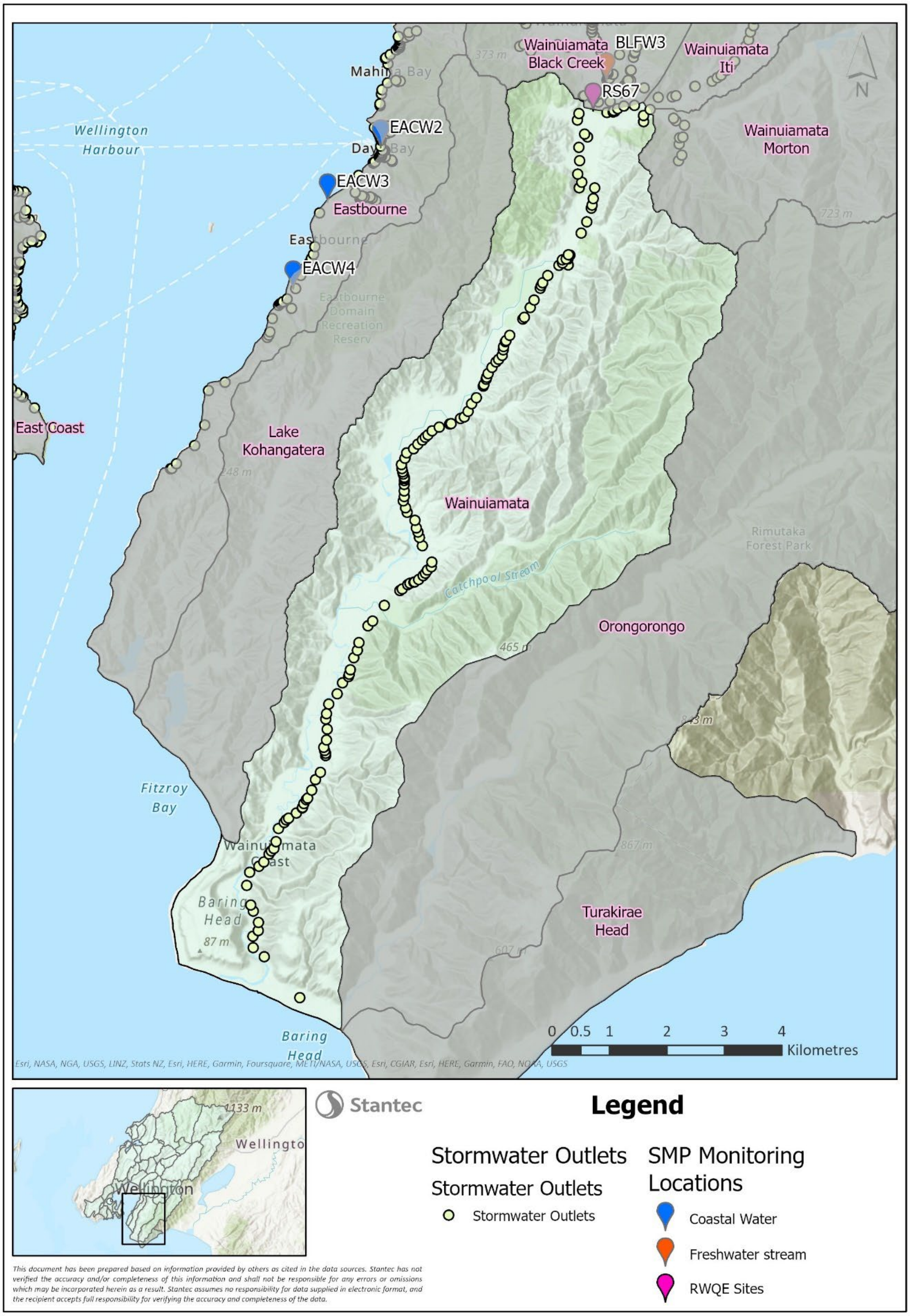


Figure 4-48: Wainuiomata Catchment

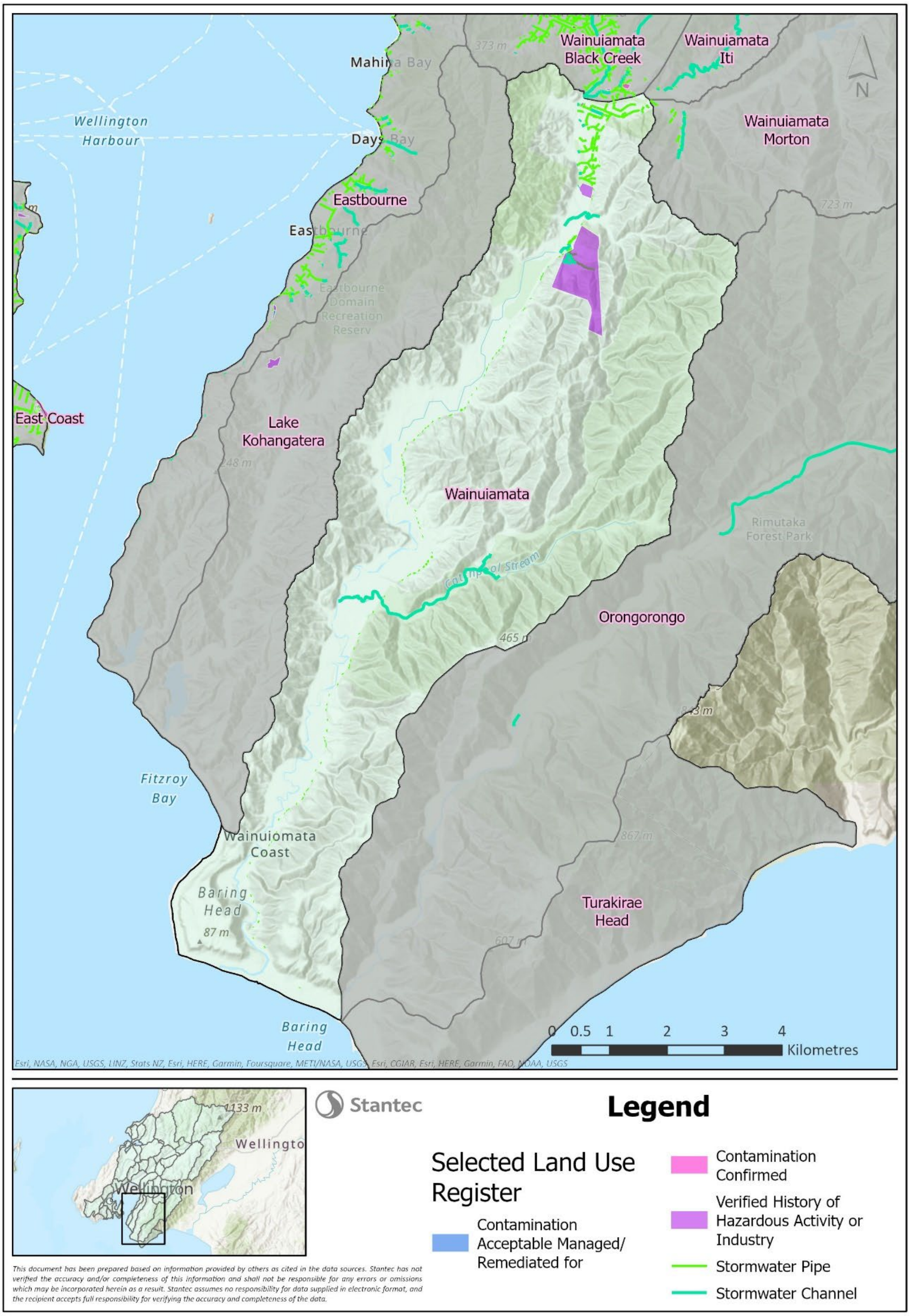


Figure 4-49: Wainuiomata Catchment SLUR sites

4.17 Pauatahanui Inlet (Kakaho, Horokiri, Pauatahanui and Duck catchments)

4.17.1 Description of Existing Environment

Pauatahanui Inlet receives freshwater inflows from Pauatahanui Stream, Duck Creek, Browns Bay Stream, Collins Creek, Kakaho Stream, Horokiri Stream and Ration Creek. The Inlet contains a world-class wetland reserve area, of the same name, at its head. The Inlet is listed in Schedule A of the NRP as an outstanding waterbody (wetland; tidal flats and saltmarsh). It supports a diverse range of regionally significant marine habitats, which in turn support rich plant and animal assemblages, including the largest seagrass beds (*Zostera muelleri*; At Risk-Declining) in the region. Seagrass is an important component of estuarine ecosystems because it has high primary productivity, provides habitat for sea creatures, traps and stabilises bottom sediments, and mediates nutrient cycling within marine sediments and between the sediments and the surrounding water. The estuary also provides seasonal or core habitat for eight Threatened and At-Risk indigenous fish species.

4.17.2 Current state summary

EMP monitoring is conducted at one site each on Duck Creek and Browns Bay Stream and at three estuarine sites in Pauatahanui Inlet (shown in Figure 4-50). The results of monitoring are attached in Appendices A to S while the current state is summarised in Table 4-23.

Results show that faecal indicator bacteria concentrations were elevated at both the Duck Creek and Browns Bay stream sites and at two of the three sites in Pauatahanui Inlet. Pauatahanui Inlet at Paramata Bridge is the only monitoring site to meet objective O18.

Frequent observations of changes in visual clarity or colour were made at both stream sites. The median concentration of copper was below the ANZG (2018) DGV in Duck Creek and Browns Bay stream. The median zinc concentration exceeded the DGV at Browns Bay Stream but was below the DGV in Duck Creek.

GWRC's Porirua Harbour marine sediment quality investigations in 2020 include three sites (PAH1, PAH2 and PAH3) in the Pauatahanui Arm of Porirua Harbour (Cummings, et al., 2021a). There were no guideline exceedances of any of the metal or metalloids in sediments at these sites (Appendix S). It is noted also that contaminant concentrations were consistently lower in sediments of the Pauatahanui Arm compared with the Onepoto Arm.

The Porirua Harbour environment provides a nursery area for juvenile elephant fish (*Callorhinchus milii*), rig (*Mustelus lenticulatus*), sand flounder (*Rhombosolea lebeian*), and kahawai (*Arripis trutta*) which support important customary, recreational and commercial fisheries off the shore of the west coast of the North Island. The harbour supports cockle beds (Austrovenus stutchburyi), and resident populations of various marine fish although there is no recreational fishing due to poor water quality and contaminants in sea floor sediments (Stevens & Robertson, 2008).

The most recent fine scale intertidal monitoring survey was conducted at two sites in each of the Onepoto Arm and Pauatahanui Arm of Porirua Harbour by Salt Ecology and reported by Forrest et al. (2020). Their findings in relation to ebibiota and sediment dwelling macrofauna are summarised as follows:

- Different mud snail species were conspicuous among the surface-dwelling epifauna in 2020, but densities have varied widely over the years and among sites.

- Nuisance macroalgae (seaweeds) were at a low prevalence across all years at the fine scale sites. However, over the last year there has been an apparent 'bloom' of a filamentous green mat-forming species near outer harbour Onep-A and Paua-A sites.
- Core sampling revealed 96 different sediment-dwelling macrofauna species over the five surveys undertaken in 2008, 2009, 2010, 2015 and 2020. The most notable change in the last three surveys has been a gradual decline in species richness (the range of species recorded) and their abundance, at all sites except Onep-B next to Porirua City. These declines appear in part attributable to increased sediment mud content, and in the case of Paua-B were accompanied in 2020 by the loss of several species intolerant of mud that had been common previously. In addition to sediment mud content, there appear to be other unknown drivers of the high spatial and temporal variability in the macrofauna assemblages.

The apparent decline in certain ecological health indicators in 2020 is consistent with parallel studies (sedimentation monitoring and a broad scale survey of estuary substrate and vegetation, Cummings et al. 2021a) that reveal a long-term harbour-wide increase in sediment and the extent of mud-dominated sediments. A previous study has discussed possible previous or ongoing sources of muddy sediments as being land disturbance in the eastern catchment (where Paua-B is located) associated with various subdivisions and the Transmission Gully motorway development (it is noted that sediment from construction activities is outside the scope of this consent application).

Cummings et al., (2021a) trialled two benthic health models (BHM) as part of the GWRC 2020 marine sediment sampling programme. BHMmud was used to assessment the health of estuarine benthic communities in response to sedimentation, and BHMmetal was used to assess the effects of lead, copper and zinc contamination. Of the three sites in Pauatahanui Inlet, PAH1 was assessed as being in 'moderate health' while PAH2 and PAH3 were in 'poor health'.

Table 4-23: Current state summary

	Pauatahanui Inlet		
Water quality	Duck Creek (PAFW1)	Browns Bay Stream (PAFW2)	Pauatahanui Inlet (PACW1, PACW2, PACW3)
Observed scums or foams (% of inspections)	10-30%	10-30%	10-30%
Observed oils or grease films	5-10%	5-10%	<5
Observed change in colour or clarity	>30%	>30%	10-30%
E. coli (freshwater, NPS attribute state)	E	E	not applicable
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	not applicable
Enterococci (coastal water, NRP O18 – 95%ile <500)	Not applicable	Not applicable	Not meeting (at 2 of 3 sites)
Dissolved Cu (ANZG 2018)	Partially meeting	Partially meeting	no data
Dissolved Zn (ANZG 2018)	Partially meeting	Not meeting	no data
Sediment quality			
Metals (ANZG 2018)	no data	Meeting	Meeting
Ecology			
Freshwater fish community (NRP O19)	meeting	no data	not applicable
Marine ecology (NRP O19)	not applicable	not applicable	Not meeting

4.17.3 Assessment against NRP Objectives O18 and O19

The NRP contact recreation and Māori customary use objective O18 was not achieved for faecal indicator bacteria at either of the freshwater stream sites or at two out of three Pauatahanui Inlet sites.

The NRP biodiversity and aquatic ecosystem objective O19 was not achieved for periphyton or macroinvertebrate communities. The NRP fish objective was not assessed due to lack of data. Table 4-24 provides an assessment of against NRP Objective O19 for coastal waters.

Table 4-24: Assessment of the Pauatahanui Inlet against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	Nutrient inputs to the Pauatahanui Arm are sufficient to sustain elevated growths of macro-algae in Porirua Harbour, sometimes to nuisance levels. Benthic invertebrate community health metric scores ranged from 'moderately healthy' to 'poor health' in 2020. The inlet supports cockle beds and resident populations of various marine fish although there is no recreational fishing due to poor water quality and contaminants in sea floor sediments. The available information suggests that NRP Objective O19 is currently not met in respect of macroalgae, invertebrate or mahinga kai species.			

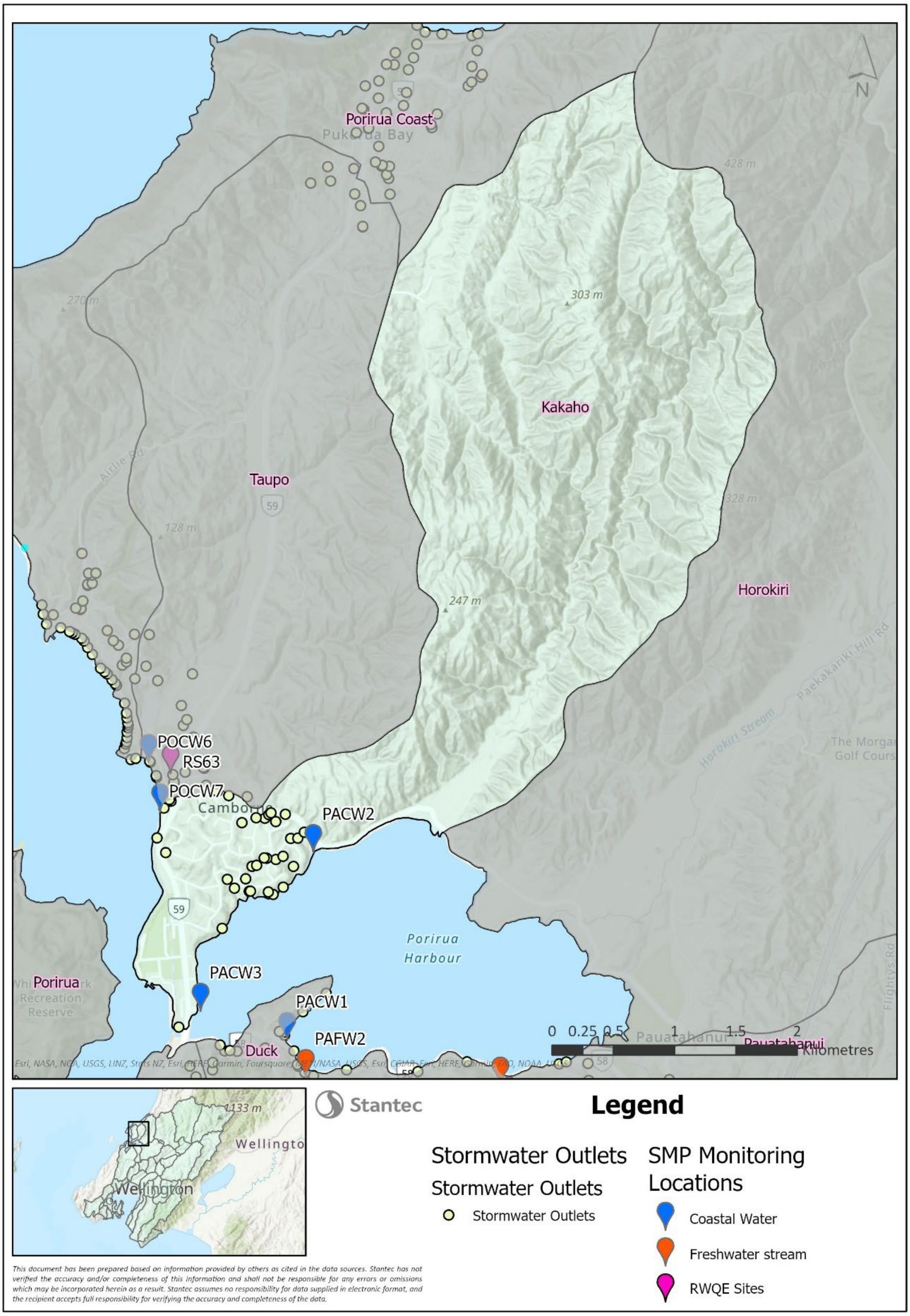


Figure 4-50: Kakaho Catchment

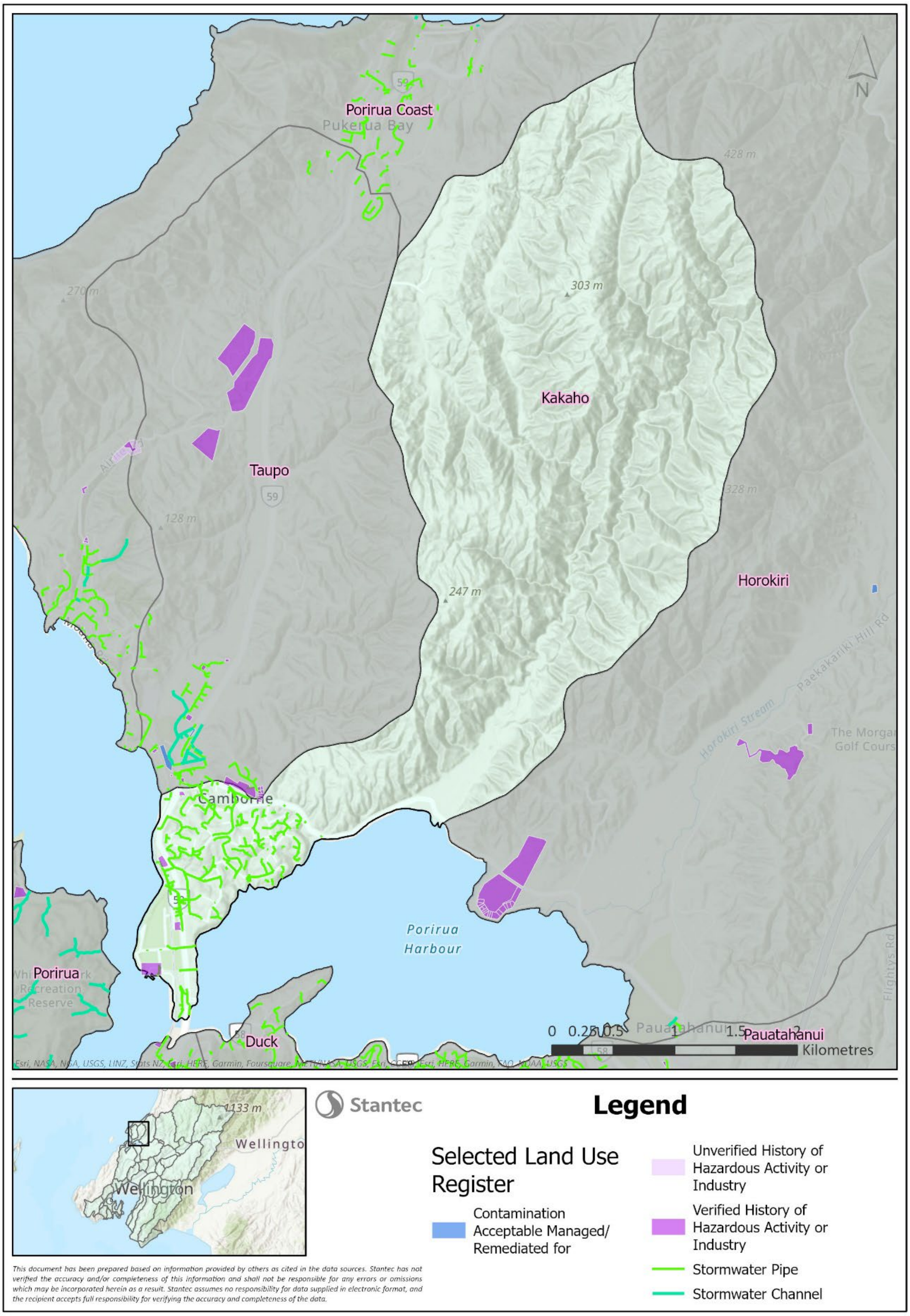


Figure 4-51: Kakaho Catchment SLUR sites

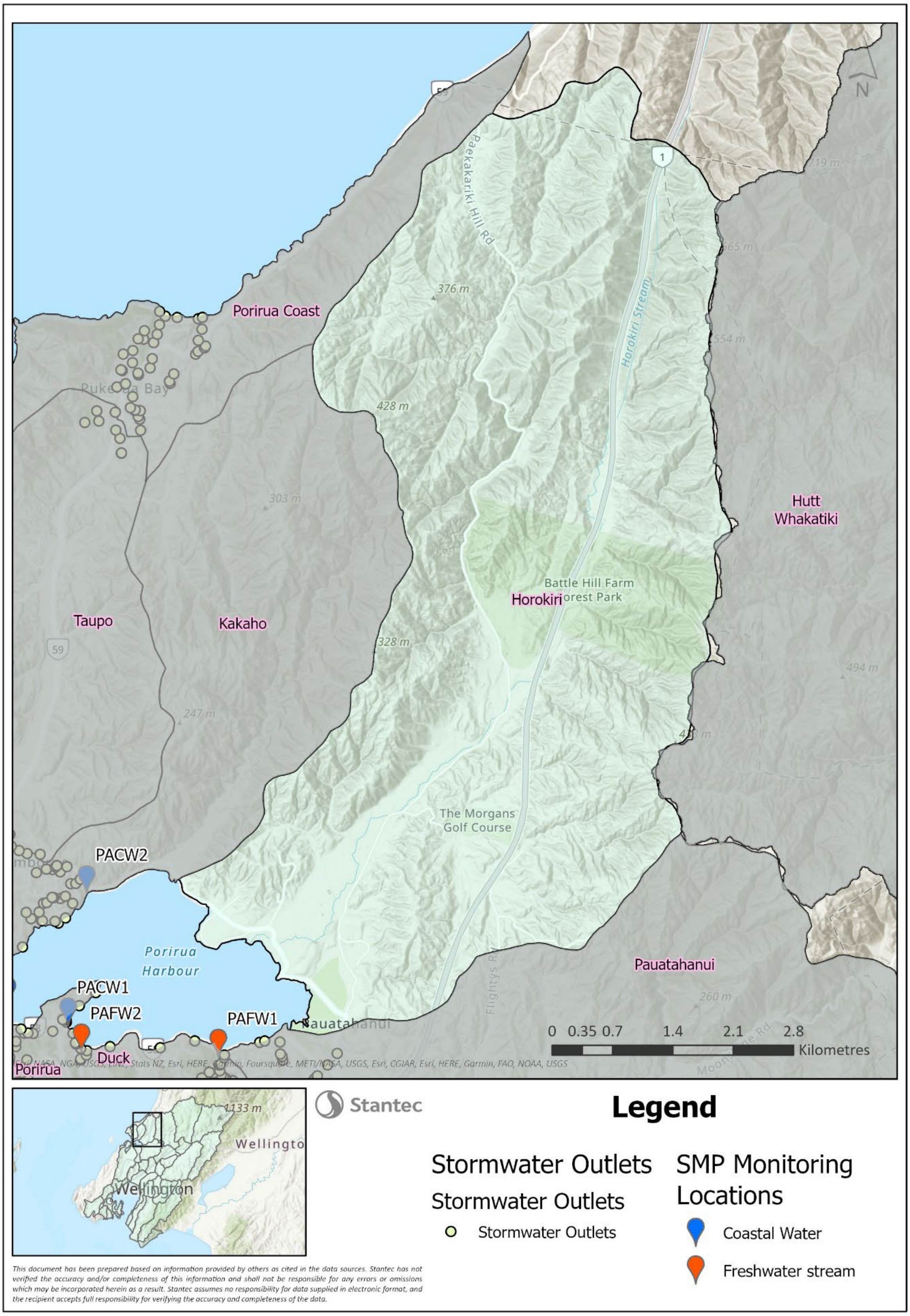


Figure 4-52: Horokiri Catchment

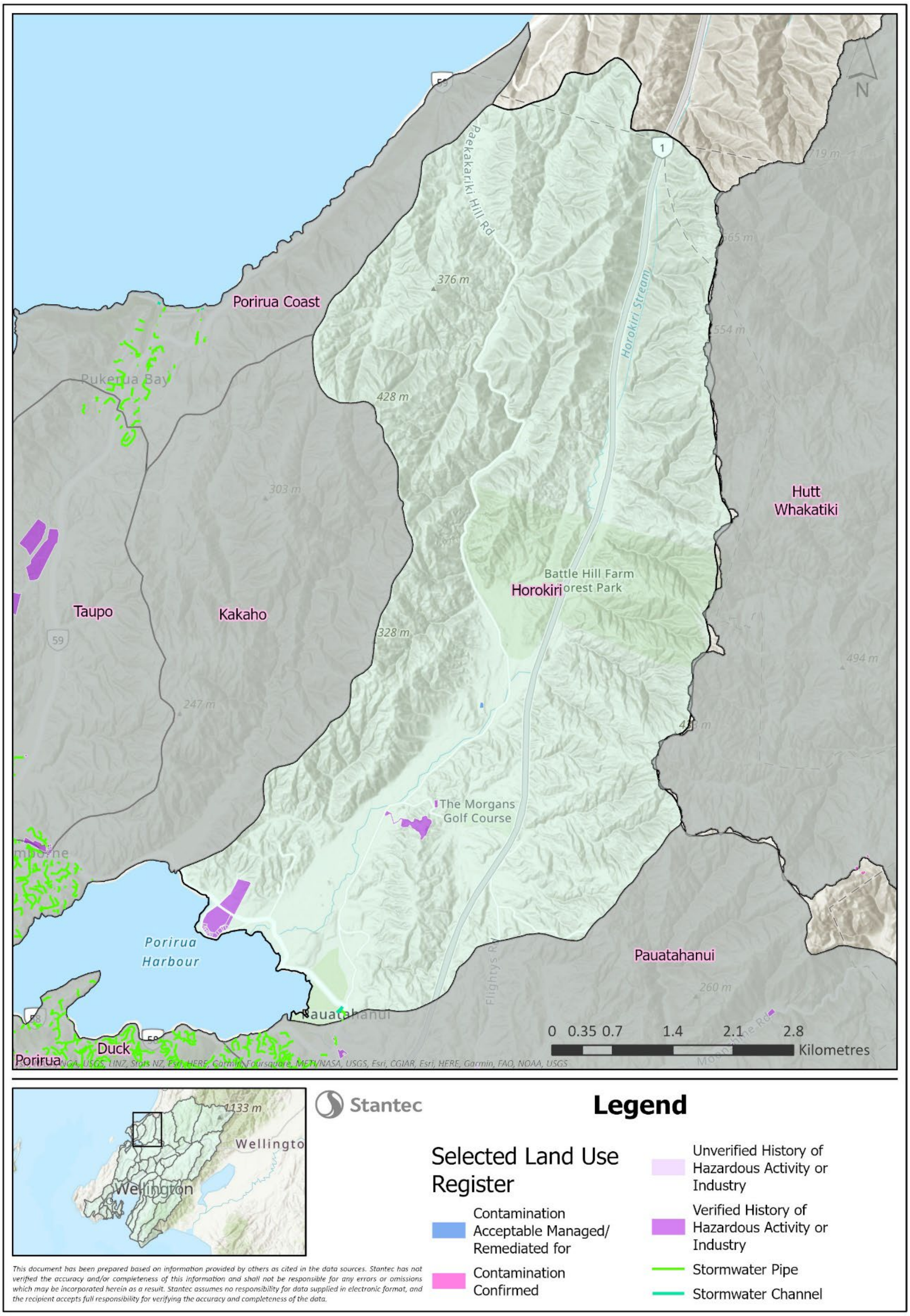


Figure 4-53: Horokiri Catchment SLUR sites

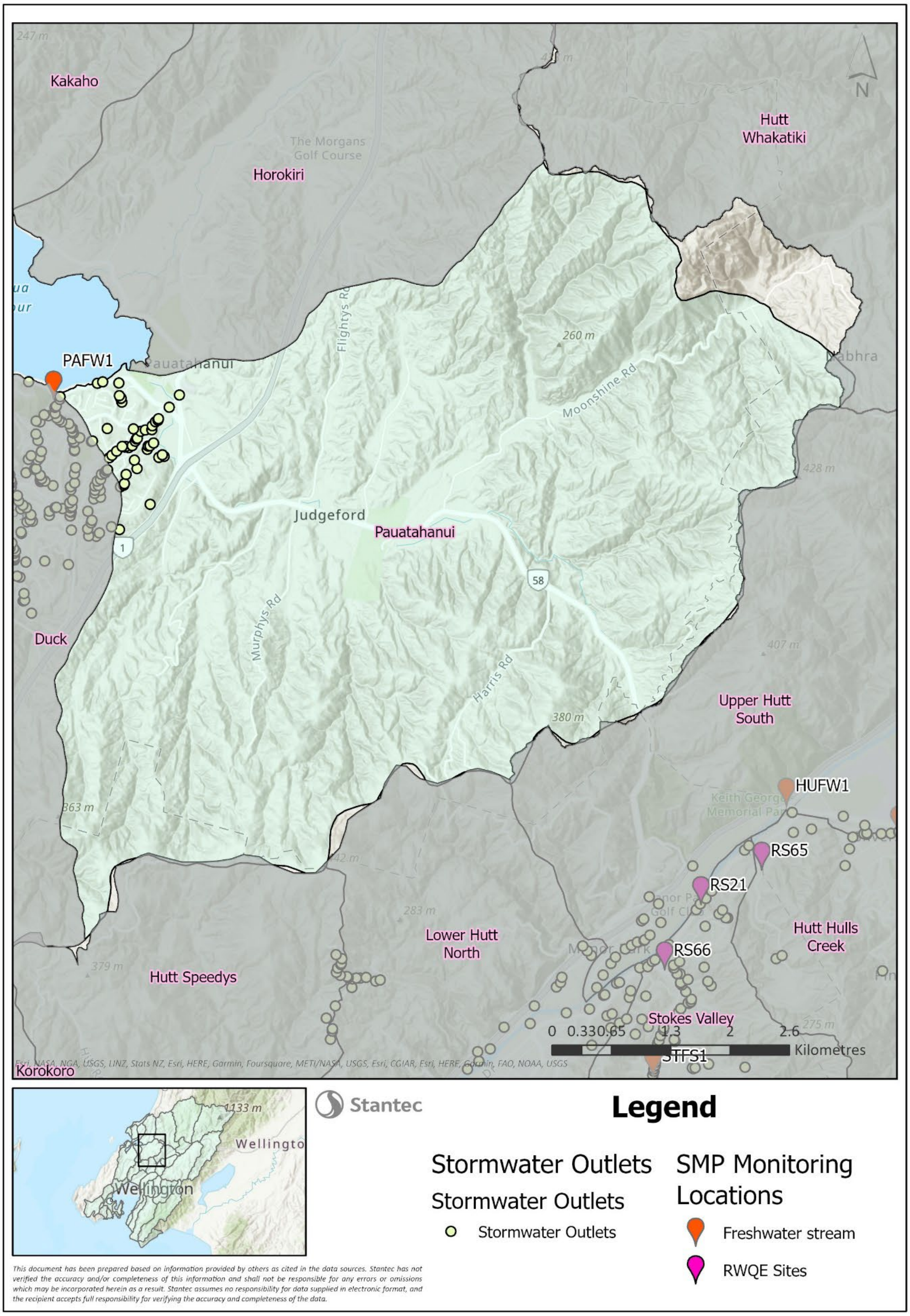


Figure 4-54: Pauatahanui Catchment

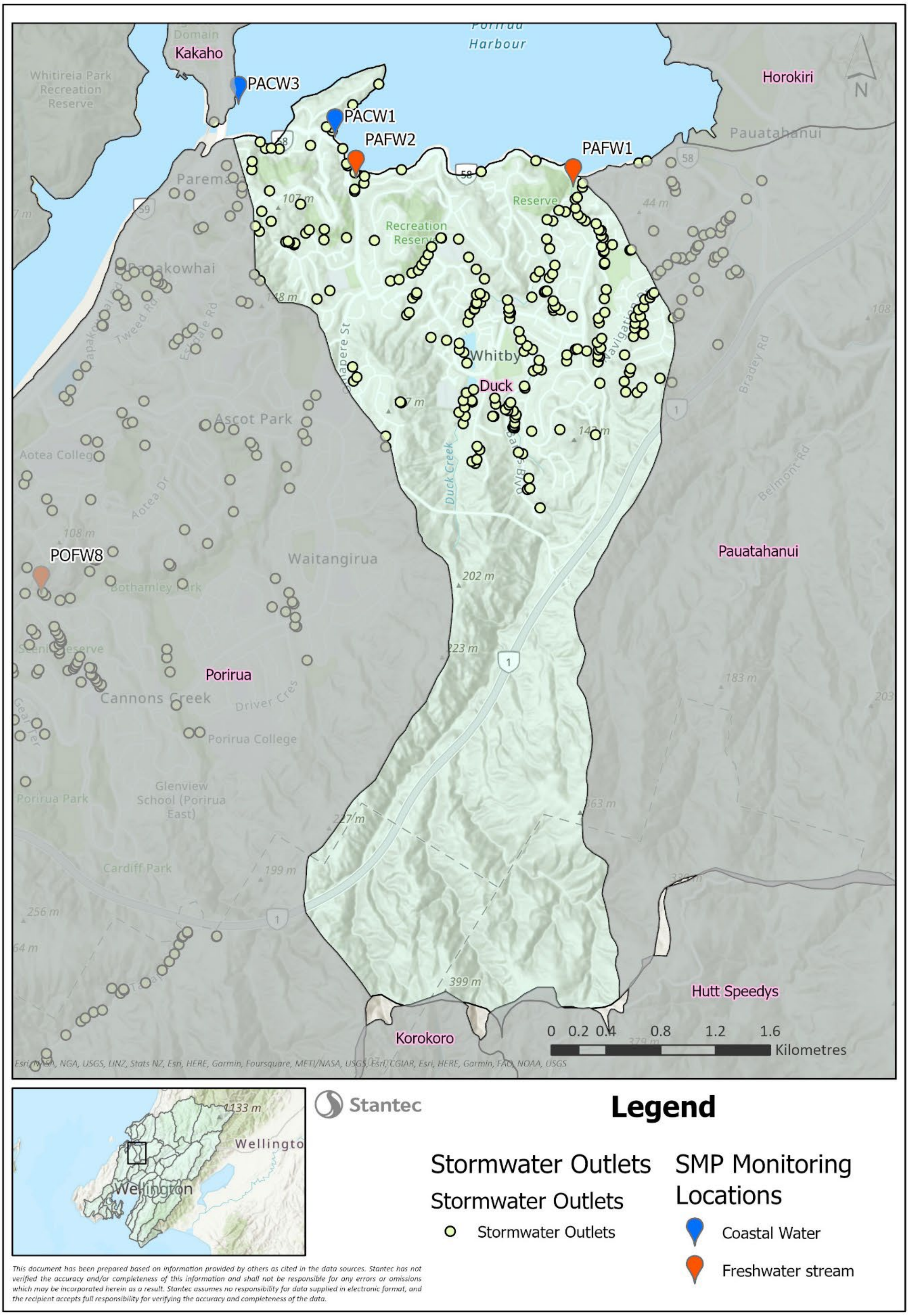


Figure 4-55: Duck Catchment

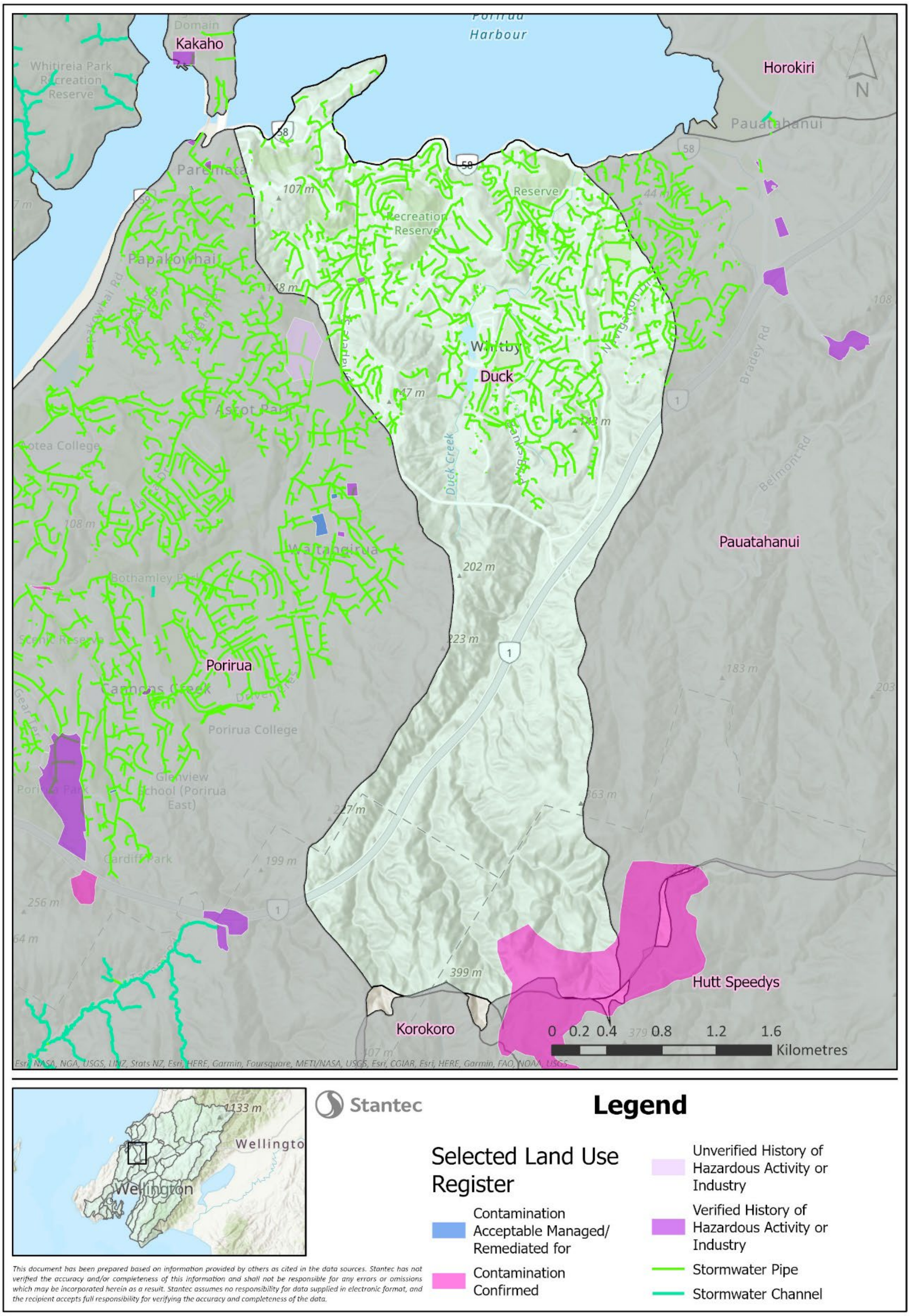


Figure 4-56: Duck Catchment SLUR sites

4.18 Porirua Stream / Onepoto Catchment

4.18.1 Description of Existing Environment

Te Awarua-o-Porirua Harbour, commonly known as Porirua Harbour, is a large, shallow, well flushed "tidal lagoon" type estuary consisting of two shallow drowned river valleys, the southern Porirua or Onepoto Arm and the northern Pāuatahanui Arm, meeting at a deep narrow confluence which opens to the west coast of the lower North Island opposite Mana Island. The Harbour can be described as an estuary, as it has free exchange with marine water, which is appreciably diluted by freshwater inputs. The Harbour is thus influenced by fluvial and ocean processes, receiving water and sediment from both. At 807 ha, Porirua Harbour is moderate in size compared to other New Zealand estuaries but is the largest estuary system in the Wellington region (Robertson & Stevens, 2007).

Stevens and Robertson (2008) undertook broad-scale habitat mapping of the harbour in 2007/08 and noted that, unlike other similar sized estuaries which largely drain at low tide, Porirua Harbour remains largely filled and is comprised of mainly sub tidal habitats (65%), particularly the Onepoto Arm. At the confluence of the two arms, water depth reaches at least 13 m. This characteristic is important as it influences the range of habitats and species occurring within the harbour. The authors observed that in relation to the major habitat types, most of the intertidal area in both arms was dominated by unvegetated, poorly sorted firm muddy sands.

Porirua Stream is the largest fresh watercourse flowing into the Onepoto Arm of Porirua Harbour. It is a 5th order watercourse with an estimated mean flow of 980 L/s and a mean annual low flow of 155 L/s. The Porirua Stream catchment lies to the south and west of Porirua Harbour. The drainage area extends from Glenside and the Takapu Valley, through Tawa and Porirua City to the western end of Porirua Harbour. It covers an area of nearly 3,200 ha of which 37% is comprised of impervious surfaces. There are seven main sub-catchments: Kenepuru, Linden, Takapu, Belmont, Churton Park, Tawa and Mitchell. The catchment is dominated by production pasture in its upper reaches and urban land covering its lower reaches, with areas of regenerating indigenous forest, scrub and exotic forest.

Other fresh watercourses in the catchment are relatively small but include the Takapūwāhia, Hukarito, Urukahika and Mahinawa streams, all of which are of particular value to Mana Whenua.

4.18.2 Current state summary

EMP monitoring is conducted at eleven freshwater stream sites in the Porirua catchment, was well as three stormwater outlets and two estuarine sites in the Onepoto Arm of Porirua Harbour (shown Figure 4-57). The results of monitoring are attached in Appendices A to S while the current state is summarised below and in Table 4-25 and Table 4-26:

- Faecal indicator bacteria concentrations were elevated at all stream sites and both coastal water sites, none of which achieved objective O18.
- Nutrient concentrations were elevated in both the upper and lower reaches of Porirua Stream
- The 95th percentile water column concentrations of copper and zinc were elevated above ANZG (2018) guideline levels in Porirua Stream, but the median concentrations were below the guideline at most locations, indicating that the O19 toxicity objective is partly achieved.
- Porirua Stream sediment concentrations of metals and PAH were below ANZG (2018) guidelines.
- The periphyton and macroinvertebrate communities of the lower Porirua Stream are significantly degraded and do not meet NRP objective O19.

GWRC's Porirua Harbour marine sediment quality investigations in 2020 include two sites (POR1 and POR2) in the Onepoto Arm of Porirua Harbour (Cummings, et al., 2021a). Sediments at sites POR1 (near the south end of the Onepoto Arm) exceeded the ARC amber guideline concentrations for copper, lead and zinc (Appendix S). Sediments at POR2 (middle of Onepoto Arm) exceeded ARC amber guidelines for lead and zinc. Sediments at both POR1 and POR2 were close to the ANZG (2018) Default Guideline Value (DGV) for mercury. No ARC red or ANZG (2018) DGVs were exceeded at either site during the 2020 survey.

The marine ecology of Porirua Harbour has been described in the previous section. Cummings et al. (2021a) trialed two benthic health models (BHM) as part of the GWRC 2020 marine sediment sampling programme. BHMmud was used to assessment the health of estuarine benthic communities in response to sedimentation, and BHMmetal was used to assess the effects of lead, copper and zinc contamination. In the Onepoto Arm, BHMmud classified POR2 as 'moderately healthy' and POR1 as in 'poor health' based on the mud content recorded. The BHMmetal model indicated that both POR1 and POR2 were in 'poor health' in 2020.

Table 4-25: Current state summary – freshwater streams

Water quality	Porirua Stream and tributaries										
	Glenside (RS15)	Wall Park (RS16)	Winfield (POFW1)	Belmont (POFW2)	Stebbings (POFW3)	Takapu (POFW4)	Porirua U/s Takapu (POFW5)	Mitchell (POFW7)	Kenepuru Bothamley (POFW8)	Kenepuru Mepham (POFW9)	Unnamed Onepu Rd (POFW10)
Observed scums or foams (% of inspections)	No data	No data	5-10%	10-30%	>30%	5-10%	>30%	>30%	10-30%	10-30%	10-30%
Observed oils or grease films	No data	No data	5-10%	5-10%	5-10%	5-10%	5-10%	5-10%	5-10%	5-10%	5-10%
Observed change in colour or clarity	No data	No data	5-10%	10-30%	10-30%	5-10%	10-30%	10-30%	>30%	>30%	>30%
E. coli (freshwater, NPS attribute state)	E	E	E	E	E	E	E	E	E	E	E
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting	Not meeting
Water temperature (Davies Colley et al. 2013)	B	B	No data	No data	No data	No data	No data	No data	No data	No data	No data
Dissolved oxygen (NPS attribute state)	A	A	No data	No data	No data	No data	No data	No data	No data	No data	No data
Dissolved reactive phosphorus (NPS attribute state)	D	D	No data	No data	No data	No data	No data	No data	No data	No data	No data
Nitrate-N (nutrient, ANZG 2018)	Not meeting	Not meeting	No data	No data	No data	No data	No data	No data	No data	No data	No data
Nitrate-N (toxicity NPS attribute state)	A	A	No data	No data	No data	No data	No data	No data	No data	No data	No data
Ammonia-N (toxicity NPS attribute state)	B	B	No data	No data	No data	No data	No data	No data	No data	No data	No data
Dissolved Cu (ANZG 2018)	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting
Dissolved Zn (ANZG 2018)	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Partially meeting	Not meeting	Partially meeting	Partially meeting	Mostly meeting
Sediment quality											
Metals (ANZG 2018)	No data	Meeting	No data	No data	No data	No data	No data	No data	No data	No data	No data
Total of reported PAH (ANZG 2018)	No data	Meeting	No data	No data	No data	No data	No data	No data	No data	no data	No data
Total DDT isomers (ANZG 2018)	No data	Meeting	No data	No data	No data	No data	No data	No data	No data	no data	No data

Water quality	Porirua Stream and tributaries										
	Glenside (RS15)	Wall Park (RS16)	Winfield (POFW1)	Belmont (POFW2)	Stebbings (POFW3)	Takapu (POFW4)	Porirua U/s Takapu (POFW5)	Mitchell (POFW7)	Kenepuru Bothamley (POFW8)	Kenepuru Mepham (POFW9)	Unnamed Onepu Rd (POFW10)
Ecology											
Periphyton (NRP O19	Meeting	Not meeting	No data	No data	No data	No data	No data	No data	No data	No data	No data
Macroinvertebrate community (NRP O19)	Not meeting	Not meeting	No data	No data	No data	No data	No data	No data	No data	No data	No data
Fish community (NRP O19	Meeting	Meeting	No data	No data	No data	No data	No data	No data	No data	No data	No data

Table 4-26: Current state summary – stormwater and Porirua Harbour estuarine water

Water quality	Porirua stormwater			Onepoto Arm coastal water	
	Semple (POSW1)	Hiko St (POSW2)	Gloaming (POSW3)	Rowing (POCW1)	Wi Neera POCW2
Observed scums or foams (% of inspections)	>30%	>30%	10-30%	10-30%	10-30%
Observed oils or grease films	>30%	>30%	5-10%	5-10%	10-30%
Observed change in colour or clarity	>30%	>30%	>30%	5-10%	10-30%
E. coli (freshwater, NPS attribute state)	E	E	E	Not applicable	Not applicable
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not meeting	Not meeting	Nat applicable	Nat applicable
Enterococci (coastal water, NRP O18 – 95%ile <500)	Not applicable	Not applicable	Not applicable	Not meeting	Not meeting
Dissolved Cu (ANZG 2018)	Not meeting	Not meeting	Not meeting		
Dissolved Zn (ANZG 2018)	Not meeting	Not meeting	Not meeting		
Sediment quality					
Metals (ANZG 2018)	No data	No data	No data	Meeting	Meeting
Ecology					
Marine ecology (NRP O19)	Not applicable	Not applicable	Not applicable	Not meeting	Not meeting

4.18.3 Assessment against NRP objective O18 and O19

The NRP contact recreation and Māori customary use objective O18 was not achieved for faecal indicator bacteria at any of the eleven freshwater stream sites or either of the two coastal water sites in Porirua Harbour.

The NRP biodiversity and aquatic ecosystem objective O19 was mostly achieved for the upper Porirua Stream at Glenside and mostly failed to be achieved for the lower Porirua Stream at Wall Part. Table 4-27 provides an assessment of against NRP Objective O19 for the coastal waters of Porirua Harbour.

Table 4-27: Assessment of the Onepoto Arm of Porirua Harbour against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	Nutrient inputs to the Onepoto Arm are sufficient to sustain elevated growths of macro-algae in Porirua Harbour, sometimes to nuisance levels. Benthic invertebrate community health metric scores ranged from 'moderately healthy' to 'poor health' in 2020. The inlet supports cockle beds (Austrovenus stutchburyi), and resident populations of various marine fish although there is no recreational fishing due to poor water quality and contaminants in sea floor sediments. The available information suggests that NRP Objective O19 is currently not met in respect of macroalgae, invertebrate or mahinga kai species.			

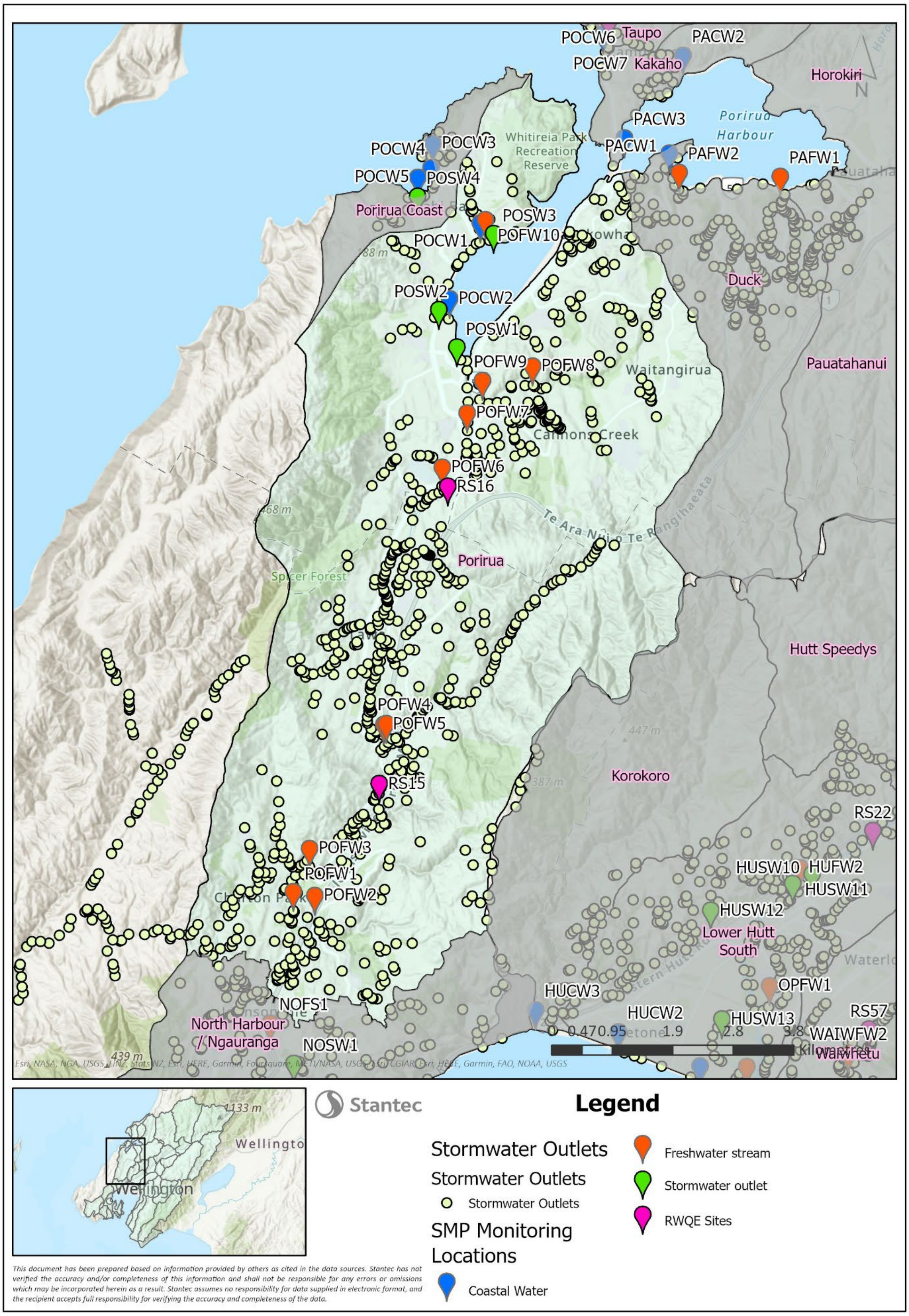


Figure 4-57: Porirua Catchment

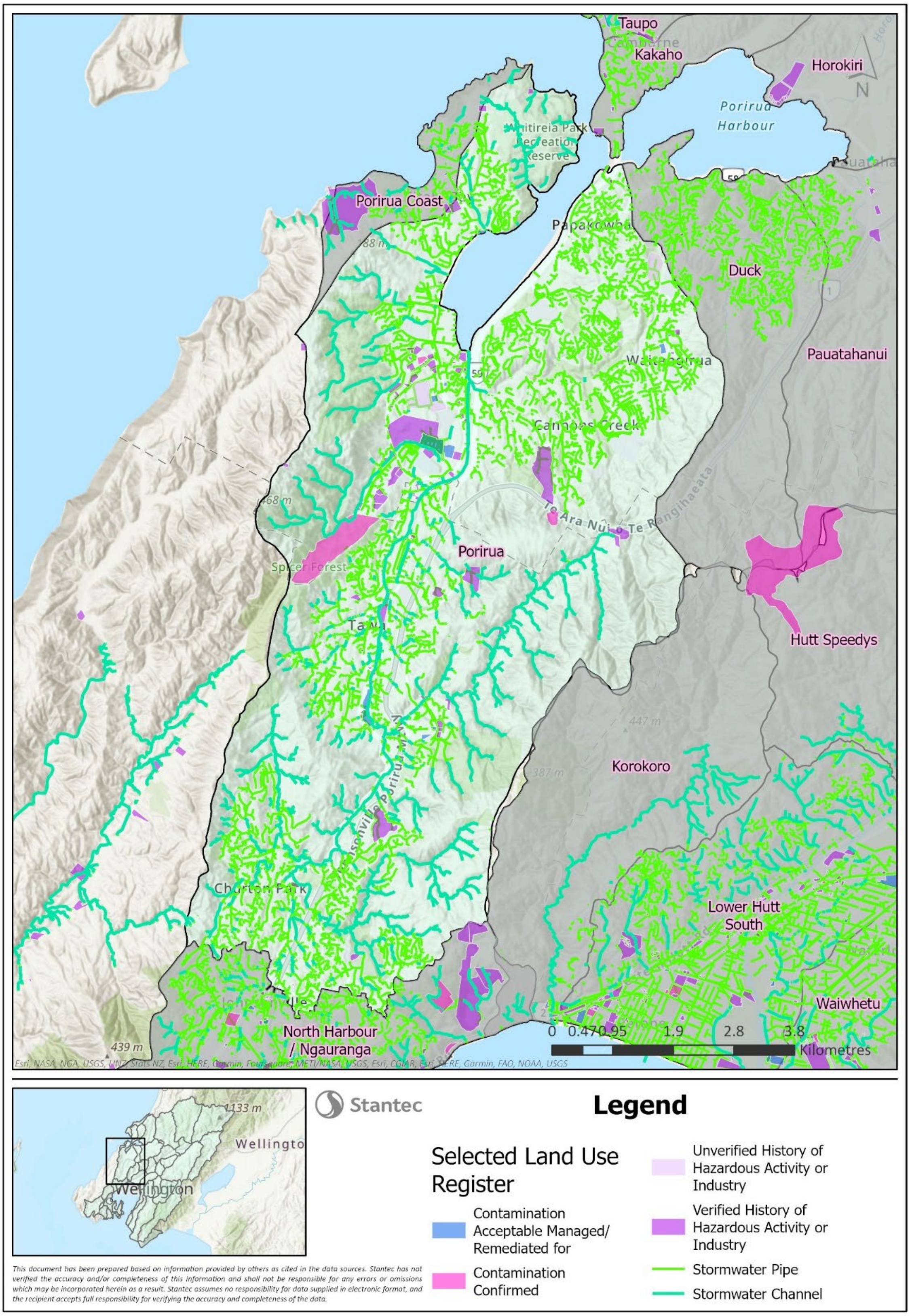


Figure 4-58: Porirua Catchment SLUR sites

4.19 Porirua Coast/Taupo

4.19.1 Description of Existing Environment

The northern part of the Porirua Coast includes the Karehana and Taupō stream catchments, Hongoeka Bay, Karehana Bay, Plimmerton North and Plimmerton South beaches. The southern part, south of the entrance to Porirua Harbour, includes Titahi Bay.

Karehana Stream is a minor 2nd order watercourse that discharges to the coastal marine area at Karehana Bay. It has an estimated mean flow of 14 L/s and a catchment area of approximately 90 hectare (ha). The catchment area is bounded by Airlie Road to the west and north, and 'The Track' to the east. Much of the middle and lower reaches of the stream are either piped or concrete lined, resulting in a significant loss of habitat and ecological function. The pipe outlet at Karehana Bay is fitted with a non-return valve to prevent sand and gravel entering the network, and which probably also constrains fish access. Upstream of the urban edge much of the catchment lies under regenerating vegetation but the stream flow is likely to be intermittent.

Taupō Stream is a 3rd order watercourse which runs approximately 6.5 kilometres from its headwaters to the coastal marine area at Southern Beach, Plimmerton. The stream has a total catchment area of 1,119ha and an estimated mean flow of 180 L/s. A central feature of the catchment is the 30ha wetland area, which is the largest remaining harakeke (flax) swamp in the Wellington region. The Queen Elizabeth II National Trust (QEII) purchased Taupō Swamp in 1986 to protect its special values. The Taupō Swamp complex is listed in NRP Schedule A3 as a wetland with outstanding biodiversity values.

Hongoeka Bay, Karehana Bay, Plimmerton North and Plimmerton South beaches are sandy beaches popular with swimmers, sunbathers and boating. Plimmerton North Beach and South Beach are very popular for windsurfers, especially as safety designated windsurfing areas are provided.

South of the entrance to Porirua Harbour, Titahi Bay is a relatively sheltered, crescent shaped beach consisting mainly of sand but with cobbles at its midpoint and rock headland at either end. The margins of the beach include relatively steep dunes with marram grass and flax and there is an artificial seawall at the southern end. Titahi Bay is a very popular beach for swimming, snorkelling, windsurfing, surfing, fishing, walking and picnicking. Surf lifeguards patrol the beach during the summer months.

Several minor unnamed watercourses discharge into Titahi Bay, including watercourses running adjacent to South Beach Access Road, Toms Road and Bay Drive (Figure 4-2). All three watercourses are best described as stream remnants, having been incorporated into the stormwater network, with very little stream habitat remaining. These are likely intermittent watercourses, with little or no surface flow during dry summer months.

The South Beach Access stream is a 1st order watercourse which is piped for almost its entire length through the stormwater network. It has an upstream catchment of approximately 36ha, an estimated mean flow of 6L/s and a mean annual low flow of <1L/s (NZ River Maps, NIWA).

The Toms Road stream is a 1st order watercourse which is piped for almost its entire length through the stormwater network. It has an upstream catchment of approximately 30ha, an estimated mean flow of 6L/s and a mean annual low flow of <1L/s.

The Bay Drive stream is a 1st order watercourse which is piped for almost its entire length through the stormwater network. It has an upstream catchment of approximately 39ha, an estimated mean flow of 7L/s and a mean annual low flow of <1L/s.

4.19.2 Current state summary

EMP monitoring is conducted at one freshwater site on Taupō Stream, two coastal water sites on Plimmerton Beach, and three coastal water sites at Titahi Bay (shown in Figures 4-59 and 4-60). The results of monitoring are attached in Appendices A to S while the current state is summarised below in Table 4-28.

Results show elevated faecal indicator bacteria in Taupo Stream, at both of the Plimmerton Beach coastal water sites and at one of the Titahi Beach coastal water site. Coastal water sites adjacent to Bay Drive and Toms Drive achieved objective O18, the other sites did not.

Nutrient concentrations were elevated in Taupo Stream. Potential toxicant including nitrate-N, ammonia-N, and zinc were ANZG (2018) guideline levels. For copper, the median concentration was below the guideline, but the 95th-percentile value exceeded the guideline, indicating that the O19 toxicity objective is partially achieved. Dissolved oxygen concentrations were low in Taupo Stream, in the NPS-FM attribute D band, indicating stress on a range of aquatic organisms and a likely loss of ecological integrity.

Stream sediment concentrations of metals and PAH were below ANZG (2018) guidelines, however 'total DDT isomers' exceeded both the DGV and GV-high, indicating that DDT isomers are present in stream sediments at concentrations that may be associated with biological effects. DDT was used extensively in New Zealand during the 1950s and 1960 to control grass grub and porina moth. By the 1970s its use was restricted, and it was finally banned in 1989. Its presence in Taupō Stream is not unexpected because of the high proportion of production pasture in the catchment.

The macroinvertebrate community of the lower Taupō Stream is significantly degraded and does not meet NRP objective O19. The information reviewed here suggests that the soft sediment bed, low dissolved oxygen levels, and elevated DDT isomers in Taupo Stream sediments may largely explain the observed poor ecosystem health.

Marine ecology off the Porirua Coast to the south of Titahi Bay has been described by Morrisey, et al. (2019) as part of the investigations into the effects of the Porirua Wastewater Treatment Plant discharge to coastal was near Rukutane Point. The findings of that study indicate that macroalgae and invertebrate objectives of NRP O19 are achieved, but there is not sufficient information to determine the current state of mahinga kai species or the coastal fish population.

Table 4-28: Current state summary

Water quality	Taupo Stream	Plimmerton Beach		Titahi Bay		
	(RS63)	At Bath (POCW6)	South Beach (POCW7)	Bay Dr (POCW3)	Toms Dr (POCW4)	South Beach (POCW5)
Observed scums or foams (% of inspections)	no data	10-30%	10-30%	5-10%	10-30%	>30%
Observed oils or grease films	no data	<5%	<5%	<5%	<5%	10-30%
Observed change in colour or clarity	no data	5-10%	5-10%	<5%	<5%	10-30%
E. coli (freshwater, NPS attribute state)	E	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
E. coli (freshwater, NRP O18 – 95%ile < 540)	Not meeting	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Enterococci (coastal water, NRP O18 – 95%ile <500)	Not applicable	Not meeting	Not meeting	Meeting	Meeting	Not meeting
Dissolved reactive phosphorus (NPS attribute state)	D	no data	no data	no data	no data	no data
Nitrate-N (nutrient, ANZG 2018)	Not meeting	no data	no data	no data	no data	no data
Nitrate-N (toxicity NPS attribute state)	A	no data	no data	no data	no data	no data
Ammonia-N (toxicity NPS attribute state)	B	no data	no data	no data	no data	no data
Dissolved Cu (NRP O19 for toxicants)	Not meeting	no data	no data	no data	no data	no data
Dissolved Zn (NRP O19 for toxicants)	Meeting	no data	no data	no data	no data	no data
Sediment quality						
Metals (ANZG 2018)	Meeting	no data	no data	no data	no data	no data
Total of reported PAH	Meeting	no data	no data	no data	no data	no data
Total DDT isomers (ANZG 2018)	Not meeting	no data	no data	no data	no data	no data
Ecology						
Macroinvertebrate community (NRP O19)	Not meeting	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Freshwater fish community (NRP O19	Meeting	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Marine ecology (NRP O19)	Not applicable	no data	no data	Meeting	Meeting	Meeting

4.19.3 Assessment against NRP Objective O18 and O19

The NRP contact recreation and Māori customary use objective O18 was not achieved for faecal indicator bacteria at Taupo Stream, either of the Plimmerton Beach coastal water site or at the Titahi Bay south beach coastal water site.

The NRP biodiversity and aquatic ecosystem objective O19 was not achieved in the lower reached of Taupo Stream. Table 4-29 provides an assessment of against NRP Objective O19 for Porirua coastal waters.

Table 4-29: Assessment of Porirua Coast marine ecology against NRP Objective O19

	Macroalgae	Invertebrates	Mahinga kai species	Fish
NRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by Mana Whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	Intertidal and subtidal habitats have an abundant and diverse algae flora. There is no evidence of nuisance algae. Intertidal and subtidal habitats have an abundant and diverse invertebrate fauna (Morrisey, *et al.*, 2019)			

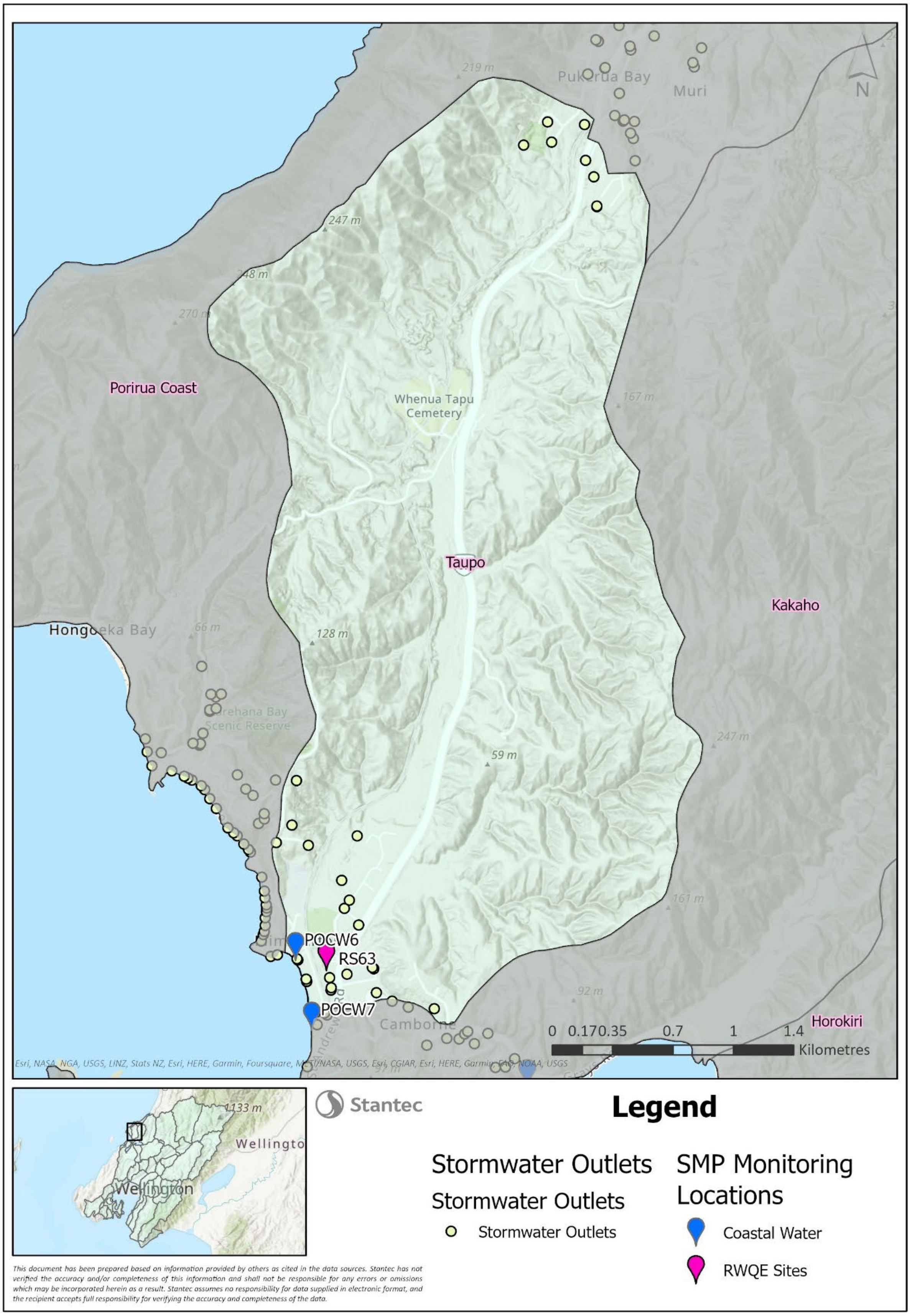


Figure 4-59: Taupo Catchment

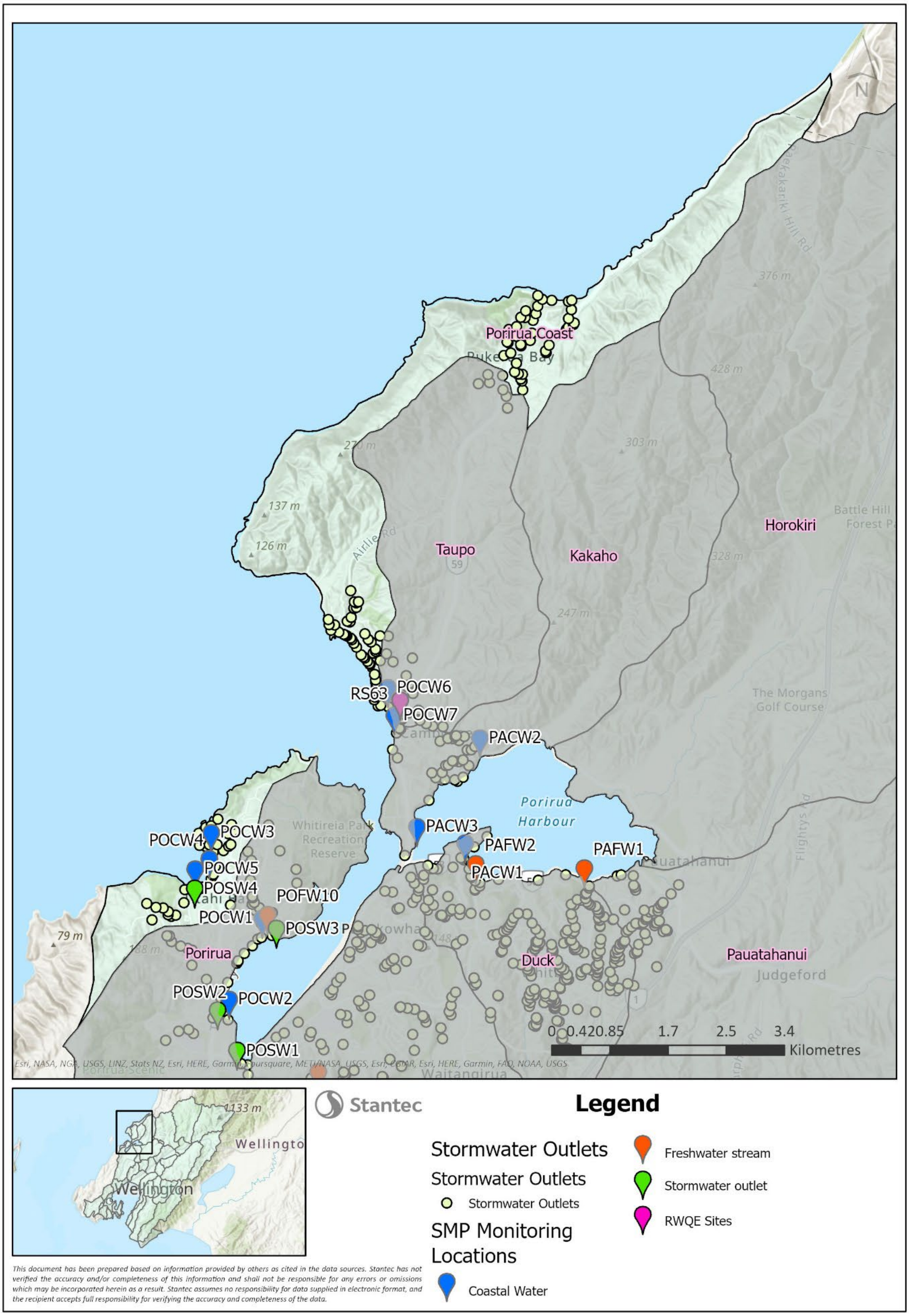


Figure 4-60: Porirua Coast

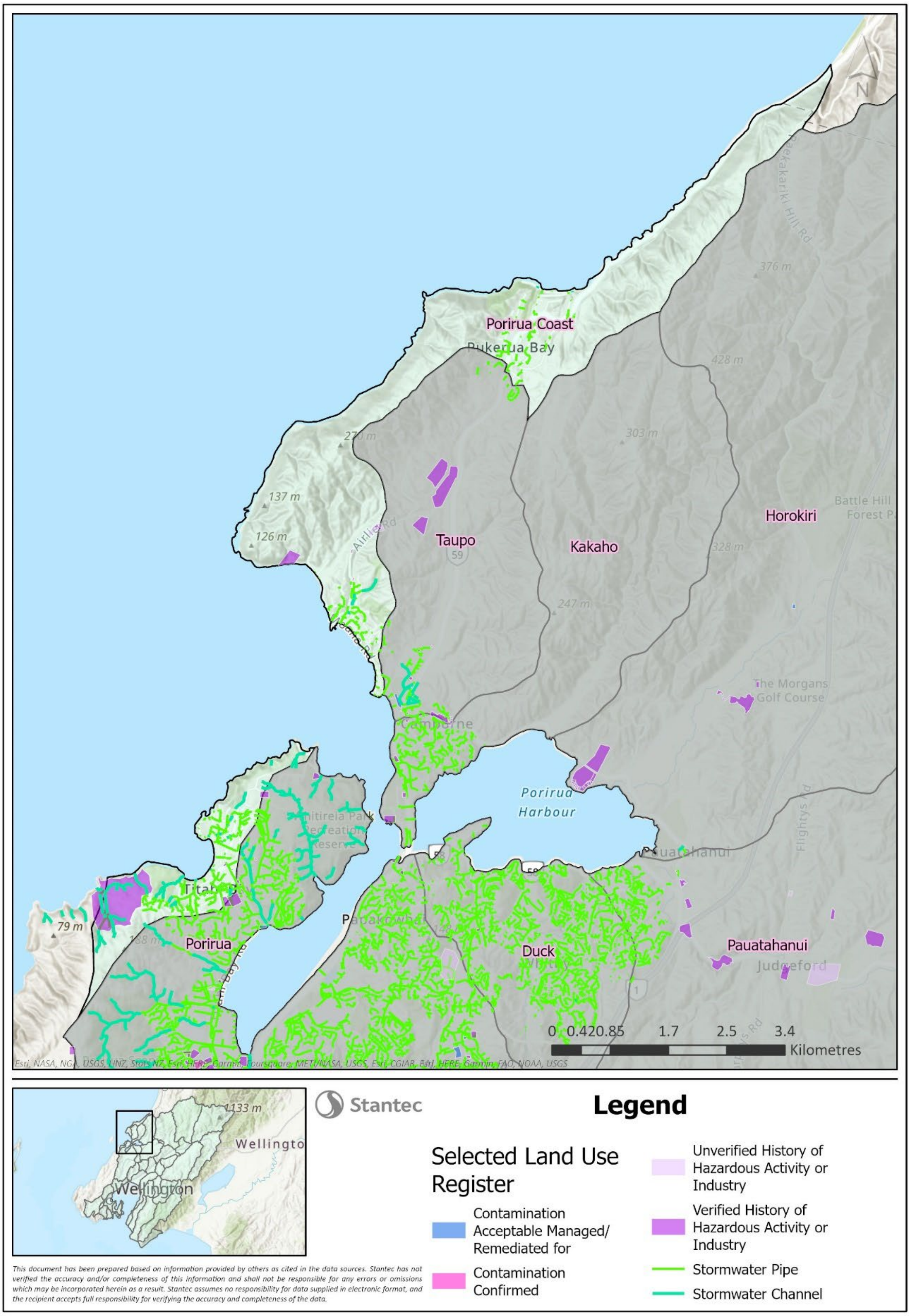


Figure 4-61: Porirua Coast SLUR sites

5 Assignment of ecological and recreational value

Table 2-2 (in section 2-3) sets out a series of habitat and species attributes that should be considered when assigning ecological values. These attributes, broadly categorised as macroinvertebrate community health, fish integrity, and habitat quality, are scored for each sub catchment based on information in Section 4, and are summarised Table 5-1. Each sub catchment was scored as either 'Negligible' 'Low', 'Moderate', 'High' or 'Very High'. For completeness, listings in NRP Schedules A, F, and H are also included in Table 5-1. Scores for Recreational Values are also included, based on relevant recreation assessments (i.e., Rob Greenaway & Associates, 2017 and 2021).

Table 5-1: Assignment of ecological value and recreational value

Sub catchment	NRP Schedules									Fish integrity	Macro-invertebrate health (freshwater / coastal)	Habitat quality	Ecological value	Recreational value
	A	F1	F1b	F2	F3	F4	F5	H1	I					
1. Karori		✓							✓	High	Mod (FW)	Mod	Moderate	Moderate
2. Owhiro		✓	✓	✓		✓	✓	✓		Mod High	Low (FW) High (CW)	Low High	High	Very high
3. Island/ Houghton				✓		✓	✓	✓		High	High (CW)	High	High	Very high
4. Lyall Bay				✓			✓	✓		mod	Mod (CW)	Mod	Moderate	Very high
5. East Coast				✓			✓	✓		High	High (CW)	High	High	Very high
6. Evans Bay				✓				✓		Mod	Mod (CW)	Mod	Mod	Very high
7. Lambton				✓				✓		Mod	Mod (CW)	Mod	Mod	Very high
8. Kaiwharawhara		✓	✓	✓		✓			✓	High Mod	Low (FW) Mod (CW)	Mod Mod	High	Moderate
9. North harbour				✓			✓			Mod Mod	Low (FW) Mod (FW)	Low Mod	Low	Low
10. Korokoro		✓		✓		✓				High Mod	High (FW) Mod (FW)	High Mod	High	Moderate
11. Speedy's		✓								High	High (FW)	high	High	Moderate
12. Waiwhetu		✓	✓	✓		✓				Low	Low (FW)	low	Moderate	low
13. Stokes Valley		✓								Mod	Low (FW)	low	Low	Low
14. Hulls		✓								Mod	Low (FW)	low	Low	Low
15. Lower Hutt South		✓	✓	✓	✓			✓	✓	High	High (FW)	high	High	Very high
16. Lower Hutt North		✓		✓	✓			✓	✓	High	High (FW)	high	High	Very high
17. Upper Hutt South		✓		✓	✓			✓	✓	High	High (FW)	high	High	Very high
18. Upper Hutt North		✓		✓	✓			✓	✓	High	V high (FW)	high	Very high	Very high
19. Hutt -Whakatiki		✓			✓					High	V high (FW)	high	Very high	High
20. Hutt Akatarawa		✓			✓			✓	✓	High	V high (FW)	high	Very high	Very high
21. Hutt Headwater	✓	✓			✓			✓	✓	High	V high (FW)	high	Very high	Very high
22. Hutt Pakuratahi		✓			✓			✓	✓	High	V high (FW)	high	Very high	Very high
23. Hutt Mangaroa									✓	Mod	Mod (FW)	high	Moderate	Moderate
24. Eastbourne	✓	✓		✓		✓	✓	✓		Mod	Mod (CW)	high	Very high	Very high
25. Black Creek		✓			✓					Low	Low (FW)	low	Low	Low
26. Wainuiomata-iti		✓			✓					No data	No data	mod	Moderate	Moderate
27. Wainuiomata		✓	✓	✓	✓	✓			✓	High	Mod (FW)	High	High	Very high
28. Morton	✓	✓			✓					High	High (FW)	V high	Very high	Moderate
29. Taupo	✓	✓	✓		✓	✓				High	Low (FW)	mod	High	Low

Sub catchment	NRP Schedules									Fish integrity	Macro-invertebrate health (freshwater / coastal)	Habitat quality	Ecological value	Recreational value
	A	F1	F1b	F2	F3	F4	F5	H1	I					
30. Kakaho	✓	✓	✓	✓	✓	✓				No data	No data	high	Very high	Very high
31. Horokiri	✓	✓	✓	✓	✓	✓				high	Mod (CW)	mod	Very high	Moderate
32. Pauatahanui	✓	✓	✓	✓		✓				high	Mod (CW)	high	Very high	Moderate
33. Duck	✓	✓	✓	✓	✓	✓				high	Mod (FW) Mod (CW)	high	Very high	Moderate
34. Porirua		✓	✓	✓	✓					mod	Low (FW) Low (CW)	Mod	Moderate	Moderate
35. Porirua coast				✓	✓		✓	✓		high	High (CW)	V high	Very high	Very high

Notes:

1. NRP schedules: A (Outstanding water body), F1 (rivers and lakes with significant indigenous ecosystems), F1b (Known inanga spawning habitat), F2 (Significant habitat for aquatic birds), F3 (Identified natural wetlands), F4 (Sites with significant indigenous biodiversity values in the coastal marine area), F5 (Habitats with significant indigenous biodiversity values in the coastal marine area), H1 (Significant contact recreation freshwater bodies, I (Important trout fishery and spawning waters)
2. Aquatic Life attribute state is from NPS-FM Table 14 (Macroinvertebrates). Data are from GWRC website and SMP.
3. Values vary across each sub-catchment; the purpose of this assessment the highest local value is taken as the value for the sub-catchment.

6 Assessment of Environmental Effects

Historically the management of urban stormwater has focused almost exclusively on the prevention of erosion and flooding and the protection of infrastructure, with very little attention given to the associated degradation of aquatic ecosystems. Nevertheless, the effects on aquatic ecosystems have become increasingly evident over the last several decades (as described in Section 1.1). There is now an increasing understanding of what has been lost as a result of urban development, and calls for a shift in how we plan, design and construct cities such that our urban waterways are managed for ecological health.

Section 4 of this AEE provides a stock-take of the current state of stormwater receiving environments, section 5 assigns values to those environments, while section 6 assesses the likely contribution made by stormwater to the observed current state. It is recognised, however, that the ability to distinguish between the effects of stormwater discharges from local authority stormwater networks and other sources and stressors is limited. Other sources include stormwater from private properties, contaminated sites contaminating groundwater, runoff from rural land, stormwater discharges from other networks (e.g., State Highway), and wastewater network overflows. Stressors include the increasing extent of impervious surfaces, loss of riparian vegetation, loss or modification of stream habitat, climate change, aquatic species recruitment success, and artificial barriers to fish passage.

6.1 Positive effects

The continued existence and effective operation of stormwater network infrastructure has considerable and demonstrable benefits including mitigation of flooding risks, separation of stormwater from wastewater, and an associated reduction in pressure on the wastewater network.

6.2 Effects on s107 matters

The current state of stormwater receiving environments in respect to oil or grease films, floatable or suspended materials, visual clarity and objectionable odours is summarised below, and detailed in subsequent sections.

6.2.1 Summary of aesthetic effects

The observations recorded during monthly inspections relate to both stormwater outlets (before reasonable mixing) and receiving waters (after reasonable mixing) and include a categorization of magnitude as either 'moderate' or 'high'. It is likely that these observations have not been consistently applied across the sampling programme and we have therefore taken them as indicative only, rather than as a direct assessment against the minimum standards of S107.

Nevertheless, the weight of evidence from records summarised in Table 6-1 is that stormwater discharges in several sub-catchments would likely not meet one or more of the minimum standards of S107 after reasonable mixing. These sub-catchments include Porirua Stream, Porirua Coast, Lambton, Evans Bay, Houghton Bay, Owhiro and Lower Hutt South. The worst performing stormwater sites include the Semple Street Outlet[10], Miramar Culvert, Houghton Bay Culvert, and Takapūwāhia Stream.

[10] It is noted that Porirua City Council, Ngati Toa and Wellington Water have recently completed a flood attenuation and stormwater treatment project at Elsdon Park, which is intended to address the impacts identified at the Semple Street stormwater outlet.

Table 6-1: Summary of SMP observations in relation to S107 matters

Sub-catchment	Location	Conspicuous oil or grease films	Conspicuous scums or foams	Conspicuous change in colour or clarity	Emission of objectionable odour
Porirua	Semple Street SW Outlet[5]	✓✓	✓✓	✓✓✓	✓✓
	Takapūwāhia Stream	✓	✓	✓✓	
	Stebbings Stream		✓		
	Belmont Stream		✓		
Porirua coast	Titahi Bay South SW Outlet		✓✓		
	Titahi Bay Beach		✓		
	South Plimmerton Beach		✓		
Lambton	Te Aro SW Outlet	✓✓			✓
	Tory SW Outlet	✓✓			✓
	Taranaki SW Outlet	✓✓			
Evans Bay	Miramar SW Outlet	✓✓✓			✓
	Hataitai SW Outlet	✓✓			
Island/Houghton	Houghton Bay SW Outlet	✓✓	✓✓	✓	✓
Owhiro	Upper Stream US T&T		✓	✓	
	Lower Owhiro Stream		✓	✓	
Lower Hutt South	Opahu Stream	✓			

Note: ✓ indicates the effect was observed on more than 20% of monthly inspections, ✓✓ on more than 50%, ✓✓✓ on more than 70%

A detailed assessment is provided in the following sections.

6.2.2 Oil or grease films, scums, foams, floatable or suspended materials

Section 107 of the RMA (1991) restricts the grant of discharge permits if, after reasonable mixing, the contaminant or water discharged gives rise to "(1)(c*) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials*" in receiving waters.

Records from SMP routine monthly monitoring show that oil or grease films were observed at stormwater outlets (prior to reasonable mixing) on 23% of sampling occasions. The worst case by far was the Miramar Culvert in Evans Bay where oil or grease films were observed on 90% of sampling occasions. The Semple Street Culvert in Porirua CBD and Houghton Bay Culvert also rated poorly at 66% and 59% of sampling occasions, respectively (Table 6-2).

Oil or grease films were also observed in freshwater and coastal water receiving environments (i.e., after reasonable mixing), but less frequently, on 4% of sampling occasions. The worst performing receiving water site was Opahu Stream (Lower Hutt South sub-catchment) where films were observed on 17% of sampling occasions.

Table 6-2: Observations of oil/grease films at the 15 worst ranked SMP sites

Sub-catchment	Sample Location	Site ID	Site type	Site visits	Oil, grease films		
					High	Moderate	%
Evans	Miramar Culvert	EVSW1	SW	29	5	21	90
Onepoto	Semple Street Outlet	POSW1	SW	29	4	15	66
Island/Houghton	Houghton Bay Culvert	HOSW1	SW	29	3	14	59
Lambton	Te Aro Culvert	LASW7	SW	29	1	16	59
Lambton	Tory Street Culvert	LASW9	SW	29	1	14	52
Lambton	Taranaki Culvert	LASW8	SW	29	4	11	52
Evans	Hataitai Culvert	EVSW4	SW	29	0	15	52
Onepoto	Takapūwāhia Stream Outlet	POSW2	SW	29	1	10	38
Evans	Cobham Culvert	EVSW2	SW	29	0	8	28
Lambton	OPT Culvert	LASW10	SW	29	0	7	24

Sub-catchment	Sample Location	Site ID	Site type	Site visits	Oil, grease films		
					High	Moderate	%
Evans	Kilbirnie Culvert	EVSW3	SW	29	0	6	21
Lambton	Grass Street Culvert	LASW12	SW	29	0	5	17
Lower Hutt South	Opahu Stream	OPFW1	FW	29	2	3	17
Lambton	Waring Taylor Culvert	LASW4	SW	29	1	4	17
Lambton	Hunter Culvert	LASW5	SW	29	0	5	17

Scums and foams were observed at stormwater outlets on 12% of sampling occasions. The worst-case stormwater outlet was the Houghton Bay Culvert where scums or foams were observed on 59% of sampling occasions. The South Beach Access Road stormwater at Titahi Bay and the Semple Street outlet in the Porirua CBD also performed poorly (Table 6-3).

Scum and foams were also observed in receiving waters on 14% of sampling occasions. Although contaminants in stormwater remain the most likely source, it is noted that foams can occur naturally in freshwater and seawater from sources such as the breakdown of algal cells. The worst-case receiving water sites were Takapūwāhia Stream, Owhiro Stream, Stebbings Stream and Black Creek where scums or foam were observed on 41% of sampling occasions.

Table 6-3: Observations of scums or foams at the 15 worst ranked SMP sites

Sub-catchment	Sample Location	Site ID	Site type	Site visits	Scums or foams		
					High	Moderate	%
Island/Houghton	Houghton Bay Culvert	HOSW1	SW	29	7	10	59
Porirua coast	South Beach Access	POSW4	SW	29	1	15	55
Onepoto	Semple Street Outlet	POSW1	SW	29	1	13	48
Onepoto	Takapūwāhia Stream Outlet	POSW2	SW	29	3	9	41
Owhiro	Owhiro Stream u/s T&T Landfill	OWFW1	FW	29	0	12	41
Onepoto	Stebbings Stream	POFW3	FW	29	1	11	41
Wainuiomata	Black Creek at Moohan St	BLFW3	FW	29	1	11	41
Stokes Valley	Stokes Valley Stream	STFS1	FW	29	0	10	34
Pauatahanui	Browns Stream at footbridge	PAFW2	FW	29	1	7	28
Owhiro	Owhiro Stream u/s Owhiro Bay Parade	OWFW2	FW	29	1	7	28
Hull	Hull Creek Trib (Pinehaven)	PIFW1	FW	29	0	8	28
Onepoto	Belmont stream at Setton	POFW5	FW	29	0	8	28
Porirua coast	South Plimmerton Beach	POCW7	CW	29	0	7	24
Waiwhetu	Waiwhetu Stream at Tilbury	WAIWFW1	FW	29	0	7	24
Porirua coast	Titahi Bay at South Beach	POCW5	CW	29	0	7	24

6.2.3 Changes in colour or visual clarity

Section 107(1)(d) of the RMA (1991) restricts the grant of discharge permits if, after reasonable mixing, the contaminant or water discharged gives rise to "*any conspicuous change in the colour or visual clarity*" in receiving waters.

Records from routine monthly monitoring show that changes in colour of visual clarity were observed at stormwater outlets on 18% of sampling occasions. The worst-case stormwater outlet is the Semple Street Culvert in the Porirua CBD where a change was observed on 72% of sampling occasions.

Changes in colour or visual clarity were also observed in receiving waters at an average of 18% of sampling occasions. The worst-case receiving water sites were at Browns Bay Stream, Takapūwāhia Stream, Owhiro Stream, Duck Creek and Waiwhetū Stream, where changes were observed on more than 50% of sampling occasions. The sites with the greatest level of change in colour or clarity are listed in Table 6-4.

Table 6-4: Observations of a change is colour or clarity at the 15 worst ranked SMP sites

Sub-catchment	Sample Location	Site ID	Site type	Site visits	Change in colour or clarity		
					High	Moderate	%
Onepoto	Semple Street Outlet	POSW1	SW	29	3	18	72
Pauatahanui	Browns Stream at footbridge	PAFW2	FW	29	6	13	66
Onepoto	Takapūwāhia Stream Outlet	POSW2	SW	29	1	16	59
Pauatahanui	Duck Creek u/s SH58	PAFW1	FW	29	3	14	59
Waiwhetu	Waiwhetu Stream at Rishworth St	WAIWFW2	FW	29	3	12	52
Onepoto	Unnamed watercourse u/s Onepoto Road	POFW10	FW	29	0	15	52
Waiwhetu	Waiwhetu Stream	WAIWFW1	FW	29	2	12	48
Onepoto	Keneperu Stream at Bothamley Park	POFW8	FW	29	5	9	48
Owhiro	Owhiro Stream u/s Owhiro Bay Parade	OWFW2	FW	29	6	7	45
Island/Houghton	Houghton Bay Culvert	HOSW1	SW	29	2	10	41
Wainuiomata	Black Creek trib. At Fitzherbert Road	BLFW2	FW	29	5	7	41
Owhiro	Owhiro Stream above T & T Landfill	OWFW1	FW	29	2	9	38
North Harbour	Waitohi Stream at Ngauranga Gorge	NOFS1	FW	29	4	7	38
Onepoto	Kenepuru Stream at Mepham Place	POFW9	FW	29	3	8	38
Upper Hutt North	8 Akatarawa Road	HUSW1	SW	29	1	10	38

6.2.4 Emissions of objectionable odour

Section 107(1)(e) of the RMA (1991) restricts the grant of discharge permits if, after reasonable mixing, the contaminant or water discharged gives rise to "*any emission of objectionable odour*" in receiving waters.

Records from routine monthly monitoring show that emissions of objectionable odour were detected at stormwater outlets on 12% of sampling occasions. The worst cases were at the Houghton Bay stormwater outlet and Semple Street outlet where objectionable odour was detected on 48% and 34% of site visits, respectively (Table 6-5).

Emissions of objectionable odour were detected in receiving waters at 1% of sampling occasions. The worst-case receiving water site was Te Mome Stream where objectionable odour was detected on 7% of sampling occasions. In that instance fine silt, mud and organic matter has accumulated on the streambed, which probably accounts for the frequent emission of odour.

Table 6-5: Emissions of objectionable odour at the 15 worst ranked SMP sites

Sub-catchment	Sample Location	Site ID	Site type	Site visits	Emission of objectionable odour		
					High	Moderate	%
Island/Houghton	Houghton Bay Culvert	HOSW1	SW	29	4	10	48
Onepoto	Semple Street Outlet	POSW1	SW	29	0	10	34
Lambton	Te Aro Culvert	LASW7	SW	29	1	8	31
Evans	Miramar Culvert	EVSW1	SW	29	1	8	31
Lambton	Thorndon	LASW1	SW	29	1	7	28
Lambton	Tory Street Culvert	LASW9	SW	29	3	4	24

Sub-catchment	Sample Location	Site ID	Site type	Site visits	Emission of objectionable odour		
					High	Moderate	%
Lambton	Davis Culvert	LASW2	SW	29	0	5	17
Lambton	Harris Street Culvert	LASW6	SW	29	2	3	17
Lambton	Taranaki Culvert	LASW8	SW	29	0	5	17
Onepoto	Takapūwāhia Stream Outlet	POSW2	SW	29	1	3	14
North Harbour	Newlands at Gorge	NOSW1	SW	29	0	4	14
Lambton	Grass Street Culvert	LASW12	SW	29	1	3	14
Porirua coast	South Beach Access	POSW4	SW	29	0	3	10
Evans	Kilbirnie Culvert	EVSW3	SW	29	3	0	10
Lambton	OPT Culvert	LASW10	SW	29	0	3	10

6.2.5 Freshwater consumption by farm animals

Section 107(1)(f) of the RMA (1991) restricts the grant of discharge permits if, after reasonable mixing, the contaminant or water discharged gives rise to "the rendering of freshwater unsuitable for consumption by farm animals".

In the context of the stormwater discharge consent application this standard is relevant only for the Karori and Wainuiomata catchments where rural land use occurs downstream of an urban area with a reticulated stormwater system. ANZECC (2000) provides stock watering guidelines for biological parameters, major ions, total dissolved solids, heavy metals and organic contaminants. Those variables for which monitoring data is available downstream of the Karori and Wainuiomata urban areas are summarised below in Table 6-6.

Table 6-6: Summary water quality statistics from monthly monitoring, July 2021 - June 2022

Variable	Unit	Karori Stream @ Makara Peak		Black Creek @ Rowe Parade		ANZECC (2000) Stock Watering Guidelines
		median	max	median	max	
E. coli[11]	cfu/100mL	2,000	10,000	1,400	31,000	<100 (median)
Dissolved calcium	mg/L	4.0	4.6	7.0	8.8	<1000
Nitrate	mg/L	5.3	6.19	1.59	3.01	<338 (maximum)
Nitrite	mg/L	0.016	0.062	0.020	0.056	<9 (maximum)
Total copper	mg/L	0.0015	0.0118	0.0012	0.007	0.5 (maximum)
Total zinc	mg/L	0.020	0.083	0.021	0.112	20 (maximum)

The monitoring results indicate that stormwater discharges do not render freshwater unsuitable for consumption by farm animals, with the possible exception of pathogen content. However, in both the Karori and Wainuiomata catchments, livestock do not have access to stream water until several kilometers downstream of the urban area where the risk is likely to be much reduced by natural purification processes and additional dilution. It is noted also that most of the faecal contamination in stormwater runoff from urban areas is attributed to wastewater network faults and overflows, with a relatively small proportion sourced from stormwater alone. On balance it is concluded that the stock watering standard is achieved in respect of stormwater discharges.

[11] The ANZECC (2000) stock watering guidelines refer to 'thermotolerant coliforms', also known as faecal coliforms, of which *E. coli* are the most common (typically >90%).

6.2.6 Adverse effects on aquatic life

Section 107(1)(f) of the RMA (1991) restricts the grant of discharge permits if, after reasonable mixing, the contaminant or water discharged gives rise to "any significant adverse effects on aquatic life". An assessment effects on aquatic life is provided in Section 6.7.

6.3 Effects on Mana Whenua values

This section is an interim assessment of effects based on summaries and excerpts extracted from the documents as listed in Section 2.6 of this report. The assessment is general in scope and does not attempt to identify the extent or severity of the effects of stormwater discharges on the values held by Mana Whenua for individual water bodies.

The documents reviewed for this assessment identify that numerous aspects of urban development have had adverse effects on the values of waterbodies to Mana Whenua. This includes adverse effect from stormwater discharges but also wastewater contamination and reclamation and culverting activities. Note that, although wastewater contamination of the stormwater and waterways and physical works including culverting of natural streams and channels have been highlighted as a particular concern of Mana Whenua, these activities are not within the scope of this consent.

The documents reviewed do not provide significant details on the specific effects arising from stormwater discharges, but these effects are generally understood to relate to:

- Degradation of food gathering and mahinga kai due to contaminants in stormwater and changes in hydrological regime.

For example, the "Te Awarua-o-Porirua Whaitua Implementation Programme: Ngāti Toa Rangatira Statement" points out, the effect of intensified landuse, contamination and siltation have resulted in poor water quality and an inability to harvest kaimoana. Likewise Te Mahere Wai 2021 states that "In many cases, Mana Whenu have been unable to maintain their kaitiaki relationships with mahinga kai due to loss or contamiantion of species and loss of habitat"

- Restrictions on other customary uses of the water ways due to contamination

Contaminated waterways restrict Mana Whenua's access to awa and to exercise customary practices such as, but not limit to tohi (bapitism), karakia (prayer), waerea (protective incantation) and tuku iho (gifting knowledge and resources to future generation).

- Diminishing the mana of the iwi

Poor water quality and the inability to harvest kai moana, raranga, and rongoā as result of contaminated waterways has diminished Mana Whenua's "ability to provide for its people and manaakitanga to its manuhiri, and by extension, the iwi's sense of mana" (Te Awarua-o-Porirua Whaitua Implementation Programme, 2019).

- Degradation of mauri of the water bodies.

Protection of the Mauri/Mouri and the ecological values of individual waterways is a priority of Mana Whenua. Both the contamination and the concealment (including piping) of the waterways degrades the mauri of the water bodies.

- Creating negative perception about the water ways

For example, the degradation of the Porirua harbour and streams causes may people to perceive the harbour and streams as dirty and undesirable place to be, and this perception and disconnection diminish people's sense of responsibility for sustaining and caring for the wellbeing of Porirua's waterways and estuary (Te Awarua-o-Porirua Whaitua Implementation Programme, 2019)

- Excluding Mana Whenua from decision-making and undermining their role as kaitiaki and ultimately their rangatiratanga.

The exclusion of Mana Whenua from decision making in relation to the stormwater network and its discharges has undermined Mana Whenua's role as kaitiaki. For example, Te Mahere Wai states "The assumed authority that regional council have had over the governance and management of water undermines rangatiratanga".

6.4 Water quality

Section 4 provides a stock-take of the current state of water quality in each of the stormwater receiving environments. To an attempt to provide an overview of the current state of each sub catchment these results are brought together in Table 6-7. The following sections assess the likely contribution from local authority stormwater networks to the current state.

Table 6-7: Summary of water quality benchmarked against NRP and NPS

Sub-Catchment	*E. coli* (per 100mL)	Entero-cocci (per 100mL) coastal	DRP (g/m³)	Nitrate-N (g/m³)		Ammonia-N toxicant (g/m³)	Cu (g/m³)	Zn (g/m³)	% Impervious surface area
				Nutrient	Toxicant				
	NPS, NRP	NRP	NPS	ANZG	NPS	NPS	ANZG 95%ile	ANZG 95%ile	
1. Karori	(E) not meeting	Not applicable	(D)	Not meeting	(B)	(B)	Not meeting	Not meeting	5% (20%)[12]
2. Owhiro	(E) not meeting	Not meeting	(D)	Not meeting	(A)	(A)	Not meeting	Meeting	6%
3. Island/ Houghton	Not applicable	Meeting	no data	no data	no data	no data	no data	no data	17%
4. Lyall Bay	Not applicable	Meeting	no data	no data	no data	no data	no data	no data	34%
5. East Coast	Not applicable	Meeting	no data	no data	no data	no data	no data	no data	20%
6. Evans Bay	Not applicable	Meeting	no data	no data	no data	no data	no data	no data	25%
7. Lambton	Not applicable	Partially meeting	no data	no data	no data	no data	no data	no data	26%
8. Kaiwharawhara	(E) not meeting	Not applicable	(C)	Not meeting	(B)	(B)	Not meeting	Not meeting	10%
9. North harbour	(E) not meeting	Not applicable	no data	no data	no data	no data	Not meeting	Not meeting	15%
12. Waiwhetu	(E) not meeting	Not applicable	(C)	Not meeting	(A)	(B)	Not meeting	Not meeting	53%
13. Stokes Valley	(E) not meeting	Not applicable	(D)	Not meeting	(A)	(B)	Not meeting	Not meeting	27%
14. Hulls	(E) not meeting	Not applicable	(D)	Not meeting	(A)	(B)	Not meeting	Not meeting	21%
15. Lower Hutt South	(D) not meeting	Not meeting	(A)	Not meeting	(A)	(A)	Meeting	Meeting	59%
16. Lower Hutt North	no data	Not applicable	no data	no data	no data	no data	no data	no data	27%
17. Upper Hutt South	(B) meeting	Not applicable	(A)	Not meeting	(A)	(A)	Meeting	Meeting	20%

12 The catchment upstream of the Karori Stream monitoring site is 7.79 ha of which an estimated 20% is impervious surface.

18. Upper Hutt North	no data	Not applicable	no data	no data	no data	no data	no data	no data	32%
21. Hutt Headwater	(A) meeting	Not applicable	(A)	Meeting	(A)	(A)	no data	no data	<1%
24. Eastbourne	Not applicable	Partially Meeting	no data	no data	no data	no data	no data	no data	11%
25. Black Creek	(E) not meeting	Not applicable	(D)	Not meeting	(A)	(B)	Not meeting	Not meeting	27%
29. Taupo	(E) not meeting	Not applicable	(D)	Not meeting	(A)	(B)	Meeting	Meeting	9%
30. Kakaho	no data	Partially Meeting	no data	no data	no data	no data	no data	no data	3%
33. Duck	(E) not meeting	Not meeting	no data	no data	no data	no data	no data	no data	15%
34. Porirua Stream	(E) not meeting	Not meeting	(D)	Not meeting	(A)	(B)	Not meeting	Not meeting	19%
35. Porirua coast	Not applicable	Not meeting	no data	no data	no data	no data	no data	no data	10%

Note, catchments containing little of no urban stormwater network are not monitored under the SMP and are not included in the above table. These include the Whakatikei, Akatarawa, and Mangaroa sub-catchments of the Hutt River Catchment, the Wainuiomata-iti, Wainuiomata, and Morton sub-catchments of the Wainuiomata River catchment, and the Kakaho, Horokiri, Pauatahanui, Korokoro and Speedy's stream catchments.

6.4.1 Faecal indicator bacteria

Elevated concentrations of the faecal indicator bacteria *E. coli* were recorded at all SMP sites on urban streams in Porirua, Wellington, Hutt Valley and Wainuiomata, placing virtually all urban streams in NPS-FM attribute band E. The Hutt River is an exception, ranging from band (A) in the headwaters to band (D) at Lower Hutt, reflecting an increasing proportion of agricultural land use in the middle catchment and urban land use in the lower catchment (the headwaters having no urban wastewater or stormwater networks).

Faecal indicator bacteria concentrations in coastal waters (enterococci) achieved NRP objectives at most sites along Wellington's South Coast, Evans Bay, Lambton Harbour and Eastbourne. NRP objectives were, however, not achieved at most sites in Porirua Harbour, Porirua Coast and Petone Beach.

Overflows from wastewater networks are known to be a major source of faecal contamination in urban catchments, however, wet weather wastewater network overflows are outside the scope of the stormwater consent applications (they are addressed separately by wastewater network consent applications). Urban stormwater could still carry faecal material sourced from wastewater leaks, illegal cross-connection wastewater laterals and surface run-off that contains waste material from warm blooded animals (rats, cats, dogs, birds, possums, etc.,) which accumulates in gutters and on hard surfaces and is transported to natural watercourses during and after a rainfall event. This is confirmed by faecal source tracking in urban streams, using DNA fingerprinting, which indicates a range of animal faecal sources including ruminants, dogs, and wildfowl in addition to humans (Milne & Morar, 2017).

The relative contribution of faecal material from stormwater alone versus wastewater network sources is unknown and would likely vary between sub-catchments. In many instances a wastewater fault or overflow would account for much of the faecal contamination.

6.4.2 Water temperature and dissolved oxygen

The monitoring results presented in Section 4 indicate that most urban streams in Porirua, Wellington, Hutt Valley and Wainuiomata are achieving good or excellent ecosystem health criteria in respect of water temperature and dissolved oxygen. One exception is Taupo Stream, which drains Taupo Flax swamp, where low dissolved oxygen concentrations (<4 mg/L) have been recorded from time to time. Occasional depletion of dissolved oxygen is most likely a natural feature of the Taupo Flax Swamp which is a fertile lowland wetland that receives nutrients and sediments from adjacent agricultural land, but this is not an effect of urban stormwater. (The Taupo Swamp Complex is further discussed in Section 6.8.1.)

There is no evidence that intermittent stormwater discharges cause ecosystem stress in respect of water temperature or dissolved oxygen.

6.4.3 Nutrients

The monitoring results presented in Section 4 and summarised in Table 6-5 indicate elevated dissolved reactive phosphorus and nitrate-N concentrations in most urban streams in Porirua, Wellington, Hutt Valley and Wainuiomata that has the potential to impact ecological communities by encouraging excessive algae and plant growth leading to changes in macroinvertebrate and fish communities, and elevated rates of respiration and decay.

These nutrients are likely to be sourced from a combination of wastewater network overflows, wastewater network leaks, incorrect cross-connections, urban stormwater runoff, and agricultural runoff. The later may occur where agricultural land is located upstream of the urban edge, as in the Hutt Valley for instance. Nevertheless, stormwater from an urban catchment with no agricultural input, such as urban Karori, is significantly elevated in both nitrogen and phosphorus. The evidence from SMP monitoring is that the nutrients delivered to streams by urban stormwater alone would be sufficient to cause increased algae and plant growth and the loss of sensitive invertebrate taxa if other factors (such as lack of shading) also favour eutrophication.

6.4.4 Copper and zinc

Copper and zinc concentrations in the water column and sediments of urban streams are variable, but in most cases are present at concentrations that are toxic to some aquatic organisms. That is clearly the case in small to medium size streams receiving stormwater from a large urban area (for instance Porirua Stream, Karori Stream, Kaiwharawhara Stream, and Waiwhetu Stream). As discussed in Section 1.3 there is a strong positive relationship between stormwater concentrations of Cu and Zn and urban land cover, where higher concentrations of dissolved metals are associated with a higher proportion of urban land use in the catchment. Concentrations are lower in waterbodies such as the Hutt and Wainuiomata rivers which have large headwater areas of near pristine native forest which can effectively dilute the metal contribution from urban runoff.

There is strong evidence from a variety of investigations that urban stormwater is the primary source of copper and zinc in urban streams (i.e., Williamson, 2003; KML, 2005; Milne & Watts, 2008; and Stantec, 2022).

6.5 Hydrology

The effect of stormwater discharges on the flow regime of urban watercourses has not been studied specifically in the Porirua, Wellington, Hutt Valley or Wainuiomata stormwater catchments. Nevertheless, it is known that a fundamental characteristic of urban catchments is their high proportion of impervious surfaces. Almost all impervious urban structures, such as roads, carparks, buildings, transport depots, and railways, reduce the area where rainwater can infiltrate into the soil. Runoff rates from these surfaces are very high, far higher than from vegetated surfaces. This results in the stream having a much higher and faster response to rainfall events than non-urban catchments. It also results in less rainfall infiltration into the ground, and loss of groundwater recharge for many small streams, some of which occasionally dry up (Suren, 2000).

There are several potential consequences from the change in flow regime. Frequent scouring from higher flows in urban streams may result in the complete loss of some in-stream animal species. In an American study, Schueler, et al. (1999) suggested that deleterious effects of high rate of stormwater runoff can occur in catchments with as little as 15% of their area in impervious material. That finding appears to be broadly consistent with the macroinvertebrate data reviewed here for urban streams in the Hutt Valley, Wellington, and Porirua. Streams bank erosion is accelerated in newly urbanised areas as the stream morphology finds its equilibrium under a new (higher) flow regime, and habitat is lost because of longer periods of lower base flows. There is strong evidence that urban stormwater discharges can alter the natural flow regime of an urban stream with consequential adverse effects on the ecological health of that stream, and that the magnitude of the adverse effect is related to the degree of flow regime change.

6.6 Aquatic ecosystem health

6.6.1 Macroinvertebrate communities

Section 4 provides a stock-take of the current state of macroinvertebrate communities in each of the stormwater receiving environments. Key results are summarised below in Table 6-8. All three monitoring sites on the Hutt River (RS20, RS21, and RS22) achieved the NRP objective O19 for MCI but the QMCI objective was met only in the upper and middle reaches of the river, not in the Lower Hutt South sub-catchment. Most invertebrate metrics show a decline between the Hutt headwater site (RS20) and those in the Upper Hutt and Lower Hutt sub-catchments, corresponding with an increasing proportion of agricultural and urban land use, and a decreasing proportion of native vegetation land use. All other urban stream sites failed to meet either of the objectives for good ecosystem health.

Table 6-8: Macroinvertebrate community health benchmarked against NRP Objectives

Catchment	Site ID	Location relative to stormwater network	Substrate	River class	Significant River?	NRP O19 Objective MCI	NRP O19 Objective QMCI	Meeting O19 MCI	Meeting O19 QMCI
1. Karori	RS18	Downstream	Hard	2	No	≥ 105	≥5.5	Not meeting	Not meeting
2. Owhiro Bay	RS64	Downstream	Hard	2	No	≥ 105	≥5.5	Not meeting	Not meeting
3. Island/ Houghton	no data	no data	no data	no data	no data	no data	no data	no data	no data
4. Lyall Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data
5. East Coast	no data	no data	no data	no data	no data	no data	no data	no data	no data
6. Evans Bay	no data	no data	no data	no data	no data	no data	no data	no data	no data
7. Lambton	no data	no data	no data	no data	no data	no data	no data	no data	no data
8. Kaiwharawhara	RS19	Downstream	Hard	2	No	≥ 105	≥5.5	Not meeting	Not meeting
9. North harbour	no data	no data	no data	no data	no data	no data	no data	no data	no data
12. Waiwhetu	RS57	Downstream	Hard	6	No	≥ 100	≥5	Not meeting	Not meeting
13. Stokes Valley	no data	no data	no data	no data	no data	no data	no data	no data	no data
14. Hulls	no data	no data	no data	no data	no data	no data	no data	no data	no data
15. Lower Hutt South	RS22	Downstream	Hard	4	No	≥ 110	≥5.5	Meeting	Not meeting
16. Lower Hutt North	no data	no data	no data	no data	no data	no data	no data	no data	no data
17. Upper Hutt South	RS21	Downstream	Hard	4	No	≥ 110	≥5.5	Meeting	Meeting
18. Upper Hutt North	no data	no data	no data	no data	no data	no data	no data	no data	no data
21. Hutt Headwater	RS20	Upstream	Hard	1	No	≥ 120	≥6	Meeting	Meeting
24. Eastbourne	no data	no data	no data	no data	no data	no data	no data	no data	no data

25. Black Creek	no data	no data	no data	no data	no data	no data	no data	no data	no data
29. Taupo	RS63	Upstream	Soft	6	No	≥ 100	≥5	Not meeting	Not meeting
30. Kakaho	no data	no data	no data	no data	no data	no data	no data	no data	no data
33. Duck	no data	no data	no data	no data	no data	no data	no data	no data	no data
34. Porirua Stream	RS15, RS16	Downstream	Hard	2	No	≥ 105	≥5.5	Not meeting	Not meeting
35. Porirua coast	no data	no data	no data	no data	no data	no data	no data	no data	no data

Clapcott & Goodwin (2014) observed invertebrate communities are related to land use through a complex chain of causality. Sediment and nutrients were identified as probable causal pathways for land use to impact MCI however the results show multiple drivers were associated with variation in macroinvertebrate community quality, and that the drivers are not independent of each other. The authors developed a general structural model which is reproduced here in Figure 6-1.

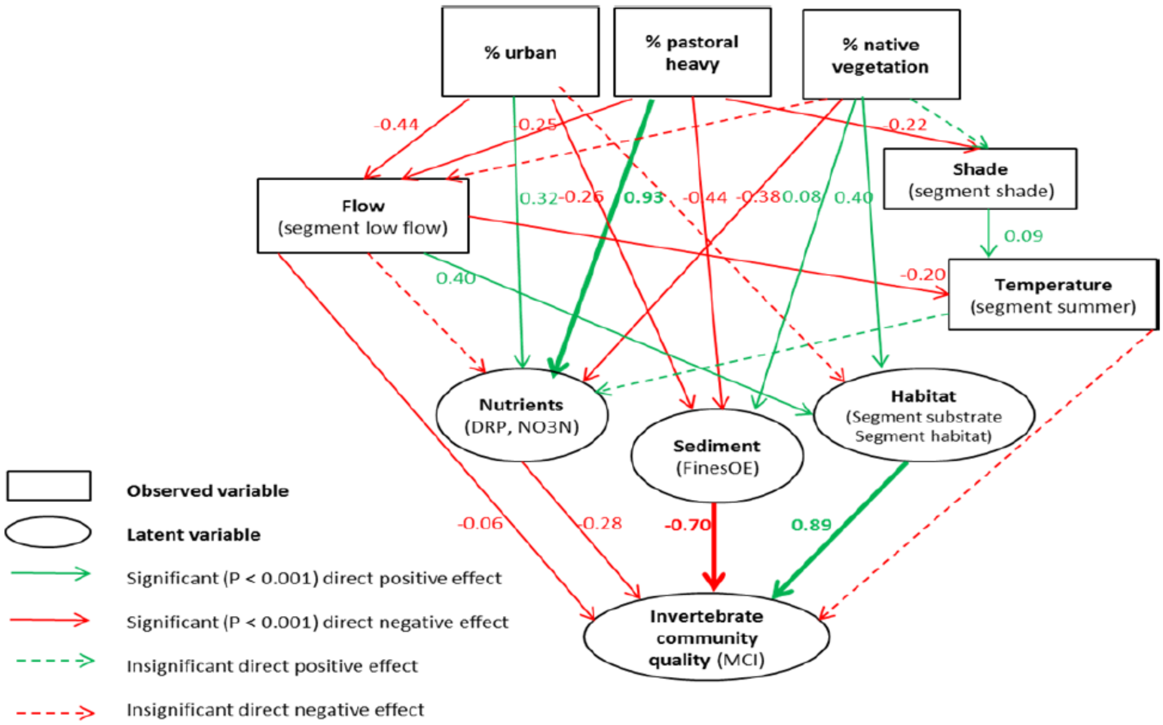


Figure 6-1: Structural model identifying the relative importance of direct pathways between human pressures and Macroinvertebrate Community Index (Clapcott & Goodwin, 2014)

Macroinvertebrate community health is driven by three external land use variables, these being % urban, % heavy pastoral and % native vegetation, which influence stream flow, stream shade, stream temperature, nutrients, sediment, habitat, and ultimately invertebrate habitat quality.

- **Stream flow**. Urbanisation has caused a rapid expansion of impervious surfaces. A large area of impervious surface in the upstream catchment results in higher peak flows and a faster response to rain events than non-urban catchments. It also results in less rainfall infiltration into the ground and loss of groundwater recharge, leader to lower baseflow in dry weather. The scouring effect of higher peak flow in combination with lower base flows reduces the quality and quantity of macroinvertebrate habitat in urban stream.
- **Stream shade**. Riparian and in-stream vegetation regulates light and temperature. It also provides food for invertebrates, shelter for fish, birds and lizards, and spawning habitat for whitebait (McDowell, 1990). Some urban streams are regularly cleared of in-stream and bank-side vegetation to maintain their hydraulic efficiency. Such action degrades in-stream habitat by removing both an important food source and important physical habitat.

- **Stream temperature**. On obvious consequence of removing riparian vegetation is that a important means of stream water temperature regulation is lost resulting in excessive summer maximums.
- **Nutrients.** The results summarised in section 4 show that dissolved nutrients are present in urban stormwater at concentrations which may drive excessive primary production and cause changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost. Nutrients are also present in agricultural runoff, typically at higher concentrations that in urban catchment.
- **Fine sediments.** Exposure of soils during development of urban areas can lead to very high suspended solids (SS) concentrations in runoff from developing areas. High SS loads are not particularly a problem of a well-established urban area, but rather are associated with the development of new urban areas, or any activity involving large scale disturbance of soil. (Note also that discharges associated with earthworks, vegetation clearance, and cultivation are excluded from the NRP definition of stormwater and are not within the scope of the current consent applications).
- **Toxicants.** Urban stormwater contains elevated concentrations of zinc, copper and polycyclic aromatic hydrocarbons. The results summarised in section 3 and 4 indicate that both zinc and copper are present in stream water and sediments at concentrations that may be toxic to sensitive biota.
- **Habitat.** All the above variables can influence the availability and quality of habitat for stream invertebrates.

Factors that are likely to be important in the context of this consent application for the discharge of stormwater from local authority stormwater networks are stream flow, fine sediment, toxicants and habitat quality.

6.6.2 Fish Communities

Fish survey records from NZFFD for the period 2012 to 2022, and additional records reported in Stantec (2022), have been used to characterise the fish populations in 35 stormwater catchments. A total on nineteen species of indigenous fish, and two species of introduced fish are recorded across all sub-catchments (see Appendix A for details). Table 6-9 brings together some important metrics for each sub-catchment, including the NPS-FM attribute state, and benchmarking against the NRP O19 objective for fish IBI.

Table 6-9: NZFFD record comparison against Fish-IBI Objective (2000-2022)

Catchment	% Impervious surface	Number of records	Distance from the sea (km)	Altitude (m)	Number of Native fish species	Number of Exotic fish species	Number large invertebrate species	Fish IBI	NPS-FM attribute state	NRP O19 Objective for F-IBI	Meeting NRP O19
1. Karori Stream[13]	5%	5	6	100	6	1	1	56	A	≥38	meeting
2. Owhiro Stream	6%	3	2	60	4	0	0	38	A	≥38	meeting
3. Island/ Houghton	17%	0							no data	no data	no data
4. Lyall Bay	34%	0							no data	no data	no data
5. East Coast	20%	0							no data	no data	no data
6. Evans Bay	25%	0							no data	no data	no data
7. Lambton	26%	1	1.8	65	1	0	1	20	C	≥38	Not meeting
8. Kaiwharawhara Stream	10%	13	1.5	25	9	2	1	60	A	≥38	meeting

[13](Fountain & Cameron, 2018)

Catchment	% Impervious surface	Number of records	Distance from the sea (km)	Altitude (m)	Number of Native fish species	Number of Exotic fish species	Number large invertebrate species	Fish IBI	NPS-FM attribute state	NRP O19 Objective for F-IBI	Meeting NRP O19
9. Tyers (Waitohi)	15%	3	1.5	80	4	0	1	42	A	≥38	meeting
10. Korokoro Stream	3%	3	1.5	5	10	1	1	60	A	≥38	meeting
11. Speedy's Stream	6%	0							no data	no data	no data
12. Waiwhetu Stream	53%	3	2	10	6	0	0	34	A	≥38	Not meeting
13. Stokes Valley Str	27%	2	16	80	4	0	1	46	A	≥38	meeting
14. Hulls Creek	21%	8	15	35	6	0	1	52	A	≥38	meeting
15. Lower Hutt South	59%	3	4	20	6	1	0	46	A	≥38	meeting
16. Lower Hutt North	27%	2	15	40	5	1	0	44	A	≥38	meeting
17. Upper Hutt South	20%	2	26	27	2	0	0	44	A	≥38	meeting
18. Upper Hutt North	32%	3	40	180	4	1	0	40	A	≥38	meeting
19. Hutt Whakatiki	<1%	1	26	210	3	1	1	48	A	≥48	meeting
20. Hutt Akatarawa	<1%	3	40	200	4	1	1	50	A	≥48	meeting
21. Hutt Headwater	<1%	3	43	200	3	1	0	56	A	≥48	meeting
22. Hutt Pakuratahi	<1%	4	53	250	5	1	1	52	A	≥48	meeting
23. Hutt Mangaroa	1%	3	40	150	3	1	1	46	A	≥48	Not meeting
24. Eastbourne	11%	5	0.5	40	5	1	1	54	A	≥38	Not meeting
25. Black Creek	27%	0							no data	no data	no data
26. Wainuiomata-iti	<1%	0							no data	no data	no data
27. Wainuiomata	1%	6	20	100	9	1	1	56	A	≥38	meeting
28. Wainuiomata Mor.	<1%	2	30	130	2	1	1	38	A	≥38	meeting
29. Taupo Stream	9%	18	2	10	9	1	1	52	A	≥38	meeting
30. Kakaho Stream	3%	0							no data	no data	no data
31. Horokiri Stream	2%	8	10	50	11	0	1	60	A	≥38	meeting
32. Pauatahanui Stm	4%	3	5	60	5	1	0	42	A	≥38	meeting
33. Duck Creek	15%	26	5	15	13	1	1	60	A	≥38	meeting
34. Porirua Stream	19%	7	5	50	8	1	1	58	A	≥38	meeting
35. Porirua coast	10%	0							no data	no data	no data

The NRP objective for freshwater fish is achieved in most freshwater streams for which data is available. The exceptions include:

- A Moturoa Stream remnant at Central Park, in the Lambton Harbour catchment, where most of the stream length is piped.
- The Waiwhetu Stream in intensively urbanized areas of Lower Hutt and Petone.
- The Mangaroa River in the Mangaroa Catchment which is mostly in grazed pastureland, and where stormwater discharges are unlikely to be the cause of the NRP objective not being met.

6.7 Outstanding waterbodies

Outstanding water bodies listed in Schedule A of the NRP are identified for each sub-catchment and detailed below in Table 6-10. Three outstanding waterbodies are directly affected by urban stormwater discharges. These are the Taupō Swamp Complex, the Pauatahanui Inlet Tidal Flats, and the Pauatahanui Inlet Saltmarsh.

Table 6-10: Outstanding water bodies identified in Schedule A of the NRP

Catchment	Outstanding water body	Hydrologically connected to urban stormwater
21. Hutt Headwater	Maymorn Wetlands	No
	Te Awa Kairangi/Hutt River	No
24. Eastbourne	Kohangapiripiri Wetlands	No
28. Morton	Wainuiomata River	No

29. Taupō	Taupō Swamp Complex	Yes
30. Kakaho	Pauatahanui Inlet Tidal Flats	Yes
31. Horokiri	Pauatahanui Inlet Tidal Flats	Yes
	Pauatahanui Inlet Saltmarsh	Yes
32. Pauatahanui	Pauatahanui Inlet Tidal Flats	Yes
	Pauatahanui Inlet Saltmarsh	Yes
33. Duck	Pauatahanui Inlet Tidal Flats	Yes

6.7.1 Taupō Swamp Complex

The Taupō Swamp is the largest remaining harakeke (flax) swamp in the Wellington region. It is owned by the Queen Elizabeth II National Trust (QEII) and is listed in NRP Schedule A as a wetland with outstanding biodiversity values.

The Taupō Stream catchment has a total area of 1060ha, of which 64ha is urban area serviced by a stormwater network, and 30ha is covered by the Taupō Swamp Complex. Stormwater from the commercial area of Ulric Street, Northpoint Street and Freshfield Place, covering an area of 15ha, discharges into the downstream end of the swamp, bypassing more than 90% of the swamp area.

Stormwater from the southern edge of the Pukerua Bay settlement also drains into the Taupō catchment, but this area is less than 10ha and is located 2000m upstream of the swamp and is not likely to be significant source of contaminant input to the swamp. The remaining 39ha of the urban area is downstream of the swamp complex and does not discharge into the swamp. A further source of stormwater runoff is from SH59 which runs beside Taupō Swamp for a distance of 2,900m, and has an impervious surface area of approximately 7.25ha. SH59 is owned by Waka Kotahi and is not part of Wellington Water's consent application. It is noted also that the proposed Plimmerton Farm Development could result in an increasing residential population within the catchment, and an associated increase in the area serviced by a stormwater network, although it is understood that stormwater from this area would not discharge into Taupō Swamp.

The Taupō Stream monitoring data summarised in Section 5.19 shows that the stream water has a relatively low dissolved oxygen content, which may be a natural feature of swamp drainage, and elevated levels of faecal indicator bacteria and dissolved reactive phosphorus. Neither copper nor zinc were significantly elevated. The stream sediments did however contain elevated concentrations of DDT isomers which are likely a legacy of the historic use of DDT for pest control in production pasture within the catchment.

There is no evidence from the information reviewed in this report that stormwater discharges are having an adverse impact on Taupō Swamp. It is concluded that the magnitude of urban stormwater discharge effects on the Taupō Swamp is low, and while the swamp has a very high ecological value, the overall level of adverse effect is low.

6.7.2 Pauatahanui Inlet saltmarsh and tidal flats

Both the Pauatahanui Inlet Saltmarsh and the Pauatahanui Inlet Tidal Flats are listed in NRP Schedule A as wetlands with outstanding biodiversity values.

The Duck, Pauatahanui, Horokiri, and Kakaho sub-catchments all discharge into Pauatahanui Inlet and have the potential to impact the saltmarsh and the tidal flat habitat in the inlet. There is no reticulated stormwater network in the Horokiri or Kakaho catchments. The Pauatahanui and Duck Creek catchment areas serviced by local authority stormwater network are 90 and 468ha, respectively. Assuming a yield of 0.74 t/ha/year for this urban area[14], the annual sediment load from urban stormwater is approximately 414t or 1.7% of the annual sediment load discharged to Pauatahanui Inlet (24,678 t/year, from Table 3-4).

As outlined in Section 4.3, the 2020 round of GWRC subtidal sediment quality monitoring in Pauatahanui Inlet has confirmed the results from earlier studies showing no guideline exceedances for any metals or metalloids at routine monitoring sites.

The sediment monitoring programme has, nevertheless, shown a decline in certain ecological health indicators that reveal a long-term harbour wide increase in sediment deposition and extent of mud dominated sediments, which are attributed mostly to the Transmission Gully motorway development. A parallel study of sediment dwelling macrofauna species has identified a gradual decline in species richness at sites in Pauatahanui Inlet, accompanied by a loss of several species intolerant of mud that had been common previously.

While it is possible that the Transmission Gully development has overshadowed other adverse effects from urban stormwater discharge, there is currently no evidence to suggest that urban stormwater related contaminants (such as copper or zinc) have had more than a minor adverse effect on the Pauatahanui Inlet Saltmarsh or the Pauatahanui Inlet Tidal Flats. The major concern remains sediment load, of which a very small proportion is sourced from stormwater.

6.8 Sites/habitats of significant indigenous biodiversity value

NRP scheduled wetlands that are either directly or indirectly affected by stormwater discharges are listed in Table 3-8 and an assessment of effects on these wetlands is provided below in Table 6-11.

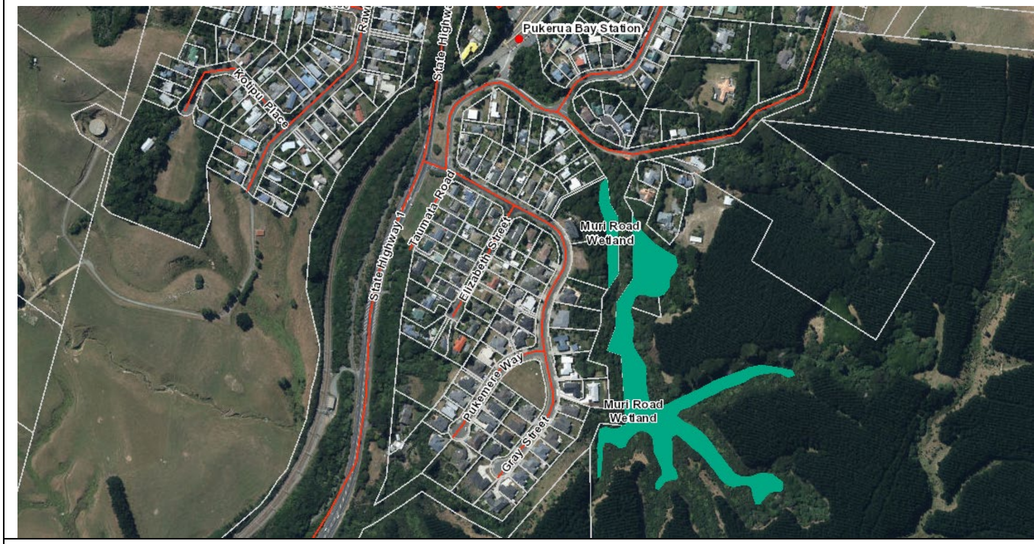
Table 6-11: Assessment of stormwater effects on NRP scheduled wetlands

Wetland	NRP Schedule	Assessment
Te Awa Kairangi/ Hutt River mouth	F3	 Stormwater from the Hautonga Street commercial/light industrial area discharges directly to the Te Awa Kairangi/ Hutt River mouth wetlands. Robertson and Stevens (2017), reporting on sediment quality monitoring in the Hutt Estuary during 2017, found that heavy metals Sb, Cd, Ce, Cu, Hg, Pb, Zn and As were below ANZECC (2000) ISQG-Low trigger values and therefore posed no significant toxicity risk to aquatic life. One of the two monitoring sites was located immediately downstream of the Waione Street

[14] A sediment yield of 0.74 t/ha/yr for intensively urbanised Semple Street Stream is taken as representative of a fully urbanised area.

		Bridge, at the edge of the Te Awa Kairangi Wetland. The conditions were described as moderate-high muddiness, moderate sediment oxygenation, low-moderate organic carbon and nutrient concentrations, but with intermittent eutrophication symptoms. It is noted that the monitoring undertaken to date has not been specifically focused on the effects of local stormwater discharges from the adjacent commercial/light industrial area and that the contribution of local stormwater discharges to the current state of the estuary is not known. There, is nevertheless, no indication of any stormwater related impacts. The level of adverse effects from urban stormwater discharge is assessed as low.
Duck Creek Saltmarsh	F3	 Stormwater from residential areas in Whitby immediately to the east of James Cook Drive discharges directly to the Duck Creek Saltmarsh while stormwater from much of the upstream urban area of the Duck catchment (~3km^2) discharges into Duck Creek where it mixes with stream water and then flows down into Pauatahanui Inlet via the saltmarsh. Approximately 39% of the Duck catchment area has urban land-use, nearly all of which is residential housing. As described in Section 4.18.8, there were no ANZG (2018) guideline exceedances of any of the metal or metalloids in sediments at the three sites within Pauatahanui Arm of Porirua Harbour. However, no sediment quality data is available for the Duck Creek Saltmarsh. The level of adverse effect from the discharge of urban stormwater to Duck Creek Saltmarsh is unknown but based on catchment characteristics is likely to be in the range from low to moderate.
Taupo Swamp Complex	A	See above in Section 6.8.1
Pauatahanui Inlet Tidal Flats and Salt Marsh	A	See above in Section 6.8.2

Cambourne Scarp Wetland	F3	 Stormwater from a small urban area of Truro Road and Pernryn Drive discharges into the Camborne Scarp Wetland. This moderate density residential area has low traffic volumes and is not expected to cause stormwater related impacts within the wetlands. The level of adverse effect from the discharge of urban stormwater is assessed as low.
Te Awarua o Porirua Harbour (Onepoto Arm) – Tidal Flats	F3	Stormwater from most of the Porirua catchment discharges into the Onepoto Arm of Te Awarua o Porirua Harbour with potential impacts on the Tidal Flats. As described in Section 4.19.9, marine sediments at the south end of the Onepoto Arm currently exceed the ARC amber guideline concentration for copper, lead and zinc but no exceedance of ANZG (2018) default guideline values has been recorded. Exceedance of the ARC amber guideline provide early warning that contaminants are approaching levels that may be ecologically harmful. The available information suggests that the NRP O19 Objective is not currently met for macroalgae, invertebrates or mahinga ka, and that the discharge of stormwater from the Porirua catchment contributes to the poor ecological health of the Onepoto Arm. The level of adverse effect from the discharge of urban stormwater is assessed as moderate to high.
Romesdale Lagoon, Papakowhai Bush, Papakowhai Lagoon	F3	 Stormwater from a small area of urban Papakowhai discharges into Romesdale Lagoon, Papakowhai Bush, Papakowhai Lagoon. This moderate density residential area has low traffic volumes and in not expected to cause stormwater related impacts within the wetlands. The level of adverse effect from the discharge of urban stormwater is assessed as low.

Muri Road Wetlands	F3	 Stormwater from a small urban area of around Gray Street in Pukerua Bay discharges into the Muri Road wetlands. This moderate density residential area has low traffic volumes and in not expected to cause stormwater related impacts within the wetland. The level of adverse effect from the discharge of urban stormwater is assessed as low.

6.9 Recreation and human health

NRP Schedules including H1 (Significant contact recreation freshwater bodies), and I (Important trout fishing rivers and spawning waters) are used in Table 5-1 (Section 5) to assign recreational value to water bodies in each of the 35 stormwater catchments. Recreational value, together with magnitude of effect from stormwater discharges, is used to determine the overall level of adverse effect, in accordance with the methodology described in Section 2. In this way known recreational values are factored into the assessment of effects.

In assessing the human health risks associated with the discharge of stormwater it is relevant that wet weather overflows from wastewater networks are specifically excluded. These types of discharge are covered by separate consent applications and are not considered here. The assessment of human health risk associated with the discharge of stormwater is therefore reduced to consideration of faecal material derived from wastewater network leaks, incorrect cross connections, and non-human warm-blooded animals (rats, cats, dogs, birds, possums, etc.,) that accumulates in gutters and on hard surfaces and is transported to watercourses during and after a rainfall event.

The effects of wastewater network overflow discharges cannot be easily separated from other sources of faecal contamination and, from the perspective of those engaged in recreational activities, the only relevant consideration is whether the water body meets the NRP O18 Objectives. For the purpose of this assessment the starting point is the current state of microbiological water quality as described for each catchment in Section 4, and an initial assumption that the observed level of faecal contamination is caused by the discharge of urban stormwater. Where it is evident that other factors are also at play, such as high proportion of agricultural land in the catchment, or a known high frequency of wastewater network overflow, the assessment is adjusted accordingly. It is recognised however that the attribution of faecal contamination to stormwater verses other sources is indicative only.

The recreational value of the water body, together with the expected magnitude of adverse effect from stormwater discharge is summarised in Table 7-1 to give an overall level of adverse effect for each stormwater catchment.

6.10 Summary of adverse effects

The level of adverse effects of stormwater discharges on aesthetic values, cultural values, aquatic ecology, recreation/human health ranges from 'Very Low' to 'High' as summarised in Table 7-12. Twelve of the 35 catchments are assessed as having a 'Moderate', 'High' or 'Very High' level of adverse effect for at least one of the four receiving environment values considered. The remaining 23 catchment had 'Low' or 'Very low' levels of stormwater related adverse effects.

Five catchments have no reticulated stormwater system but are included for completeness, at the bottom of Table 7-12. These are Hutt-Headwaters, Hutt-Pakuratahi, Wainuiomata-iti, Wainuiomata-Morton, and Horokiri.

In general, the catchments with the longest stormwater network length and highest proportion of stormwater network area (i.e., Evans Bay, Porirua, Lambton, Waiwhetu) had the highest level of adverse effects.

The Owhiro Bay and Houghton Bay catchments showed high levels of adverse effects, but this is attributed, at least partly, to landfills within the catchment boundaries. Locations on the Porirua Coast including Plimmerton South Beach and Titahi Bay South also had elevated levels of effect on aesthetic values and recreational values but in both cases faults with the wastewater network are the dominant source of contamination.

Table 6-12: Summary of potential effects of stormwater discharges to freshwater and coastal water habitats, with catchments ranked by 'Level of Adverse Effects' (ranked from worst to best)

Sub-catchment	Environmental value	Feature	Factors considered in determining 'Magnitude of Effect'			Factors considered in determining 'Level of Effect'		Level of Adverse Effect[15][16]
			Spatial scale	Duration	Receiving environment	Magnitude of effect	Value	
Porirua	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Medium	intermittent	Medium river, estuary	High	High	**Very high**
	Mana Whenua	Mahinga kai species			Medium river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Medium river, estuary	High	High	**High**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Medium	Persistent	Medium river, estuary	Moderate	Moderate	**Moderate**
Evans Bay	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Medium	Persistent	Inner harbour	High	Moderate	**Moderate**
	Mana Whenua	Mahinga kai species			Inner harbour			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Medium	Persistent	Inner harbour	High	High	**High**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Persistent	Inner harbour	Low	High	Low
Island/ Houghton	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Medium	Intermittent	Open coast	Moderate	High	**High**
	Mana Whenua	Mahinga kai species			Open coast			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Open coast	Low	High	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Medium	Persistent	Open coast	Low	Very high	**Moderate**
Lambton	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Medium	Persistent	Inner harbour	Moderate	High	**High**
	Mana Whenua	Mahinga kai species			Inner harbour			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Medium	Persistent	Inner harbour	High	Moderate	**Moderate**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Persistent	Inner harbour	Low	Very high	**Moderate**
Owhiro	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Medium	Intermittent	Small river	Moderate	Moderate	**Moderate**
	Mana Whenua	Mahinga kai species			Small river			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river	Moderate	High	**High**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Persistent	Small river	Low	Very high	**Moderate**
Porirua coast	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Medium	intermittent	Open coast	Moderate	High	**Moderate**
	Mana Whenua	Mahinga kai species			Open coast			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Open coast	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Medium	Intermittent	Open coast	Low	Very high	**Moderate**
Kaiwharawhara	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Small river, estuary	Low	Moderate	Low
	Mana Whenua	Mahinga kai species			Small river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river, estuary	Moderate	High	**High**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river, estuary	Low	Moderate	Low
Karori	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Small river	Low	Moderate	Low
	Mana Whenua	Mahinga kai species			Small river			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river	High	Moderate	**Moderate**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river	Low	Moderate	Low
Waiwhetu	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Moderate	Intermittent	Small river	Low	Moderate	Low
	Mana Whenua	Mahinga kai species			Small river			
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river	High	Moderate	**Moderate**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river	Moderate	Low	Low
Black Creek	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Moderate	intermittent	Small River	Moderate	Moderate	**Moderate**
	Mana Whenua	Mahinga kai species			Small River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small River	High	Low	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Moderate	Persistent	Small River	Moderate	Low	Low

[15] The levels of adverse effect have intentionally been described in 'non-RMA' language.

[16] It is important to note that a high ranking in this table does not mean that the sub-catchment will be one of the first ones to be resolved under this application. The output from this AEE is one of several inputs to the Stormwater Management Strategy which is tasked with determining how sub-catchments within the stormwater network will be managed in accordance with any relevant objectives identified in the NRP.

Sub-catchment	Environmental value	Feature	Factors considered in determining 'Magnitude of Effect'			Factors considered in determining 'Level of Effect'		Level of Adverse Effect[15 16]
			Spatial scale	Duration	Receiving environment	Magnitude of effect	Value	
Taupo	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	intermittent	Small river	Low	Moderate	Low
	Mana Whenua	Mahinga kai species			Small river			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Medium	Persistent	Small river	Moderate	Moderate	**Moderate**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Moderate	Persistent	Small river	Moderate	Low	Low
Duck	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	intermittent	Small river, estuary	Low	High	Low
	Mana Whenua	Mahinga kai species			Small river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Medium	Intermittent	Small river, estuary	Low	Very high	**Moderate**
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Persistent	Small river, estuary	Low	Moderate	Low
Lyall Bay	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Open coast	Negligible	Very High	Low
	Mana Whenua	Mahinga kai species			Open coast			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Open coast	Negligible	Moderate	Very low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Persistent	Open coast	Negligible	Very High	Low
Pauatahanui Stream	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	intermittent	Small river, estuary	Negligible	High	Low
	Mana Whenua	Mahinga kai species			Small river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Small river, estuary	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Persistent	Small river, estuary	Negligible	Moderate	Low
Kakaho	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	intermittent	Small river, estuary	Negligible	Very high	Low
	Mana Whenua	Mahinga kai species			Small river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Small river, estuary	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river, estuary	Negligible	Very high	Low
Lower Hutt South	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Large River	Low	High	**Low**
	Mana Whenua	Mahinga kai species			Large River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Large River	Low	High	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Large River	Low	High	Low
Lower Hutt North	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Large River	Negligible	Very high	Low
	Mana Whenua	Mahinga kai species			Large River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Large River	Low	High	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Large River	Low	High	Low
Upper Hutt South	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Large River	Negligible	Very high	Low
	Mana Whenua	Mahinga kai species			Large River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Large River	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Large River	Negligible	Very high	Low
Upper Hutt North	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Large River	Negligible	Very high	Low
	Mana Whenua	Mahinga kai species			Large River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Large River	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Large River	Negligible	Very high	Low
Hutt Whakatiki	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Medium River	Negligible	Very high	Low
	Mana Whenua	Mahinga kai species			Medium River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Medium River	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Medium River	Negligible	Very high	Low
Stokes Valley	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Moderate	intermittent	Small river	Moderate	Low	Low
	Mana Whenua	Mahinga kai species			Small river			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river	High	Low	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Moderate	Persistent	Small river	Moderate	Low	Low
East Coast	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Open coast	Negligible	Very High	Low
	Mana Whenua	Mahinga kai species			Open coast			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Open coast	Negligible	Very High	Low

Sub-catchment	Environmental value	Feature	Factors considered in determining 'Magnitude of Effect'			Factors considered in determining 'Level of Effect'		Level of Adverse Effect[15,16]
			Spatial scale	Duration	Receiving environment	Magnitude of effect	Value	
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Open coast	Negligible	Very High	Low
Hutt Akatarawa	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Medium River	Negligible	High	Very low
	Mana Whenua	Mahinga kai species			Medium River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Medium River	Negligible	Very high	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Medium River	Negligible	Very high	Low
North Harbour	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Small river, harbour	Low	Low	Very low
	Mana Whenua	Mahinga kai species			Small river, harbour			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river, harbour	Moderate	Low	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river, harbour	Negligible	Moderate	Very low
Hulls Creek	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Small river	Low	Low	Very low
	Mana Whenua	Mahinga kai species			Small river			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Large	Persistent	Small river	High	Low	Low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river	Low	Low	Very low
Korokoro Stream	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Small river, estuary	Negligible	Moderate	Very low
	Mana Whenua	Mahinga kai species			Small river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Small river, estuary	Negligible	High	Very low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river, estuary	Negligible	Moderate	Very low
Speedy's Stream	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Small river	Negligible	High	Very low
	Mana Whenua	Mahinga kai species			Small river			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Small river	Negligible	High	Very low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Small river	Negligible	Moderate	Very low
Hutt Mangaroa	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Medium River	Negligible	Moderate	Very low
	Mana Whenua	Mahinga kai species			Medium River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Medium River	Negligible	Moderate	Very low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Medium River	Negligible	Moderate	Very low
Wainuiomata	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Medium River	Negligible	High	Very low
	Mana Whenua	Mahinga kai species			Medium River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Medium River	Negligible	High	Very low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Medium River	Negligible	Very high	Very low
Eastbourne	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	Small	Intermittent	Outer Harbour	Negligible	Very high	Very low
	Mana Whenua	Mahinga kai species			Outer Harbour			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	Small	Intermittent	Outer Harbour	Negligible	Very high	Very low
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	Small	Intermittent	Outer Harbour	Negligible	Very high	Very low
Hutt Headwater	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	None	None	Medium River	None	Very high	None
	Mana Whenua	Mahinga kai species	None	None	Medium River	None	Very High	None
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	None	None	Medium River	None	Very high	None
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	None	None	Medium River	None	Very high	None
Hutt Pakuratahi	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	None	None	Medium River	None	Very high	None
	Mana Whenua	Mahinga kai species			Medium River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	None	None	Medium River	None	Very high	None
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	None	None	Medium River	None	Very high	None
Wainuiomata-iti	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	None	None	Small River	None	Moderate	None
	Mana Whenua	Mahinga kai species			Small River			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	None	None	Small River	None	Moderate	None
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	None	None	Small River	None	Moderate	None
Morton	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	None	None	Medium River	None	Moderate	None
	Mana Whenua	Mahinga kai species			Medium River			Not assessed

Sub-catchment	Environmental value	Feature	Factors considered in determining 'Magnitude of Effect'			Factors considered in determining 'Level of Effect'		Level of Adverse Effect[15][16]
			Spatial scale	Duration	Receiving environment	Magnitude of effect	Value	
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	None	None	Medium River	None	Very high	None
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	None	None	Medium River	None	Moderate	None
Horokiri Stream	Aesthetic (S107 matters)	Oil films, scums, foams, suspendible materials, colour clarity, odour	None	None	Small river, estuary	None	Moderate	None
	Mana Whenua	Mahinga kai species			Small river, estuary			Not assessed
	Aquatic ecology	Water quality, flow regime, sediment, algae, invertebrates, fish	None	None	Small river, estuary	None	Very high	None
	Recreation/public Health	Swimming, surfing, boating, fishing, food gathering	None	None	Small river, estuary	None	Moderate	None

Notes: 1. The 'Moderate' level of adverse effects for Aesthetic (S107 matters) Lower Hutt South catchment is due to frequent observations of scums, foams, oil films and poor clarity in Opahu Stream, which is a minor tributary of the Hutt River

2. The levels of adverse effect have intentionally been described with out the use of planning or legal terms, as recommended by Roper-Lyndsay (2018), however guidance on interpretation of Table 7-1, is as follows:

a) 'Very High adverse effects' are unlikely to be acceptable on ecological grounds

b) 'High' and 'Moderate' adverse effects require careful assessment, but could be managed through avoidance, design, offsetting or compensation action

c) 'Low' and Very low' categories should not normally be of concern, although normal car should be exercised to minimise adverse effects.

6.11 Management of environmental effects

This AEE indicates that 12 of the 35 catchments covered by the application have a 'Moderate' or 'High' level of stormwater related adverse effect in respect of at least one of the four receiving environment values considered, which will require a management response. The catchments, their NRP scheduled values and a summary of adverse effects are listed in Table 6-13.

Table 6-13: Summary of 'moderate', 'high' or 'Very High' stormwater related effects

Catchment	NRP Scheduled value	Adverse effect type (& level)
Porirua	F1 (Migratory & threated fish habitat) F1b (Inanga spawning habitat) F2 (Indigenous bird habitat) F3 (Natural wetland) F4 (Indigenous biodiversity coastal)	Conspicuous foams, scums, oil/grease films, change in colour/clarity, ands odour at Semple Street SW outlet (**Very High**). Periphyton and macroinvertebrate communities in the lower stream are indicative of poor ecological health and do not meet NRP Objective O19. Moderately elevated Pb, Cu, and Zn concentrations occur in marine sediments of Porirua Harbour. Marine ecology community is disturbed and likely does not meet NRP O19 (**High**). Elevated faecal indicator concentrations throughout Porirua Stream and in the Onopoto Arm of Porirua Harbour (**Moderate**). This is likely caused by a combination of wastewater network overflows, leaks, and stormwater. 19% of the catchment area is impervious surface.
Evans Bay	F2 (Indigenous bird habitat) F5 (subtidal rocky reefs)	Conspicuous oil/grease films consistently occur at Miramar and Hataitai SW outlets (**High**) Elevated Pb, Hg, Cu, Zn, and PAH concentrations occur in marine sediments, especially near Miramar SW outlet (**High**) 25% of the catchment area is impervious surface.
Island/ Houghton	F2 (Indigenous bird habitat) F4 (Indigenous biodiversity coastal - Taputeranga Marine reserve) F5 (subtidal rocky reefs)	Conspicuous scums, foams, and oil/grease films common at the Houghton Bay SW outlet (**High**). Elevated faecal indicator concentrations in Island Bay opposite Derwent Street (**Moderate**). This is likely caused by a combination of wastewater network overflows, leaks, and stormwater. 17% of the catchment area is impervious surface.
Lambton	F2 (Indigenous bird habitat)	Conspicuous oil/grease films common at Te Aro and Tory SW outlets (**High**). Elevated Pb, Hg, Cu, Zn, and PAH concentrations occur in marine sediments at Lambton Harbour. Marine ecology community is disturbed, and habitats close to the port area likely do not meet NRP O19 (**Moderate**). Elevated faecal indicator concentrations at the Waterfront near Shed 6 and the Taranaki Dive Platform (**Moderate**). This is likely caused by a combination of wastewater network overflows, leaks, and stormwater. 26% of the catchment area is impervious surface.
Owhiro	F1 (migratory & threated fish habitat) F1b (Inanga spawning habitat) F2 (Indigenous bird habitat) F4 (Indigenous biodiversity coastal – Taputeranga Marine reserve) F5 (subtidal rocky reefs)	Conspicuous scums and foams common in upper and lower stream (**Moderate**). Stream periphyton and macroinvertebrate communities are indicative of poor ecological health and do not meet NRP O19 (**High**). Elevated faecal indicator concentrations in Owhiro Stream and Owhiro Bay (**Moderate)**. This is likely caused by a combination of wastewater network overflows, leaks, and stormwater. 6% of the catchment surface area is impervious surface.
Porirua coast	F2 (Indigenous bird habitat) F3 (Natural wetland)	Conspicuous scums and foams common at the Titahi Bay South Beach SW outlet and adjacent beach (**Moderate**).

Catchment	NRP Scheduled value	Adverse effect type (& level)
	F5 (subtidal rocky reefs)	Elevated faecal indicator concentrations at Plimmerton Beach, Plimmerton South Beach and Titahi Bay South beach (**Moderate**). This is likely caused by a combination of wastewater network overflows, leaks, and stormwater. 10% of the catchment surface area is impervious surface.
Kaiwharawhara	F1 (Migratory & threated fish habitat) F1b (Inanga spawning habitat) F2 (Indigenous bird habitat) F4 (Indigenous biodiversity coastal)	Elevated Cu and Zn concentrations occur in stream water. Elevated Pb and Zn concentrations occur in stream sediments. Stream periphyton and macroinvertebrate communities are indicative of poor ecological health and do not meet NRP O19 (**High**). 10% of the catchment surface area is impervious surface.
Karori	F1 (migratory & threated fish habitat)	Elevated Cu and Zn concentrations in Karori Stream water. Elevated Pb and Zn in stream sediments. Stream macroinvertebrate communities are indicative of poor ecological health and do not meet NRP O19 (**Moderate**). 5% of the catchment area is impervious surface.
Waiwhetu	F1b (Inanga spawning habitat) F2 (Indigenous bird habitat) F4 (Indigenous biodiversity coastal)	Elevated Zn concentrations in stream water. Elevated Pb and Zn in stream sediments. Stream periphyton and macroinvertebrate communities are indicative of poor ecological health and do not meet NRP O19 (**Moderate**). 53% of the catchment area is impervious surface.
Black Creek	F3 (Natural wetland)	Conspicuous scums and foams common in Black (**Moderate**). 27% of the catchment area is impervious surface.
Taupo	F1 (migratory & threated fish habitat) F1b (Inanga spawning habitat) A (Outstanding wetland) F3 (Natural wetland)	Occasionally depleted dissolved oxygen levels in Taupo Stream water. Elevated DDT isomers in stream sediments. Stream periphyton and macroinvertebrate communities are indicative of poor ecological health and do not meet NRP O19 (**Moderate**). 9% of the catchment area is impervious surface.
Duck	A (Outstanding wetland) F1 (Migratory & threated fish habitat) F1b (Inanga spawning habitat) F2 (Indigenous bird habitat) F3 (Natural wetland) F4 (Indigenous biodiversity coastal)	Occasionally elevated Cu and Zn concentrations in stream water (**Moderate**). 15% of catchment area is impervious surface.

Wellington Water has, in accordance with condition 17 of the current Stage 1 Global Stormwater Discharge Consent, developed a Stormwater Management Strategy (SMS). The output of this AEE is one of several inputs to the SMS. The purpose of Wellington Water's SMS is to:

- provide a strategy for how sub-catchments within the stormwater network will be managed in accordance with any relevant objectives identified in the NRP, including any relevant whaitua-specific objectives, and
- describe how the stormwater network will be managed in accordance with good management practice, that evolves through time, to minimise the adverse acute, chronic, and cumulative effects of stormwater discharges on fresh and coastal water.

The SMS, which forms part of the global consent application, outlines the management response to stormwater related adverse effects identified in each sub-catchment.

7 Conclusion

This AEE Part 2 Report has been prepared to support WWLs application to consent the discharge of stormwater from local authority stormwater networks in 35 sub-catchments within the Porirua Harbour and Wellington Harbour catchments. It should be read in conjunction with the AEE Part 1 Report and the SMS. The Part 1 Report sets out the framework to manage the process of applying and implementing the global resource consents required for stormwater discharges, while the SMS sets out the management response to stormwater related adverse effects.

The AEE has identified the potential for urban stormwater to cause a Moderate (more than minor) or High (significant) level of adverse effect in the receiving environment in 12 of the 35 sub-catchments included in this application. The application proposes to resolve these adverse effects through the SMS, under the governance of a Collaborative Committee.

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Appendix A: Number of observations of scums, foams, oil, or grease films from monthly site visits (January 2020 to June 2022)

No.	Sub-catchment	Sample Location	Site ID	Site type	Site visits	Scums or foams			Oil, grease films		
						High	Moderate	%	High	Moderate	%
1	Karori	Karori Stream at Friend Street	KAFW1	FW	29	0	1	3	0	1	3
1	Karori	Karori Stream at Campbell Street Bridge	KAFW2	FW	29	0	0	0	0	0	0
2	Owhiro	Owhiro Bay	OWCW1	CW	29	0	1	3	0	0	0
2	Owhiro	Owhiro Stream above T & T Landfill	OWFW1	FW	29	0	12	41	0	3	10
2	Owhiro	Owhiro Stream u/s Owhiro Bay Parade	OWFW2	FW	29	1	7	28	0	3	10
3	Island_Houghton	Princess Bay	HOCW1	CW	29	0	1	3	0	0	0
3	Island_Houghton	Houghton Bay Culvert	HOSW1	SW	29	7	10	59	3	14	59
3	Island_Houghton	Island Bay at Derwent Street	ISCW1	CW	29	0	2	7	0	0	0
3	Island_Houghton	Island Bay at Reef Street	ISCW2	CW	29	0	0	0	0	0	0
3	Island_Houghton	Island Bay at Surf Club	ISCW3	CW	29	0	2	7	0	0	0
3	Island_Houghton	Island Bay	ISSW1	SW	29	0	3	10	0	3	10
4	Lyall	Lyall Bay at Queens Drive	LYCW1	CW	29	0	3	10	0	0	0
4	Lyall	Lyall Bay at Onepu Road	LYCW2	CW	29	0	4	14	0	1	3
4	Lyall	Lyall Bay West Culvert	LYSW1	SW	29	0	2	7	0	2	7
4	Lyall	Lyall Bay East Culvert	LYSW2	SW	29	0	1	3	0	3	10
6	Evans	Evans Bay Public Boat Ramp	EVCW1	CW	29	0	2	7	0	0	0
6	Evans	Hataitai Beach	EVCW2	CW	29	0	1	3	0	1	3
6	Evans	Balaena Bay	EVCW3	CW	29	0	0	0	0	0	0
6	Evans	Miramar Culvert	EVSW1	SW	29	0	1	3	5	21	90
6	Evans	Cobham Culvert	EVSW2	SW	29	0	1	3	0	8	28
6	Evans	Kilbirnie Culvert	EVSW3	SW	29	0	1	3	0	6	21
6	Evans	Hataitai Culvert	EVSW4	SW	29	0	0	0	0	15	52
7	Lambton	Waterfront at Shed 6	LACW1	CW	29	0	2	7	1	1	7

No.	Sub-catchment	Sample Location	Site ID	Site type	Site visits	Scums or foams			Oil, grease films		
						High	Moderate	%	High	Moderate	%
7	Lambton	Whairepo Lagoon	LACW2	CW	29	0	2	7	0	0	0
7	Lambton	Taranaki Diving Platform	LACW3	CW	29	0	4	14	0	4	14
7	Lambton	Oriental Bay at Freyberg Beach	LACW4	CW	29	0	3	10	0	0	0
7	Lambton	Oriental Bay at Wishing Well	LACW5	CW	29	0	2	7	0	0	0
7	Lambton	Oriental Bay at band Rotunda	LACW6	CW	29	0	0	0	0	0	0
7	Lambton	Thorndon	LASW1	SW	29	0	3	10	0	3	10
7	Lambton	OPT Culvert	LASW10	SW	29	0	0	0	0	7	24
7	Lambton	Oriental Bay at Hay Street	LASW11	SW	29	0	0	0	0	3	10
7	Lambton	Grass Street Culvert	LASW12	SW	29	0	3	10	0	5	17
7	Lambton	Davis Culvert	LASW2	SW	29	0	1	3	0	1	3
7	Lambton	Bowen Culvert	LASW3	SW	29	0	1	3	0	4	14
7	Lambton	Waring Taylor Culvert	LASW4	SW	29	0	0	0	1	4	17
7	Lambton	Hunter Culvert	LASW5	SW	29	0	2	7	0	5	17
7	Lambton	Harris Street Culvert	LASW6	SW	29	0	1	3	0	4	14
7	Lambton	Te Aro Culvert	LASW7	SW	29	0	4	14	1	16	59
7	Lambton	Taranaki Culvert	LASW8	SW	29	0	2	7	4	11	52
7	Lambton	Tory Street Culvert	LASW9	SW	29	0	0	0	1	14	52
8	Kaiwharawhara	Kaiwharawhara Stream at Otari Park	KAFS1	FW	29	0	4	14	0	1	3
8	Kaiwharawhara	Koromiko Stream at Cummings Park	KAFS2	FW	29	0	2	7	0	0	0
8	Kaiwharawhara	Kaiwharawhara Stream u/s of Hutt Road	KAFS3	FW	29	0	3	10	0	2	7
9	North Harbour	Waitohu Stream at Ngauranga Gorge	NOFS1	FW	29	0	6	21	0	2	7
9	North Harbour	Waitohu Stream near Harbour	NOFS2	FW	29	0	5	17	0	0	0
9	North Harbour	Newlands at Gorge	NOSW1	SW	29	0	2	7	0	2	7
9	North Harbour	Tyers Stream at Gorge	NOSW2	SW	29	0	5	17	0	1	3
12	Waiwhetu	Waiwhetu Stream at Tilbury St	WAIWFW1	FW	29	0	7	24	1	0	3
12	Waiwhetu	Waiwhetu Stream at Rishworth St	WAIWFW2	FW	29	0	5	17	0	4	14
13	Stokes Valley Stream	Stokes Valley Stream, Rawhiti Street	STFW1	FW	29	0	10	34	0	1	3

No.	Sub-catchment	Sample Location	Site ID	Site type	Site visits	Scums or foams			Oil, grease films		
						High	Moderate	%	High	Moderate	%
14	Hulls	Hull Creek Trib (PineHaven Stream)	PIFW1	FW	29	0	8	28	0	1	3
15	Lower Hutt South	Petone Beach at Kiosk	HUCW1	CW	29	1	2	10	0	0	0
15	Lower Hutt South	Petone Beach at Sydney St	HUCW2	CW	29	0	5	17	0	0	0
15	Lower Hutt South	Petone Beach at Waterski Club	HUCW3	CW	29	1	1	7	0	1	3
15	Lower Hutt South	Hutt River u/s Melling Bridge	HUFW2	FW	29	0	2	7	0	1	3
15	Lower Hutt South	Brunswick	HUSW10	SW	29	0	2	7	0	3	10
15	Lower Hutt South	Block Road	HUSW11	SW	29	0	1	3	0	0	0
15	Lower Hutt South	Normandale Road SW011387	HUSW12	SW	29	0	1	3	0	1	3
15	Lower Hutt South	West Hill Culvert	HUSW13	SW	29	0	3	10	0	2	7
15	Lower Hutt South	Opahu Stream at Whites Line West	OPFW1	FW	29	0	5	17	2	3	17
15	Lower Hutt South	Te Mome Stream at Jackson Street	TEFW1	FW	29	0	3	10	1	3	14
16	Lower Hutt North	Hutt River u/s Silverstream Bridge	HUFW1	FW	29	0	1	3	0	1	3
16	Lower Hutt North	Harcourt Werry Drive at Percy Cameron	HUFW5	FW	29	0	2	7	0	3	10
16	Lower Hutt North	Harcourt Werry Drive at Taita Drive	HUFW6	FW	29	0	6	21	0	2	7
18	Upper Hutt North	8 Akatarawa Road	HUSW1	SW	29	0	1	3	0	0	0
24	Eastern Bays	Lowry Bay at Cheviot Road	EACW1	CW	29	0	1	3	0	0	0
24	Eastern Bays	Days Bay at Wharf	EACW2	CW	29	0	1	3	0	0	0
24	Eastern Bays	Rona Bay at Wharf	EACW3	CW	29	0	2	7	0	1	3
24	Eastern Bays	Robinson Bay at Nikau St	EACW4	CW	29	0	3	10	0	1	3
27	Wainuiomata	Black Creek at Edmonds Street	BLFW1	FW	29	1	0	3	1	0	3
27	Wainuiomata	Black Creek trib. At Fitzherbert Road	BLFW2	FW	29	1	4	17	0	2	7
27	Wainuiomata	Black Creek at Moohan St	BLFW3	FW	29	1	11	41	0	0	0
32	Pauatahanui	Pauatahanui Inlet at Browns Bay	PACW1	CW	29	0	3	10	0	0	0
32	Pauatahanui	Pauatahanui Inlet at Water Ski Club	PACW2	CW	29	0	6	21	0	1	3
32	Pauatahanui	Pauatahanui at Paremata Bridge	PACW3	CW	29	0	4	14	0	0	0
32	Pauatahanui	Duck Creek u/s SH58	PAFW1	FW	29	1	3	14	2	0	7
32	Pauatahanui	Browns Stream at footbridge	PAFW2	FW	29	1	7	28	2	1	10
32	Onepoto	Porirua Harbour at Rowing Club	POCW1	CW	29	0	4	14	0	1	3

No.	Sub-catchment	Sample Location	Site ID	Site type	Site visits	Scums or foams			Oil, grease films		
						High	Moderate	%	High	Moderate	%
32	Onepoto	Porirua Harbour, Wi Neera Drive Boat Ramp	POCW2	CW	29	1	5	21	0	3	10
32	Onepoto	Porirua Stream d/s Wingfield Place	POFW1	FW	29	1	2	10	0	0	0
32	Onepoto	Unnamed watercourse u/s Onepoto Road	POFW10	FW	29	1	3	14	1	2	10
32	Onepoto	Belmont stream at Setton Nossiter Park	POFW2	FW	29	0	7	24	0	0	0
32	Onepoto	Stebbings Stream at end of Glenside Rd	POFW3	FW	29	1	11	41	1	1	7
32	Onepoto	Takapu Stream u/s mouth	POFW4	FW	29	0	2	7	0	0	0
32	Onepoto	Belmont stream at Setton Nossiter Park	POFW5	FW	29	0	8	28	0	0	0
32	Onepoto	Porirua Stream at Town Centre	POFW6	FW	29	1	1	7	1	0	3
32	Onepoto	Mitchell Stream at Kenepuru Drive	POFW7	FW	29	1	5	21	1	1	7
32	Onepoto	Keneperu Stream at Bothamley Park	POFW8	FW	29	0	4	14	1	0	3
32	Onepoto	Kenepuru Stream at Mepham Place	POFW9	FW	29	1	3	14	1	1	7
34	Onepoto	Semple Street Outlet	POSW1	SW	29	1	13	48	4	15	66
34	Onepoto	Takapuwahia Stream Outlet at Hiko St	POSW2	SW	29	3	9	41	1	10	38
34	Onepoto	Gloaming Hill	POSW3	SW	29	0	6	21	0	1	3
35	Porirua coast	Titahi Bay at Bay Drive	POCW3	CW	29	0	3	10	0	0	0
35	Porirua coast	Titahi Bay at Toms Drive	POCW4	CW	29	0	6	21	0	1	3
35	Porirua coast	Titahi Bay at South Beach	POCW5	CW	29	0	7	24	0	0	0
35	Porirua coast	Plimmerton Beach at Bath St	POCW6	CW	29	0	6	21	0	0	0
35	Porirua coast	South Plimmerton Beach	POCW7	CW	29	0	7	24	0	1	3
35	Porirua coast	South Beach Access	POSW4	SW	29	1	15	55	1	3	14

Notes: 1. Observations are recorded as highly conspicuous (high), moderately conspicuous (moderate), or not observed (0)

2. Site types are freshwater (FW), coastal water (CW), and stormwater (SW)

Appendix B: Number of observations of change in water colour or clarity, or objectionable odour, monthly from 1 January 2020 to 30 June 2022)

No.	Sub catchment	Site Location	Site ID	Site type	Site visits	Change in colour or visual clarity			Emission of objectionable odour		
						High	Moderate	%	High	Moderate	%
1	Karori	Karori Stream at Friend Street	KAFW1	FW	29	0	6	21	0	0	0
1	Karori	Karori Stream at Campbell Street Bridge	KAFW2	FW	29	0	1	3	0	0	0
2	Owhiro	Owhiro Bay	OWCW1	CW	29	0	0	0	0	0	0
2	Owhiro	Owhiro Stream above T & T Landfill	OWFW1	FW	29	2	9	38	0	0	0
2	Owhiro	Owhiro Stream u/s Owhiro Bay Parade	OWFW2	FW	29	6	7	45	0	0	0
3	Island_Houghton	Princess Bay	HOCW1	CW	29	0	0	0	1	1	7
3	Island_Houghton	Houghton Bay Culvert	HOSW1	SW	29	2	10	41	4	10	48
3	Island_Houghton	Island Bay at Derwent Street	ISCW1	CW	29	0	0	0	0	0	0
3	Island_Houghton	Island Bay at Reef Street	ISCW2	CW	29	0	0	0	0	0	0
3	Island_Houghton	Island Bay at Surf Club	ISCW3	CW	29	0	0	0	0	0	0
3	Island_Houghton	Island Bay	ISSW1	SW	29	1	5	21	0	1	3
4	Lyall	Lyall Bay at Queens Drive	LYCW1	CW	29	0	0	0	0	0	0
4	Lyall	Lyall Bay at Onepu Road	LYCW2	CW	29	0	0	0	0	0	0
4	Lyall	Lyall Bay West Culvert	LYSW1	SW	29	0	4	14	0	2	7
4	Lyall	Lyall Bay East Culvert	LYSW2	SW	29	1	4	17	0	1	3
6	Evans	Evans Bay Public Boat Ramp	EVCW1	CW	29	0	0	0	0	0	0
6	Evans	Hataitai Beach	EVCW2	CW	29	0	0	0	0	0	0
6	Evans	Balaena Bay	EVCW3	CW	29	0	0	0	0	0	0
6	Evans	Miramar Culvert	EVSW1	SW	29	0	4	14	1	8	31
6	Evans	Cobham Culvert	EVSW2	SW	29	0	3	10	0	0	0
6	Evans	Kilbirnie Culvert	EVSW3	SW	29	0	2	7	3	0	10

No.	Sub catchment	Site Location	Site ID	Site type	Site visits	Change in colour or visual clarity			Emission of objectionable odour		
						High	Moderate	%	High	Moderate	%
6	Evans	Hataitai Culvert	EVSW4	SW	29	0	5	17	0	1	3
7	Lambton	Waterfront at Shed 6	LACW1	CW	29	0	1	3	0	1	3
7	Lambton	Whairepo Lagoon	LACW2	CW	29	0	1	3	0	0	0
7	Lambton	Taranaki Diving Platform	LACW3	CW	29	0	2	7	0	0	0
7	Lambton	Oriental Bay at Freyberg Beach	LACW4	CW	29	0	2	7	0	0	0
7	Lambton	Oriental Bay at Wishing Well	LACW5	CW	29	0	1	3	0	0	0
7	Lambton	Oriental Bay at band Rotunda	LACW6	CW	29	0	0	0	0	0	0
7	Lambton	Thorndon	LASW1	SW	29	0	1	3	1	7	28
7	Lambton	OPT Culvert	LASW10	SW	29	0	2	7	0	3	10
7	Lambton	Oriental Bay at Hay Street	LASW11	SW	29	0	4	14	0	0	0
7	Lambton	Grass Street Culvert	LASW12	SW	29	1	0	3	1	3	14
7	Lambton	Davis Culvert	LASW2	SW	29	0	3	10	0	5	17
7	Lambton	Bowen Culvert	LASW3	SW	29	0	0	0	0	0	0
7	Lambton	Waring Taylor Culvert	LASW4	SW	29	0	0	0	1	0	3
7	Lambton	Hunter Culvert	LASW5	SW	29	0	0	0	0	1	3
7	Lambton	Harris Street Culvert	LASW6	SW	29	0	2	7	2	3	17
7	Lambton	Te Aro Culvert	LASW7	SW	29	1	6	24	1	8	31
7	Lambton	Taranaki Culvert	LASW8	SW	29	0	1	3	0	5	17
7	Lambton	Tory Street Culvert	LASW9	SW	29	0	2	7	3	4	24
8	Kaiwharawhara	Kaiwharawhara Stream at Otari Park	KAFS1	FW	29	2	4	21	0	0	0
8	Kaiwharawhara	Koromiko Stream at Cummings Park	KAFS2	FW	29	1	4	17	0	0	0
8	Kaiwharawhara	Kaiwharawhara Stream u/s of Hutt Road	KAFS3	FW	29	3	3	21	0	0	0
9	North Harbour	Waitohu Stream at Ngauranga Gorge	NOFS1	FW	29	4	7	38	0	0	0
9	North Harbour	Waitohu Stream near Harbour	NOFS2	FW	29	2	8	34	0	0	0
9	North Harbour	Newlands at Gorge	NOSW1	SW	29	3	5	28	0	4	14
9	North Harbour	Tyers Stream at Gorge	NOSW2	SW	29	1	5	21	1	1	7
12	Waiwhetu	Waiwhetu Stream at Tilbury St	WAIWFW1	FW	29	2	12	48	0	0	0

No.	Sub catchment	Site Location	Site ID	Site type	Site visits	Change in colour or visual clarity			Emission of objectionable odour		
						High	Moderate	%	High	Moderate	%
12	Waiwhetu	Waiwhetu Stream at Rishworth St	WAIWFW2	FW	29	3	12	52	0	0	0
13	Stokes Valley Stream	Stokes Valley Stream, Rawhiti Street	STFW1	FW	29	1	7	28	0	0	0
14	Hulls	Hull Creek Trib (PineHaven Stream)	PIFW1	FW	29	1	9	34	0	0	0
15	Lower Hutt South	Petone Beach at Kiosk	HUCW1	CW	29	1	4	17	0	1	3
15	Lower Hutt South	Petone Beach at Sydney St	HUCW2	CW	29	2	5	24	0	0	0
15	Lower Hutt South	Petone Beach at Waterski Club	HUCW3	CW	29	1	4	17	0	0	0
15	Lower Hutt South	Hutt River u/s Melling Bridge	HUFW2	FW	29	1	5	21	0	0	0
15	Lower Hutt South	Brunswick	HUSW10	SW	29	1	8	31	0	2	7
15	Lower Hutt South	Block Road	HUSW11	SW	29	0	4	14	0	0	0
15	Lower Hutt South	Normandale Road SW011387	HUSW12	SW	29	1	4	17	0	2	7
15	Lower Hutt South	West Hill Culvert	HUSW13	SW	29	1	3	14	0	1	3
15	Lower Hutt South	Opahu Stream at Whites Line West	OPFW1	FW	29	0	9	31	0	1	3
15	Lower Hutt South	Te Mome Stream at Jackson Street	TEFW1	FW	29	1	6	24	0	2	7
16	Lower Hutt North	Hutt River u/s Silverstream Bridge	HUFW1	FW	29	1	4	17	1	0	3
16	Lower Hutt North	Harcourt Werry Drive at Percy Cameron	HUFW5	FW	29	0	4	14	0	1	3
16	Lower Hutt North	Harcourt Werry Drive at Taita Drive	HUFW6	FW	29	0	9	31	0	1	3
18	Upper Hutt North	8 Akatarawa Road	HUSW1	SW	29	1	10	38	0	0	0
24	Eastern Bays	Lowry Bay at Cheviot Road	EACW1	CW	29	0	4	14	0	0	0
24	Eastern Bays	Days Bay at Wharf	EACW2	CW	29	0	3	10	0	0	0
24	Eastern Bays	Rona Bay at Wharf	EACW3	CW	29	0	3	10	0	0	0
24	Eastern Bays	Robinson Bay at Nikau St	EACW4	CW	29	0	3	10	0	0	0
27	Wainuiomata	Black Creek at Edmonds Street	BLFW1	FW	29	1	6	24	0	0	0
27	Wainuiomata	Black Creek trib. At Fitzherbert Road	BLFW2	FW	29	5	7	41	0	0	0
27	Wainuiomata	Black Creek at Moohan St	BLFW3	FW	29	2	5	24	1	1	7
32	Pauatahanui	Pauatahanui Inlet at Browns Bay	PACW1	CW	29	0	4	14	0	0	0
32	Pauatahanui	Pauatahanui Inlet at Water Ski Club	PACW2	CW	29	1	3	14	0	1	3
32	Pauatahanui	Pauatahanui at Paremata Bridge	PACW3	CW	29	0	2	7	0	0	0

No.	Sub catchment	Site Location	Site ID	Site type	Site visits	Change in colour or visual clarity			Emission of objectionable odour		
						High	Moderate	%	High	Moderate	%
32	Pauatahanui	Duck Creek u/s SH58	PAFW1	FW	29	3	14	59	0	1	3
32	Pauatahanui	Browns Stream at footbridge	PAFW2	FW	29	6	13	66	1	1	7
32	Onepoto	Porirua Harbour at Rowing Club	POCW1	CW	29	0	4	14	0	0	0
32	Onepoto	Porirua Harbour, Wi Neera Drive Boat Ramp	POCW2	CW	29	0	4	14	0	1	3
32	Onepoto	Porirua Stream d/s Wingfield Place	POFW1	FW	29	0	2	7	0	0	0
32	Onepoto	Unnamed watercourse u/s Onepoto Road	POFW10	FW	29	0	15	52	1	1	7
32	Onepoto	Belmont stream at Setton Nossiter Park	POFW2	FW	29	1	4	17	0	1	3
32	Onepoto	Stebbings Stream at end of Glenside Rd	POFW3	FW	29	1	5	21	0	0	0
32	Onepoto	Takapu Stream u/s mouth	POFW4	FW	29	0	4	14	0	0	0
32	Onepoto	Belmont stream at Setton Nossiter Park	POFW5	FW	29	1	5	21	0	0	0
32	Onepoto	Porirua Stream at Town Centre	POFW6	FW	29	0	7	24	1	0	3
32	Onepoto	Mitchell Stream at Kenepuru Drive	POFW7	FW	29	2	5	24	0	0	0
32	Onepoto	Keneperu Stream at Bothamley Park	POFW8	FW	29	5	9	48	0	0	0
32	Onepoto	Kenepuru Stream at Mepham Place	POFW9	FW	29	3	8	38	0	0	0
34	Onepoto	Semple Street Outlet	POSW1	SW	29	3	18	72	0	10	34
34	Onepoto	Takapuwahia Stream Outlet at Hiko St	POSW2	SW	29	1	16	59	1	3	14
34	Onepoto	Gloaming Hill	POSW3	SW	29	0	10	34	1	1	7
35	Porirua coast	Titahi Bay at Bay Drive	POCW3	CW	29	0	0	0	0	0	0
35	Porirua coast	Titahi Bay at Toms Drive	POCW4	CW	29	0	0	0	0	0	0
35	Porirua coast	Titahi Bay at South Beach	POCW5	CW	29	0	1	3	0	0	0
35	Porirua coast	Plimmerton Beach at Bath St	POCW6	CW	29	1	2	10	0	0	0
35	Porirua coast	South Plimmerton Beach	POCW7	CW	29	1	2	10	0	0	0
35	Porirua coast	South Beach Access	POSW4	SW	29	0	7	24	0	3	10

Notes: 1. Observations are recorded as highly conspicuous (high), moderately conspicuous (moderate), or not observed (0)

2. Site types are freshwater (FW), coastal water (CW), and stormwater (SW)

Appendix C: *E. coli* summary, monthly from 1 January 2020 to 30 June 2022

No.	Sub catchment	Site Name	Site ID	*E. coli* (cfu/100mL)					NPS-FM Attribute State	NRP O18 (95th%ile less than 540)
				n	% exceedance over 540	% exceedance over 260	Median	95%ile		
1	Karori	Karori Stream at Friend Street	KAFW1	36	75%	92%	2,100	26,000	E	Not meeting
		Karori Stream at Campbell Street Bridge	KAFW2	35	43%	69%	438	4,980	E	Not meeting
		Karori Stream at Makara Peak MB Park	RS18	23	96%	100%	1,950	5,850	E	Not meeting
2	Owhiro	Owhiro Stream above T & T Landfill	OWFW1	35	37%	57%	400	8,659	E	Not meeting
		Owhiro Stream u/s Owhiro Bay Parade	OWFW2	41	71%	85%	1,040	5,000	E	Not meeting
		Owhiro Stream at Owhiro Bay Parade	RS64	23	83%	96%	1500	7,700	E	Not meeting
8	Kaiwhara-whara	Kaiwharawhara Stream at Otari Park	KAFS1	33	33	61	408	5,580	E	Not meeting
		Koromiko Stream at Cummings Park	KAFS2	33	36	58	320	4,960	E	Not meeting
		Kaiwharawhara Stream u/s of Hutt Road	KAFS3	32	78	94	833	29,000	E	Not meeting
		Kaiwharawhara Stream at Ngaio Gorge	RS19	23	83	100	1,800	11,800	E	Not meeting
9	North Harbour	Waitohi Stream at Ngauranga Gorge	NOFS1	37	95	100	2,700	7,500	E	Not meeting
		Waitohi Stream near Harbour	NOFS2	34	62	91	925	8,491	E	Not meeting
12	Waiwhetu	Waiwhetu Stream at Tilbury St	WAIWFW1	34	65%	94%	850	5,055	E	Not meeting
		Waiwhetu Stream at Rishworth St	WAIWFW2	38	95%	100%	2,050	9,430	E	Not meeting
		Waiwhetu Stream at Whites Line East	RS57	22	77%	95%	1,200	16,850	E	Not meeting
13	Stokes	Stokes Valley Stream, Rawhiti Street	STFS1	37	70%	92%	1,700	7,220	E	Not meeting
14	Hulls	Hull Creek Trib (PineHaven Stream)	PIFW1	34	74%	88%	873	4,875	E	Not meeting
15	Lower Hutt South	Opahu Stream at Whites Line West	OPFW1	33	85%	100%	2,450	7,240	E	Not meeting
		Te Mome Stream at Jackson Street	TEFW1	28	29%	46%	208	2,245	E	Not meeting
		Hutt River u/s Melling Bridge	HUFW2	27	37	70	365	3,170	E	Not meeting
		Hutt River at Boulcott	RS22	22	9	36	160	1,353	D	Not meeting
16		Harcourt Werry Drive at Percy Cameron St	HUFW5	19	74%	89%	3,200	245,120	E	Not meeting

No.	Sub catchment	Site Name	Site ID	*E. coli* (cfu/100mL)					NPS-FM Attribute State	NRP O18 (95th%ile less than 540)
				n	% exceedance over 540	% exceedance over 260	Median	95%ile		
	Lower Hutt North	Harcourt Werry Drive at Taita Drive	HUFW6	31	45%	48%	156	9,200	E	Not meeting
17	Upper Hutt South	Hutt River u/s Silverstream Bridge	HUFW1	25	8	20	100	558	B	Meeting
		Hutt River at Opposite Manor Park Golf Course	RS21	22	18	41	180	1,080	D	Not meeting
19	Hutt Headwaters	Hutt River at Te Marua Lakes	RS20	22	0	5	50	228	A	Meeting
27	Wainuiomata	Black Creek at Edmonds Street	BLFW1	31	58%	77%	619	11,350	E	Not meeting
		Black Creek trib. At Fitzherbert Road	BLFW2	29	52%	83%	562	15,000	E	Not meeting
		Black Creek at Moohan St	BLFW3	29	55%	83%	600	8,540	E	Not meeting
		Black Creek at end of Rowe Parade end	RS67	22	73%	91%	1,250	6,330	E	Not meeting
29	Taupo	Taupo Stream at Plimmerton Domain	RS63	23	35%	48%	260	4,160	E	Not meeting
33	Duck	Duck Creek u/s SH58	PAFW1	29	45%	69%	454	2,900	E	Not meeting
		Browns Stream at footbridge	PAFW2	35	74%	94%	1500	18,960	E	Not meeting
34	Porirua	Porirua Stream d/s Wingfield Place	POFW1	35	51%	63%	544	6,140	E	Not meeting
		Belmont stream at Seton Nossiter Park	POFW2	29	24%	28%	104	2,480	E	Not meeting
		Stebbings Stream at end of Glenside Rd	POFW3	35	43%	71%	452	6,040	E	Not meeting
		Takapu Stream u/s mouth	POFW4	31	29%	74%	400	3,000	E	Not meeting
		Porirua Stream u/s Takapu Stream	POFW5	33	36%	88%	458	5,900	E	Not meeting
		Porirua Stream at Town Centre	POFW6	31	61%	74%	676	8,200	E	Not meeting
		Mitchell Stream at Kenepuru Drive	POFW7	31	32%	65%	348	9,000	E	Not meeting
		Keneperu Stream at Bothamley Park	POFW8	33	76%	85%	1,090	14,740	E	Not meeting
		Kenepuru Stream at Mepham Place	POFW9	29	55%	86%	655	10,960	E	Not meeting
		Unnamed watercourse u/s Onepoto Road	POFW10	33	67%	85%	1,160	14,380	E	Not meeting

Appendix D: Enterococci, monthly from 1 January 2020 to 30 June 2022

No.	Sub catchment	Site Name	Site ID	Enterococci (cfu/100mL)				NRP Objective O18 – 95%ile
				n	Min	Median	95%ile	
3	Island/Houghton	Princess Bay	HOCW1	23	<4	3.9	257	≤500
		Island Bay at Derwent Street	ISCW1	26	<4	6	1,250	
		Island Bay at Reef Street	ISCW2	20	<4	4	92	
		Island Bay at Surf Club	ISCW3	22	<4	6	116	
4	Lyall	Lyall Bay at Queens Drive	LYCW1	23	<4	4	339	
		Lyall Bay at Onepu Road	LYCW2	23	<4	4	136	
6	Evans	Evans Bay Public Boat Ramp	EVCW1	23	<4	4	45	
		Hataitai Beach	EVCW2	23	<4	4	180	
		Balaena Bay	EVCW3	23	<4	4	96	
7	Lambton	Waterfront at Shed 6	LACW1	24	<4	18	590	
		Whairepo Lagoon	LACW2	24	<4	12	160	
		Taranaki Diving Platform	LACW3	24	4	74	1,543	
		Oriental Bay at Freyberg Beach	LACW4	24	<4	4	143	
		Oriental Bay at Wishing Well	LACW5	24	<4	10	154	
		Oriental Bay at band Rotunda	LACW6	24	<4	4	113	
15	Lower Hutt-S	Petone Beach at Kiosk	HUCW1	24	<4	12	763	
		Petone Beach at Sydney Street	HUCW2	23	<4	20	893	
		Petone Beach at Waterski Club	HUCW3	23	<4	16	936	
24	Eastbourne	Lowry Bay at Cheviot Road	EACW1	23	<4	16	928	
		Days Bay at Wharf	EACW2	22	<4	4	164	
		Rona Bay at Wharf	EACW3	22	<4	4	84	
		Robinson Bay at Nikau Street	EACW4	24	<4	4	149	
35	Porirua Coast	Titahi Bay at Bay Drive	POCW3	23	<4	24	442	
		Titahi Bay at Toms Drive	POCW4	23	<4	16	140	
		Titahi Bay at South Beach	POCW5	23	<4	12	4,630	
		Plimmerton Beach at Bath Street	POCW6	23	<4	20	1,614	
		South Plimmerton Beach	POCW7	23	<4	60	819	

Appendix E: Water Temperature, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Water temperature (℃)					Ecosystem health thresholds for temperature (Davies-Colley et al. 2013)
				n	Min	Median	95%ile	Maximum	
1	Karori	Karori Stream at Makara Peak MB Park	RS18	23	8.8	13.5	16.67	17.5	A
2	Owhiro	Owhiro Bay Stream at Mouth	RS64	12	9.39	10.19	11.26	11.35	A
8	Kaiwharawhara	Kaiwharawhara Stream at Ngaio Gorge	RS19	22	7.7	14.15	19.14	19.2	B
12	Waiwhetu	Waiwhetu Stream at Whites Line East	RS57	23	10.1	15.7	21.34	21.9	C
21	Hutt Headwaters	Hutt River at Te Marua Lakes	RS20	22	6.2	11.7	14.37	15	A
17	Upper Hutt South	Hutt River at Manor Park Golf Course	RS21	23	8	14.9	19.83	26.1	D
15	Lower Hutt South	Hutt River at Boulcott	RS22	23	8	15.4	20.21	24.5	D
25	Black Creek	Black Creek at end of Rowe Parade	RS67	23	8.2	13.7	17.97	18.7	B
34	Porirua	Porirua Stream at Glenside	RS15	23	7.7	14.5	19.49	19.7	B
34	Porirua	Porirua Stream at Wall Park	RS16	23	8.5	15	17.94	19.1	B

Appendix F: Dissolved oxygen, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Dissolved oxygen (g/m3)					NPS-FM Attribute State for dissolved oxygen
				n	Min	Median	95%ile	Maximum	
1	Karori	Karori Stream at Makara Peak MB Park	RS18	23	9.18	10.08	11.35	11.41	A
2	Owhiro	Owhiro Bay Stream at Mouth	RS64	12	9.39	10.19	11.26	11.35	A
8	Kaiwharawhara	Kaiwharawhara Stream at Ngaio Gorge	RS19	22	9.38	10.26	11.52	11.85	A
12	Waiwhetu	Waiwhetu Stream at Whites Line East	RS57	23	7.75	10.46	16.37	16.79	A
21	Hutt Headwaters	Hutt River at Te Marua Lakes	RS20	22	9.94	11.09	12.28	12.3	A
17	Upper Hutt South	Hutt River at Manor Park Golf Course	RS21	23	9.84	10.78	11.88	12.26	A
15	Lower Hutt South	Hutt River at Boulcott	RS22	23	9.24	10.56	11.64	13.28	A
25	Black Creek	Black Creek at end of Rowe Parade	RS67	22	6.7	9.29	10.95	11.49	B
34	Porirua	Porirua Stream at Glenside	RS15	22	9.2	10.53	11.95	12.53	A
34	Porirua	Porirua Stream at Wall Park	RS16	22	9.45	10.57	11.87	12.54	A

Appendix G: Dissolved reactive phosphorus, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Dissolved reactive phosphorus (g/m^3)			NPS-FM Attribute State for DRP
				n	Median	95%ile	
1	Karori	Karori Stream at Makara Peak MB Park	RS18	23	0.035	0.048	D
2	Owhiro	Owhiro Bay Stream at Mouth	RS64	23	0.0177	0.0413	D
8	Kaiwharawhara	Kaiwharawhara Stream at Ngaio Gorge	RS19	23	0.036	0.052	C
12	Waiwhetu	Waiwhetu Stream at Whites Line East	RS57	23	0.03	0.0535	D
13	Stoke	Stokes Valley Stream at Eastern Hutt Road	RS66	22	0.01845	0.0369	D
14	Hulls	Hulls Creek adjacent Reynolds Bach Drive	RS65	21	0.0179	0.025	C
15	Lower Hutt South	Hutt River at Boulcott	RS22	22	0.005	0.008	A
17	Upper Hutt South	Hutt River at Opposite Manor Park Golf Course	RS21	22	0.005	0.008	A
21	Hutt Headwaters	Hutt River at Te Marua Lakes	RS20	22	0.004	0.006	A
25	Black Creek	Black Creek at end of Rowe Parade	RS67	23	0.022	0.0422	D
34	Porirua	Porirua Stream at Glenside	RS15	23	0.024	0.0338	D
34	Porirua	Porirua Stream at Wall Park	RS16	23	0.024	0.036	D

Appendix H: Nitrate-N, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Nitrate nitrogen (g/m^3)			NPS-FM Attribute State for NO_3-N toxicity
				n	Median	95%ile	
1	Karori	Karori Stream at Makara Peak MB Park	RS18	23	1.14	1.383	B
2	Owhiro	Owhiro Bay Stream at Mouth	RS64	23	1.64	2.39	B
8	Kaiwharawhara	Kaiwharawhara Stream at Ngaio Gorge	RS19	23	0.93	1.182	A
12	Waiwhetu	Waiwhetu Stream at Whites Line East	RS57	23	0.47	0.568	A
13	Stoke	Stokes Valley Stream at Eastern Hutt Road	RS66	22	0.245	0.33	A
14	Hulls	Hulls Creek adjacent Reynolds Bach Drive	RS65	21	0.25	0.51	A
15	Lower Hutt South	Hutt River at Boulcott	RS22	22	0.183	0.308	A
17	Upper Hutt South	Hutt River at Opposite Manor Park Golf Course	RS21	22	0.176	0.316	A
21	Hutt Headwaters	Hutt River at Te Marua Lakes	RS20	22	0.061	0.128	A
25	Black Creek	Black Creek at end of Rowe Parade	RS67	23	0.38	0.676	A
34	Porirua	Porirua Stream at Glenside	RS15	23	0.87	1.209	A
34	Porirua	Porirua Stream at Wall Park	RS16	23	0.83	1.341	A

Appendix I: Total ammonia nitrogen, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Total ammonia nitrogen (g/m^3)			NPS-FM Attribute State for -NH_3-N toxicity
				n	Median	95%ile	
1	Karori	Karori Stream at Makara Peak MB Park	RS18	23	0.015	0.08	B
2	Owhiro	Owhiro Bay Stream at Mouth	RS64	23	0.034	0.59	B
8	Kaiwharawhara	Kaiwharawhara Stream at Ngaio Gorge	RS19	23	0.01	0.15	B
12	Waiwhetu	Waiwhetu Stream at Whites Line East	RS57	23	0.049	0.12	B
13	Stoke	Stokes Valley Stream at Eastern Hutt Road	RS66	22	0.02	0.1	B
14	Hulls	Hulls Creek adjacent Reynolds Bach Drive	RS65	21	0.017	0.27	B
15	Lower Hutt South	Hutt River at Boulcott	RS22	22	0.005	0.01	A
17	Upper Hutt South	Hutt River at Opposite Manor Park Golf Course	RS21	22	0.005	0.01	A
21	Hutt Headwaters	Hutt River at Te Marua Lakes	RS20	22	0.005	0.01	A
25	Black Creek	Black Creek at end of Rowe Parade	RS67	23	0.06	0.16	B
34	Porirua	Porirua Stream at Glenside	RS15	23	0.009	0.12	B
34	Porirua	Porirua Stream at Wall Park	RS16	23	0.016	0.091	B

Appendix J: Copper (mg/L) in freshwater streams, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Copper (mg/L)								NRP: ANZG (2018) 95%ile
				Total Cu				Dissolved Cu				
				n	Min	Median	95%ile	n	Min	Median	95%ile	
1	Karori	Karori Stream at Friend Stream	KAFW1	29	0.0010	0.0030	0.0116	28	0.0010	0.0025	0.0066	0.0014
		Karori Stream at Campbell Street Bridge	KAFW2	29	0.0010	0.0030	0.0070	28	0.0012	0.0026	0.0056	
		Karori Stream at Makara Peak MB Park	RS18	23	0.0010	0.0018	0.0085	23	0.0009	0.0014	0.0045	
2	Owhiro	Owhiro Stream at Mouth	RS64	23	0.0007	0.0014	0.0036	23	0.0007	0.0010	0.0020	
8	Kaiwharawhara	Kaiwharawhara Stream at Otari Park	KAFS1	29	0.0010	0.0010	0.0090	28	0.0005	0.0010	0.0037	
		Koromiko Stream at Cummings Park	KAFS2	29	0.0010	0.0020	0.0092	28	0.0005	0.0012	0.0047	
		Kaiwharawhara Stream u/s of Hutt Road	KAFS3	29	0.0010	0.0020	0.0150	28	0.0005	0.0015	0.0036	
		Kaiwharawhara Stream at Ngaio Gorge	RS19	23	0.0009	0.0017	0.0075	23	0.0009	0.0014	0.0032	
9	North Harbour	Waitohi Stream at Ngauranga Gorge	NOFS1	29	0.0010	0.0020	0.0102	28	0.0007	0.0014	0.0039	
		Waitohi Stream near harbour	NOFS2	26	0.0010	0.0020	0.0138	25	0.0005	0.0014	0.0038	
		Newlands at Gorge	NOSW1	29	0.0010	0.0030	0.0448	0				
		Tyers Stream at Gorge	NOSW2	29	0.0010	0.0030	0.0114	0				
12	Waiwhetu	Waiwhetu Stream at Tilbury St	WAIWFW1	30	0.0010	0.0025	0.0066	29	0.0006	0.0011	0.0049	
		Waiwhetu Stream at Rishworth St	WAIWFW2	30	0.0010	0.0020	0.0072	28	0.0004	0.0011	0.0030	
		Waiwhetu Stream at Whites Line East	RS57	23	0.0008	0.0020	0.0071	23	0.0007	0.0010	0.0038	
13	Stokes	Stokes Valley Stream, Rawhiti St.	STFS1	29	0.0010	0.0010	0.0036	28	0.0004	0.0008	0.0028	
14	Hulls	Hull Creek Trib (PineHaven Stream)	PIFW1	30	0.0010	0.0030	0.0071	29	0.0007	0.0013	0.0041	
15	Lower Hutt S	Hutt River at Boulcott	RS22	22	0.0005	0.0006	0.0013	22	0.0005	0.0005	0.0006	
		Opahu Stream at Whites Line West	OPFW1	29	0.0010	0.0030	0.0136	28	0.0005	0.0015	0.0066	
		Te Mome Stream at Jackson Street	TEFW1	28	0.0010	0.0010	0.0050	0				
17	Upper Hutt S	Hutt River at Manor Park Golf C.	RS21	22	0.0005	0.0005	0.0012	22	0.0005	0.0005	0.0006	
25	Black Creek	Black Creek at end of Rowe Parade	RS67	23	0.0007	0.0013	0.0042	23	0.0006	0.0010	0.0025	

No	Sub-catchment	Site Name	Site ID	Copper (mg/L)								NRP: ANZG (2018) 95%ile
				Total Cu				Dissolved Cu				
				n	Min	Median	95%ile	n	Min	Median	95%ile	
29	Taupo	Taupo Stream at Plimmerton Domain	RS63	23	0.0005	0.0009	0.0038	23	0.0005	0.0007	0.0017	0.0014
33	Duck	Duck Creek u/s SH58	PAFW1	29	0.0007	0.0020	0.0056	28	0.0004	0.0008	0.0027	
		Browns Stream at footbridge	PAFW2	29	0.0010	0.0020	0.0062	28	0.0004	0.0009	0.0047	
34	Porirua	Takapu Stream u/s mouth	POFW4	28	0.0010	0.0010	0.0050	28	0.0004	0.0007	0.0015	
		Porirua Stream u/s Takapu Stream	POFW5	29	0.0007	0.0010	0.0050	28	0.0004	0.0010	0.0020	
		Porirua Stream at Town Centre	POFW6	29	0.0009	0.0010	0.0050	28	0.0005	0.0011	0.0026	
		Mitchell Stream at Kenepuru Drive	POFW7	29	0.0010	0.0012	0.0126	28	0.0004	0.0011	0.0026	
		Keneperu Stream at Bothamley Park	POFW8	29	0.0010	0.0010	0.0100	28	0.0006	0.0012	0.0032	
		Kenepuru Stream at Mepham Place	POFW9	29	0.0010	0.0020	0.0072	28	0.0007	0.0014	0.0035	
		Unnamed watercourse u/s Onepoto Road	POFW10	29	0.0010	0.0030	0.0114	0				
		Porirua Stream at Glenside	RS15	23	0.0007	0.0013	0.0056	23	0.0005	0.0010	0.0027	
		Porirua Stream at Wall Park	RS16	23	0.0009	0.0016	0.0072	23	0.0007	0.0012	0.0031	

Appendix K: Copper (mg/L) in stormwater, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Total Copper (mg/L)			
				n	Min	Median	95%ile
3	Island/Houghton	Houghton Bay Culvert	HOSW1	29	0.0010	0.0020	0.0100
		Island Bay	ISSW1	29	0.0010	0.0030	0.0102
4	Lyall	Lyall Bay West Culvert	LYSW1	28	0.0010	0.0050	0.0185
		Lyall Bay East Culvert	LYSW2	29	0.0010	0.0050	0.0692
6	Evans	Miramar Culvert	EVSW1	29	0.0010	0.0020	0.0098
		Cobham Culvert	EVSW2	29	0.0010	0.0020	0.0122
		Kilbirnie Culvert	EVSW3	29	0.0010	0.0020	0.0108
		Hataitai Culvert	EVSW4	29	0.0010	0.0030	0.0076
7	Lambton	Thorndon Culvert	LASW1	27	0.0010	0.0020	0.0074
		Davis Culvert	LASW2	28	0.0010	0.0040	0.0229
		Bowen Culvert	LASW3	28	0.0010	0.0030	0.0150
		Waring Taylor Culvert	LASW4	25	0.0010	0.0030	0.0202
		Hunter Culvert	LASW5	25	0.0010	0.0020	0.0210
		Harris Street Culvert	LASW6	27	0.0010	0.0020	0.0050
		Te Aro Culvert	LASW7	28	0.0010	0.0030	0.0170
		Taranaki Culvert	LASW8	28	0.0010	0.0020	0.0159
		Tory Street Culvert	LASW9	29	0.0020	0.0050	0.0170
		OPT Culvert	LASW10	20	0.0010	0.0050	0.0113
		Oriental Bay at Hay Street	LASW11	26	0.0020	0.0055	0.0178
		Grass Street Culvert	LASW12	28	0.0010	0.0030	0.0210
34	Porirua	Semple Street Outlet	POSW1	29	0.0010	0.0040	0.0118
		Takapuwahia Stream Outlet at Hiko St	POSW2	28	0.0010	0.0015	0.0056
		Gloaming Hill	POSW3	29	0.0010	0.0030	0.0082

Appendix L: Zinc (mg/L) in freshwater streams, monthly from 1 January 2020 to 30 June 2022

No	Sub catchment	Site Name (FW or CW)	Site ID	Zinc (mg/L)								NRP: ANZG (2018) 95%
				Total Zn				Dissolved Zn				
1	Karori	Karori Stream at Friend Stream	KAFW1	29	0.008	0.022	0.068	28	0.012	0.017	0.042	0.008
		Karori Stream at Campbell Street Bridge	KAFW2	29	0.013	0.037	0.113	28	0.015	0.028	0.082	
		Karori Stream at Makara Peak MB Park	RS18	23	0.008	0.020	0.069	23	0.007	0.020	0.041	
2	Owhiro	Owhiro Stream at Mouth	RS64	23	0.002	0.004	0.025	23	0.001	0.002	0.007	
8	Kaiwharawhara	Kaiwharawhara Stream at Otari Park	KAFS1	29	0.004	0.008	0.131	28	0.003	0.005	0.014	
		Koromiko Stream at Cummings Park	KAFS2	29	0.004	0.017	0.089	28	0.006	0.012	0.041	
		Kaiwharawhara Stream u/s of Hutt Road	KAFS3	29	0.004	0.010	0.090	28	0.002	0.006	0.019	
		Kaiwharawhara Stream at Ngaio Gorge	RS19	23	0.002	0.009	0.038	23	0.001	0.006	0.010	
9	North Harbour	Waitohi Stream at Ngauranga Gorge	NOFS1	29	0.009	0.024	0.150	28	0.007	0.016	0.084	
		Waitohi Stream near harbour	NOFS2	25	0.004	0.012	0.097	25	0.002	0.007	0.051	
		Newlands at Gorge	NOSW1	29	0.018	0.042	0.140	0				
		Tyers Stream at Gorge	NOSW2	29	0.005	0.017	0.093	0				
12	Waiwhetu	Waiwhetu Stream at Tilbury St	WAIWFW1	30	0.004	0.019	0.069	29	0.002	0.007	0.053	
		Waiwhetu Stream at Rishworth St	WAIWFW2	30	0.011	0.025	0.061	29	0.006	0.018	0.049	
		Waiwhetu Stream at Whites Line East	RS57	23	0.005	0.016	0.050	23	0.003	0.014	0.049	
13	Stokes	Stokes Valley Stream, Rawhiti St.	STFS1	29	0.004	0.010	0.035	28	0.002	0.005	0.022	
14	Hulls	Hull Creek Trib (PineHaven Stream)	PIFW1	30	0.004	0.023	0.067	29	0.002	0.008	0.042	
15	Lower Hutt South	Opahu Stream at Whites Line West	OPFW1	29	0.012	0.056	0.167	28	0.009	0.038	0.096	
		Te Mome Stream at Jackson Street	TEFW1	28	0.004	0.012	0.053	0				
		Hutt River at Boulcott	RS22	22	0.001	0.001	0.004	22	0.001	0.001	0.003	
17	Upper Hutt South	Hutt River at Manor Park Golf Course	RS21	22	0.001	0.001	0.004	22	0.001	0.001	0.002	
25	Black Creek	Black Creek at end of Rowe Parade	RS67	23	0.008	0.013	0.089	23	0.004	0.011	0.036	

29	Taupo	Taupo Stream at Plimmerton Domain	RS63	23	0.001	0.003	0.012	23	0.001	0.002	0.004	0.008
33	Duck	Duck Creek u/s SH58	PAFW1	29	0.002	0.009	0.027	28	0.001	0.004	0.011	
		Browns Stream at footbridge	PAFW2	29	0.004	0.021	0.086	28	0.004	0.012	0.048	
34	Porirua	Takapu Stream u/s mouth	POFW4	29	0.003	0.007	0.102	28	0.001	0.005	0.024	
		Porirua Stream u/s Takapu Stream	POFW5	29	0.004	0.007	0.051	28	0.001	0.004	0.009	
		Porirua Stream at Town Centre	POFW6	29	0.004	0.009	0.095	28	0.001	0.006	0.022	
		Mitchell Stream at Kenepuru Drive	POFW7	29	0.006	0.014	0.258	28	0.004	0.011	0.051	
		Keneperu Stream at Bothamley Park	POFW8	29	0.004	0.008	0.054	28	0.001	0.004	0.015	
		Kenepuru Stream at Mepham Place	POFW9	29	0.004	0.007	0.047	28	0.001	0.004	0.014	
		Unnamed watercourse u/s Onepoto Road	POFW10	29	0.008	0.029	0.079	0				
		Porirua Stream at Glenside	RS15	23	0.002	0.005	0.031	23	0.001	0.003	0.012	
		Porirua Stream at Wall Park	RS16	23	0.004	0.010	0.082	23	0.001	0.007	0.035	

Appendix M: Zinc (mg/L) in stormwater, monthly from 1 January 2020 to 30 June 2022

No	Sub-catchment	Site Name	Site ID	Total Zinc (mg/L)			
				n	Min	Median	95%ile
3	Island/Houghton	Houghton Bay Culvert	HOSW1	29	0.004	0.015	0.065
		Island Bay	ISSW1	29	0.004	0.035	0.085
4	Lyall	Lyall Bay West Culvert	LYSW1	28	0.004	0.028	0.266
		Lyall Bay East Culvert	LYSW2	29	0.004	0.054	0.562
6	Evans	Miramar Culvert	EVSW1	29	0.004	0.009	0.099
		Cobham Culvert	EVSW2	29	0.004	0.010	0.077
		Kilbirnie Culvert	EVSW3	29	0.004	0.011	0.063
		Hataitai Culvert	EVSW4	29	0.004	0.010	0.069
7	Lambton	Thorndon Culvert	LASW1	27	0.011	0.021	0.057
		Davis Culvert	LASW2	28	0.006	0.025	0.138
		Bowen Culvert	LASW3	28	0.004	0.011	0.052
		Waring Taylor Culvert	LASW4	25	0.004	0.011	0.080
		Hunter Culvert	LASW5	25	0.004	0.011	0.090
		Harris Street Culvert	LASW6	28	0.004	0.008	0.038
		Te Aro Culvert	LASW7	28	0.010	0.018	0.295
		Taranaki Culvert	LASW8	28	0.005	0.012	0.123
		Tory Street Culvert	LASW9	29	0.023	0.063	0.337
		OPT Culvert	LASW10	20	0.016	0.042	0.142
		Oriental Bay at Hay Street	LASW11	26	0.018	0.028	0.118
		Grass Street Culvert	LASW12	28	0.004	0.018	0.087
34	Porirua	Semple Street Outlet	POSW1	29	0.006	0.05	0.1946
		Takapuwahia Stream Outlet at Hiko St	POSW2	29	0.004	0.01	0.0276
		Gloaming Hill	POSW3	29	0.009	0.037	0.1298

Appendix N: Stream sediment quality

Results of analysis of the <2mm sediment fraction from stream bed samples collected during April 2021. Exceedance of default guideline value (DGV) and guideline value high (GV-high) are highlighted in red.

Test	Unit	Karori Stream	Owhiro Stream	Kaiwharawhara Stream	Waitohi Stream	Hulls Creek	Stokes Valley Stream	Waiwhetu Stream	Black Creek	Porirua Stream	Taupo Stream	Toxicant guidelines for sediments (ANZG 2018)	
		RS18	RS64	KAFW3	NOFS2	RS65	RS66	RS57	RS67	RS16	RS63	DGV	GV-high
TOC, metals, and metalloids													
Dry Matter (Env)	g/100g as rcvd	74	77	80	78	63	78	76	77	81	78		
Total Organic Carbon	g/100g dry wt	0.2	0.21	6.2	0.42	1.73	0.56	6.6	0.8	0.43	0.27		
Total Recoverable Antimony	mg/kg dry wt	< 0.4	0.8	0.6	< 0.4	0.4	< 0.4	0.6	< 0.8	< 0.4	< 0.4	2	25
Total Recoverable Arsenic	mg/kg dry wt	5	6	5	4	4	5	5	6	5	4	20	70
Total Recoverable Boron	mg/kg dry wt	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20		
Total Recoverable Cadmium	mg/kg dry wt	0.12	0.11	0.13	< 0.10	0.13	< 0.10	0.61	< 0.10	< 0.10	0.1	1.5	10
Total Recoverable Chromium	mg/kg dry wt	17	16	20	19	10	11	16	11	16	13	80	370
Total Recoverable Cobalt	mg/kg dry wt	9.2	8.3	7.6	7.5	6.2	5.5	7.6	7.9	7.9	6.8		
Total Recoverable Copper	mg/kg dry wt	23	17	18	18	17	10	25	13	17	9	65	270
Total Recoverable Lead	mg/kg dry wt	56	40	55	43	32	24	52	24	27	15.2	50	220
Total Recoverable Molybdenum	mg/kg dry wt	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total Recoverable Nickel	mg/kg dry wt	16	13	15	14	10	10	12	12	15	11	21	52
Total Recoverable Tin	mg/kg dry wt	1.4	1.4	2.8	1.1	4.4	1.1	3.3	< 1.0	1.2	1.2		
Total Recoverable Zinc	mg/kg dry wt	320	220	290	300	136	170	210	210	188	98	200	410
DDT screening													
2,4'-DDD	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005		
4,4'-DDD	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.067		
2,4'-DDE	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005		
4,4'-DDE	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.011		
2,4'-DDT	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005		
4,4'-DDT	mg/kg dry wt	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.014		
Total DDT Isomers	mg/kg dry wt	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.09	0.0012	0.005
Polycyclic aromatic hydrocarbons													
Total of Reported PAHs in Soil	mg/kg dry wt	0.2	0.77	2.2	0.24	0.8	0.2	0.4	< 0.05	0.1	0.31	10	50
1-Methylnaphthalene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	< 0.002	< 0.003	0.002	< 0.002	< 0.002	< 0.002	< 0.002		
2-Methylnaphthalene	mg/kg dry wt	< 0.002	< 0.002	0.002	< 0.002	< 0.003	0.005	< 0.002	< 0.002	< 0.002	< 0.002		
Acenaphthene	mg/kg dry wt	< 0.002	< 0.002	0.002	< 0.002	< 0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002		
Acenaphthylene	mg/kg dry wt	< 0.002	0.005	0.023	< 0.002	0.006	< 0.002	0.005	< 0.002	< 0.002	0.003		
Anthracene	mg/kg dry wt	< 0.002	0.013	0.029	0.005	0.008	0.002	0.005	< 0.002	< 0.002	0.012		
Benzo[a]anthracene	mg/kg dry wt	0.013	0.069	0.186	0.016	0.064	0.016	0.026	0.003	0.008	0.027		
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.019	0.068	0.23	0.019	0.084	0.017	0.034	0.003	0.009	0.021		
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.023	0.078	0.28	0.023	0.1	0.022	0.045	0.005	0.01	0.022		
Benzo[e]pyrene	mg/kg dry wt	0.014	0.042	0.147	0.015	0.051	0.013	0.025	0.002	0.005	0.012		
Benzo[g,h,i]perylene	mg/kg dry wt	0.019	0.042	0.167	0.018	0.058	0.013	0.03	0.003	0.006	0.01		
Benzo[k]fluoranthene	mg/kg dry wt	0.008	0.032	0.108	0.009	0.038	0.009	0.016	< 0.002	0.004	0.01		
Chrysene	mg/kg dry wt	0.016	0.053	0.173	0.014	0.05	0.014	0.026	0.003	0.008	0.022		
Dibenzo[a,h]anthracene	mg/kg dry wt	0.003	0.008	0.033	0.003	0.011	0.003	0.005	< 0.002	< 0.002	0.002		
Fluoranthene	mg/kg dry wt	0.026	0.126	0.27	0.036	0.096	0.027	0.054	0.005	0.016	0.052		
Fluorene	mg/kg dry wt	< 0.002	< 0.002	0.004	< 0.002	< 0.003	< 0.002	< 0.002	< 0.002	< 0.002	0.003		
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.016	0.045	0.179	0.015	0.063	0.012	0.029	0.002	0.005	0.01		
Naphthalene	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	< 0.011	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
Perylene	mg/kg dry wt	0.005	0.016	0.058	0.005	0.048	0.006	0.013	0.003	0.002	0.014		
Phenanthrene	mg/kg dry wt	0.009	0.047	0.082	0.027	0.025	0.009	0.022	< 0.002	0.006	0.047		
Pyrene	mg/kg dry wt	0.027	0.117	0.27	0.034	0.096	0.025	0.053	0.004	0.014	0.046		
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES	mg/kg dry wt	0.029	0.1	0.34	0.029	0.123	0.026	0.052	< 0.005	0.013	0.031		
Benzo[a]pyrene Toxic Equivalence (TEF)	mg/kg dry wt	0.028	0.099	0.33	0.029	0.122	0.026	0.052	< 0.005	0.013	0.03		

Appendix O: Periphyton weighted composite cover summary statistics

No.	Sub catchment	**Site Name**	**Site ID**	**Year to end of June**	**n**	**Maximum PeriWCC (%cover)**	**n ≥ 40% cover**	**NRP O19 – (no more than 8% of samples ≥ 40% cover)**
1	Karori	Karori Stream at Makara Peak Mountain Bike Park	RS18	2020/2021	11	25	0	meeting
				2021/2022	9	31	0	meeting
2	Owhiro	Owhiro Stream at mouth	RS64	2020/2021	7	64	1	not meeting
				2021/2022	8	76	3	not meeting
8	Kaiwharawhara	Kaiwharawhara Stream at Ngaio Gorge	RS19	2020/2021	11	32	0	meeting
				2021/2022	8	42	1	Not meeting
15	Lower Hutt South	Hutt River at Boulcott	RS22	2020/2021	9	27	0	meeting
				2021/2022	5	83	3	not meeting
17	Upper Hutt South	Hutt River at Manor Park	RS21	2020/2021	7	12	0	meeting
				2021/2022	6	65	1	not meeting
21	Hutt Headwaters	Hutt River at Te Marua	RS20	2020/2021	5	5	0	meeting
				2021/2022	6	0	0	meeting
25	Black	Black Creek at Rowe Parade End	RS67	2020/2021	6	68	2	not meeting
				2021/2022	5	44	1	not meeting
34	Porirua	Porirua Stream at Glenside	RS15	2020/2021	9	10	0	meeting
				2021/2022	8	16	0	meeting
		Porirua Stream at Wall Park	RS16	2020/2021	8	27	0	meeting
				2021/2022	8	44	1	Not meeting

Appendix P: Macroinvertebrate community metric scores

No	Subcatchment	Site Name	Site ID	Sampling period	Substrate	River class	Significant river	Taxa richness	% EPT	MCI (3-yr median)	QMCI (3-yr median)	NRP O19 MCI	NRP O19 QMCI	Meeting O19 MCI	Meeting O19 QMCI	NPS Attribute
1	Karori	Makara Peak MBP	RS18	2019/2022	Hard	2	No	26	18.0	90.1	3.2	≥ 105	≥5.5	Not meeting	No data	D
2	Owhiro	Owhiro Stream at mouth	RS64	2020/2022	Hard	2	No	17	11.7	80.0	2.8	≥ 105	≥5.5	Not meeting	Not meeting	D
8	Kaiwharawhara	Ngaio Gorge	RS19	2019/2022	Hard	2	No	26	21.9	88.0	3.6	≥ 105	≥5.5	Not meeting	no data	D
12	Waiwhetu	Waiwhetu Stream at Whites Line East	RS57	2019/2021	Soft	6	No	20	0.0	69.1	3.7	≥ 105	≥5.5	Not meeting	No data	D
15	Lower Hutt South	Hutt River Boulcott	RS22	2019/2022	Hard	4	No	24	49.0	122.2	4.3	≥ 110	≥ 5.5	meeting	not meeting	D
17	Upper Hutt South	Hutt River Manor Park	RS21	2019/2022	Hard	4	No	22	64.3	114.7	6.1	≥ 110	≥ 5.5	meeting	meeting	B
21	Hutt Headwaters	Hutt River Te Marua	RS20	2019/2022	Hard	1	No	22	70.9	131.0	7.9	≥ 120	≥ 6	meeting	meeting	A
25	Black Creek	Black Creek at Rowe Parade	RS67	2020/2022	Hard	3	No	33	31.8	98.8	4.2	≥ 105	≥5.5	Not meeting	Not meeting	D
29	Taupo	Plimmerton Domain	RS63	2021/2022	Soft	6	No	21	5.7	69.0	3.3	≥ 100	≥ 5	Not meeting	Not meeting	D
34	Porirua	Porirua Stream at Glenside	RS15	2019/2022	Hard	2	No	22	40.9	102.4	6.3	≥ 105	≥5.5	Not meeting	Meeting	C
		Porirua Stream at Wall Park	RS16	2019/202	Hard	2	No	24	23.0	93.6	4.6	≥ 105	≥5.5	Not meeting	Not meeting	C

Appendix Q: Fish Species Records

Table A1: Fish species records from the New Zealand Freshwater Fish Database 2012 to 2022 (and Stantec, 2022)).

Catchment	Banded kokopu	Bluegill bully	Common bully	Common smelt	Crans bully	Dwarf galaxias	Estuarine triple	Giant bully	Giant kokopu	Grey mullet	inanga	koaro	lamprey	Longfin eel	Shortfin eel	Redfin bully	Shortjaw kokopu	Upland bully	Yelloweye mullet	Brown trout	Perch	N species
1. Karori Stream	✓										✓	✓		✓	✓			✓		✓		7
2. Owhiro Stream	✓													✓	✓	✓						4
3. Island/ Houghton																						NR
4. Lyall Bay																						NR
5. East Coast																						NR
6. Evans Bay																						NR
7. Lambton	✓																					1
8. Kaiwharawhara Str	✓	✓						✓	✓			✓		✓	✓	✓	✓			✓	✓	11
9. North harbour Tyers	✓											✓		✓	✓							4
10. Korokoro Stream	✓	✓	✓	✓					✓		✓	✓		✓	✓	✓				✓		11
11. Speedy's Stream																						NR
12. Waiwhetu Stream	✓			✓			✓				✓				✓				✓			6
13. Stokes Valley Str	✓								✓					✓	✓	✓						5
14. Hulls Creek	✓		✓	✓					✓		✓			✓		✓						7
15. Lower Hutt South	✓	✓	✓					✓						✓						✓		6
16. Lower Hutt North		✓						✓						✓	✓	✓				✓		5
17. Upper Hutt South		✓										✓		✓	✓	✓				✓		6
18. Upper Hutt North		✓										✓		✓		✓				✓		5
19. Hutt Whakatiki												✓		✓		✓				✓		4
20. Hutt Akatarawa		✓										✓		✓		✓				✓		5
21. Hutt Headwater		✓		✓	✓	✓						✓		✓	✓	✓				✓		9
22. Hutt Pakuratahi					✓	✓						✓		✓		✓				✓		6
23. Hutt Mangaroa					✓									✓		✓				✓		4
24. Eastbourne	✓		✓						✓					✓	✓					✓		6
25. Black Creek																						3
26. Wainuiomata-iti																						2
27. Wainuiomata		✓	✓			✓			✓			✓	✓	✓		✓				✓		9
28.Wainuiomata Morton						✓								✓						✓		3
29. Taupo	✓							✓			✓	✓		✓	✓	✓						7
30. Kakaho																						NR
31. Horokiri	✓		✓	✓			✓	✓			✓	✓	✓	✓	✓				✓	✓		12
32. Pauatahanui Stm	✓		✓							✓				✓	✓					✓		6
33. Duck	✓		✓	✓					✓		✓	✓	✓	✓	✓	✓						10
34. Porirua Stream			✓	✓					✓		✓	✓		✓	✓	✓				✓		9
35. Porirua coast																						NR

Table A2: NZFFD record comparison against Fish-IBI Objective (2000-2022)

Catchment	% Impervious surface	Number of records	Distance from the sea (km)	Altitude (m)	Number of Native fish species	Number of Exotic fish species	Number large invertebrate species	Fish IBI	NPS-FM attribute state	NRP O19 Objective for F-IBI	Meeting NRP O19
1. Karori Stream[17]	5%	5	6	100	6	1	1	56	A	≥38	meeting
2. Owhiro Stream	6%	3	2	60	4	0	0	38	A	≥38	meeting
3. Island/ Houghton	17%	0									NR
4. Lyall Bay	34%	0									NR
5. East Coast	20%	0									NR
6. Evans Bay	25%	0									NR
7. Lambton	26%	1	1.8	65	1	0	1	20	C	≥38	Not meeting
8. Kaiwharawhara Str	10%	13	1.5	25	9	2	1	60	A	≥38	meeting
9. Tyers (Waitohi)	15%	3	1.5	80	4	0	1	42	A	≥38	meeting
10. Korokoro Stream	3%	3	1.5	5	10	1	1	60	A	≥38	meeting
11. Speedy's Stream	6%	0									NR
12. Waiwhetu Stream	53%	3	2	10	6	0	0	34	A	≥38	Not meeting
13. Stokes Valley Str	27%	2	16	80	4	0	1	46	A	≥38	meeting
14. Hulls Creek	21%	8	15	35	6	0	1	52	A	≥38	meeting
15. Lower Hutt South	59%	3	4	20	6	1	0	46	A	≥38	meeting
16. Lower Hutt North	27%	2	15	40	5	1	0	44	A	≥38	meeting
17. Upper Hutt South	20%	2	76	27	2	0	0	44	A	≥38	meeting
18. Upper Hutt North	32%	3	40	180	4	1	0	40	A	≥38	meeting
19. Hutt Whakatiki	<1%	1	26	210	3	1	1	48	A	≥48	meeting
20. Hutt Akatarawa	<1%	3	40	200	4	1	1	50	A	≥48	meeting
21. Hutt Headwater	<1%	3	43	200	3	1	0	56	A	≥48	meeting
22. Hutt Pakuratahi	<1%	4	53	250	5	1	1	52	A	≥48	meeting
23. Hutt Mangaroa	1%	3	40	150	3	1	1	46	A	≥48	Not meeting
24. Eastbourne	11%	3	0.5	40	1	0	0	18	C	≥38	Not meeting
25. Black Creek	27%	0									NR
26. Wainuiomata-iti	<1%	0									NR
27. Wainuiomata	1%	6	20	100	9	1	1	56	A	≥38	meeting
28. Wainuiomata Mor.	<1%	2	30	130	2	1	1	38	A	≥38	meeting
29. Taupo Stream	9%	18	2	10	9	1	1	52	A	≥38	meeting
30. Kakaho Stream	3%	0									NR
31. Horokiri Stream	2%	8	10	50	11	0	1	60	A	≥38	meeting
32. Pauatahanui Stm	4%	3	5	60	5	1	0	42	A	≥38	meeting
33. Duck Creek	15%	26	5	15	13	1	1	60	A	≥38	meeting
34. Porirua Stream	19%	7	5	50	8	1	1	58	A	≥38	meeting
35. Porirua coast	10%	0									NR

[17](Fountain & Cameron, 2018)

Appendix R: Wellington Harbour Subtidal Sediment Quality

Chemical contaminant guidelines and their exceedances in subtidal sediments at Wellington Harbour in 2020 (from Cummings, et al., 2021b)

Guidelines	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Total PAH	HMW PAH	No. of Exceedances
ARC amber				19	30			124		660	
ARC red				34	50			150		1700	
DGV	20	1.5	80	65	50	0.15	21	200	10000		
DGV-High	70	10	370	270	220	1	52	410	50000		
Site											
WH1B	5.7	0.1	25.8	22.8	69.8	0.70	16.2	129.0	2481.4	1461.0	5
WH2B	5.5	0.0	24.2	15.9	49.2	0.51	15.9	105.4	1392.8	822.8	3
WH3B	6.7	0.1	26.2	27.4	64.6	0.60	16.8	129.2	2101.1	1247.7	5
WH4B	6.1	0.0	24.8	17.1	46.4	0.40	16.6	107.4	1325.0	774.1	3
WH5B	6.1	0.0	23.8	13.0	35.6	0.26	16.6	93.6	682.7	387.9	2
WH9B	6.4	0.0	24.6	13.8	37.6	0.23	17.3	100.4	536.2	294.2	2
WH10B	6.9	0.0	26.0	17.2	48.0	0.32	17.9	115.0	847.1	473.2	2
WH13B	7.4	0.1	23.2	15.7	39.2	0.18	17.0	104.4	359.6	195.5	2
WH15B	7.4	0.1	19.4	14.4	29.4	0.14	15.7	90.8	196.6	102.5	0
WH17B	5.7	0.0	20.8	10.7	28.2	0.13	16.1	83.0	344.8	183.2	0
EB2B	3.4	0.0	14.1	9.1	38.2	0.45	7.1	68.8	2673.1	1574.0	3
AQ1B	6.2	0.0	23.6	18.8	48.4	0.43	16.2	109.2	1811.9	1059.8	3
AQ2B	6.0	0.1	21.8	18.3	52.2	0.39	14.7	105.6	2061.5	1182.9	3
LB1B	6.3	0.0	23.6	45.8	70.0	0.65	14.7	132.8	3123.1	1821.0	5
LB2B	6.9	0.1	23.4	34.2	67.0	0.64	14.7	126.4	3041.0	1798.2	5

Appendix S: Porirua Harbour Subtidal sediment quality

Chemical contaminant guidelines and their exceedances in subtidal sediments at Porirua Harbour in 2020 (from Cummings, et al., 2021a)

Site	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	No. of exceedances
ARC amber				19	30			124	
ARC red				34	50			150	
DGV	20	1.5	80	65	50	0.15	21	200	
GV-High	70	10	370	270	220	1	52	410	
PAH1	9.0	0.04	16.8	10.4	18.1	0.08	11.6	77	0
PAH2	8.3	0.06	16.1	11.5	18.3	0.08	11.2	78	0
PAH3	9.1	0.04	15.1	7.9	13.6	0.05	10.6	69	0
POR1	10.5	0.13	18.6	20.7	34.3	0.12	12.1	196	3
POR2	12.1	0.05	20.2	18.2	31.3	0.11	13.5	149	2