BEFORE THE INDEPENDENT HEARINGS PANELS APPOINTED TO HEAR AND MAKE RECOMMENDATIONS ON SUBMISSIONS AND FURTHER SUBMISSIONS ON PROPOSED PLAN CHANGE 1 TO THE NATURAL RESOURCES PLAN FOR THE WELLINGTON REGION

UNDER	the Resource Management Act 1991 (the Act)
AND	
IN THE MATTER	of Hearing of Submissions and Further Submissions on Proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region under Schedule 1 of the Act

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STATEMENT OF EVIDENCE OF DR MEGAN CLAIR MELIDONIS

ON BEHALF OF GREATER WELLINGTON REGIONAL COUNCIL

TECHNICAL EVIDENCE (COASTAL ECOLOGY)

HEARING STREAM 2 – OBJECTIVES

28 JANUARY 2025

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INTRODUCTION

1 My full name is Megan Clair Melidonis. I am a Senior Coastal Scientist at Greater Wellington Regional Council (**the Council**).

2 I have read the submissions provided by submitters on the coastal water objectives relevant to the Section 42A report on Objectives and the S42A report on Ecosystem Health and Water Quality Policies.

3 I have prepared this statement of evidence on behalf of the Council in respect of technical matters arising from the submissions and further submissions on Proposed Plan Change 1 (**PC1**) to the Natural Resources Plan for the Wellington Region **(NRP**).

4 Specifically, this statement of evidence relates to the coastal ecology matters in the Section 42A Report – Objectives and the Section 42A Report - Ecosystem Health and Water Quality Policies, with a particular focus on Objectives WH.O3 and P.O3 and their associated Tables 8.1 and 9.1 and Policy P.P4 and Table 9.3.

5 My Statement of Evidence does not address the human contact elements of Objectives WH.O3 and P.O3 and the associated enterococci parameter in Tables 8.1 and 9.1. This is addressed in the Statement of Evidence (Coastal Human Contact) from Dr Wilson.

CODE OF CONDUCT

6 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023 (Part 9). I have complied with the Code of Conduct in preparing this evidence. My experience and qualifications are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

QUALIFICATIONS AND EXPERIENCE

7 I hold a PhD degree in Ecology and a Bachelor of Science in Zoology and Ecology from the University of Cape Town, South Africa.

8 I have over 13 years of work experience in marine ecology and have worked for local government, the Department of Conservation, and consultancies. Since May 2020 I have been a Senior Environmental Scientist at the Council. Prior to that I was employed by the Department of Conservation as a Technical Advisor, Anchor Environmental Consultants as a

Senior Marine Biologist and commercial diver, and CapFish as a Marine Mammal Observer and Fisheries Liaison Officer.

9 I have worked as a technical expert on behalf of the Council reviewing the ecological effects of over 50 resource consent applications and compliance assessments for a wide range of activities, including stormwater discharges and reclamation and prior to that as a consultant where I authored close to a hundred environmental impact assessments, calculated and modelled contaminant outfalls, and led bimonthly estuarine survey campaigns.

10 I co-authored the Council's coastal report summarising environmental current state for Whaitua Te Whanganui-a-Tara (**TWT**) to support the Whaitua Implementation Programmes (**WIPs**) and was on the expert panel for this project. I have been managing the Council's Marine and Coastal Programme since 2023 and the monitoring programme since 2020.

11 Since 2024 I have acted as an ecological expert for PC1. This role involves preparing this technical evidence to respond to submissions on the inclusion of the coastal objectives in PC1.

SCOPE OF EVIDENCE

12 My statement of evidence addresses the following matters:

12.1 The biophysical background to the marine environments in TWT and the Te Awarua-o-Porirua Whaitua (**TAoP**), including their benthic ecology;

12.2 The source and impact of the parameters in Tables 8.1 and 9.1 in PC1 including:

12.2.1 The origin and significance of the different parameters; and

12.2.2 The process through which the targets were set

12.3 The technical work conducted to inform the development of PC1, both during and after Whaitua processes;

12.4 The actions required to achieve the targets and the extent to which the provisions of PC1 contribute; and

12.5 Responses to the technical matters raised in submissions related to marine ecology.

13 Considerations around human health (i.e. enterococci) are not addressed as part of this technical evidence but are addressed in Dr Wilson's evidence.

14 This statement of evidence does not repeat information included in previously published technical reports, but rather summarises key points, with reference to the section of the relevant reports.

15 This evidence relies on the following key information:

15.1 Technical evidence of Mr John Oldman (DHI), providing the output of the modelled scenarios

15.2 Technical evidence of Dr Peter Wilson (SLR), providing ecotoxicological risk assessments

15.3 Technical evidence of Dr Michael Greer (Torlesse Environmental Ltd), providing freshwater science evidence

15.4 PC1 (October 2023), with specific reference to Objectives WH.O3 and P.O3 and Tables 8.1 and 9.1 Coastal water objectives

15.5 Background information contained in technical assessments undertaken to inform proposed Plan Change 1 to the Natural Resources Plan for the Wellington Region

BACKGROUND CONTEXT

16 PC1 implements the National Policy Statement for Freshwater Management (**NPS-FM**) 2020 for TWT and the TAoP. This involves setting objectives, policies, rules, and other methods to manage activities such as urban development, earthworks, stormwater, wastewater, and rural land-use. This process is described in Dr Greer's evidence.

17 PC1 proposes to change the coastal water quality objectives in the operative NRP in TWT and TAoP in response to the fact that the NPS-FM applies to estuaries and the wider coastal marine area (**CMA**) to the extent that they are affected by freshwater (see Clause 1.5 of the NPS-FM).

18 There are proposed objectives, policies, and methods in PC1 that are aimed at decreasing sediment and metal loads in freshwater streams that will also contribute towards achieving coastal ecological health outcomes.

BIOPHYSICAL SETTING OF TAOP

19 Te Awarua-o-Porirua Harbour (Porirua Harbour) is located 21 km north of Wellington City and comprises two inlets; Onepoto, which extends from Mana to the shoreline of Porirua City and Pāuatahanui, which stretches eastwards from the Paremata Bridge towards the Pāuatahanui Wildlife Reserve.

20 This system is of great cultural, recreational, and ecological value. The catchment includes 18,470 ha of rural farmland, lifestyle blocks, urban settlement, parkland, and rail and road corridors that exert ongoing pressure on the estuarine ecosystem. The key issues facing this ecologically sensitive environment include excessive sedimentation, habitat loss, and ecological degradation.

21 To better understand the cumulative impacts of human activities at key sites, the Council currently monitors estuary sedimentation rate annually, and undertakes intertidal[1] and subtidal[2] sediment and macrofaunal assessments, broadscale habitat mapping, and harbour bathymetry surveys every five years or when substantial shifts are recorded during annual sediment plate surveys.

22 TAoP WIP identified three coastal Water Management Units (**WMUs**) for TAoP as illustrated in Figure 1:

22.1 **Onepoto Arm**, which is the receiving environment for part of the Te Riu o Porirua and Rangituhi WMUs;

22.2 **Pāuatahanui Inlet**, which is the receiving environment for the Pouewe and Takapū WMUs and part of the Te Riu o Porirua WMU; and

22.3 The **Open Coast**, which is the open western coast of the Whaitua, including the entrance to the harbour and the outer harbour and is the receiving environment for the Taupō WMU and part of the Pouewe, Rangituhi and Te Riu o Porirua WMUs.

[1] The coastal area between the mean high water spring tide (**MHWS**) and low water spring tide (**MLWS**) line
[2] Seaward of the MLWS tide line

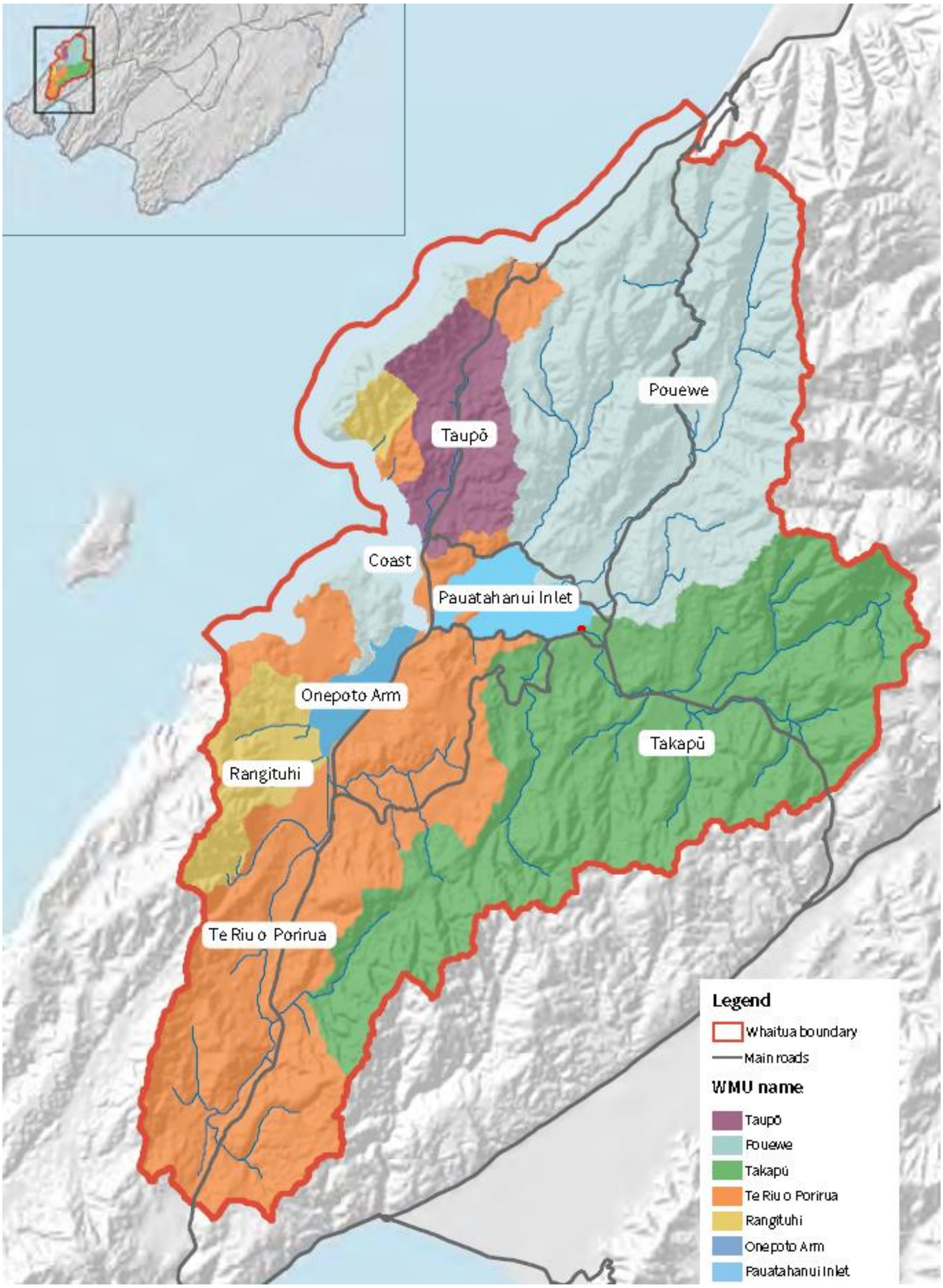

Figure 1. Map of Te Awarua-o-Porirua Water Management Units (WMUs) as identified in TAoP WIP. WMUs are shaded in blue (WCTAoP 2019, Page 21).

23 An in-depth discussion of the state of Porirua Harbour can be found in the technical intertidal (Forrest et al. 2020, Forrest et al. 2023) and subtidal (Cummings et al. 2022) sediment quality and macrofauna reports, habitat mapping report (Stevens & Forrest 2020b), and intertidal and subtidal sediment plate reports (Stevens et al. 2023, Stevens & Rabel 2024), the results of which are summarised below.

24 Porirua Harbour is showing signs of poor ecological health, with the Onepoto Arm near Porirua City Central Business District (**CBD**) impacted by urbanisation and the north-eastern and southern Pāuatahanui Inlet impacted by rural land-use and development. Sedimentation is of most concern within Porirua Harbour, with newly deposited sediment remaining in the shallow intertidal areas of the inlets for up to two weeks before being washed into deeper subtidal areas or flushed out of the estuary mouth to the open ocean by tidal currents (Forrest et al. 2020).

25 Increased fine sediments and the resultant decrease in sediment oxygenation in Porirua Harbour creates poor living conditions for benthic infauna, such as cockles, and reduces overall biodiversity (Forrest et al. 2023); however, mud-tolerant organisms (e.g. some species of polychaete worms) manage to inhabit muddy, anoxic areas, where more sensitive species struggle to survive.

26 **Mud content** at intertidal sites in the Pāuatahanui Inlet has decreased slightly since January 2023, while in the subtidal zone, mud content has increased since monitoring began in 2013 (Cummings et al. 2022, Stevens & Rabel 2024). The subtidal sites in the Onepoto Arm include the well-flushed, marine sand-dominated site at Te Onepoto and the muddy Tītahi Bay site, with an overall trend of increasing mud content since 2013 (Stevens & Rabel 2024).

27 One of the key indicators of estuary health is the **spatial extent of muddy sediment**, which indicates whether intertidal mud flats are expanding or shrinking. Since January 2020, broad scale mapping has shown a consistent reduction in the spatial extent of intertidal mud-elevated (>25-50% mud) and mud-dominated (>50% mud) substrate in north-eastern Pāuatahanui Inlet, which is consistent with intertidal sediment plate measurements (Stevens & Rabel 2024); however, bathymetric surveys showed substantial subtidal accretion over time (Gibb & Cox 2009, DML 2024a &b), evidence that indicates that wind-driven wave-action is likely causing mobilisation, redistribution and deposition of muddy intertidal sediments into the deeper subtidal basin where they are retained.

28 Concentrations of **sediment metal contaminants** in Porirua Harbour are generally very low and are unlikely to be of ecological concern, except at hotspots where metal contaminants that exceed international guidelines may be causing ecological damage (Clissold & Melidonis 2025). Zinc concentrations and high molecular weight (**HMW**) polycyclic aromatic hydrocarbons (**PAHs**) exceeded guidelines at most sites sampled in 2009 (Sorensen & Milne 2009) and 2023 (Clissold & Melidonis 2025), especially adjacent to Porirua CBD.

29 In areas of the harbour where nitrogen concentrations are higher due to wastewater-contaminated stormwater, urban and industrial stormwater, and/or rural run off, **nuisance macroalgae**[3] occasionally exploit these nutrients and temporarily smother habitats and then decompose, resulting in reduced sediment and/or water quality (Stevens & Forrest 2020b). Areas covered by nuisance macroalgae may lead to localised patches of exacerbated sediment anoxia and smothering of epifauna and seagrass.

30 The Council holds limited information on the health of the TAoP open coast but in areas that are not subject to localised contamination from point source inputs, species and habitats generally appear to be in a healthy state. The open coast is highly dynamic, and the impacts of sediment and occasional contaminant inputs are expected to be short-lived and of little impact. Exceptions are poorly regulated point source outfalls, during non-complying wastewater discharges from the Porirua Wastewater Treatment Plant (**WWTP**) at Rukutane Point, and occasional wastewater overflows at pump stations during high rainfall events that may result in discharges of water high in nutrients and faecal bacteria, posing a significant health risk to humans and promoting macroalgae growth. These impacts are monitored and reported on by consent holders and Wellington Water Limited (**WWL**).

BIOPHYSICAL SETTING OF TWT

31 The coastal assessment identified six Coastal Assessment Units (**CAUs**) as well as focus areas or locations of particular interest within each CAU based on their current state, vulnerability, and ecological importance (Melidonis et al. 2020). TWT WIP used these CAUs to identify five coastal areas and set objectives for each.

[3] Some species of fast-growing green and red seaweeds (e.g. *Ulva* spp.).

32 Table 1 lists the CAUs identified in the coastal assessment report, TWT WIP coastal areas, and the coastal sites of interest. WIP coastal areas are illustrated in Figure 2. CAUs are described in paragraph 33 to 46 below.

Table 1. The five Coastal Assessment Units (CAUs) identified by the coastal assessment informed TWT WIP assessment of coastal areas and Water Management Units (WMUs).

<table>
<tr><th>CAU</th><th>TWT WIP</th><th>Coastal area</th><th>Focus Area</th></tr>
<tr><td>West Coast</td><td rowspan="2">South-West Coast</td><td rowspan="2">North of Mākara to the west of Ōwhiro Stream</td><td rowspan="2">Mākara Estuary, Karori Stream mouth</td></tr>
<tr><td>South Coast</td></tr>
<tr><td>South Coast</td><td>South Coast</td><td>Ōwhiro Stream to the east of Tarakena Bay</td><td>Ōwhiro Bay, Island Bay, Taputeranga Marine Reserve, Lyall Bay/Moa Point</td></tr>
<tr><td>Inner Harbour</td><td>Inner Harbour</td><td>West of Point Halswell to west of Korokoro Estuary</td><td>Evans Bay, Oriental Bay, Queens Wharf, Kaiwharawhara Estuary</td></tr>
<tr><td>Outer Harbour</td><td>Outer Harbour</td><td>East of Point Halswell to Korokoro Estuary, to Pencarrow Head</td><td>Korokoro Estuary, Te Awa Kairangi, Eastbourne</td></tr>
<tr><td>East Coast</td><td>South-East Coast</td><td>Pencarrow Head to Turakirae Head</td><td>Wainuiomata Estuary</td></tr>
</table>

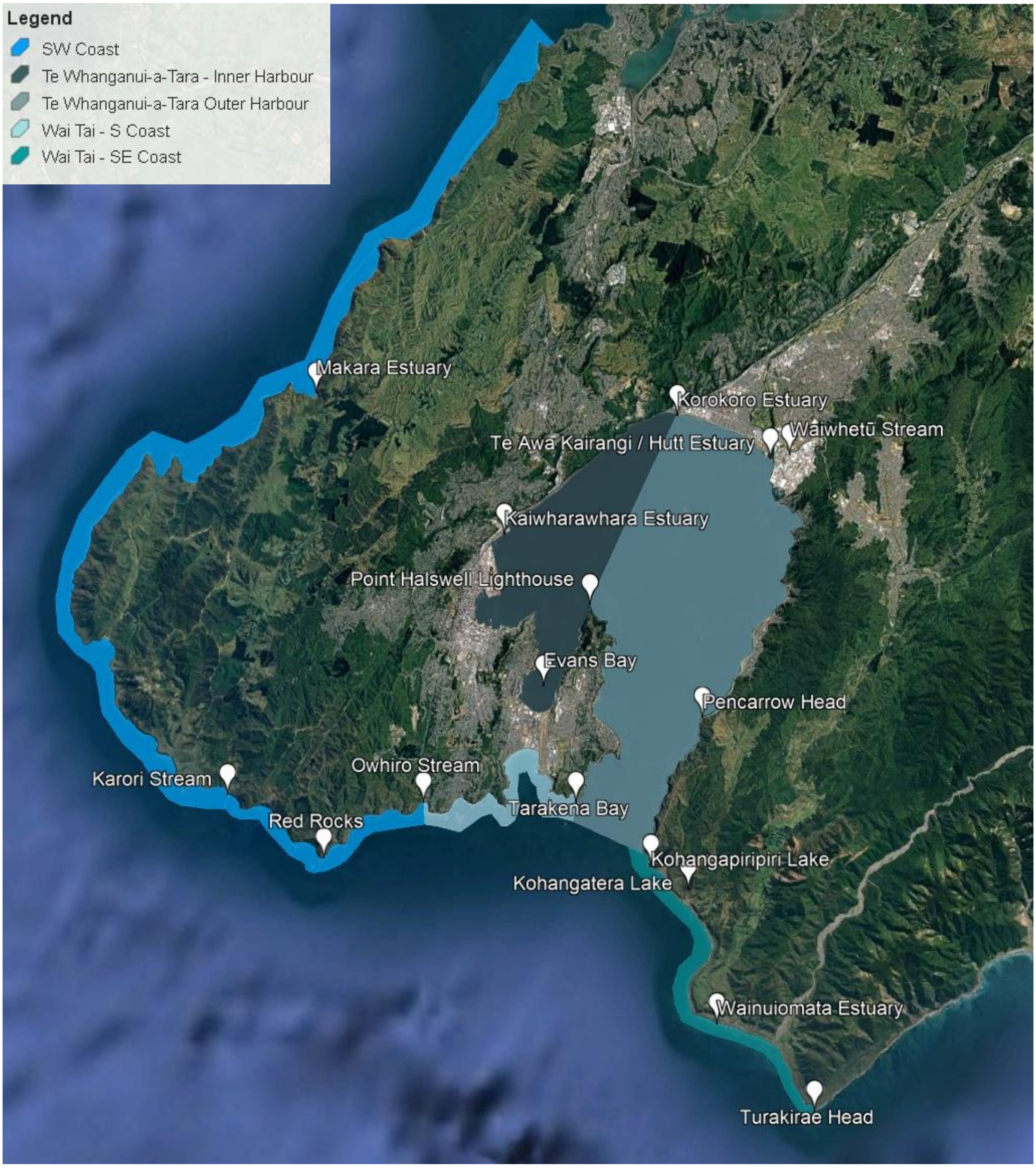

Figure 2. Coastal Assessment Units (CAU) for Whaitua Te Whanganui-a-Tara.

SOUTH-WEST COAST

33 The West Coast of TWT is relatively undeveloped, with land cover dominated by pasture, regenerating scrub, and forest. Rocky shores, and steep gravel or cobble beaches characterise the inshore coastal environment. Mākara Estuary has the only notable saltmarsh and dune area along this coast. Although naturally low in species-richness, Mākara Estuary is in a degraded condition, primarily due to elevated inputs of fine sediment and nutrients contributing to poor sediment oxygenation, blooms of macroalgae and phytoplankton, and soft anoxic subtidal muds and gravels in the lower estuary during

periods of naturally intermittent mouth restriction (Stevens 2018b). Other stressors to the river and estuary include two stormwater outlets at Mākara Beach, historical drainage and stock grazing of saltmarsh, farming, and riverbank erosion.

34 Further east, toward Karori and Ōwhiro Bay, ephemeral freshwater-dominated estuaries discharge onto gravel beaches with some streams channelised and in a poor state of ecological health. There are several areas of contamination on the South-west Coast, notably a stormwater outlet and a treated wastewater outlet at the mouth of Karori Stream and landfill leachate that enters Ōwhiro Stream; however, in other areas metal contaminants are generally low due to minimal urban inputs and good water mixing in the high energy open coastal areas.

35 Rocky shore habitat and offshore reefs host a high biodiversity of marine species, while the steep beaches with coarse sediments are not species-rich due to the harsh physical conditions on this coastline. The catchment is pasture-dominated and localised hillside erosion is relatively common, particularly on coastal cliff faces.

SOUTHERN COAST

36 Coastal habitats along the southern coast are in a good state given the fishing protection provided by the Taputeranga Marine Reserve and the dynamic nature of the shoreline, but again there are localised areas impacted by stormwater and treated wastewater discharges (i.e. Lyall Bay, Moa Point, Tarakena Bay). Other than the gently sloping, sandy Lyall Bay Beach, the coastal areas are relatively steep with coarse sediments and have low species richness. A rock revetment lies at the western end of Lyall Bay, retaining reclaimed land for the airport runway.

OUTER HARBOUR

37 Wellington (Te Whanganui-a-Tara) Harbour is a large, deep basin that is relatively well flushed by seawater on each incoming tide. Approximately 70% of the intertidal margins are modified by seawalls, and the remaining natural habitat is mostly rocky. Resident little penguins (kororā) live along the modified shoreline and occasionally migratory whales, dolphins and seals enter the harbour. The harbour can be divided into the inner and outer harbours according to catchments as shown in Figure 2.

38 The Outer Harbour, from Point Halswell across the bay to Korokoro Estuary, and down to Pencarrow Head, is characterised by Petone Beach to the West and a string of urban

sandy/gravel beach embayments separated by hard rocky shores and high biodiversity reefs southward from Te Awa Kairangi (Hutt River). Sandy beach habitat generally supports a wide variety of sand dwelling invertebrates, while gravel and cobble beaches tend to have less diversity due to the highly mobile sediments. The coastline has lost much of its previously extensive dune land, saltmarsh, and tidal flats, with large tracts reclaimed at the commercial area of Seaview to the East of the Hutt River mouth. Small areas of seagrass are present in the shallow subtidal area of Lowry Bay. The coastline south of Eastbourne and around Pencarrow Head consists of a rural stretch of isolated, moderately sheltered rocky shore and shallow subtidal reef habitat with high biodiversity values. Treated wastewater from the Hutt Valley and Wainuiomata is discharged at Pencarrow Head.

39 Te Awa Kairangi discharges sediment, nutrients, pathogens and potentially other contaminants (e.g., leaked industrial waste delivered via tributaries such as the Waiwhetū Stream) to Wellington Harbour during high flows. The scarcity of estuarine habitat in the harbour makes Te Awa Kairangi, Waiwhetū, and Korokoro estuaries high priorities for restoration.

INNER HARBOUR

40 There is a commercial port located within this area. Outside of the port, areas of benthic soft-sediment habitat, rocky shores, and subtidal reefs generally support moderately high biodiversity, while Evans Bay is relatively sheltered and supports biogenic subtidal red algal beds. Some of these areas are used for recreation and mahinga kai.

41 Harbour water quality is expected to be good, except in areas affected by river plumes during rain events and near stormwater outfalls, especially in areas adjacent to major urban stormwater inputs, such as Queens Wharf, CentrePort, and adjacent to the CBD.

42 The majority of the smaller stream estuaries flowing into the Inner Harbour have been piped and modified. The Inner Harbour has also lost much of its previously extensive dune land, saltmarsh, and tidal flat areas to reclamation, including at the Wellington commercial port area near the Kaiwharawhara Estuary.

43 Although highly modified with vertical concrete channels, gabion baskets, and large parts of the lower estuary covered by road and rail bridges, the Kaiwharawhara tidal river mouth estuary is a vital part of the connection between the sea and the upper catchment (which includes the Zealandia Wildlife Sanctuary).

SOUTH-EASTERN COAST

44 The coastline from Pencarrow Head to Wainuiomata Estuary features exposed, relatively wide, steep gravel beaches, with rocky reefs offshore. Vegetation cover on the cliffs is relatively sparse and is dominated by pasture, regenerating scrub, and forest. Much of the catchment is within the Remutaka Forest Park and the Wainuiomata/Orongorongo Water Collection Area, which are covered by extensive areas of native forest and scrub. Dune areas are relatively extensive and diverse at Fitzroy Bay (near Baring Head). Streams that discharge to the coast are generally small and lack stream mouth estuaries but where present, estuaries are small, and freshwater dominated.

45 There is limited direct road access to much of the coast, which restricts public usage to low intensity fishing, although commercial gravel extraction occurs at Fitzroy Bay. Low-intensity grazing in the pasture-dominated catchment may contribute elevated fine sediments compared to natural state condition; however, the existing state of all habitat types is expected to be good.

46 The Wainuiomata Estuary has a raised river mouth several metres above the high tide line with a sandy gravel bar across its entrance that occasionally breaches. The estuary is dominated by gravel and sand, which is unlikely to support a highly diverse benthic macrofaunal community. The Wainuiomata river is affected by dams, stormwater contamination, occasional leakage from the Wainuiomata landfill, fertiliser runoff, and sedimentation, which result in build-ups of nutrients, organic matter, and algal and phytoplankton blooms in the estuary over summer months.

DESCRIPTION OF THE ATTRIBUTES IN TABLES 8.1 AND 9.1 OF PC1

47 Estuarine and coastal ecosystem health can be assessed by measuring components of marine habitat and biota. Measures commonly used for the assessment of ecological health are summarised in Table 2.

48 In Tables 8.1 and 9.1 of PC1, the following attributes are listed for both TAoP and TWT:

48.1 Sedimentation rate/Sediment Accretion Rate (**SAR**) in mm per year

48.2 Muddiness, represented by areal extent of intertidal habitat with sediment mud content greater than 50%

48.3 Copper and zinc concentrations in sediment with an objective of maintaining or improving concentrations within deposited sediment

48.4 Macroalgae, as the Ecological Quality Rating (**EQR**)

PC1 Table 8.1 objectives for TWT also include benthic marine invertebrate diversity, which is an indicator of ecosystem health and the level of disturbance, and phytoplankton measured in mg of chlorophyll-*a per* m^3.

49 The various measures of ecological health these attributes relate to are set out in Table 2 and Table 3.

Table 2. Measures used for the assessment of ecological health. See Table 3 below for provisional ecological thresholds.

Measure	Description	Attributes in PC1 Tables
Contaminants	Metals occur naturally in the environment, but high concentrations can be harmful to marine life. A proportion of the metals bind to sediment, which is transported along waterways and accumulates in receiving environments. These metals are used as indicators of potential risk of contaminant effects on marine life. Decreasing metal concentration will protect benthic invertebrates and their prey species (e.g. fish). Zinc (**Zn**) and copper (**Cu**) are routinely monitored in estuarine sediments because they are the most prevalent metal contaminants derived largely from urban sources, such as unpainted metal roofs and vehicle brake pads respectively. **Sediment metal concentrations** can be compared to established thresholds, based on sediment quality guidelines, to understand likely toxicity effects and to understand trends over time. The Australian and New Zealand Guidelines for fresh and marine water quality (**ANZG 2018**) were derived from a range of studies using both field ecology and laboratory ecotoxicity-effects data. The ANZG 2018 sediment quality guidelines provide ANZG Default Guideline Values (**DGV**) or trigger values that indicate contaminant concentrations at which biological effects may begin to occur, which provide an early warning for enabling management intervention. ANZG DGV-High trigger values indicate contaminant concentrations at which adverse environmental effects are likely already occurring resulting in significant biological effects. The Auckland Regional Council's (**ARC**) amber and red Environmental Response Criteria (**ERC**) were derived for estuaries from threshold effect levels and provide a conservative early warning of environmental degradation, which allows time for investigations into the causes of contamination to be carried out.	Table 8.1 and 9.1 - Copper and zinc in Sediment

Measure	Description	Attributes in PC1 Tables
Sediment	Mud is fine sediment (grain size <63 µm) that is measured by the Council as the proportion of mud within sediment at selected sites (**mud content**), and the **spatial extent** of sediment that is >25%[4] mud (decreased from the original measure of 50% mud). Increasing mud content within sediments can cause detrimental and often irreversible ecosystem changes, as can increases in the spatial extent of mud-dominated sediment. Sensitive sediment-dwelling species (e.g. pipi) are adversely impacted when mud content increases above ~10%. Muddiness can also have negative impacts on high value habitat such as seagrass, as well as water clarity, aesthetics, spiritual and recreational values, and mahinga kai. Sediment can be expressed in two ways: 1) as a sedimentation rate (mm/year), or 2) as a ratio of Current Sedimentation Rate (**CSR**) vs Natural Sedimentation Rate (**NSR**). Sedimentation rate is determined by measuring the annual change in sediment depth from the estuary bed to a buried concrete plate at a specified depth. Site-specific measurements are averaged, and a 5-year rolling mean (mm/year) is calculated to reduce the influence of annual variability. A sediment sample from each site is analysed for particle size distribution to determine the percentage of fine sediment present at the surface, to better understand the source and potential ecological impact of deposition (e.g., land-derived mud or marine sands). The CSR:NSR ratio, proposed in the Estuary Trophic Index (ETI), provides a comparative measure of sedimentation relative to natural conditions. It can be determined in two ways: (1) by comparing site specific measurements of CSR (as described above) with NSR values derived from sediment cores, or (2) by using hydrodynamic modelling of estuary sedimentation rate under both current and natural land-use conditions. The latter approach is particularly useful where no monitoring data is available. DGVs indicate a 'potential risk' of adverse ecological effects at a site. In New Zealand, there are insufficient analysed data examining the relationships between annual sedimentation rates and ecological condition to produce DGVs from local biological-effects data, but a considerable body of experimental data exists on the responses of soft-sediment macrobenthic communities to fine-sediment deposition after high rainfall events. These data were used to set a DGV for annual sedimentation rate at 2 mm of sediment accumulation per year above the NSR for the specific estuary, or part of the estuary. Elevated rates of sediment deposition in coastal and estuarine environments can affect ecological health through alteration/degradation of habitat, smothering of biota, clogging of gills and filter-feeding appendages, and reduction in water clarity causing impairment of fish feeding behaviour as sediment is disturbed by wind, wave, and tidal action. On a micro scale, sedimentation can alter microbial activity and benthic primary productivity, change oxygenation, cohesiveness and nutritional qualities of surface sediments and deter larval settlement, resulting in significant ecosystem responses.	Table 8.1 and 9.1 - Muddiness and sedimentation rate

[4] Previous work on ecological breakpoints and subsequent analysis of national data indicates that the most

Measure	Description	Attributes in PC1 Tables
Nutrients	Long-lasting, persistent blooms of fast-growing **macroalgae** (seaweeds) can have negative impacts on both ecological and aesthetic values and can be indicative of excessive nutrients and/or deteriorating sediment conditions. The presence of certain macroalgal species (e.g. the green alga *Ulva* and the red alga *Gracilaria*) is used as an indicator of excessive inputs of nutrients, primarily nitrogen, which is generally the limiting nutrient in coastal environments. **Phytoplankton** biomass (measured by chlorophyll-a) is a well-proven approach to assessing overall estuarine and marine ecosystem condition as it is sensitive to nutrient and sediment inputs, forms the basis of the food web, and is indicative of enrichment effects. Sediment oxygenation is assessed by measuring the depth of the apparent redox potential discontinuity layer (**aRPD**) depth, which is a rough measure of the enrichment state of sediments according to the visual transition between light brown oxygenated surface sediments and black-coloured oxygen-depleted sediments below. It is not an indicator in the Plan due to the subjective nature of the measurement but is a quick way of gauging sediment health in the field.	Table 8.1 and 9.1 - Macroalgae Table 9.1 - phytoplankton
Benthic marine invertebrates	Marine invertebrates have differing tolerances to natural and human-induced disturbance in coastal and estuarine environments. The presence of invertebrate species with different tolerances to fine sediment, organic enrichment, or contaminants are quantified to give an indication of ecosystem health. Diversity is a measure of the variety of species in a macrofaunal community, while abundance is the number of each species present. They both provide measures of macrofaunal community health. There are many indices of marine invertebrate health. The Traits Based Index (**TBI**) categorises organisms according to biological characteristics that are likely to reflect ecosystem function. An index based on the sensitivities of different trait groups to stressors (mud and heavy metals) was developed from the richness of taxa in seven broad trait categories. Values of this index range from 0-1. In the Auckland region where the index was developed, TBI scores <0.3 indicate low levels of functional redundancy and highly degraded sites, scores of 0.3-0.4 indicate intermediate conditions, and scores >0.4 indicate high levels of functional redundancy where the communities likely have some inherent resilience to environmental change (Stevens et al. 2024). Although the TBI was developed from intertidal estuarine data in the Auckland Region, it has subsequently been shown to be a sensitive index in estuaries across New Zealand. As the TBI is based on biological traits, it is slightly more flexible than indices based on specific taxa lists. This is because while species may differ across sites or regions, functional traits usually do not, allowing for equitable comparisons of index values across sites or regions. Whilst the TBI has not been explicitly validated in the subtidal realm yet, TBI scores can be calculated from subtidal macroinvertebrate community data sets.	Table 8.1 - Benthic marine invertebrate diversity

diverse and abundant macrobenthic communities occur in sediments with mud concentrations of <25%. Therefore, sediments >25% mud were reclassified as ‘mud-elevated’, which is indicative of likely ecological degradation (Stevens et al. 2024, Appendix 3).

SETTING THE COASTAL OBJECTIVES IN PC1

WIP OBJECTIVES AS THE PRIMARY SOURCE

50 The coastal objectives in PC1 are based on those published by TWT and TAoP Whaitua Committees (**the Committees**) in their WIPs.

TE AWARUA-O-PORIRUA WIP OBJECTIVES

51 TAoP WIP set coastal objectives to maintain or improve current ecological state as at the time the WIP was developed. In some cases, the objectives for the harbour inlets were set for intertidal and/or subtidal areas to recognise differences in physico-chemical and ecological conditions of these two environments.

52 The specific attributes for which objectives were set are described above in paragraph 48. Those objectives were set in accordance with attribute states decided by an expert panel (See WCTAoP 2019, Section 4.7, Tables 3 and 4) and at the spatial scale described in paragraph 22 and Figure 1.

53 Estuarine sedimentation rates were of particular concern to the Whaitua Committee. I understand from the Whaitua documentation[5] that the process for setting the sedimentation rate targets for the Porirua Harbour was:

53.1 To consider a sedimentation rate of 2 mm/year (NSR unknown so set to 0 mm/year) as

53.1.1 the rate above which adverse effects on estuarine benthic organisms are likely (Townsend and Lohrer 2015; Stevens 2018a; Hunt 2019, 2023); and

53.1.2 what SAR could be achieved, according to WIP modelling (DHI 2019) in the Pāuatahanui Inlet under an extremely conservative water sensitive scenario of 4,000 ha of retirement, full stock exclusion, and riparian planting.

53.2 This rate was reduced to 1 mm/year in the Onepoto Arm because the harbour modelling indicated it could be achieved with all the retirement under the water sensitive scenario (DHI 2019), and it aligned with the 1 mm long-term target

[5] https://www.gw.govt.nz/assets/Documents/2022/05/Recommended-harbour-objectives-Final.pdf

from the Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan (PCC et al. 2014).

54 The following commentary and objectives were included in the WIP:

54.1 To **reduce the sedimentation rate** in both arms of TAoP and to maintain muddiness in intertidal areas. Even with a reduction in sediment inflows from the wider catchment, the level of overall improvement in sediment levels will be constrained by existing high levels of sediment in the harbour and limited estuarine flushing capacity.

54.2 To **maintain estuarine zinc and copper** at current levels (WCTAoP 2019, Table 4), the WIP coastal water objectives require a **reduction in total zinc and copper load** matching the reduction in sediment load to ensure that metal concentrations in harbour sediment do not increase with reduced sediment input. This will require new developments to minimise additional loads of zinc and copper, improvements in existing stormwater management practice, and a reduction in the metal contamination from urban areas (e.g. buildings and vehicles).

54.3 To **maintain macroalgae** in the harbour at current levels, which requires sediment and nutrient inputs (e.g. nitrogen) to remain the same or to be reduced.

TE WHANGANUI-A-TARA WIP OBJECTIVES

55 The Whaitua Committee identified objectives for freshwater, the harbour, and the coast in TWT to deliver on the values of the Whaitua.

56 The specific attributes for which objectives were set are described above in paragraph 48. Those objectives were set in accordance with letter grade attribute states developed for the TWT coastal attribute assessment report (Melidonis *et al*. 2020).

57 PC1 objectives were set for the following coastal areas:

57.1 Te Whanganui-a-Tara (Harbour and estuaries)

57.2 Mākara Estuary

57.3 Wainuiomata Estuary

57.4 Wai Tai (TWT Open Coast)

58 Attribute states were graded in the WIP and used to set objectives, which are summarised below:

58.1 To **prevent decline in the state of estuaries and coast in the short-term** to maintain current state into the next generation.

58.2 To **improve state of estuaries and coast in the longer-term** as detailed in the WIP attribute tables (WCTWT 2021, p74-93). The restoration of estuarine environments is expected to take multiple generations and may require significant improvements in water quality in the upstream catchments. 'Longer-term' expresses continuous improvements towards wai ora across the whaitua.

58.3 To **improve the sedimentation rate in Mākara Estuary** within a generation.

59 Attributes considered for estuaries and coast include benthic macroinvertebrates, macroalgae, deposited sediment and metals attached to sediment with no differentiation made between intertidal and subtidal, only between specific estuaries and coastal areas.

AMENDMENTS FOR READABILITY

60 I understand that Dr Greer (Torlesse Environmental Ltd – pers. comm) initially transcribed all of the objectives in the TAoP and TWT WIPs into a single table for each whaitua chapter. These tables contained both the letter grades (A-D) and the corresponded numeric for each attribute for each spatial area included in the WIPs. This resulted in a very large table that only required a very small number of the dozens of attributes it contained to improve. Consequently, Tables 8.1 and 9.1 discarded the current state estimates and replaced all numeric targets that did not require an improvement with a simple narrative to maintain or improve the attribute, and reduced the number of coastal units in the TWT WIP (see paragraph 48) from six broad 'catchment areas' to the following four that shared the same target:

60.1 Te Whanganui-a-Tara (Harbour and estuaries)

60.2 Mākara Estuary

60.3 Wainuiomata Estuary

60.4 Wai Tai (TWT Open Coast)

ASSESSMENT OF CURRENT STATE

61 Assessment criteria, or 'general indicator thresholds', used to monitor and report on the ecological health of coastal areas were derived by Salt Ecology from the New Zealand Estuary Tropic Index (**ETI**) and were recently reviewed by MfE (Stevens et al. 2024[6]). Proposed national assessment criteria applicable to the coastal attributes included in Tables 8.1 and 9.1 of PC1 are presented in Table 3.

62 Where data exist, the current state of the attributes in Tables 8.1 and 9.1 of PC1 are benchmarked against these assessment criteria as shown in Table 4. Current state is also benchmarked against the numeric PC1 objectives included in Table 8.1 and 9.1.

[6] See Summary page ii of Stevens et al. 2024 (https://environment.govt.nz/assets/publications/Freshwater/Advice-on-indicators-thresholds-and-bands-for-estuaries-in-Aotearoa-New-Zealand.pdf).

Table 3. A range of national condition ratings developed to assist the Council in assessing changes in estuarine health over time. The column entitled 'Appearance in NRP and/or PC1' indicates whether attributes are included in Table 3.8 of the NRP and/or in PC1 (i.e., Table 8.1 for TAoP and Table 9.1 for TWT). See Forrest et al. 2023 for explanation of the derivation of metrics.

	Estuarine health indicator	Unit	Appearance in NRP/PC1	Monitored by Council	A Very good	B Good	C Fair	D Poor
Mud	Mud-dominated substrate	% intertidal area with mud-elevated sediment (>25% mud content)[7]	NRP, PC1 - TAoP & TWT	Yes	<1	1 to <5	≥5 to <15	≥15
Mud	Sedimentation rate	mm/year	NRP, PC1 - TAoP	Yes	<0.5	≥0.5 to <1	≥1 to <2	≥2
Mud	Sedimentation rate	Current vs Natural Sedimentation Rate Ratio	PC1 - TWT	No	1 to 1.1	1.1 to 2	2 to 5	>5
Mud	Mud content	% of sample	NRP, PC1 - TAoP & TWT	Yes	<5	≥5 to <10	≥10 to <25	≥25
Metals in sediment	Copper (Cu)	mg/kg	PC1 - TAoP & TWT	Yes	<32.5	32.5 to <65	65 to <270	≥270
Metals in sediment	Zinc (Zn)	mg/kg	PC1 - TAoP & TWT	Yes	<100	100 to <200	200 to <410	≥410
Nutrients	Macroalgae	Ecological Quality Rating (EQR)	NRP, PC1 - TAoP & TWT	Yes	≥0.8 to 1.0	≥0.6 to <0.8	≥0.4 to <0.6	0 to <0.4
Nutrients	Phytoplankton biomass - estuaries	mg chl-*a*/m³	PC1 - TWT	No	≤5	>5 to ≤12	>12 to ≤16	>16
Nutrients	Phytoplankton biomass - open coast	mg chl-*a*/m³	PC1 - TWT	No	≤3	>3 to ≤8	>8 to ≤12	>12
Benthic macrofauna	Indices (e.g., diversity, abundance, functional group)	Species count & biomass	NRP, PC1 - TWT	Yes	Community typical of undisturbed or reference conditions for the habitat type	Good state of EH with low levels of disturbance	Moderate state of EH with moderate levels of disturbance	Poor state of EH with significant levels of disturbance
Benthic macrofauna	TBI[8]	Index	Narrative in NRP, PC1 - TWT	Yes	-	>0.4	0.3-0.4	<0.3
Habitat	Seagrass extent	% decrease from baseline	NRP	Yes	<5	≥5 to 10	≥10 to 20	≥20
Habitat	Saltmarsh	% historical intertidal area remaining	NRP	Yes	≥80 to 100	≥60 to 80	≥40 to 60	<40

[7] Stevens et al. 2024

[8] Hewitt et al. 2012; Rodil et al. 2013

Table 4. Current state (C) based on average values from the most recent sampling survey or 5-year rolling means for sedimentation rate from most recent Council survey data colour coded against condition ratings with knowledge gaps listed as attributes 'not measured' (NM). Each PC1 objective state (O) is listed as a numerical value or as 'maintain or improve' (MI).

Attribute	Unit	Te Whanganui-a-Tara										Te Awarua-o-Porirua[9]									
		Te Whanganui-a-Tara Harbour[10]		Estuaries						Open coast		Onepoto Arm				Pāuatahanui Inlet				Open coast	
				Mākara Estuary		Te Awa Kairangi[11]		Wainuiomata		TWT Wai Tai		Intertidal		Subtidal		Intertidal		Subtidal		TAoP Wai Tai	
		C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O
Sedimentation rate	mm/year	NM	MI	NM	≤2:1	-14.1	MI	NM	MI	NM	MI	2.7	1	9.8	1	1.9	2	2.8	2	NM	MI
Muddiness	% intertidal area with mud-elevated sediment (>25%)	NM	MI	NM	<-5	NM	MI	NM	MI	NM	MI	13.5	MI	N/A	MI	13.5	MI	N/A	MI	NM	MI
	% of sample	62.3	MI	NM	<10	14.5	MI	NM	MI	NM	MI	9.3	MI	94.5	MI	9.4	MI	63.0	MI	NM	MI
Copper in sediment	mg/kg	13.7	MI	NM	MI	11.8	MI	NM	MI	NM	MI	3.9	MI	19.5	MI	3.8	MI	9.9	MI	NM	MI
Zinc in sediment	mg/kg	113.8	MI	NM	MI	69.9	MI	NM	MI	NM	MI	53.9	MI	172.5	MI	32.5	MI	74.7	MI	NM	MI
Macroalgae	EQR	NM	MI	NM	MI	0.41	MI	NM	MI	NM	MI	0.71	MI	NM	MI	0.71	MI	NM	MI	NM	MI
Benthic macrofauna	Average TBI	0.56	MI	NM	MI	NM	MI	NM	MI	NM	MI	NM	MI	0.36	MI	NM	MI	0.43	MI	NM	MI

[9] Data sources for TAoP: sediment rate and mud content (Stevens & Rabel 2024), extent of mud and macroalgae (Stevens & Forrest 2020b), intertidal sediment metals and macroalgae (Forrest et al. 2022), subtidal sediment survey (Cummings et al. 2022a).

[10] Data sources for TWT: Subtidal sediment survey (Cummings et al. 2022b).

[11] Data sources for Te Awa Kairangi: Sediment rate and mud content (Rabel 2024), sediment metals (Robertson & Stevens 2017).

GENERAL ALIGNMENT BETWEEN PC1 PROVISIONS AND COASTAL OBJECTIVES

63 There are several streams of technical evidence that contribute to this assessment. Mr Blyth's evidence provides technical evidence on the models used to inform the TAoP and TWT Whaitua processes and described their applicability to PC1 , while Mr Oldman's evidence reassesses the data using the Coupled Routing and Excess Storage (CREST) interface portal . Dr Greer undertook an assessment of whether the regulatory provisions contained in PC1 were sufficient to achieve the coastal water objectives (Greer 2023 a & b), the findings of which are summarised below.

64 The following three scenarios were assessed for both the TAoP and TWT WIPs:

64.1 Business as usual (**BAU**) – the current regulatory and management approach;

64.2 Improved – a range of actions to minimise the impact of urban and rural land uses (e.g. stormwater treatment, wastewater network upgrades, riparian planting, space planting and retirement); and

64.3 Water Sensitive – the same actions as 'Improved', but with an increase in their extent and efficacy.

65 Plan objectives are set to maintain from a measured ecological baseline, not to maintain within a broad band as in the WIP. This is to prevent degradation of healthy ecosystems.

TE AWARUA-O-PORIRUA PC1 COASTAL OBJECTIVES

66 Greer (2023b) outlined the extent to which the proposed regulatory provisions of PC1 will achieve the freshwater Target Attribute States (**TAS**) and coastal objectives for TAoP Whaitua. The aforementioned three scenarios formed part of the Collaborative Modelling Project (**CMP**) that helped inform TAoP Whaitua Committee attribute selection.

67 Results suggest that the proposed regulatory provisions of PC1 require outcomes and actions that are likely to achieve all of the assessed TAoP coastal ecological objectives (this does not include enterococci which is discussed in Dr Peter Wilson's Statement of Evidence) (Greer 2023b).

TE WHANGANUI-A-TARA PC1 COASTAL OBJECTIVES

68 Greer (2023a) outlined the extent to which the proposed regulatory provisions of PC1 will achieve the freshwater TASs and coastal objectives for TWT. The three aforementioned

scenarios formed part of the Biophysical Science Programme (**BSP**), which informed the TWT Committee attribute selection.

69 As with TAoP, results suggested that the proposed provisions of PC1 require outcomes and actions that are likely to achieve most of the assessed TWT ecological coastal objectives. However, muddiness (areal extent, particle size, and sedimentation rate) in Mākara Estuary are unlikely to be met through the proposed provisions alone (Greer 2023a).

TECHNICAL REVIEW OF THE PORIRUA HARBOUR SEDIMENTATION RATE OBJECTIVES FOR PC1

70 As explained in Table 2, elevated rates of sediment deposition in coastal and estuarine environments can affect ecological health through degradation of habitat, smothering of biota, clogging of gills and filter-feeding appendages, and reduction in water clarity as sediment is disturbed by wind, wave, and tidal action.

71 As set out above in paragraph 53, the sedimentation rate objective values of 2 and 1 mm per year in the Pāuatahanui and Onepoto Arms respectively were identified in the 2019 TAoP Whaitua (WCTAoP 2019) and adopted for PC1. I understand that to meet these objectives, a 40% reduction in catchment sediment load is required from a baseline period of 2004 to 2014 (see Mr Oldman's evidence). Based on the findings of Greer (2023b), I understand that achievement of this sediment load reduction (and consequently the sedimentation rate objectives) is dependent on the full implementation of the provisions of PC1, which require significant retirement.

72 In my opinion, the best available guidelines should be used to set sedimentation rate targets. As the pre-human geological Natural Sedimentation Rate (**NSR**) was not accounted for in the targets, I recommend that the NSR identified in Mr Oldman's statement of evidence is added if sedimentation rate objectives are to be retained.

73 In terms of available approaches for setting scientifically robust sedimentation rate objectives:

73.1 Townsend and Lohrer (2015) proposed an ANZG Default Guideline Value (**DGV**) average annual estuarine sediment accumulation rate of 2 mm of per year above the NSR. This guidance was retained in revised national guidance (ANZG 2018), which states: "The hierarchy for deriving guideline values ideally uses local biological-effects data first but if these are not available, then local reference data can be used. In the absence of both these, the default approach is to use regional reference data or generic effects-based guidance to develop a DGV". Sedimentation rates exceeding the DGV of 2 mm per year is likely to have adverse effects on estuarine benthic organisms[12]. When setting environmental targets, if the NSR is unknown the value is assumed to be 0 mm/year, resulting in the DGV being used as the threshold.

73.2 Salt Ecology Limited, an estuarine consultant for the Council, has used the ANZG DGV of 2 mm/year to propose preliminary Sediment Accretion Rate (**SAR**) thresholds; whereby a value of >2 mm/year above NSR is rated as being reflective of 'Poor' benthic conditions (Stevens et al. 2024). Guidance on bands of 'Very good' (<0.5 mm/year) to 'Fair' (<1 mm/year) were derived from both the international literature on geological sedimentation rates, and studies of the short-term impacts of sediment deposition (Stevens et al. 2024).

74 Importantly, all the above approaches require the consideration of the NSR. Of the approaches listed above, I consider the ANZG guidelines to be the most practical approach currently available for setting sedimentation rate targets for each harbour arm. However, I acknowledge that place-based assessments would provide a more accurate measure of ecological health. These can be derived from sediment core data specific to an estuary (McDougall 1976) .

75 Mr Oldman's evidence estimates historical deposition rates at 0.7 mm/year for the Onepoto Arm and 1.2 mm/year for the Pāuatahanui Inlet. His calculations show that current sedimentation rates are around three times higher than historical rates, and the PC1 objectives of 1 mm/year and 2 mm/year are around 1.5 times the estimated Pre-European sedimentation rates. In contrast, NIWA's sediment load estimator predicts a NSR of 0.8 mm/year in Porirua Harbour and suggests that the CSR is conservatively at least 5 times the NSR expected for the estuary (Hicks et al. 2019). Of these two estimates I consider Mr Oldman's to be the more robust as they consider local historical sedimentation rates rather than national modelling. On that basis, I consider the following coastal sedimentation rate objectives to be consistent with the best available guidelines (NSR + 2mm as per ANZG):

75.1 Pāuatahanui Inlet = 3.2 mm

[12] See Stevens et al. 2024 for a revision of sedimentation rate.

75.2 Onepoto arm = 2.7 mm

CURRENT AND PAST SEDIMENTATION RATES COMPARED TO PC1 OBJECTIVES AND ANZG GUIDELINES

76 Table 5 shows mean annual sedimentation rates calculated over a rolling five-year period from 2020 to 2024 for the Onepoto Arm and Pāuatahanui Inlet and the exceedance of these compared to the proposed PC1 objectives of 1 and 2 mm/year. Exceedance was also calculated for the ANZG guidelines discussed in paragraph 75 (2.7 and 3.2 mm/year at the Onepoto Arm and Pāuatahanui Inlet respectively). Results show that:

76.1 Both the PC1 objective and the ANZG guideline are currently exceeded in the Onepoto Arm, particularly in the subtidal, where sediment settles over time (Table 5); and

76.2 The ANZG guideline is currently being met in the Pāuatahanui Inlet but the PC1 objective is exceeded (Table 5).

Table 5. Mean annual sedimentation rates calculated over a rolling five-year period from 2020 to 2024 for Pāuatahanui Inlet and Onepoto Arm. Exceedance is highlighted in red.

Total sedimentation (mm/yr)	Onepoto Arm	Pāuatahanui Inlet
Current sedimentation rate (5-year mean)	**6.0**	**2.4**
Exceedance of PC1 objective	**5.0**	**0.4**
Exceedance of ANZG	**3.3**	**-0.8**

77 It is important to note that sedimentation rate varies through time. To demonstrate this, five-year rolling mean sedimentation rates for the Onepoto and Pāuatahanui inlets were calculated over the period 2013 to 2024 as summarised in Table 6. Results show that exceedance of PC1 objectives and the ANZG Guidelines were recorded over most assessment periods for both inlets of the harbour. However, an apparent improvement was observed between 2014 and 2019 in Onepoto and from 2021 in Pāuatahanui.

78 Significant events to note between 2016 and 2022 include the November 2016 earthquake, followed immediately by a 1:20 year storm event, a second 1:20 year storm event in 2017, and construction of Transmission Gully motorway from 2015 to 2022, during which there were numerous sediment retention pond failures. Several subdivisions would also have contributed to increased sediment loads.

Table 6. Five-year rolling means for the Onepoto and Pāuatahanui inlets calculated over the period 2013 to 2024. Orange highlights indicate where the PC1 Table 9.1 objectives are exceeded but the ANZG guideline is met. Red highlights indicate where SAR does not meet the PC1 objectives or the ANZG Guidelines.

5-year rolling mean (mm/yr)	2013-2017	2014-2018	2015-2019	2016-2020	2017-2021	2018-2022	2019-2023	2020-2024
Onepoto Arm	-3.7	-1.6	-1.0	4.7	4.7	4.6	5.0	6.0
Pāuatahanui Inlet	6.2	5.7	3.8	3.9	4.1	1.7	2.3	2.4

79 These results highlight that regardless of whether the PC1 objectives or ANZG guidelines are considered, there is a need for improvement in sedimentation rates in the Porirua Harbour. However, ANZG guidelines indicate that smaller and less spatially extensive improvements are required than what the PC1 objectives suggest.

Notes: *A suite of indicators should be considered when making judgements about impacts of catchment derived sediment on ecological health. It is apparent from 1) the exceedance of the national guideline in Onepoto since 2016 and in Pāuatahanui up until 2021, 2) five-yearly bathymetry surveys, 3) the increasing percentage of mud at Council monitoring sites, and 4) the increasing areal extent of intertidal mud, ecosystems in Porirua Harbour are being increasingly negatively affected over time.*

Standard deviations between replicate measures of sediment rate are generally large due to the method of measurement.

LOAD REDUCTIONS REQUIRED TO ACHIEVE THE PC1 OBJECTIVES AND THE ANZG GUIDELINES (POLICY P.P4)

80 Table 7 provides a comparison of the extent to which sediment loads would need to be reduced to achieve the notified PC1 and alternative sedimentation rate objectives set out above in paragraph 75. Load reductions have been calculated for two time periods:

80.1 2004-2014, which is baseline period used in Table 9.3 of PC1; and

80.2 5 year rolling mean for 2020 – 2024, which reflects current state. Note for this period load reductions are based on current sedimentation rates (6.0 mm/yr Onepoto Arm and 2.4 mm/year in the Pāuatahanui Inlet (Table 6) and the modelled relationship between sediment load and sedimentation rate presented in Mr Oldman's evidence.

81 These results show:

81.1 The notified PC1 coastal objectives require:

81.1.1 A~47% reduction from the 2004-2014 baseline load and an estimated 73% reduction from the current sediment load to the Onepoto Arm;

81.1.2 A ~38% reduction from the 2004-2014 baseline load and a 17% reduction from the current sediment load to the Pāuatahanui Inlet

81.2 In contrast, it is estimated that the ANZG guidelines (i.e., the alternative sedimentation rate objectives set out above in paragraph 75) would be met with:

81.2.1 ~0% reduction from the 2004-2014 baseline load and an estimated 49% reduction from the current sediment load to the Onepoto Arm;

81.2.2 A ~17% reduction from the 2004-2014 baseline load and a 0% reduction from the current sediment load to the Pāuatahanui Inlet

Table 7. Estimated sediment load reductions required to achieve the current PC1 Table 9.1 sedimentation objectives and ANZG guidelines. Options for setting coastal sediment rate objectives in TAoP. Sedimentation rates are measured in mm/year and calculated over a five-year rolling mean.

Time period	Sedimentation rate objective			Required load reduction	
	Based on:	Onepoto Arm	Pāuatahanui Inlet	Onepoto Arm	Pāuatahanui Inlet
2004-2014[13]	WIP sedimentation rate (as notified in PC1)	1.0	2.0	47%	38%
	ANZG 2018 guideline	2.7	3.2	Maintain current load	Maintain current load
2020 – 2024[14]	WIP sedimentation rate (as notified in PC1)	1.0	2.0	73%	17%
	ANZG 2018 guideline	2.7	3.2	49%	Maintain current load

[13] Mr Oldman in his Statement of Evidence used current estimates of SAR of 2.6 mm/year for the Onepoto Arm and 3.2 mm/year for Pāuatahanui Inlet based on scaled Whaitua modelling results. Scaling was based on the assumption that loads for the period 2004-2014 are representative of "long-term".

[14] The five-year rolling mean for 2020-2024 of 6 mm/year in the Onepoto Arm and 2.4 mm/year in Pāuatahanui Inlet were calculated from Council SOE sediment plate monitoring data in 2020-2024.

82 It must be noted that there is significant uncertainty in all of the load reductions set out in Table 7 and paragraph 81 above. Specifically, load reductions derived from the modelled loads between 2004 and 2014 are unlikely to be relevant in 2025, and this is demonstrated by the differences between current sedimentation rates and the rates recorded during that period (see Table 6). The estimated load reductions from current (2020 to 2024) rely on the relationship established between loads and sedimentation rate between 2004 to 2014 data. Thus, while they provide a useful indication of the likely scale of the reductions required, they cannot be considered accurate. As a result, I consider that the inclusion of sediment load reduction targets in PC1 is unlikely to provide an accurate representation of the actual reductions required to achieve the sedimentation rate objectives.

TECHNICAL REVIEW OF PC1 METAL MANAGEMENT APPROACH FOR PORIRUA HARBOUR

83 The metal load reductions in Table 9.3 of PC1 were set to maintain metal concentrations in Porirua Harbour. A reduction was considered necessary to achieve this outcome as modelling conducted for the Whaitua process indicated that a 40% reduction in sediment loads to Porirua Harbour should be coupled with a 40% reduction in metal loads to prevent sediment metal concentrations from increasing. Further advice was then provided by NIWA re-affirming this position (Greer et al. 2023). However, both the Whaitua model assumptions and NIWA's advice was largely based on a review of international literature from a range of estuarine types. As a result, there was a high degree of uncertainty regarding its applicability to Porirua Harbour. Nevertheless, it is my understanding that the Council considered that the decline in attribute state for zinc and copper in the inner Onepoto Arm and the hotspots of contamination near Porirua City justified application of a "precautionary approach". Accordingly, based on NIWA's advice and the best evidence available at the time, Council set a 40% load reduction target for copper and zinc in Table 9.3 in PC1 on the assumption that it would be required to maintain current estuarine state on the backdrop of a 40% sediment load reduction (Greer et al. 2023).

84 Following provision of this advice, in 2024 DHI developed the Porirua Harbour Coastal Receiving Environment Scenario Tool (**CREST**), providing an online portal for visualising whaitua model results at a sub-catchment and sub-estuary level. Sub-estuaries are illustrated in Figure 3 below. Underlying the CREST portal are the full process-based hydrodynamic, sediment transport, nutrient, and metal fate models, details of which are provided in DHI (2019).

Figure 3. Whaitua sub-estuaries showing delineation between intertidal and subtidal estuarine areas (Oldman 2025).

85 A major component of CREST development was calibration of the whaitua metal model, which uses estimates of the predicted level of deposition and assumptions of sediment zinc and copper concentrations to calculate mixing of inflowing catchment derived metals and legacy metals currently present in the estuary. Mixing was estimated from the level of deposition of new sediments, the depth of disturbance of old sediments, and the equilibrium concentration of metals in estuarine sediment (Statement of Evidence – John Oldman).

86 Through this model, Mr Oldman has confirmed in his Statement of Evidence that if there is a sediment load reduction of 40%, a metal load reduction of 40% is likely to be required to maintain the current rate of sediment metal accumulation (noting that concentrations will continue to increase with current loads and land-use).

87 On that basis, setting the Table 9.3 metal load reductions at the same level as the sediment load reductions in the same table is necessary to ensure that the rate of sediment metal accumulation is not increased from current state. If the sediment load reductions in Table 9.3 are amended in response to the adoption of the ANZG 2018 sedimentation rate targets discussed in paragraph 81, the same amendments will need to be applied to the metal load reduction targets in that table to maintain the current rate of sediment metal accumulation.

88 However, upon review of Mr Oldman's modelling, Dr Peter Wilson concludes in his statement of evidence that even if the metal load reductions in Table 9.3 of PC1 were set at 0%, the increase in sediment metal concentrations associated with a 40% reduction in sediment loads would not result in an increased risk of ecotoxicological effects.

89 On this basis, it is my opinion that setting inlet wide metal load reduction targets may not be justified from an effects management perspective. Even with no change in metal or sediment loads, sediment metal concentrations in Porirua Harbour are expected to increase according to Mr Oldman's evidence. As documented in Dr Wilson's evidence, no additional ecotoxicity risk is generated under any of the scenarios modelled by Mr Oldman. As such, it is likely that targeted metal load reductions are not needed to maintain the current ecotoxicological risk to marine biota, even if sediment loads were reduced by up to 40%.

90 Revised objectives for metals (copper and zinc) in subtidal and intertidal sediments in the Onepoto Arm and Pāuatahanui Inlet were derived from the CREST modelled scenarios. These are described in Dr Wilson's evidence.

ASSESSMENT OF THE SEDIMENT AND METAL LOAD REDUCTIONS IF SEDIMENTATION RATE GUIDELINES ARE CHANGED

91 If the method of calculating load reductions using the 2004-2014 time period (which is consistent with the approach in the notified version of Table 9.3) was used to calculate the load reduction required for the ANZG 2018 guideline sedimentation rate, this would result in the following changes to Table 9.3 within Policy P.P4 as set out in Table 8. However, I do not consider that these values provide an accurate representation of the actual reductions required to achieve the sedimentation rate objectives.

Table 8: Changes that would be required to Tables 9.3 of PC1 if the ANZG sedimentation rate guidelines were adopted and the load reductions calculations were consistent with the notified PC1.

Coastal Water Management Unit (Map 82)	Contaminant	Timeframe	% reduction in baseline total load from 2004-2014[15]
Onepoto Arm	Sediment	By 2040	~~-40%~~ -0%
	Zinc		~~-40%~~ -0%
	Copper		~~-40%~~ -0%
Pāuatahanui Inlet	Sediment		~~-40%~~ 0%
	Zinc		~~-40%~~ 0%
	Copper		~~-40%~~ 0%

TECHNICAL REVIEW OF THE NON-SEDIMENT AND METAL ATTRIBUTES IN TABLES 8.1 AND 9.1 OF PC1

92 Table 9 provides an assessment of the 'relevance' of the different attributes included in Tables 8.1 and 9.1 of PC1. This assessment considers:

92.1 Whether an attribute is currently monitored and if so, where e and how frequently;

92.2 Whether robust effects thresholds exist for the attribute;

92.3 Whether the provisions of PC1 directly affect the attribute; and

92.4 Whether the attribute is already included in Table 3.8 of the operative NRP.

[15] The load reductions from PC1 are currently from the same period.

Table 9. Assessment of scientific relevance of coastal attributes in PC1. Non-regulatory actions may be required in addition to the regulatory actions to meet the objectives currently included in PC1 (see Greer 2023a &b for full assessments). TAoP = Te Awarua-o-Porirua, TWT = Te Whanganui-a-Tara, EH = Ecosystem Health.

<table>
<tr><th></th><th>Attribute</th><th>Unit</th><th>Council monitoring frequency</th><th>Existing thresholds</th><th>Is it in the operative NRP?</th><th>Is it in PC1?</th><th>Requires non-regulatory actions</th><th>Applicability as a regional plan objective</th></tr>
<tr><td rowspan="2">Sediment contaminants</td><td>Copper (Cu)</td><td>mg/kg</td><td>5-yearly – TAoP & TWT</td><td>ANZG 2018</td><td>No</td><td>TAoP & TWT</td><td>No</td><td rowspan="2">Yes - estuaries and harbours</td></tr>
<tr><td>Zinc (Zn)</td><td>mg/kg</td><td>5-yearly – TAoP & TWT</td><td>ANZG 2018</td><td>No</td><td>TAoP & TWT</td><td>No</td></tr>
<tr><td rowspan="3">Mud</td><td>Mud-dominated substrate</td><td>% of intertidal area with mud-elevated sediment (>25% mud content)</td><td>5-yearly – TAoP</td><td>No</td><td>Yes, only estuaries & harbours</td><td>TAoP & TWT</td><td rowspan="3">Yes - Mākara Estuary</td><td>Yes - estuaries and harbours but not suitable for open coast (subjective measure)</td></tr>
<tr><td>Sedimentation rate</td><td>Current: Natural</td><td>Annually – TAoP & Hutt Estuary</td><td>ANZG 2018</td><td>Yes, only estuaries & harbours</td><td>TAoP & TWT</td><td>Yes - estuaries and harbours but not suitable for open coast</td></tr>
<tr><td>Mud content</td><td>% of sample</td><td>Annually – TAoP & Hutt Estuary</td><td>Yes</td><td>Yes, only estuaries & harbours</td><td>TAoP & TWT</td><td>Yes - estuaries and harbours but not suitable for open coast</td></tr>
<tr><td rowspan="2">Nutrients</td><td>Macroalgae</td><td>Ecological Quality Rating (EQR)</td><td>5-yearly – TAoP & TWT</td><td>Yes</td><td>Yes</td><td>TAoP & TWT</td><td>No</td><td>Yes – estuaries, harbours and open coast</td></tr>
<tr><td>Phytoplankton</td><td>mg chlorophyll-a/m^3</td><td>N/A</td><td>Stevens et al. 2024</td><td>No</td><td>TWT</td><td>No</td><td>Yes - open coast but not estuaries & large harbours</td></tr>
<tr><td>Biota</td><td>Macroinvertebrates</td><td>Benthic marine macroinvertebrate diversity</td><td>5-yearly – TAoP & TWT</td><td>Yes</td><td>Yes</td><td>TWT</td><td>No</td><td>Yes - estuaries & harbours</td></tr>
</table>

93 Through this assessment I have identified the following issues with the attributes in Tables 8.1 and 9.1 of PC1:

93.1 **There is significant uncertainty around whether the PC1 provisions can or will result in the achievement of the sedimentation rate objectives for Mākara Estuary.** The Council does not monitor sediment in Mākara Estuary. In the absence of reliable monitoring data, it is not possible to understand the extent of the improvement required by the current PC1 objective or whether the Table 8.5 freshwater sediment load reductions will be sufficient to achieve those. In my opinion, there would be far greater certainty around the achievement of the outcome and consistency with the freshwater TAS if this objective was amended to be a narrative 'improve' (which is already required by the freshwater visual clarity TASs for the Mākara Stream). This would also allow for the sedimentation rate statistic to be changed to mm/yr to make it consistent with the objectives set for Porirua Harbour.

93.2 **The sedimentation rate, muddiness, and sediment metal (zinc and copper), attributes are of limited relevance in TAoP Open Coast and TWT Wai Tai (Open Coast); however, sediment mud content and sediment metals are relevant attributes to measure in Wellington Harbour and some estuaries**. Open coastal areas are generally dynamic environments that readily mix and disperse land-based freshwater inputs and are naturally influenced by sediment movement, which limits infaunal diversity. Wellington Harbour is a deeper subtidal dominated, longer residence time estuary (DSDE), and is naturally a depositional environment that supports benthic infauna moderately tolerant to fine sediments. Measuring sediment mud content and sediment metals can provide an indication of the ecosystem health of this environment. The muddiness metric should be updated to percentage of intertidal area with >25% mud content rather than >50% to align with the most recent revision of the NEMP (Stevens et al. 2024, Appendix 3).

93.3 **The sediment metal (zinc and copper) attributes are of limited relevance in the Mākara Estuary and are not monitored as a result.** The Council does not monitor estuarine sediment metals in Mākara Estuary as this is a rural influenced catchment with limited input of these metals due to a small human population and no major road traffic.

93.4 **The macroalgae attribute is of limited relevance in TAoP Open Coast, TWT Wai Tai, and Wellington Harbour, but is useful to measure in most estuaries**. Macroalgae can be measured in harbours, estuaries and coastal environments as an indicator of water column or sediment nutrient input, since nuisance macroalgae may become entrained in sediment or attached to rocks on coastal rocky shores. In areas with limited substrate available for macroalgal attachment, nutrient inputs are more likely to result in phytoplankton blooms than measurable nuisance macroalgal blooms. Both phytoplankton and macroalgae can be measured as a nutrient indicator in coastal and estuarine environments; however, I recommend measuring macroalgae where possible for practicality.

93.5 **Monitoring phytoplankton as a measure of water column nutrient inputs is applicable to harbours, estuaries, and open coast if these areas are subjected to point source discharges or riverine mouth closures** (i.e., shallow, short residence time tidal rivers with adjoining lagoon estuaries or **SSRTREs**, intermittently closed/open lakes and lagoons or **ICOLLs**), but may be of limited applicability in areas with dynamic water mixing.

93.6 **Monitoring of marine benthic invertebrates is a useful indicator of ecological health in harbours, estuaries, and open coastal environments where cumulative stressors are well understood.** Invertebrate community changes may be driven by multiple stressors, which might not all be practical to measure and this should be considered when interpreting localised data. In this context, marine benthic invertebrates include macroinvertebrate benthic soft-bottom communities, and macroinvertebrate subtidal rocky reef communities, for which species count and biomass data are used to derive indices (e.g., diversity, abundance, functional group) as measures of ecosystem health. It excludes intertidal estuarine habitat, open coast sandy beach, and intertidal rocky shore.

RESPONSE TO TECHNICAL MATTERS IN SUBMISSIONS

SUBMISSIONS REQUESTING ADDITION OF TURBIDITY TO TABLES 8.1 AND 9.1

94 In their submissions the Environmental Defence Society Inc. (EDS) and the Royal Forest and Bird Protection Society NZ (F&B) both seek the inclusion of a turbidity objective in Tables 8.1 and 9.1 of PC1. I understand the objectives they are seeking include a narrative objective of "Turbidity must be maintained at or below the current annual median or at or below pre-existing levels, whichever is lesser)" and specific objectives for the following areas:

94.1 Te Whanganui-a-Tara Harbour and estuaries, Makara Estuary, Wainuiomata Estuary: <6.9

94.2 Wai Tai: No discernible change

94.3 Onepoto Arm: <10.8

94.4 Pāuatahanui Inlet: <6.9

94.5 Open Coast: No discernible changes

95 I do not consider the inclusion of a turbidity objective in Tables 8.1 and 9.1 of PC1 to be scientifically justified.

96 Turbidity is an optical determination of water clarity, with turbid water often noticeably cloudy or murky. Turbidity measurements may be used as an indicator of water quality based on clarity and estimated Total Suspended Solids (**TSS**) in water, but discrete water samples are required to translate optical turbidity estimates to absolute values. Optical backscatter is a measurement of turbidity at specific optical wavelengths depending on the site and data required. Backscatter sensors may be fitted with a manufacturer turbidity calibration to translate data into Nephelometric Turbidity Units (**NTUs**).

97 Unless measured continuously over a long period of time, water quality information measured in tidal estuaries may be of limited use for understanding the effects of changes in riverine sediment load as turbidity cannot be linked to sediment load alone. Wind, wave and tidal effects will also contribute to increased turbidity readings varying according to water depth, tide, and weather conditions (i.e., winds, currents and waves).

98 There is also no direct correlation between measured sediment concentration and sedimentation rate, nor between turbidity and sedimentation rate. Turbidity is a measure

of water quality, rather than of benthic ecosystem health. While water quality measurements (including turbidity) in Wellington Harbour captured between 2017 and 2022[16], have proven to be useful in understanding the behaviour of the Awa Kairangi (Hutt River) plume, it has not been possible to link these data to benthic ecological health measured by benthic sediment data (i.e., muddiness and concentration of contaminants) and benthic macrofaunal data, nor to pelagic ecosystem health. Coastal environments are also highly dynamic and may be naturally turbid during unsettled weather conditions (e.g., storm events).

SUBMISSIONS REQUESTING THE INCLUSION OF OTHER ADDITIONAL ATTRIBUTES IN TABLES 8.1 AND 9.1 OF PC1

99 In their submissions the Environmental Defence Society Inc. (EDS) and the Royal Forest and Bird Protection Society NZ (F&B) seek for further parameters to be added to Tables 8.1 and 9.1 including as lead, dissolved oxygen, temperature, pH, secchi depth, chlorophyll-a, total phosphorous, total nitrogen, nitrite-nitrate nitrogen, ammoniacal nitrogen, and faecal coliforms) to ensure the narrative objectives in Table 3.8 of the operative NRP are retained in some form. I do not consider the additions requested in these submissions to be scientifically justified.

100 In my opinion, it is not necessary to measure the water quality parameters mentioned in EDS and F&B submissions to determine the state of health of Wellington tidal estuaries. The transient nature of estuarine waters limits the usefulness of such water quality measurements that will be costly to collect and verify. Table 10 provides an assessment of the 'relevance' of the different attributes requested by EDS and F&B. This assessment considers:

100.1 Whether an attribute is currently monitored and if so, where and how frequently;

100.2 Whether robust effects thresholds exist for the attribute;

100.3 Whether the provisions of PC1 directly affect the attribute; and

100.4 Whether the attribute is already included in Table 3.8 of the operative NRP.

[16] https://graphs.gw.govt.nz

101 Water quality is largely dependent on water movement, which is influenced by currents, tidal flow, and wind. In tidal estuaries, saline coastal waters enter on the incoming tide, and estuarine water (coastal water and freshwater combined) flows towards the estuary mouth and out to the coast on the outgoing tide. In open coastal environments, water movements are complex and site-specific water quality measurements are generally only recommended for monitoring impacts over a relatively short period (e.g., consent related impacts). Water quality buoys can be installed at great expense (e.g., the Council's deployment of a coastal water quality monitoring buoy in TWT) with the aim of characterising site-specific water quality; however, the use of this information is limited to localised water quality insights that may not impact system-wide ecological health such as fish movement. Here benthic macrofaunal community composition may be more informative as certain functional groups (e.g. benthic filter-feeders) may be impacted over longer time periods.

102 Water quality measurements including current speed and direction, temperature, salinity, dissolved oxygen, turbidity, chlorophyll-a, and CDOM (coloured dissolved organic matter, a product of decaying material) in Wellington Harbour captured between 2017 and 2022 have proven to be useful in understanding the behaviour of the Awa Kairangi (Hutt River) plume[17] but it has not been possible to link these data to benthic ecological health measured by benthic sediment data (i.e., muddiness and concentration of contaminants) and benthic macrofaunal data, nor to pelagic ecosystem health.

103 I also do not consider that the addition for the Operative NRP Table 3.8 ecological attributes requested in EDS and F&B submissions to Tables 8.1 and 9.1 of PC1 is scientifically justified other than in the open coast (TAoP) and Wai Tai (TWT) where I have identified that the current attributes are not fit for purpose. I consider the proposed PC1 attributes are sufficient to characterise coastal environments and assess ecosystem health and the Table 3.8 attributes are generally well captured within the PC1 tables and narrative.

[17] https://graphs.gw.govt.nz

Table 10. Assessment of the scientific relevance of additional submitter requested coastal attributes for inclusion as objectives in PC1.

	Attribute	Unit	Council monitoring frequency	Existing thresholds	Is it in the operative NRP?	Is it in PC1?	Requires non-regulatory actions	Applicability as a regional plan objective
Biota	Fish	Diversity & abundance	N/A	No	Yes	No	N/A	No – estuaries, harbours and open coast
Habitat extent	Seagrass & saltmarsh	m^2	10-yearly – TAoP & TWT	No	Yes	Yes, narrative outcome	N/A	Yes – estuaries, harbours and open coast
	Rocky shore, sandy beach etc.	m^2	3-year baseline at key sites but not currently monitored	No	No	**Yes** – narrative objectives P.O3 (e) & WH.O3 (e)	Yes	Yes – estuaries, harbours and open coast
Water quality	Turbidity, water temperature, dissolved oxygen, dissolved metals	Various	Not measured	ANZG 2018	No	**No** – water conditions mentioned in narrative P.O3 (f) & WH.O3 (f)	Yes	No - estuaries, harbours and open coast

SUBMISSIONS REQUESTING MORE INFORMATION ON THE LOCATION AND EXTENT OF HIGH CONTAMINANT CONCENTRATIONS

104 In their submission, Wellington Water Limited (WWL) has requested that further detail be provided in relation to the baseline state of the attributes included in Table 8.1 and Table 9.1 of PC1 and that maps be provided showing locations of the high contaminant concentrations referenced in Objectives WH.O3 and P3.O3.

105 WH.O3 (b) asserts that the "health and wellbeing of coastal water quality, ecosystems and habitats in Te Whanganui-a-Tara is maintained or improved to achieve the coastal water objectives set out in Table 8.1, and by 2040 b) high contaminant concentrations, including around discharge points, are reduced".

106 Sediment metal data at the Council monitoring sites are summarised in the figures below. The latest coastal monitoring data can be accessed on the Council's website (Porirua Harbour reporting and Wellington Harbour reporting) and on LAWA. Figure 4 and Figure 5 below are extracted from the TAoP web report (GW 2023c) and show where sediment zinc and copper concentrations are highest at State of the Environment sites monitored in Porirua Harbour. Figure 6 and Figure *7* summarise sediment metal concentrations (mg/kg) measured during 2019 and 2023 targeted sediment investigations.

107 These figures and their associated technical reports demonstrate that concentrations of measured contaminants at SOE sites range between 'Fair' to 'Very good' (according to the grading systems set out in Table 3 of this evidence) and are slightly elevated in the Onepoto Arm of the Porirua Harbour near the mouth of the Porirua Stream (Figure 4 and Figure 5). As measured concentrations were mostly below DGV, they are unlikely to result in ecological impacts.

108 Sediment metal concentrations are slightly elevated near the outfalls of some point source discharges that do not constitute part of the Council SOE monitoring programme as shown by the Council 2009 and 2023 targeted investigations of intertidal estuarine sediment contaminant levels in Porirua Harbour (Figure 6 and Figure *7* respectively). Zinc concentrations and high molecular weight PAHs exceeded guidelines at most sites sampled in 2009 (Sorensen & Milne 2009, Table 3.1, p9). This investigation was repeated in December 2023 and results generally remained consistent with 2009 values (Clissold & Melidonis 2025), with the exception of one significantly elevated value of lead in 2023 that was likely a result of a metal flake in the sediment sample (Figure *7*).

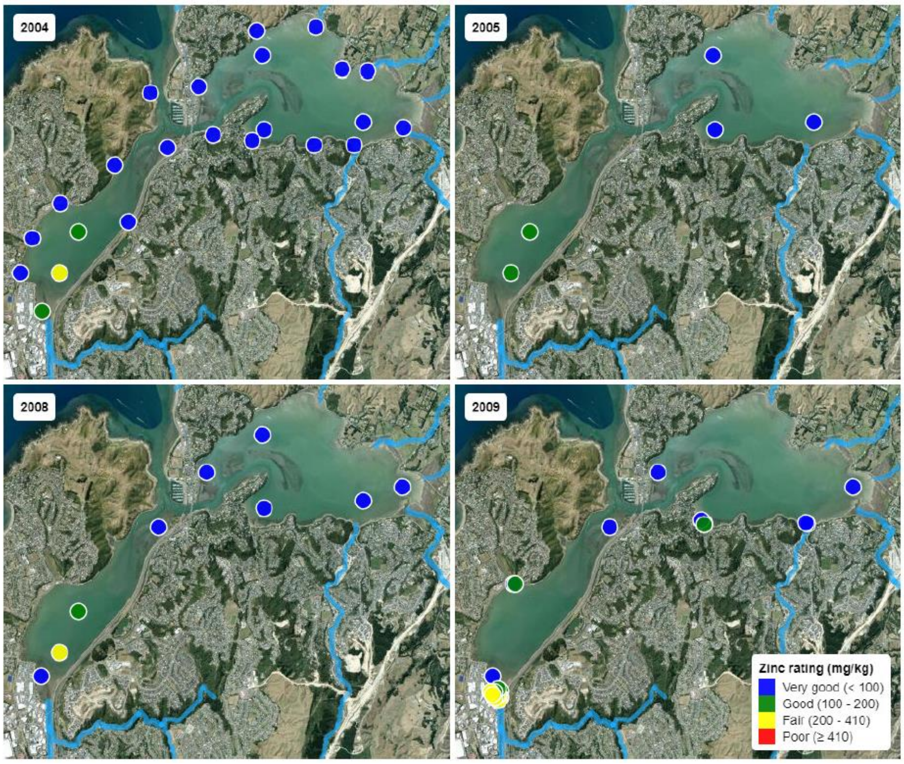

Figure 4. Zinc (mg/kg) ratings for 2004, 2005, 2008 and 2009 (GW 2023c).

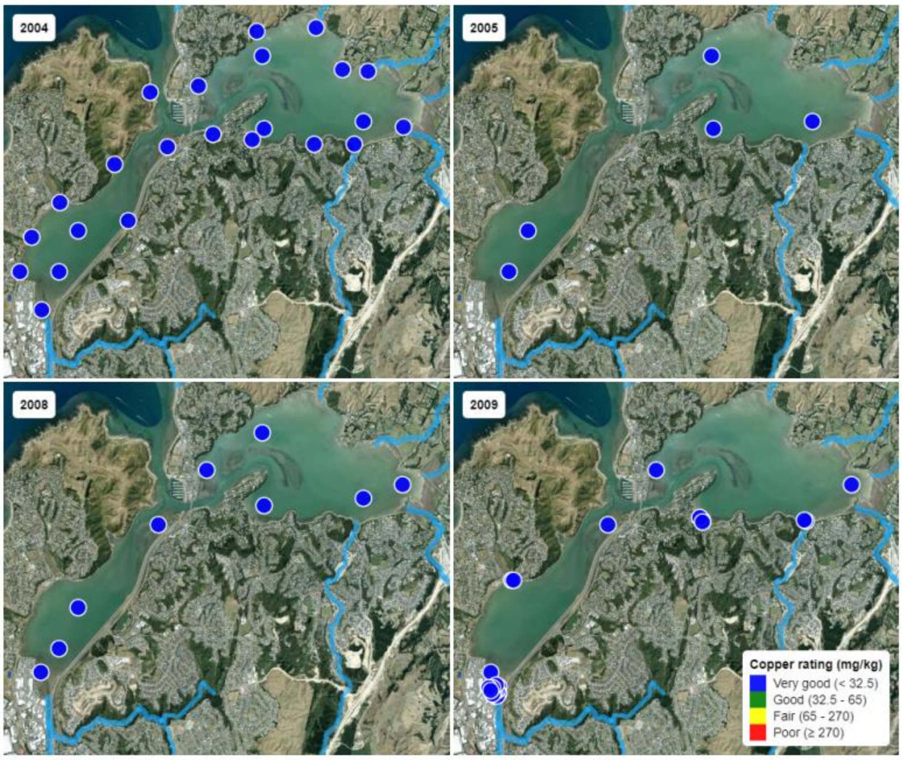

Figure 5. Copper (mg/kg) ratings for 2004, 2005, 2008 and 2009 (GW 2023c).

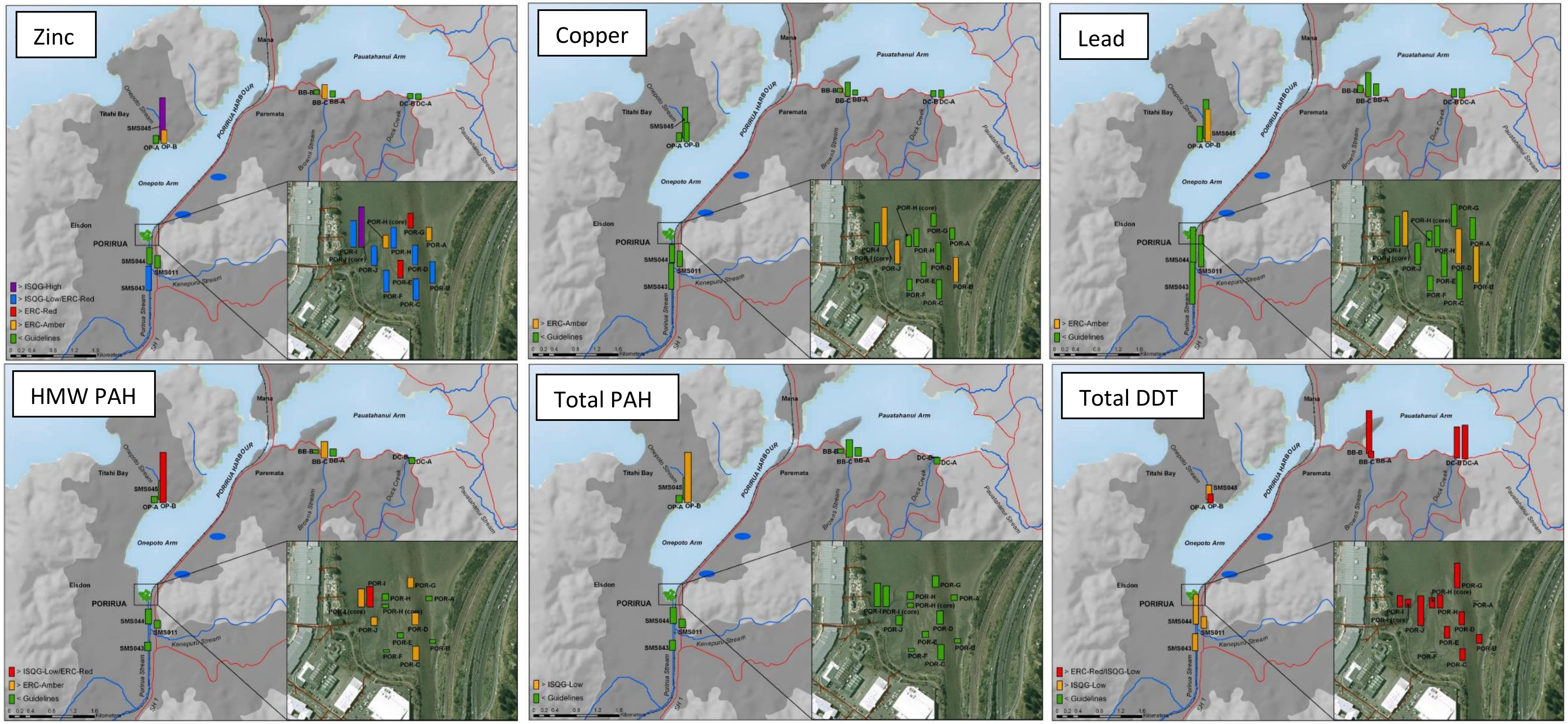

Figure 6. Concentrations of contaminants in sediments at sites sampled as part of the Porirua Harbour targeted intertidal sediment quality assessment in February 2009. Analysis of the <2 mm fraction of a single composite sample from each site. Scale used for the bars is unique to each map (Sorensen & Milne 2009). Red, orange, purple and blue bars indicate values > guidelines, while green bars indicate values < guidelines.

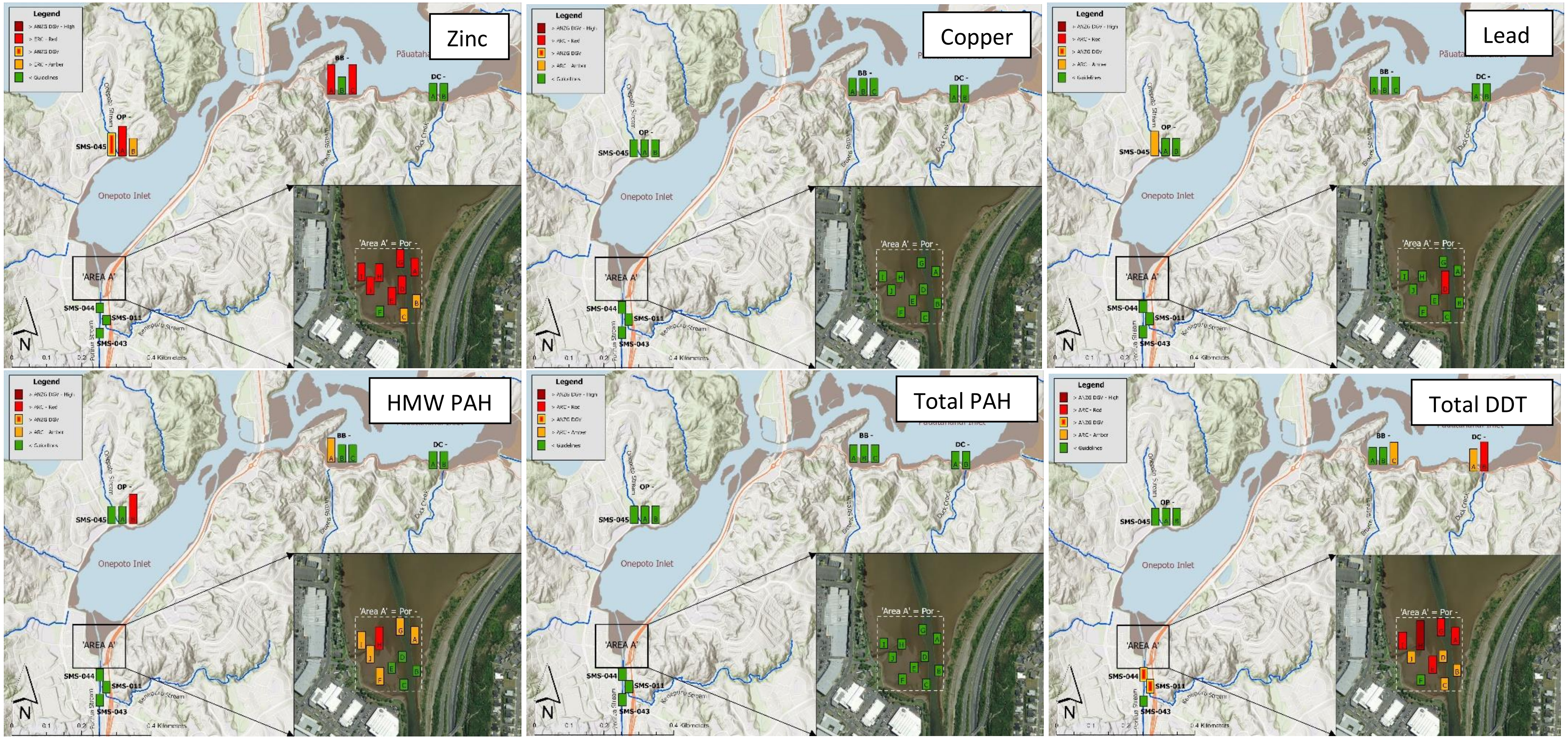

Figure 7. Mean zinc (Zn), copper (Cu), lead (Pb), PAH and DDT concentrations measured in sediments from 17 targeted intertidal sites in Porirua Harbour in 2023 (Clissold & Melidonis 2025). Yellow-orange bars indicate values > ANZG DGV, brown > ANZG DGV High, red > ARC Red and orange > ARC Amber, while green < all guideline values.

CONCLUSION

SUMMARY OF RESPONSES TO SUBMISSIONS

109 I do not consider the submission requesting the inclusion of a turbidity objective in Tables 8.1 and 9.1 of PC1 to be scientifically justified.

110 I do not consider that submissions requesting further parameters to be added to Tables 8.1 and 9.1 including lead, dissolved oxygen, temperature, pH, secchi depth, chlorophyll-a, total phosphorous, total nitrogen, nitrite-nitrate nitrogen, and ammoniacal nitrogen to be scientifically justified.

111 I do not consider that the addition for the Operative NRP Table 3.8 ecological attributes to Tables 8.1 and 9.1 of PC1 is scientifically justified. However, I have identified that the PC1 attributes for open coast (TAoP) and Wai Tai (TWT) are not fit for purpose.

SUMMARY OF SCIENTIFICALLY JUSTIFIED CHANGES TO TABLES 8.1, 9.1 AND 9.3

112 The changes to Tables 8.1 and 9.1 that are scientifically justified (as explained in paragraph 93) are listed below:

112.1 There is significant uncertainty around whether the PC1 provisions can or will result in the achievement of the sedimentation rate objectives for Mākara Estuary. In my opinion, there would be far greater certainty around the achievement of the outcome and consistency with the freshwater TAS if this objective was amended to be a narrative 'improve' (which is already required by the freshwater visual clarity TASs for the Mākara Stream).

112.2 The sedimentation rate, muddiness, and sediment metal (zinc and copper), attributes are of limited relevance in TAoP Open Coast and TWT Wai Tai (Open Coast); however, sediment mud content and sediment metals are relevant attributes to measure in Wellington Harbour and some estuaries. The muddiness metric should be updated to percentage of intertidal area with >25% mud content rather than >50% to align with the most recent revision of the NEMP.

112.3 The sediment metal (zinc and copper) attributes are of limited relevance in the Mākara Estuary and are not monitored as a result.

112.4 The macroalgae attribute is of limited relevance in TAoP Open Coast, TWT Wai Tai, and Wellington Harbour, but is useful to measure in most estuaries.

112.5 Monitoring phytoplankton as a measure of water column nutrient inputs is applicable to harbours, estuaries, and open coast if these areas are subjected to point source discharges or riverine mouth closures (i.e., shallow, short residence time tidal rivers with adjoining lagoon estuaries or SSRTREs, intermittently closed/open lakes and lagoons or ICOLLs), but may be of limited applicability in areas with dynamic water mixing.

112.6 Monitoring of marine benthic invertebrates is a useful indicator of ecological health in harbours, estuaries, and open coastal environments where cumulative stressors are well understood.

113 Given my conclusions regarding the applicability of the attributes in Tables 8.1 and 9.1 to the TAoP Open Coast and TWT Wai Tai coastal areas, I recommend adapting the narrative objectives for fish, invertebrates and macroalgae set in Table 3.8 of the operative NRP to set an objective in these areas to maintain ecological health.

114 The Porirua Harbour contaminant load changes to Table 9.3 calculated in Mr Oldman's evidence are summarised in Table 8. As set out in paragraph 82, I consider that the inclusion of sediment load reduction targets in PC1 is unlikely to provide an accurate representation of the actual reductions required to achieve the sedimentation rate objectives.

115 The metal load reduction targets set out above for the Onepoto Arm of Porirua have been included to ensure the rate of sediment metal accumulation does not increase from current. However, making them more lenient (from the notified version of PC1), or removing them altogether is not expected to result in a change in ecotoxicological effects on aquatic life (based on Dr Wilson's Evidence).

DATE: 28 FEBRUARY 2025

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