Whaitua Te-Whanganui-a-Tara Coastal Assessment Report

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GW/ESCI-T-21/16

March 2020

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The report may be cited as:

Melidonis M, Stevens L, Oliver M and Conwell C. 2020. *Whaitua Te-Whanganui-a-Tara Coastal Assessment Report*. Greater Wellington Regional Council. Publication No GW/ESCI-T-21/16, Wellington.

Executive summary

The Whaitua Te Whanganui-a-Tara Committee was established to set freshwater and coastal objectives and limits for Whaitua Te Whanganui-a-Tara. The Whaitua coastal area includes estuaries, rocky and sandy intertidal, inshore reef, and benthic sediment habitats, which serve as the receiving environment for much of the freshwater flow delivered by the Hutt and Wellington Harbour catchments.

The Whaitua Te Whanganui-a-Tara Coastal Expert Panel was formed to provide scientific advice to the Whaitua Committee on the likely significance of the biophysical effects of different catchment management scenarios on the coast. This report discusses the likely environmental state of the coast under each of three scenarios as follows:

- Business as Usual (BAU) – which assumes all the natural resources plan (NRP) rules are operative and being undertaken at 100% compliance.
- Improved Scenario (IS) – Applies increasing levels of mitigations to the rural/urban environment.
- Water Sensitive Design (WS) – Applies high levels of mitigations to rural/urban environments, significantly more than BAU.

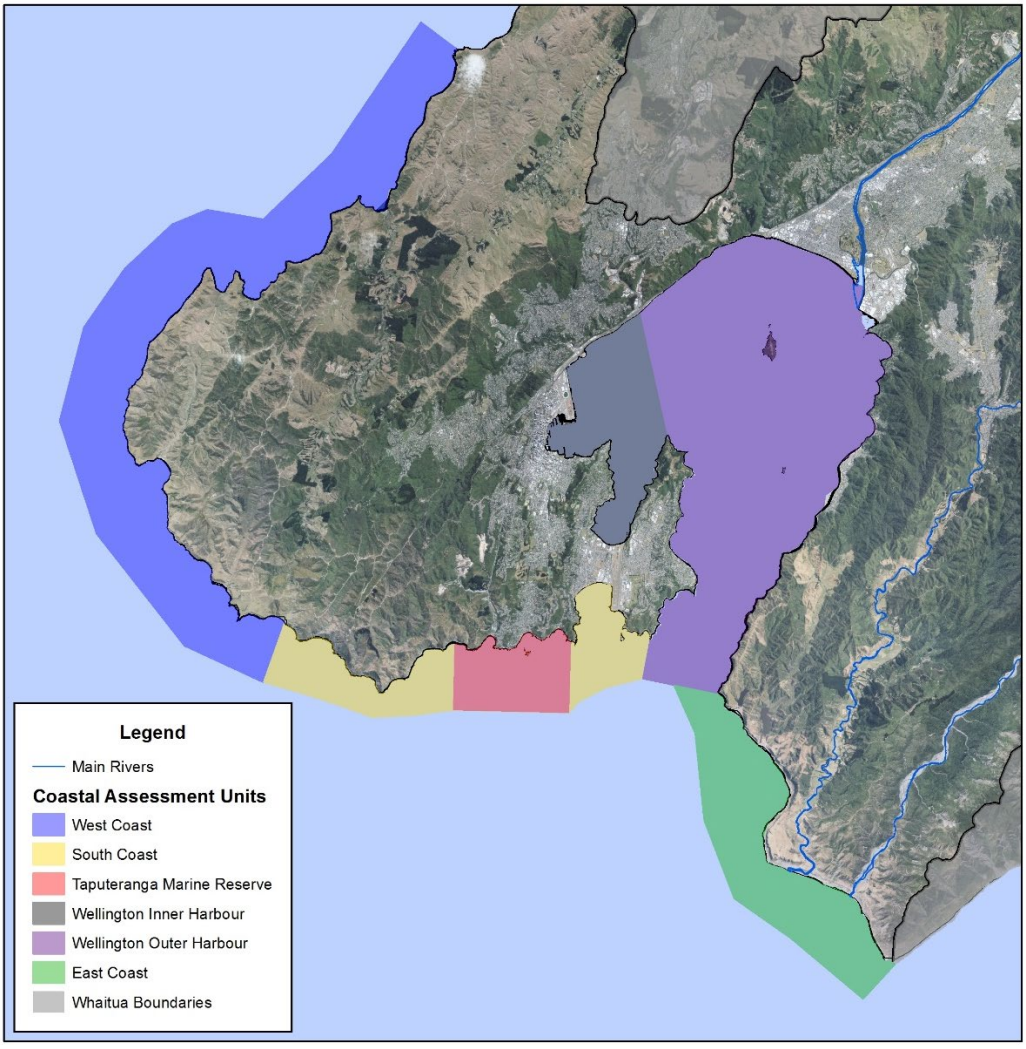
The assessments are ecology-focused and should be considered alongside other scientific, social, cultural, and economic information to assist the Committee with their decision-making.

Approach

The coastal assessment process drew on existing catchment information compiled as part of the freshwater assessment and was supplemented with available data on the current state of estuarine and coastal habitats, and expert input from four marine scientists who specialise in the fields of coastal science, ecology and ecotoxicology.

Five coastal units were defined for assessment; West Coast, South Coast, Wellington Inner Harbour, Wellington Outer Harbour, and East Coast (see inset Figure). Hot spots or locations of interest (e.g. estuaries) were identified within each assessment unit for targeted assessment.

The Panel assessed current state based on four bands (A- Very good, B- Good, C- Fair, D- Poor), using defined narrative or numerical thresholds to score selected attributes, then assessed the expected change under the BAU, IS and WS scenarios. Attributes assessed included sediment metal concentrations (copper and zinc), sediment mud content, phytoplankton and macroalgae (as proxies for nutrient availability), benthic marine invertebrate diversity, and enterococci (as an indicator of faecal contamination affecting recreational water use).



Assessment outcomes

The expected changes to the attributes assessed under the three scenarios are summarised below for each of the Coastal Assessment Units and selected estuaries of interest. There was consensus that BAU would result in ongoing degradation for the majority of the attributes assessed. Under IS, current state conditions were generally maintained or improved. Under WS, there was further improvement in many attributes, but changes predominantly occurred within bands. Specific results for each of the Coastal Assessment Units are presented in the main body of the report.

CAU	Area	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro algae	Phyto-plankton	Macro invert	Entero-cocci		
West Coast	Makara Estuary	Current	A	A	C	C	B	D	C	Fair	Good
		BAU	A↓	A↓	D	C	B	D	C	Poor	Good
		Improved	A	A	C↑	C	B	D↑	C↑	Fair	Good
		WS	A↑	A↑	B	C↑	B↑	D↑	C↑	Fair	Good
	Open Coast West	Current	A	A	A	A	A	A	A	Very good	Very good
		BAU	A	A	A↓	A	A	A	A	Very good	Very good
		Improved	A	A	A	A	A	A	A	Very good	Very good
		WS	A	A	A	A	A	A	A	Very good	Very good
South Coast	Coastal areas	Current	A	A	A	A	A	B	C	Good	Fair/Good
		BAU	A	B	A↓	A	A	B	C	Good	Fair/Good
		Improved	A↑	A	A↑	A	A	B	C↑	Good	Fair/Good
		WS	A↑	A	A↑	A	A	B	C↑	Good	Fair/Good
	Open Coast South	Current	A	A	A	A	A	B	B	Good	Good
		BAU	A	B	A↓	A	A	B	B	Good	Good
		Improved	A↑	A	A↑	A	A	B	B↑	Good	Good
		WS	A↑	A	A↑	A	A	B	B↑	Good	Good
Whole Harbour	Inner	Current	B	A	D	A	A	B	C	Fair	Fair
		BAU	C	B	D↓	A	A	C	C	Poor	Fair
		Improved	B	A	D	A	A	B	C	Fair	Fair
		WS	B↑	A↑	D↑	A	A	B↑	B	Fair	Good
	Outer	Current	A	A	D	A	A	B	C	Fair	Good
		BAU	A↓	A↓	D↓	A	A	B↓	C	Fair	Good
		Improved	A	A	D	A	A	B	B	Fair	Very good
		WS	A↑	A↑	D	A	A	B	B	Fair	Very good

CAU	Area	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro algae	Phyto-plankton	Macro invert	Entero-cocci		
East Coast	Wainui-omata Estuary	Current	A	A	A	A	A	B	B	Fair	Good
		BAU	A↓	A↓	A↓	A↓	A↓	B	B	Fair	Good
		Improved	A	A	A↑	A	A	B	B↑	Good	Good
		WS	A	A	A↑	A	A	B	B↑	Good	Good
	Open Coast East	Current	A	A	A	A	A	A	A	Very good	Good
		BAU	A	A	A	A	A	A	A	Very good	Good
		Improved	A	A	A	A	A	A	A	Very good	Good
		WS	A	A	A	A	A	A	A	Very good	Good

Current = Current state, BAU = Business as Usual, WS = Water Sensitive
A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band

Much of the Harbour edge and sections of the south coast are armoured (Photograph: Salt Ecology, 2017).

Synthesis of findings

The scenarios assessed by the Expert Panel were based on mitigation of existing and predicted land use impacts using currently available methods, rather than considering land use changes or novel mitigation methods. Consequently, even under the most intensive mitigation scenario, only small improvements to ecological health are expected in the marine environment relative to current state.

The key reasons for this are:

- The mitigation scenarios may not reduce contaminants (e.g. fine sediment, nutrients, trace metals, pathogens) sufficiently to make large-scale changes in the coastal environment.

- The receiving environment may have been historically modified to the extent that improvements are not easily achieved – for example, in estuaries that have high sediment loads, or those that have undergone armouring and reclamation.

- There may be legacy effects where past damage will be slow to recover even if the source of the contaminant is removed. For example, areas historically impacted by fine sediment may take tens to hundreds of years to recover because of high retention rates, or contaminants such as trace metals or DDT, which have slow breakdown rates, will persist long after inputs cease.

- The scenarios allow for increasing intensification pressure in the catchment, such that predicted inputs may still increase despite the proposed catchment mitigation.

Overall, there was consensus that BAU would result in ongoing ecological degradation for the majority of the coastal attributes assessed. This was particularly the case for estuaries that are generally the most modified and most sensitive of the coastal environments affected by land-based activities, and less so for open sections of the coast, which have much higher capacity to dilute and assimilate catchment inputs.

Under IS, current state conditions were generally maintained or improved. Changes primarily reflect improvements within the existing state bands and were seldom large enough to shift bands. Under WS, there was further improvement in many attributes, but changes also predominantly occurred within bands. Much of the open coastal receiving environment is currently in a good or very good condition. For estuaries or inner harbour areas that are already degraded, any reversal of past impacts will be very slow or difficult to achieve under the proposed scenarios. The most significant predicted improvements were to human health and recreation from a reduction in pathogen inputs to the coast.

It is emphasised that the absence of large-scale changes does not mean that the incremental improvements predicted are not ecologically significant, particularly at a local scale. Maintaining current state under increasing intensification is in itself a very

positive outcome and the IS and WS scenario are expected to make a significant positive difference. To achieve larger improvements in ecological health, different catchment management scenarios may need to be considered, for example changes in land use rather than mitigation of existing activities.

In addition to the components assessed by the Expert Panel, future climate change and associated sea level rise effects are expected to add additional ecological stress (e.g. habitat displacement, greater competition for food resources, changes in the dilution and flushing of pollutants, elevated water temperatures, and depleted dissolved oxygen). As estuaries are generally the most sensitive of the coastal environments affected by land-based activities, they provide a good indicator of catchment pressures. For this reason, catchment management that maintains a high level of estuary ecological health will go a long way to minimising catchment impacts on the wider coastal environment.

Aerial view of an undeveloped section of the southwest coast (Photograph: Salt Ecology, 2017).

Acronyms

AFRI	Acute Febrile Respiratory Illness
AMBI	AZTI Marine Biotic Index
ANZG	Australia and New Zealand Guidelines for Fresh and Marine Water Quality
AU	Assessment Unit
BAU	Business As Usual
CAU	Coastal Assessment Unit
CBD	Central Business District
CEP	Coastal Expert Panel
CFU	Colony Forming Unit
CMP	Coastal Monitoring Programme
CPA	Commercial Port Area (as zoned in the PNRP)
DDT	Dichlorodiphenyltrichloroethane
DGV	Default Guideline Value (ANZG)
EC	East Coast Assessment Unit
EH	Ecosystem Health
EQR	Ecological Quality Rating
ETI	Estuary Tropic Index
FEP	Freshwater Expert Panel
FWS	Freshwater Scenarios
GI	Gastrointestinal Illness
GWRC	Greater Wellington Regional Council
IS	Improved Scenario
MLWS	Mean Low Water Springs
MCI	Macroinvertebrate Community Index
NZ	New Zealand
OMBT	Opportunistic Macroalgal Blooming Tool
PNRP	Proposed Natural Resources Plan
RWQP	Recreational Water Quality Programme
SC	South Coast Assessment Unit
SFR	Suitability for Recreation
WC	West Coast Assessment Unit
WIH	Wellington Inner Harbour Assessment Unit
WNO	Wastewater Network Overflow
WOH	Wellington Outer Harbour Assessment Unit
WS	Water Sensitive Scenario

Contents

1. Introduction

The Whaitua Te Whanganui-a-Tara Committee was established to set freshwater and coastal objectives and limits for the Te Whanganui-a-Tara Whaitua. The Whaitua coastal area includes estuaries, rocky and sandy intertidal, inshore reef, and benthic sediment habitats, which serve as the primary receiving environments for much of the freshwater flow delivered from the Whaitua.

The Coastal Expert Panel (CEP) was formed to provide scientific advice to the Whaitua Committee on the likely coastal significance of the biophysical effects of different freshwater management scenarios outlined by the Freshwater Expert Panel (FEP). This report discusses the likely environmental state under each of the three Freshwater Scenarios (FWS):

- Business as Usual (BAU) – which assumes all the natural resources plan (NRP) rules are operative and being undertaken at 100% compliance.
- Improved Scenario (IS) – Applies increasing levels of mitigations to the rural/urban environment.
- Water Sensitive Design (WS) – Applies high levels of mitigations to the rural/urban environment, significantly more than BAU.

The BAU scenario predicts the expected trajectory of environmental outcomes based on current urban development trends, the application of current policy settings in the Proposed Natural Resources Plan (PNRP) and the likely effects of climate change. The IS and WS scenario help us understand how improvements to urban development and catchment management might change the expected trajectory of environmental outcomes. These assessments are ecology-focused and should be considered alongside other scientific, social, cultural, and economic information to assist the Committee with their decision-making.

2. Approach

2.1 Coastal Assessment Units

The Coastal Expert Panel assessment process included collation of available data including information collected by the Greater Wellington Regional Council (GWRC) Coastal Monitoring Programme (CMP) and the Recreational Water Quality Programme (RWQP). Outcomes were supported by input from four marine scientists who specialise in the fields of coastal science, ecology, and ecotoxicology. The assessment process also drew on the literature, pre-existing catchment information, and information compiled by the Freshwater Expert Panel.

Five Coastal Assessment Units (CAUs), shown in Figure 2.1, were defined based on their current state. Hot spots, or locations of interest, were identified within each assessment unit as outlined below.

CAU	Area
West Coast	North of Makara to the west of Karori Stream Focus area: Makara Estuary
South Coast	Karori Stream to the east of Tarakena Bay Focus areas: Karori Stream mouth, Ōwhiro Bay, Island Bay, Taputeranga Marine Reserve, Lyall Bay/Moa Point
Inner Harbour	West of Point Halswell to Ngauranga Gorge Focus areas: Evans Bay, Oriental Bay, Queens Wharf, Kaiwharawhara
Outer Harbour	East of Point Halswell to Ngauranga Gorge, to Pencarrow Head Focus areas: Hutt Estuary, Eastbourne
East Coast	Pencarrow Head to Turakirae Head Focus area: Wainuiomata Estuary

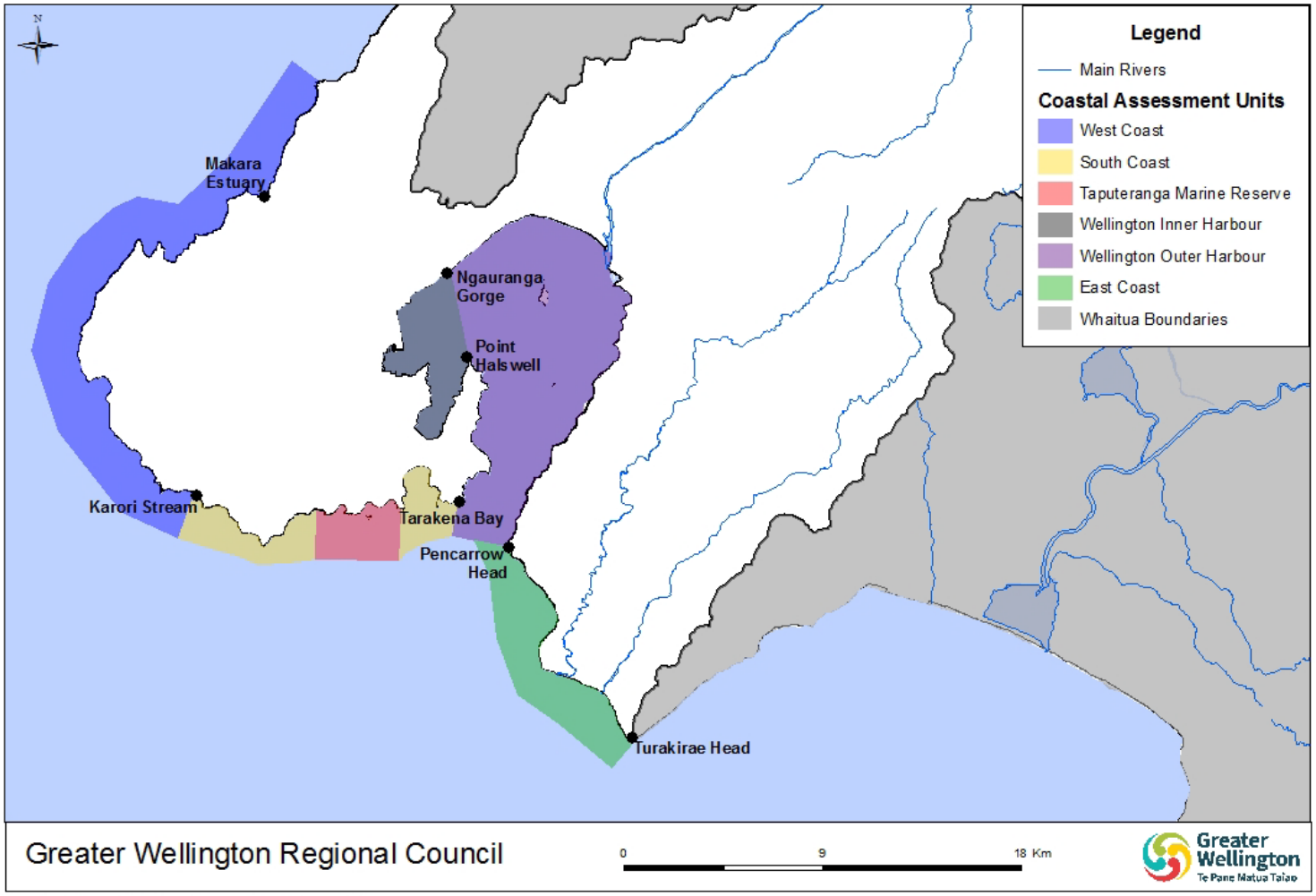


Figure 2.1: Coastal Assessment Units within Whaitua Te-Whanganui-a-Tara

2.2 Attributes

The expert panel proposed a set of attributes (Table 2.1) to characterise ecological health in relation to common catchment pressures (i.e. sediment, nutrients, disease-causing organisms, contaminants), and a scoring method based on defined narrative or numerical thresholds (Table 2.2) to assess expected environmental change under each of the three management scenarios. Bands A to D (A - Very good, B - Good, C - Fair, D - Poor) were used to define the current state of aquatic ecosystem health, which represents the degree to which an aquatic ecosystem is able to sustain its ecological structure, processes, functions, and resilience within a natural range of variability. The bands were used to assess each attribute based on available information and expert opinion. Expected change under the 'Business as Usual', 'Improved' and 'Water Sensitive' scenarios was then assessed.

The underlying principle for the selection of band thresholds was that the risk of adverse ecological effects increases from weak to strong as habitat quality deviates from a natural, undisturbed state to that of an ecosystem affected by disturbance or pollution. The assessment of predicted ecological effects were based upon a combination of objective and subjective measures and provide an environmentally conservative interpretation of risk with respect to the potential effects of the scenarios, especially where data were sparse.

Attributes assessed included the following indicators of wider ecosystem health (Table 2.1):

- trace metal concentrations in marine sediment
- mud content of sediments, and areal extent of mud-dominated sediment
- macroalgae
- phytoplankton
- benthic marine invertebrates
- enterococci

Overall Ecosystem Health (EH) and overall Suitability for Recreation (SFR) were two high-level attributes narratively assessed to allow the expert panel to comment on the potential effects that any changes in the core attributes may have on overall ecosystem health, recreational values, or any data deficient aspects (i.e. emerging contaminants).

Table 2.1: Attributes used for the assessment of ecosystem health

Attribute	Description
Metals in sediment • Zinc • Copper	Trace metals occur naturally in the environment but high concentrations can be harmful to flora and fauna (biota). Metals bind to sediment, which is transported along waterways from urban environments and accumulates in estuarine and coastal environments. This attribute is assessed by measures of zinc and copper (as indicators of a wider suite of contaminants) bound to sediment in receiving environments, and indicates the potential risk of contaminant effects occurring on animals living within this sediment.
Extent and proportion of muddy sediment	Mud is fine sediment (grain size <63 µm) that feels smooth between your fingers. This attribute measures not only the proportion of mud within sediment at selected sites (sediment "muddiness"), but also the spatial extent of sediment that is mud-dominated (i.e. the area of sediment with >50% mud content). 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, water clarity, aesthetics, recreational values, and mahinga kai. Elevated rates of sediment deposition in coastal and estuarine environments can affect ecological health through alteration/degradation of habitat, smothering of biota, and reduction in water clarity. Where deposition data are unavailable, predictive models of current sedimentation rates compared to natural rates may be used as a proxy.
Macroalgae	Long-lasting, persistent blooms of macroalgae 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 a proxy for excessive inputs of nutrients, primarily nitrogen, which is generally the limiting nutrient in coastal environments.
Phytoplankton Biomass	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.
Benthic marine invertebrate diversity	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. There are many indices of marine invertebrate health and we do not yet have a universal index applicable to all marine habitat types or stressors. Rather, we have several indices each developed for specific purposes and each have been taken into consideration for this assessment.
Enterococci	Pathogens (bacteria, viruses, and protozoa) are found in the faecal material of mammals and birds, and are capable of causing infection/sickness in humans. The presence of waterborne pathogens indicates how healthy the water is for recreation and mahinga kai. Enterococci are an indicator of pathogen risk distinguished by their ability to survive in salt water and are typically more human-specific than other disease risk indicators.

2.3 Attribute assessment framework

Data available for each part of the coast were assessed according to the criteria listed in Table 2.2 for each attribute. The spatial extent of mud-dominated substrates was assessed using indicator thresholds derived from broad scale estuary mapping assessments throughout New Zealand (e.g. Stevens and Forrest 2020). Sedimentation rate, macroalgae, phytoplankton biomass (measured as chlorophyll-a 90th percentile), and mud content were assessed using general indicator thresholds derived from a New Zealand Estuarine Tropic Index (ETI) (Robertson *et al*. 2016).

Copper and zinc thresholds were based on Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018). The Default Guideline Value (DGV) and Guideline Value-High (GV-high) specified in ANZG are thresholds that can be interpreted as reflecting the potential for 'possible' or 'probable' ecological effects, respectively. Thresholds were scaled as follows: Very good = <0.5 x DGV; Good = 0.5 x DGV to <DGV; Moderate = DGV to <GV-high; Poor = ≥GV-high.

Enterococci were assessed according to the Microbiological Water Quality Guidelines (MfE 2003). The PNRP objectives for maintaining satisfactory primary contact recreation, Māori customary use for achievement of huanga (benefits) identified by mana whenua, and mahinga kai are less than 500 enterococci per 100 mL (PNRP appeals version 2019). Suitability for Recreation (SFR) was defined as the degree to which a body of water is not visibly polluted, is accessible, is able to be used safely for contact recreation, and provides for mahinga kai. Although poor water quality is commonly experienced in winter, enterococci levels can also spike in summer due to low flow. As a result, the assessment tables report on the lowest overall rating regardless of whether they were experienced in summer or winter.

Since the Harbour lacks an 'open coast' environment, assessments were summarised into 'whole inner harbour' and 'whole outer harbour' categories to simplify the comparison of current state and expected changes under the freshwater scenarios. This was done by listing the lowest scoring assessment category from each of the areas of interest. Full assessment details for each of the areas of interest can be found in the assessment tables in the Appendix.

Table 2.2: Assessment criteria applied to each attribute for the coastal environment

Indicator		Unit	A	B	C	D
			Very good	Good	Fair	Poor
Metals	Copper (Cu)	mg/kg	< 32.5	32.5 to <65	65 to < 270	≥ 270
	Zinc (Zn)	mg/kg	< 100	100 to <200	200 to < 410	≥ 410
Mud	Mud-dominated substrate	% of area >50% mud	< 1	1-5	> 5-15	> 15
	Sedimentation rate	Current vs Natural Sedimentation Rate Ratio	1 to 1.1	1.1 to 2	2 to 5	> 5
	Mud content	% of sample	< 5	5 to < 10	10 to < 25	≥ 25
Nutrients	Macroalgae - Opportunistic Macroalgal Blooming Tool (OMBT) index	Ecological Quality Rating (EQR)	≥ 0.8 - 1.0	≥ 0.6 - < 0.8	≥ 0.4 - < 0.6	0.0 - < 0.4
	Phytoplankton biomass (estuaries)	µg/l	< 5	5 to 10	> 10 to 16	> 16
	Phytoplankton biomass (open coast)	µg/l	< 3	3 to 8	8 to 12	>12
Macroinvertebrates	Benthic marine invertebrate diversity	Subjective	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
Enterococci	95th percentile	cfu/100 mL	≤ 40	≤ 200	≤ 500	> 500
	Percentage exceedances over 500 enterococci/100mL	%	≤ 5%	≤ 10%	≤ 20%	> 20%
	Estimated risk from a single exposure	%	GI < 1% AFRI < 0.3%	GI 1 to 5% AFRI 0.3 to 2%	GI 5 to 10% AFRI 2 to 4%	GI > 10% AFRI > 4%
	Estimated amount of time probability of gastrointestinal illness (GI) > 10% and acute febrile respiratory illness (AFRI) > 4%	% of time	< 5% of the time	5 to 10% of the time	10 to 20% of the time	> 20% of the time

2.4 Assessment of change

Each attribute was assessed based on current state conditions, and the degree of change (improvement or deterioration of environmental health) expected under the three management scenarios. Changes in state were rated according to the criteria listed in Table2.3. A two-score change resulted in a shift between scoring bands, while a one-score change did not. For the latter, where there was no shift in the predicted band, the direction of change was indicated by an arrow (↑ or ↓) in the assessment tables (see Appendix for Assessment tables).

Table 2.3: Assessment of environmental change

Score	Change	Definition
-3	Large negative	A significant degradation in contaminant concentration or environmental state expected, likely resulting in a decline of two attribute states.
-2	Moderate negative	A marked degradation in contaminant concentration or environmental state expected, likely resulting in a decline of one attribute state.
-1	Small negative	A detectable degradation in contaminant concentration or environmental state expected; however, a decline in attribute state is unlikely. Indicated by ↓ in the assessment tables.
0	None or negligible	Changes in contaminant concentration or environmental state is non-existent or unlikely to be detectable.
+1	Small positive	A detectable improvement in contaminant concentration or environmental state expected; however, an increase in attribute state is unlikely. Indicated by ↑ in the assessment tables.
+2	Moderate positive	A marked improvement in contaminant concentration or environmental state expected, likely resulting in an increase of one attribute state.
+3	Large positive	A significant improvement in contaminant concentration or environmental state expected, likely resulting in an improvement of two attribute states.
++3	Strong positive	Changes in a metric are likely to result in a significant improvement for one or more higher-order metrics (i.e. life supporting capacity or contact recreation restored).

Confidence was assessed as low, moderate, or high according to the availability and quality of data. Scores were displayed as asterisks in the full assessment tables (see Appendix for Assessment tables).

- **Low confidence (*)** – Data on current state of metric is limited, of poor quality, or is conflicting. Limited research available on the response of metrics to the changes applied in the scenario. Relationships between metric and key drivers not well understood or predictable.

- **Moderate confidence (**)** – Data on current state of metric available but has some limitations (i.e. poor spatial resolution), or basic modelling data

available. Some research available on the response of metrics to the changes applied in the scenario. Relationships between metric and key drivers well documented but not predictable.

- **High confidence (***)** - Data on current state of metric available for much of the assessment unit, or high-resolution modelling data available. Good research available on the response of metrics to the changes applied in the scenario. Relationships between metric and key drivers well understood and predictable.

Wellington swimming beaches are popular recreational areas in summer (Photograph: Salt Ecology, 2017).

3. Coastal Assessment Units

The site descriptions and assessments of existing state were summarised from the Whaitua Te Whanganui-a-Tara coastal habitat vulnerability and ecological condition report (Stevens 2018), while scenario assessments were written based on expert panel discussions and scoring. The location of the coastal assessment units are presented in (Figure 2.1).

3.1 West Coast Assessment Unit

This section of coastline is relatively undeveloped as the terrain is dominated by cliffs, rocky shores, and steep gravel or cobble beaches. Vegetation cover on the cliffs is sparse and land cover is dominated by pasture, regenerating scrub, and forest. Streams that discharge to the coast are generally small with small, low diversity, ephemeral freshwater-dominated estuaries around gravel beaches. Makara Estuary has the only notable saltmarsh and dune area in this CAU. Rocky shore habitat and offshore reefs host a high biodiversity of marine species.

3.1.1 Existing state

The existing state of the coastal habitat is good due to limited land-based public access, and relatively low intensity grazing in the catchment. However, the pasture-dominated catchment contributes elevated fine sediment to the coastal environment compared to natural state conditions and the past clearance of native cover has transformed the terrestrial margin and many dunes to areas dominated by exotic weeds and plants. Localised hillside erosion is relatively common, particularly on coastal cliff faces. There are several water outlets including two stormwater outlets at Makara Beach, and one stormwater outlet and one treated wastewater outlet at the mouth of Karori Stream that affect water quality in the immediate vicinity of the outfall; however, metal contaminants are generally low due to urban inputs being relatively low combined with mixing in high energy open coastal areas. There is localised depletion of rocky shore and reef biota as a consequence of fishing, diving and harvesting. Other human activities include walking, mountain biking, and customary uses around Waiariki Stream mouth, Oterongo Bay, Ohau Bay, and Wharehou Bay. Additional issues and threats for this section of coastline include climate change and coastal property development.

Makara Estuary, a key site of interest, is currently in a degraded condition, primarily due to elevated inputs of fine sediment and nutrients contributing to poor sediment oxygenation, frequent blooms of nuisance algae and soft anoxic subtidal muds and gravels in the lower estuary. Although naturally low in species-richness, Makara supports an even sparser macroinvertebrate community than expected. Other stressors include two stormwater outlets, historical drainage and stock grazing of saltmarsh, the presence of weed and pest plant species, and riverbank erosion. Makara Estuary is moderately susceptible to nutrient enrichment due to intermittent mouth restriction, which may promote phytoplankton and macroalgal blooms under restricted flow conditions. Nevertheless, Makara Estuary has good potential for

restoration and is a very under-represented habitat type on the southwest coast with a high priority for protection.

3.1.2 Assessment of freshwater scenarios

The expected impacts of the three freshwater scenarios are summarised in Table 3.1 for both the Makara Estuary and the offshore coastal environment seaward of Mean Low Water Springs (MLWS).

(a) Makara Estuary

Within Makara Estuary, key components of ecosystem functioning are currently present in a degraded state, which will cause the system to continue functioning at suboptimal levels under BAU. A small decrease in fine sediment inputs is anticipated under the IS, but is unlikely to result in noticeable improvements in the Estuary. Under the WS scenario, a decrease in opportunistic macroalgae is expected due to a reduction of nutrient inputs, while a measurable improvement in mud condition is expected over the longer term through reduced catchment inputs and the protection of saltmarsh from grazing, land clearance and drainage.

During dry weather, estuarine water is suitable for recreation but suitability declines after heavy rainfall as catchment wide faecal contaminants from septic tanks and rural runoff wash downstream. Suitability for Recreation is not expected to change under BAU, although some improvement is likely from a small reduction in catchment derived contaminants (i.e. pathogens, sediment) under the IS and WS scenarios.

(b) Open Coast West

Due to the low influence of catchment sourced nutrients, pathogens and sediment on the open coast, no improvement in ecological condition is expected under the BAU, IS or the WS scenarios. Although the open coast is suitable for recreation insofar as the water quality is good, Suitability for Recreation may be temporarily limited after heavy rain due to faecal contaminant delivery from the catchment. Due to the highly dynamic nature of the coastal environment, conditions will return to a suitable state shortly after adverse weather passes. Slight improvements in catchment sources will maintain the current state but no change is expected under any of the three scenarios.

Table 3.1: Current attribute states and CEP assessments for the West Coast

Area	Scenario	Sediment quality			Ecology			Human health
		Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	*Enterococci*
Makara Estuary	Current	A	A	C	C	B	D	C
	BAU	A↓	A↓	D	C	B	D	C
	Improved	A	A	C↑	C	B	D↑	C↑
	WS	A↑	A↑	B	C↑	B↑	D↑	C↑
Open Coast West	Current	A	A	A	A	A	A	A
	BAU	A	A	A↓	A	A	A	A
	Improved	A	A	A	A	A	A	A
	WS	A	A	A	A	A	A	A

Current = Current state, BAU = Business as Usual, WS = Water Sensitive

A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band

3.2 South Coast Assessment Unit

The South Coast is characterised by high biodiversity rocky shores and reefs interspersed by a string of embayments, most with small stream mouth estuaries. These estuaries are freshwater and gravel dominated, lack intertidal flats and saltmarsh, and are often piped or channelised. Most bays have steep gravel dominated beaches with dumping waves, and a narrow inshore beach margin with grasses, marram, flaxes and scrub species growing below the road. The steep and coarse beach sediments are not naturally species-rich, primarily due to the very harsh physical conditions present. Lyall Bay, the largest of these bays, is an exception with a sandy, low gradient beach and dunes that have been extensively revegetated and are actively managed. A rock revetment lies at the western end of Lyall Bay retaining reclaimed land for the airport runway. Between Ōwhiro Bay and Houghton Bay lies the Taputeranga Marine Reserve, which is a no take zone for marine species.

3.2.1 Existing state

Habitat along the south coast is in a good state given its well-flushed nature and the protection provided by the Taputeranga Marine Reserve, although exceptions may be found around localised areas where stormwater and treated wastewater discharges impact water quality close to the shore (i.e. Lyall Bay, Moa Point, Tarakena Bay), as evident in previous exceedances of shellfish disease risk criteria. Although this highly dynamic stretch of coast is less vulnerable to the accumulation of sediments and associated contaminants than more sheltered areas, the impact of suspended sediments and emerging contaminants (i.e. from landfill leachate and personal care products, medicine etc. in wastewater) on the reproductive success, settlement and development of organisms is unknown.

The embayments along this section of the coastline are popular for fishing and shellfish collection where permitted, which has resulted in localised depletion of some rocky habitat biota. Recreational diving, scientific activities, boating, swimming, surfing, walking, picnics, and scenic driving are popular along this section of the coast, and Red Rocks is a significant customary kaimoana area. Stressors include human pressure on fish and shellfish stocks, changes in water quality through stormwater and wastewater discharges, weed and pest invasions, including toxic algal blooms, intertidal habitat loss, and the loss of the natural upper beach berm and dunes.

3.2.2 Assessment of freshwater scenarios

Full scoring for the areas of interest along the coast are presented in the assessment tables (see Appendix) but for brevity are grouped into a 'Coastal Areas' category in Table 3.2. Scores for the Open Coast South relate to waters influenced by currents, waves and other coastal processes rather than areas immediately on the coast.

(a) Coastal areas

Key ecosystem components are expected to continue functioning well under all freshwater scenarios, although longer-term pressure from sea level rise will result in coastal squeeze between shoreline habitat and infrastructure, with habitat loss likely. Under BAU a predicted 9% increase in zinc and 27% increase in copper deposited into the coastal environment will likely result in the degradation of environmental health. There is also potential for a small increase in the accumulation of mud in stream mouths, and periodic deposition of mud on rocky habitats, although any impact is likely to be small and temporary. Nuisance macroalgae and phytoplankton are currently not an obvious issue in any of the smaller stream estuaries.

Overall Suitability for Recreation is good with access to the coast largely unrestricted. At Karori Stream and Ōwhiro Bay Suitability for Recreation can be impacted by reduced clarity of the near-shore coast due to sediment inputs and faecal contamination during wet weather. The use of the area for mahinga kai is expected to be low and the collection of filter feeding shellfish is not recommended.

(b) Open Coast South

This highly dynamic stretch of coast is less vulnerable to the accumulation of sediments and associated contaminants than more sheltered areas; however, the impact of emerging contaminants on fish and reef species is unknown and periodic deposition of sediment could be problematic for taonga species. Copper loads are expected to increase under BAU, which could at very high levels impact reproduction and survival of invertebrates such as kina and pāua, although it is considered unlikely that such thresholds will be reached on the open coast. Under IS and WS scenarios, copper and zinc concentrations, and mud content are predicted to reduce.

Suitability for swimming and other types of recreation is good but can become slightly limited during periods of reduced water quality following heavy rain, and during rough weather that will prevent recreational use of the shoreline. Under IS and WS scenarios, small improvements are predicted.

Table 3.2: Current attribute states and CEP assessments for the South Coast

Area	Scenario	Sediment quality			Ecology			Human health
		Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	*Enterococci*
Coastal areas	Current	A	A	A	A	A	B	C
	BAU	A	B	A↓	A	A	B	C
	Improved	A↑	A	A↑	A	A	B	C↑
	WS	A↑	A	A↑	A	A	B	C↑
Open Coast South	Current	A	A	A	A	A	B	B
	BAU	A	B	A↓	A	A	B	B
	Improved	A↑	A	A↑	A	A	B	B↑
	WS	A↑	A	A↑	A	A	B	B↑

Current = Current state, BAU = Business as Usual, WS = Water Sensitive
A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band

3.3 Wellington Inner Harbour Assessment Unit

Wellington Harbour is a large, deep, sheltered basin that is relatively well flushed by clean seawater on each tide. Intertidal margins are largely modified by seawalls (69%) but the remaining natural habitat is mostly rocky in nature with a few small pocket beaches (Oriental Bay being an artificial coarse sand beach), and gravel dominated beaches near the Harbour entrance. Evans Bay has rocky shores with many narrow rock/cobble embayments (Shelly, Kio, Weka, Balaena, Little Karaka, and Shark Bays), while sandy gravel beaches are found at Hataitai and Kio Bay.

The majority of the smaller stream estuaries flowing into the Inner Harbour have been piped and modified with only the larger estuaries still functioning as significant open waterways. The scarcity of these remaining habitats places a high level of importance on maintaining and enhancing their ecological values. The Harbour has lost much of its previously extensive dune land, saltmarsh, and tidal flat areas to reclamation, including the Wellington commercial port area near the Kaiwharawhara Estuary. Although highly modified, this tidal river mouth estuary is a vital part of the connection between the sea and the upper catchment (which includes the Zealandia Wildlife Sanctuary), and the scarcity of this type of habitat in the Harbour makes it a priority for protection and restoration.

3.3.1 Existing state

The Inner Harbour is a high use area for commercial shipping, recreational boating, swimming, fishing, diving, shellfish gathering, scientific study, and land-based recreational activities, and provides great cultural significance to iwi. In December 2012, a Deed of Settlement was signed between Ngati Toa Rangātira and the Crown that recognises the role of Ngati Toa as kaitiaki of the coastal marine area of Wellington Harbour.

Kaiwharawhara Estuary is the most significant estuary in this part of the Harbour, but is highly modified. Margins comprise vertical concrete channels and gabion baskets, while large parts of the lower estuary are covered over by road and rail bridges. Habitat diversity is low given the modified upstream channel, dominance of coarse gravel and cobble substrate, and absence of vegetation providing poor habitat for native fish, tidal flat organisms and birds. Water is generally clear and the sediments well oxygenated but elevated E. coli and nutrient levels are common and high concentrations of Dichlorodiphenyltrichloroethane (DDT), lead and zinc have been recorded.

Across the wider Inner Harbour, biota have been affected by large changes following urbanisation, although biodiversity is still moderately high in the remaining marine habitats. Rocky shores and reefs are biodiverse and sandy beach habitats support a wide variety of sand dwelling invertebrates. Many areas of soft sediment habitat on the Harbour floor support high macroinvertebrate diversity. Biota imported on marine vessels (e.g. the Asian kelp Undaria) are present in the Harbour. Microscopic phytoplankton, zooplankton and various fish species inhabit the open water environment and occasionally migratory whales, dolphins, seals and resident penguins utilise the area for food.

Because the Harbour is relatively deep and sheltered, it acts as a natural settling basin for sediment, nutrients, pathogens and toxicants. However, it is also relatively well flushed with clean seawater each tide and so has a certain resilience to degradation. The muddy harbour bed habitat is most susceptible to toxins and organic build-up, while the relatively resilient rocky habitat is susceptible to excessive sediment, invasive pests and human disturbance. Metal concentrations are highest in areas adjacent to major urban stormwater inputs, such as Queens Wharf, near the Port, and adjacent to the central business district (CBD). Subtidal sites close to shore in southern Evans Bay are predominantly sandy and do not pose a significant metal contamination risk.

Harbour waters are generally of good quality except in areas affected by river plumes during rain events and near stormwater outfalls. Lowered water clarity, excessive sedimentation, metal contaminants, faecal bacteria, and excessive nutrients are the major factors affecting the Inner Harbour environment. Other important stressors include habitat modification, reclamation, marina activities, point source and non-point discharges, invasive marine pest species, vessel activities, and contaminant spills. Historically, many point-source discharges existed and although urban stormwater outfalls are the only

remaining direct contributors of localised contaminants, sewer overflows during wet weather are common.

3.3.2 Assessment of freshwater scenarios

The expected impacts of the three freshwater scenarios are summarised in Table 3.3 for the coastal Harbour environment seaward of Mean Low Water Springs (MLWS). Detail for the Kaiwharawhara Estuary is presented in the assessment tables (see Appendix).

(a) Kaiwharawhara Estuary

As Kaiwharawhara Estuary is excessively modified, sediment and associated metals do not accumulate and the system no longer functions as an estuary. The current state is considered fair for macroinvertebrates and human health, and very good for all other indicators. No change is predicted under BAU. Enterococci is predicted to improve significantly under IS and WS scenarios, with metals and mud showing a slight improvement under the WS scenario.

(b) Coastal areas

Harbour monitoring over the last 20 years has shown a significant increase in mud and metal concentrations at Inner Harbour sites. Mud is rated poor and although metal concentrations are currently rated very good, without treatment of stormwater and sediment mitigation the concentrations of these contaminants are expected to increase. Benthic biodiversity is currently in a good condition; however, biodiversity and natural ecological processes can be expected to decline under BAU.

The IS will result in a reduction in mud and metal contaminant concentrations entering the Harbour, which is expected to halt further environmental degradation; however, no noticeable improvement in environmental health is expected from the current state. Improvement in metal concentrations in deep subtidal areas is expected over a period greater than 50 years under the WS scenario, while improvements in mud content and macrofaunal health are expected to be apparent over shorter time periods. Swimming water quality will improve under the IS and WS scenario; however, suitability for mahinga kai may continue to be compromised due to the presence of faecal contaminants and reduced access in some areas.

Table 3.3: Current attribute states and CEP assessments for Wellington Inner Harbour

Area	Scenario	Sediment quality			Ecology			Human health
		Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	*Enterococci*
Whole Inner Harbour	Current	B	A	D	A	A	B	C
	BAU	C	B	D↓	A	A	C	C
	Improved	B	A	D	A	A	B	B
	WS	B↑	A↑	D↑	A	A	B↑	B

Current = Current state, BAU = Business as Usual, WS = Water Sensitive

A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band

3.4 Wellington Outer Harbour Assessment Unit

As for the previous CAU, this part of Wellington Harbour is a large, deep, sheltered basin that is relatively well flushed by clean seawater on each tide. Sandy beaches are located at Petone, Lowry Bay and Days Bay. A string of urban embayments separated by hard rocky shores and reefs extends southward from Seaview (i.e. Sorrento, Lowry, York, Mahina, Sunshine, Days, Rona, Eastbourne, and Robinson Bays). The Hutt River discharges sediment, nutrients, pathogens and possibly toxicants to the harbour during high flows. The scarcity of estuarine habitat in the Harbour makes both the Hutt/Waiwhetu and Korokoro estuaries a high priority for protection and restoration.

3.4.1 Existing state

The stretch of coastline between Seaview and Pencarrow Head is utilised for swimming, fishing, boating, shellfish collection, diving, and its scenic value. The coastline has lost much of its previously extensive dune land, saltmarsh and tidal flat areas, with large areas reclaimed at the commercial area of Seaview to the east of the Hutt River mouth. Despite the construction of coastal seawalls, rocky shores and inshore reefs are biodiverse. Sandy beach habitat generally supports a wide variety of sand dwelling invertebrates, while steep gravel and cobble beaches (e.g. Eastbourne, Camp Bay) tend to have less diversity due to the highly mobile sediments. Beaches are typically narrow, of moderate gradient and are a mix of sand, gravel and cobbles. The inshore beach vegetated margin is either weedy and narrow or non-existent, and dunes are rare having been affected by development around the Harbour. Small areas of seagrass are present in the shallow subtidal areas of Lowry Bay. The coastline between Camp Bay and Pencarrow Head consists of a rural and uninhabited stretch of isolated, moderately sheltered rocky shore and shallow subtidal reef habitat with high to moderate biodiversity values. Camp Bay is a steep gravel cobble beach, with a small area of pingao dune field. Treated wastewater from the Hutt Valley and Wainuiomata is discharged at Pencarrow Head.

(a) Hutt Estuary

The Hutt Estuary (including the Waiwhetu Stream) is a tidal river estuary that drains into Wellington Harbour at the eastern end of Petone Beach. It has been

extensively reclaimed and modified by stabilised boulder riprap banks supporting low biodiversity. The only areas suitable for inanga spawning are near the mouth where margin vegetation provides reasonable spawning habitat. Saltmarsh and tidal flat habitat was once extensive but reclamation has reduced this habitat drastically. The scarcity of these habitat types in Wellington Harbour, and the functioning of the estuary as an access corridor for migratory fish and birds and as a nursery area for juvenile flatfish, makes it a very high priority for protection and restoration.

Human use of the Hutt Estuary is high with recreational paths running along the length of the estuarine area on both banks. The area is also used for boating, bird watching, conservation activities, white baiting, and fishing. Stressors include stormwater, riprap margins, non-point discharges (e.g. urban streams), historical drainage, weed and pest invasions, tidal flap gates, harvesting of fish and shellfish, and dredging. Te Āti Awa iwi have advocated for the planting of native bush and restoration of wetlands on the river margins, and tighter restrictions on industrial discharge.

Habitat diversity in the Hutt Estuary is low with significantly degraded subtidal macroinvertebrate communities given the straightened and armoured channel margins and severely reduced area of tidal flats and saltmarsh. Water quality monitoring in the Hutt River has indicated low nutrient and E.coli concentrations upstream of the Waione Bridge, but contamination from urban stormwater and industrial sources remains a risk. Nutrient inputs from groundwater may also occur. Because of its high volume, the Hutt River is the major contributor of nutrients, sediment and contaminants to the Harbour. Intertidal estuarine sediments are in good health, but in dredged areas downstream where water is deeper, sediments are enriched, anoxic and have elevated concentrations of nutrients and some heavy metals including mercury, nickel and zinc. Opportunistic macroalgae is present throughout the intertidal area but not at nuisance levels, although it can be very extensive subtidally possibly due to catchment or localised nutrient inputs. Toxic algae are frequently reported and high levels of enterococci are occasionally of concern at Petone Beach.

(b) Korokoro Estuary

The heavily modified tidal river estuary located at the mouth of the Korokoro Stream at the western end of Petone Beach supports a small area of planted saltmarsh vegetation suitable for inanga spawning. Migratory native freshwater fish species have been found in the catchment indicating that the estuary is an important migratory pathway. Human use of Korokoro Estuary is moderate; the lower reaches are primarily used for recreation, picnics, bathing, fishing, and dog walking. Gravel extraction due to flood conveyance works causes significant stream disturbance, while beach visitors and dogs discourage bird roosting or nesting. Ecologically, habitat diversity is low, given the modified upstream channel, absence of tidal flats, and limited saltmarsh vegetation. Stream and estuarine water quality is expected to be relatively good reflecting the dominant native forest land use; however, in the lower reaches it passes

through road and rail corridors and an industrial estate where stormwater contaminants may be present. Estimated nutrient loadings are high, although retention in the estuary is likely to be low due to high flushing. The estuary is freshwater dominated at low tide and water is commonly clear and flows over gravel and mud sediments that show little sign of anoxic conditions, although organic matter does accumulate and rot in parts of the lower estuary.

3.4.2 Assessment of freshwater scenarios

The current state of selected coastal indicators and the changes predicted by the panel for each freshwater scenario is summarised in Table 3.4.

The Outer Harbour was defined as the area removed from central port activities, although some commercial activities are based at Seaview. Coastal water in the Outer Harbour is generally of good quality except during rain events when big plumes exit the Hutt River mouth carrying sediment and other contaminants into Harbour waters. Although affected by urbanisation, biodiversity is still relatively high in remaining habitats. Mud content is the major issue and is higher in the subtidal depositional zones of the central harbour basin and subtidal areas of the Hutt Estuary. Metal contaminants in these areas are generally low because of their distance from the Port and Wellington City, although there are likely to be historic and potentially ongoing localised inputs from urban and industrial sources to the Hutt Estuary and Waiwhetu Stream.

Key ecosystem components are present and functioning well but subtidal sediment deposition zones are expected to continue to degrade under BAU. Under the IS and WSS, a significant improvement in infrastructure is likely to result in an improvement in state for enterococci; however, mud content in the subtidal depositional zones of the central harbour basin and subtidal areas of the Hutt Estuary are not expected to change in the short to medium term.

The overall Suitability for Recreation of the Outer Harbour is considered good, although this can drop to fair in close proximity to the shoreline after heavy rainfall. Access for recreational users is largely unrestricted, with the exception of the Commercial Port Area (CPA). Mahinga kai related practices may be restricted along the shoreline and water quality is compromised in localised areas, but deeper areas are generally safe for collection of kai moana.

Table 3.4: Current attribute states and CEP assessments for Wellington Outer Harbour

Area	Scenario	Sediment quality			Ecology			Human health
		Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci
Korokoro Estuary	Current	A	A	A	B	A	C	C
	BAU	A↓	A↓	A↓	B↓	A	D	C
	Improved	A	A	A↑	B↑	A	C↑	B
	WS	A↑	A↑	A↑	A	A	B	B
Hutt Estuary	Current	A	A	B	C	A	C	C
	BAU	A↓	A↓	B↓	C↓	A	D	C
	Improved	A	A	B↑	C↑	A	C↑	B
	WS	A↑	A↑	B↑	B	A	B	B
Outer Harbour	Current	A	A	D	A	A	B	C
	BAU	A↓	A↓	D↓	A	A	B↓	C
	Improved	A	A	D	A	A	B	B
	WS	A↑	A↑	D	A	A	B	B

Current = Current state, BAU = Business as Usual, WS = Water Sensitive

A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band

3.5 East Coast Assessment Unit

The coastline from Pencarrow Head to Wainuiomata Estuary features exposed, relatively wide, steep gravel beaches, with rocky reefs and outcrops offshore. Vegetation cover on the cliffs is relatively sparse and is dominated by pasture and regenerating scrub and forest. Much of the catchment is within the Rimutaka 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 but include weed growth. Streams that discharge to the coast are generally small and lack stream mouth estuaries but where present, estuaries are small and freshwater dominated. Two freshwater lakes are present east of Pencarrow Head, Lake Kohangapiripiri and Lake Kohangatera. The Wainuiomata Estuary, a key area of interest, is dominated by gravel and sand with very little soft sediment habitat present. Vegetation is scarce and characterised by terrestrial plants with no evidence of saltmarsh species.

3.5.1 Existing state

There is limited direct road access to much of the coast, which restricts public usage. Activities in the area include fishing, shellfish collection, diving, boating, surfing, walking, rock climbing, scenic viewing, and gravel extraction at Fitzroy Bay. The Wainuiomata Estuary receives moderate recreational use, with some surfing and surfcasting activity on the adjacent beach. The river mouth is the

access point for rock climbers that scale the boulders at Baring Head and Fitzroy Bay.

The existing state of all habitat types is expected to be good given its relative remoteness, but the area is close to a large population centre and serves as a popular fishing and diving destination. Rocky shore and shallow subtidal reef habitat has the highest ecological and human use value and is most susceptible to human pressure through over-fishing. Although low in intensity, grazing in the pasture-dominated catchment is likely to contribute elevated fine sediment compared to natural state conditions. Other stressors include habitat change as a consequence of climate change (i.e. sea level rise, sea temperature and pH), the presence of terrestrial weeds, offshore toxic algal blooms, and oil spills.

The Wainuiomata Estuary has a raised river mouth several metres above the high tide line with a sandy gravel bar permanently across its entrance. The mouth drains to the sea via seepage through beach gravels and is freshwater dominated with the only saltwater influence likely to come from salt spray. Records of migratory native freshwater fish species indicate that at times the system has an open connection to the coast. When the connection to the coast is closed, there is likely to be cyclical build-ups of nutrients, organic matter and algal growth, which reduce after flushing of the estuary under high flows or periods when the estuary mouth is open. The overall condition in the lower Wainuiomata River is fair, although concentrations of E. coli and periphyton are often elevated and the river is affected by stormwater contamination, occasional leakage from the Wainuiomata landfill, fertiliser runoff, and sedimentation. Predicted nutrient loads are high for a poorly flushed estuary and toxic algal blooms are known to occur in the river during summer months. Much of the western branch of the river is regulated by a series of dams for the purposes of metropolitan water supply and water abstraction, which can significantly reduce river flow limiting flushing of the estuary and contributing to prolonged closure periods of the mouth. Combined with variable flows and salinities, the estuary is not expected to support a highly diverse community.

3.5.2 Assessment of freshwater scenarios

The current state of selected indicators and the changes predicted by the panel for each freshwater scenario is summarised in Table 3.5.

(a) Wainuiomata Estuary

Data availability was very limited compared with areas closer to Wellington City. The expert panel assessment is high-level and based primarily on a conceptual understanding of the effects commonly experienced in this type of environment. Accordingly, it is accompanied by a lower level of confidence. Without monitoring or baseline data, it is not possible to be certain of the effects of each freshwater scenario, although it is expected that continuation with BAU could cause a slight decrease in ecosystem health within the estuary. In particular, the increased frequency and magnitude of low flows is likely to promote algal and macrophyte growth in the estuary, which remains closed for

much of the time. Suitability for Recreation at the Wainuiomata Estuary is good in terms of water quality, contact recreation, and suitability for mahinga kai.

(b) Coastal areas

Key ecosystem components are present and functioning at a high level in the open coast environment and no change is expected under any of the freshwater scenarios.

Suitability for Recreation is good in terms of water quality, contact recreation, and suitability for mahinga kai, although it may occasionally be limited by rough sea conditions on the south coast making recreational activities unsafe. Suitability for Recreation is not expected to change under any of the freshwater scenarios.

Table 3.5: Current attribute states and CEP assessments for the East Coast

Area	Scenario	Sediment quality			Ecology			Human health
		Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	*Enterococci*
Wainui-omata Estuary	Current	A	A	A	A	A	B	B
	BAU	A↓	A↓	A↓	A↓	A↓	B	B
	Improved	A	A	A↑	A	A	B	B↑
	WS	A	A	A↑	A	A	B	B↑
Open Coast East	Current	A	A	A	A	A	A	A
	BAU	A	A	A	A	A	A	A
	Improved	A	A	A	A	A	A	A
	WS	A	A	A	A	A	A	A

Current = Current state, BAU = Business as Usual, WS = Water Sensitive

A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band

4. Synthesis of findings

The scenarios assessed by the expert panel were based on the mitigation of existing and predicted land use using currently available methods, rather than considering land use changes or novel mitigation methods. Consequently, even under the most intensive mitigation scenario, only small improvements to ecological health are expected in the marine environment relative to current state.

The key reasons for this are:

- The mitigation scenarios may not reduce contaminants (e.g. fine sediment, nutrients, trace metals, pathogens) sufficiently to make large-scale changes in the coastal environment.

- The receiving environment may have been historically modified to the extent that improvements are not easily achieved – for example, in estuaries that have high sediment loads, or those that have undergone armouring and reclamation.

- There may be legacy effects where past damage will be slow to recover even if the source of the contaminant is removed. For example, areas historically impacted by fine sediment may take tens to hundreds of years to recover because of high retention rates, or contaminants such as trace metals or DDT, which have slow breakdown rates, will persist long after inputs cease.

- The scenarios allow for increasing intensification pressure in the catchment, such that predicted inputs may still increase despite the proposed catchment mitigation.

Overall, there was consensus that BAU would result in ongoing ecological degradation for the majority of the coastal attributes assessed. This was particularly the case for estuaries that are generally the most modified and most sensitive of the coastal environments affected by land-based activities, and less so for the more open sections of the coast, which have much higher capacity to dilute and assimilate catchment inputs.

Under IS, current state conditions were generally maintained or improved. Changes primarily reflect improvements within the existing state bands and were seldom large enough to shift bands.

Under WS, there was further improvement in many attributes, but changes also predominantly occurred within bands. For much of the open coastal receiving environment this reflects that these areas are currently in a good or very good condition. For estuaries or inner harbour areas that are already degraded, it primarily reflects that any reversal of past impacts will be very slow or difficult to achieve under the proposed scenarios. The most significant predicted

improvements were to human health and recreation from a reduction in pathogen inputs to the coast.

It is emphasised that the absence of large-scale changes does not mean that the incremental improvements predicted are not ecologically significant, particularly at a local scale, and that maintaining current state under increasing intensification is in itself a very positive outcome. To this end, the IS and WS scenarios are considered make a significant positive difference. To achieve larger improvements in ecological health, different catchment management scenarios may need to be considered, for example changes in land use rather than mitigation of existing activities.

In addition to the components assessed by the expert panel, climate change and associated sea level rise effects are expected in future to add additional ecological stress (e.g. habitat displacement, greater competition for food resources, changes in the dilution and flushing of pollutants, elevated water temperatures, and depleted dissolved oxygen). As estuaries are generally the most sensitive coastal environments affected by land-based activities, they provide a good indicator of catchment pressures. For this reason, catchment management that maintains a high level of estuary ecological health will go a long way to minimising catchment impacts on the wider coastal environment.

A calm day across Wellington Harbour with Matiu/Somes Island in view (Photo: GWRC, 2017).

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6. Appendix: Assessment Tables

Summary of the current state of Coastal Assessment Units as well as the predicted change in state under the three freshwater management scenarios Business as Usual (BAU), Improved and Water Sensitive (WS) scenarios. A = Very good, B = Good, C = Fair, D = Poor, ↓ degradation within a band, ↑ improvement within a band. The confidence of each assessment is indicated as either: *low, **moderate, or ***high. Overall ecosystem health considers the degree of alteration of an environment from its natural state, which is not necessarily taken into account in each of the attribute assessments. Suitability for recreation considers whether an area is suitable for swimming in terms of water safety, water quality and access, as well as the safe collection of seafood.

CAU	Area of interest	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci		
West Coast	Makara Estuary	Current	A **	A **	C **	C **	B **	D ***	C **	Fair	Good
		BAU	A↓ **	A↓ **	D **	C **	B **	D ***	C **	Poor	Good
		Improved	A **	A **	C↑ **	C **	B *	D↑ *	C↑ **	Fair	Good
		WS	A↑ **	A↑ **	B **	C↑ *	B↑ *	D↑ *	C↑ **	Fair	Good
	Open Coast West	Current	A **	A **	A **	A **	A **	A ***	A **	Very good	Very good
		BAU	A **	A **	A↓ **	A **	A **	A ***	A **	Very good	Very good
		Improved	A **	A **	A **	A **	A **	A **	A **	Very good	Very good
		WS	A **	A **	A **	A **	A **	A **	A **	Very good	Very good

CAU	Area of interest	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci		
South Coast	Karori Stream Mouth	Current	A **	A **	A **	A ***	A **	B *	C **	Good	Fair
		BAU	A **	B **	A↓ **	A ***	A **	B *	C **	Good	Fair
		Improved	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Fair
		WS	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Fair
	Ōwhiro Bay	Current	A **	A **	A **	A ***	A **	B *	C **	Good	Fair
		BAU	A **	B **	A↓	A ***	A **	B *	C **	Good	Fair
		Improved	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Fair
		WS	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Fair
	Island Bay	Current	A **	A **	A **	A ***	A **	B *	C **	Good	Fair
		BAU	A **	B **	A↓ **	A ***	A **	B *	C **	Good	Fair
		Improved	A↑ *	A *	A↑ *	A **	A *	B *	C↑ **	Good	Fair
		WS	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Fair
	Taputeranga Marine Reserve	Current	A **	A **	A **	A ***	A **	B *	C **	Good	Good
		BAU	A **	B **	A↓ **	A ***	A **	B *	C **	Good	Good
		Improved	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Good
		WS	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Good

CAU	Area of interest	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci		
South Coast	Lyall Bay/Moa Point	Current	A **	A **	A **	A ***	A **	B *	C **	Good	Good
		BAU	A **	B **	A↓ **	A ***	A **	B *	C **	Good	Good
		Improved	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Good
		WS	A↑ *	A *	A↑ *	A **	A **	B *	C↑ **	Good	Good
	Open Coast South	Current	A **	A **	A **	A ***	A **	B *	B **	Good	Good
		BAU	A **	B **	A↓ **	A ***	A **	B *	B **	Good	Good
		Improved	A↑ *	A *	A↑ *	A **	A **	B *	B↑ **	Good	Good
		WS	A↑ *	A *	A↑ *	A **	A **	B *	B↑ **	Good	Good
Inner Harbour	Kaiwharawhara Estuary	Current	A **	A **	A **	A ***	A **	C **	C **	Poor	Poor
		BAU	A **	A **	A **	A ***	A **	C **	C **	Poor	Poor
		Improved	A *	A *	A *	A ***	A **	C **	B **	Poor	Poor
		WS	A↑ *	A↑ *	A↑ *	A ***	A **	C **	B **	Poor	Poor
	Aotea Quay	Current	A **	A **	D **	A ***	A **	B **	C **	Good	Poor
		BAU	B **	B **	D↓ **	A ***	A **	C **	C **	Fair	Poor
		Improved	A *	A *	D *	A ***	A **	B **	B **	Good	Poor
		WS	A↑ *	A↑ *	D↑ *	A ***	A **	B↑ **	B **	Good	Poor

CAU	Area of interest	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci		
Inner Harbour	Queens Wharf	Current	B **	B **	D **	A ***	A **	C **	C **	Fair	Fair
		BAU	C **	C **	D↓ **	A ***	A **	D **	C **	Poor	Poor
		Improved	B *	A *	D *	A ***	A **	C **	B **	Fair	Fair
		WS	B↑ *	B↑ *	D↑ *	A ***	A **	C↑ **	B **	Fair	Fair
	Oriental Bay	Current	A **	A **	D **	A ***	A **	B **	C **	Fair	Fair
		BAU	B **	B **	D↓ **	A ***	A **	B↓ **	C **	Poor	Poor
		Improved	A *	A *	D *	A ***	A **	B **	B **	Fair	Fair
		WS	A↑ *	A↑ *	D↑ *	A ***	A **	B **	B **	Fair	Fair
	Evan's Bay	Current	A **	A **	A **	A ***	A **	B **	C **	Good	Fair
		BAU	A↓ **	A↓ **	A↓ **	A ***	A **	B↓ **	C **	Fair	Fair
		Improved	A *	A *	A *	A ***	A **	B **	B **	Good	Fair
		WS	A↑ *	A↑ *	A↑ *	A ***	A **	B **	B **	Good	Fair
	Whole Inner Harbour	Current	B **	A **	D **	A ***	A **	B **	C **	Fair	Fair
		BAU	C **	B **	D↓ **	A ***	A **	C **	C **	Poor	Fair
		Improved	B *	A *	D *	A ***	A **	B **	C **	Fair	Fair
		WS	B↑ *	A↑ *	D↑ *	A ***	A **	B↑ **	B **	Fair	Good

CAU	Area of interest	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci		
Outer Harbour	Korokoro Estuary	Current	A *	A *	A *	B **	A **	C *	C *	Poor	Fair
		BAU	A↓ *	A↓ *	A↓ *	B↓ **	A **	D *	C *	Poor	Fair
		Improved	A *	A *	A↑ *	B↑ *	A *	C↑ *	B *	Fair	Good
		WS	A↑ *	A↑ *	A↑ *	A *	A *	B *	B *	Good	Good
	Hutt Estuary	Current	A ***	A ***	B ***	C **	A **	C **	C **	Poor	Fair
		BAU	A↓ ***	A↓ ***	B↓ ***	C↓ **	A **	D **	C **	Poor	Fair
		Improved	A **	A **	B↑ ***	C↑ *	A *	C↑ **	B **	Fair	Good
		WS	A↑ **	A↑ **	B↑ ***	B *	A *	B **	B **	Good	Good
	Eastbourne	Current	A *	A *	A *	A ***	A **	B **	C **	Fair	Good
		BAU	A↓ *	A↓ *	A↓ *	A ***	A **	B↓ **	C **	Fair	Good
		Improved	A *	A *	A *	A *	A *	B **	B **	Good	Very good
		WS	A↑ *	A↑ *	A↑ **	A *	A *	B **	B **	Good	Very good
	Whole Outer Harbour	Current	A *	A *	D *	A ***	A **	B **	C **	Fair	Good
		BAU	A↓ *	A↓ *	D↓ *	A ***	A **	B↓ **	C **	Fair	Good
		Improved	A *	A *	D **	A *	A *	B **	B **	Fair	Very good
		WS	A↑ *	A↑ *	D **	A *	A *	B **	B **	Fair	Very good

CAU	Area of interest	Scenario	Sediment quality			Ecology			Human health	Overall Ecosystem health	Suitability for Recreation
			Zinc	Copper	Mud content	Macro-algae	Phyto-plankton	Macro-invertebrate	Enterococci		
East Coast	Wainuiomata Estuary	Current	A **	A **	A **	A **	A **	B *	B *	Fair	Good
		BAU	A↓ **	A↓ **	A↓ **	A↓ **	A↓ **	B *	B *	Fair	Good
		Improved	A **	A **	A↑ **	A **	A **	B *	B↑ *	Good	Good
		WS	A **	A **	A↑ **	A **	A **	B *	B↑ *	Good	Good
	Open Coast East	Current	A **	A **	A **	A **	A **	A **	A **	Very good	Good
		BAU	A **	A **	A **	A **	A **	A **	A **	Very good	Good
		Improved	A **	A **	A **	A **	A **	A **	A **	Very good	Good
		WS	A **	A **	A **	A **	A **	A **	A **	Very good	Good