greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Whaitua Te Whanganui-a-Tara Expert Panel

Proxy Modelling Catchment Assessment

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Executive summary

Comprehensive flow and water quality modelling was undertaken in Te Awarua-o-Porirua Whaitua (Porirua Whaitua). Shorter timeframes in Te Whanganui-a-Tara Whaitua (Wellington Whaitua) and the utilising of an expert panel to assess water quality change led to the progression of a 'proxy catchment assessment'.

The purpose of this assessment was to select suitable proxy modelling catchments from Porirua Whaitua that could be utilised by the expert panel when assessing water quality changes in Wellington Whaitua. The panel are assessing water quality at a variety of 'Expert Panel Assessment Units' (EPAU's), of which there are 8 in total. Three EPAU are not considered in this assessment (Lakes, Hutt River Mainstem and Predominantly Forest).

The proxy assessment compared landuse statistics between different catchments within each of the Whaituas' and applied a weighting to certain landuse types for four contaminant groupings (metals, nutrients, sediment and E.coli). The purpose of the weighting was to capture the landuses generating the largest loads and also the landuses treated under scenarios (where various 'mitigations' were modelled to improve water quality).

This resulted in a ranked list of suitable proxy catchments for each of the EPAU's, for each of the four contaminant groupings. This list was then used to select a final proxy catchment for each EPAU, based on factors such as how often the proxy catchment appeared in the rankings, the size of the catchment and the landuse proportions. Consideration was also given to roading scenarios (i.e. Transmission Gully and Petone to Grenada Highways) which were modelled in Porirua Whaitua, but are not comparable to any roading development scenario in the Wellington Whaitua.

Following selection of five proxy catchments for the remaining five EPAU's, further refinement was undertaken to narrow this down to two suitable proxy catchments. This is because modelling results from Porirua Whaitua showed minimal difference across scenarios between some of these catchments, meaning they could be grouped and therefore simplify the amount of data the expert panel will need to comprehend when undertaking their assessments.

The selected proxy modelling catchments for various EPAU's are identified below.

Groundwater/surfacewater fed predominantly urban streams, and surface water fed predominantly urban streams:

Porirua at Mouth

Mixed rural and Mangaroa/Pakuratahi Valleys:

Horokiri and Motukaraka at Mouth

Headwater Urban:

No suitable proxy catchment exists from Porirua Whaitua. This EPAU was split into an urban proxy and a rural/mixed proxy catchment. The panel will need to consider modelling results from both catchments to consider the potential combined water quality improvements, using their best judgement. The urban catchment is *Porirua at Mouth*, while the mixed rural catchment is *Horokiri and Motukaraka at Mouth.*

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1. Introduction

1.1 Background and objectives

Comprehensive flow and water quality modelling were undertaken in Te Awarua-o-Porirua Whaitua (referred here on as Porirua Whaitua), and have been detailed in Jacobs 2019a and Jacobs 2019b technical reports. Shorter timeframes in Te Whanganui-a-Tara Whaitua (referred here on as Wellington Whaitua) and a modified approach (utilising an expert panel) led to the progression of a 'proxy catchment assessment'.

The purposes of this assessment was to minimise detailed daily water quality and flow modelling for the Whaitua and utilise the extensive well calibrated and validated modelling results from Porirua Whaitua as a proxy; where appropriate. The panel are working through a range of assessment units that do not always follow defined catchment boundaries, but are a mosaic of similar landuses and hydrological functions, which when modified through mitigation packages (scenarios) would be expected to respond in a similar manner, despite their geographical distribution.

The expert panel will be able to undertake an assessment of the appropriate unit (i.e. surface water fed predominantly urban streams), and take into account how water quality and flow may change or improve using the proxy modelling results and any supporting technical information. The results will be sourced from a Porirua Whaitua modelled subcatchment that has been paired with a similar subcatchment within each representative expert panel assessment unit (EPAU) in the Wellington Whaitua. Not all of the EPAU's have a suitable proxy (for example Hutt River main stem), in which case the panel will have to undertake assessments without modelling results.

This document provides a description of the methodology used to determine the proxies, and presents the modelling results for that proxy taken directly from the Porirua Whaitua catchment model outputs.

2. Modelling Scenarios

Detailed scenario assumptions applied in Porirua and Wellington Whaituas have been included in Appendix A. Scenario packages represent a range of possible mitigations that could be undertaken which are then modelled to determine water quality improvements.

There are numerous combinations of mitigation packages that could be modelled, and for this reason the packages are intended to be a guide on how much effort is needed to improve water quality. Each mitigation removes a certain proportion of daily load from the appropriate landuse that is being treated. The load reduction factors (which vary by contaminant) are discussed in section 3 of the Jacobs 2019b report.

Any new development (infill or greenfield) contributes additional load to the environment, and even when treated with best practice (i.e. water sensitive design), would still have a net increase in contaminants from the baseline, if no treatment was undertaken on existing landuses.

Three scenarios were modelled in Porirua Whaitua and will be assessed in Wellington Whaitua:

1. Business as Usual (BAU) – represents full implementation of the Natural Resources Plan rules and objectives (an improvement from current state).

2. Improved – Incorporates increasing amounts of mitigations in both the rural and urban environment.

3. Water Sensitive – Comprehensive implementation of mitigations across large areas.

3. Proxy Assessment Methodology

3.1 Overview

Modelling catchments from Porirua Whaitua (17 in total) were compared against Wellington Whaitua catchments (28 in total). While there were more Porirua Whaitua catchments, those under 5 km^2 were excluded from the analysis as their small sizes are un-representative of large catchments in Wellington that will have different flow and nutrient dynamics.

For each Wellington Whaitua EPAU (i.e. surface water fed predominantly urban streams), a proxy catchment assessment of certain criteria (defined below) was undertaken comparing all of the Porirua Whaitua subcatchments against the various Wellington subcatchments that were within that EPAU (i.e. Korokoro Stream, Owhiro Stream etc). This was undertaken for four main nutrient/contaminants, in order to see if there was catchment variability.

The selected contaminants were:

- E.coli
- Nutrients
- Sediment
- Metals

3.2 Landuse assessments

Different landuses contribute varying amounts of contaminant loads and some are targeted by scenario mitigations, which is applied in the models. Using the contaminant load model (CLM) and Porirua Whaitua modelling results as a guide, certain landuse types were selected for the proxy catchment assessment that influenced the contaminants listed in Section 3.1. These landuse types were grouped in order to simplify the approach. The landuse groupings were:

- Metals
- E.coli, Sediment and Nutrients

Metals (i.e. copper and zinc) were treated separately as they are heavily influenced by urban landuses, while the other contaminants can generally be linked to similar landuses types.

The 'metals' grouping assessed the landuse proportions per subcatchment for:

- Urban greenspace
- Commercial paved
- Industrial paved
- Residential paved
- Low vehicle per day roads
- High vehicle per day roads
- Commercial roofs
- Residential roofs
- Industrial roofs

The E.coli/Sediment/Nutrients landuse proportions assessed per subcatchment were:

- Scrub/forest
- Farmland
- Other
- Urban greenspace
- Urban impervious

3.3 Additional assessment criteria

Additional criteria in the proxy catchment assessment were included to capture processes that may heavily influence a baseline load or be affected from a scenario treatment (for example, retiring all LUC class 6e land and above in the

Water Sensitive Scenario. This land contributes a high amount of baseline sediment load).

The additional assessment criteria were:

1. Erosion – the proportion of class 6e, 7e and 8e Land Use Capability (LUC) land per subcatchment. The effects of catchment slope is considered to be captured within this assessment criteria.

2. Wastewater Overflow frequencies – The average amount of overflows events per year, per subcatchment. Wellington Water provided wastewater overflow records from 2018 – 2019 for Porirua and Wellington Whaituas. This was broken down to an average amount per subcatchment. Only two subcatchments within Porirua had overflow information, which limited the scope of this assessment.

3. Streams in grassland – This considered the proportion of stream length passing through grassland versus the total stream length (within each subcatchment). This is useful for scenario assessments of fencing and riparian planting.

3.4 Analysis of landuse and additional assessment criteria

For each of the landuse criteria and 'additional assessment criteria' listed in sections 3.2 and 3.3, the relative proportion (as a %) was calculated for each subcatchment across both Porirua and Wellington Whaituas.

Then for each of the EPAU's for the Wellington Whaitua, the relevant subcatchments within each unit were then compared against all of the Porirua subcatchments, simply by determining the percentage (%) difference between each landuse or additional assessment criteria. See Table 1 as an example. The smaller the difference, the 'better' the proxy fit.

Table 1. Example catchment comparison

Landuse category	TWT Catchment 1 landuse (%)	Porirua Catchment A landuse (%)	% difference
Scrub / forest	25	14	11
Farmland	41	35	6
Urban greenspace	12	24	12
Urban impervious	9	15	6
Other	13	12	1
Total	100	100	

3.5 Weightings Assessment

In order to strengthen this proxy catchment assessment, a secondary 'weightings' assessment was incorporated into the analysis, that could provide greater 'importance' to certain landuses or additional assessment criteria, if they contributed large proportions of load or were heavily influenced by scenario mitigations.

Greater Wellington Regional Council (GWRC) worked through each of the landuse and additional assessment criteria defined in Tables 2-4 below and assigned best estimates for weightings to help strengthen the catchment comparisons (differences) developed in section 3.4.

Those categories with a zero weighting, or not mentioned in the weighting table, are completely ignored in the weighting process.

Using the sediment weighting table as an example (Table 5), our weighted catchment comparison equation would look like:

*(farmland diff * 0.3) + (urban greenspace diff * 0.2) + (scrub/forest diff * 0.15) + (LUC e diff * 0.2) + (stream grassland diff * 0.15)*

This equation produces a total weighted difference value for each catchment comparison, which was then ranked from lowest to highest in order to select the top proxy catchments per EPAU. An example of this ranking is presented in Figure 1.

Table 2. Metal weightings

industrial paved %	commercial paved %	roads high %	residential roof %	commercial roof %	industrial roof %	residential paved %
20	12.5	12.5	20	12.5	12.5	10

Table 3. E-coli weightings

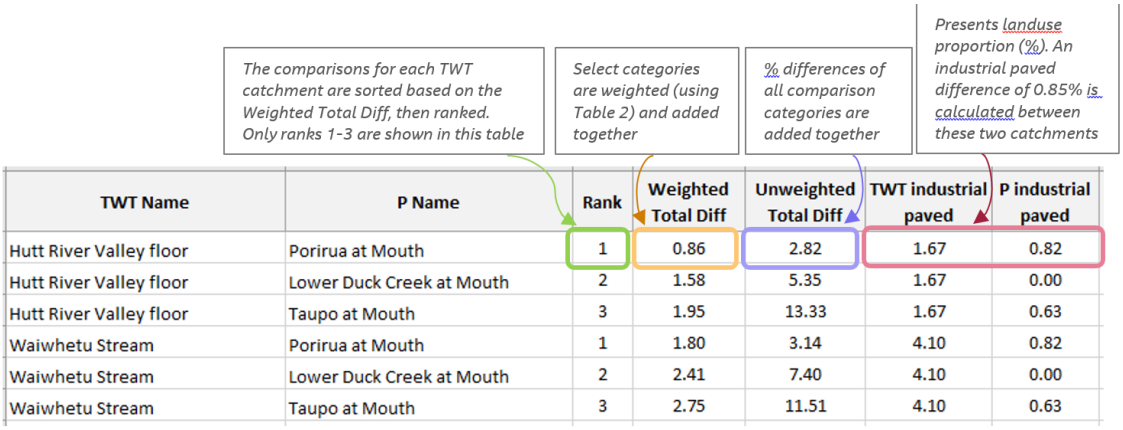
farmland %	urban greenspace %	scrub / forest %	urban impervious %	overflows %	grassland stream length %
25	10	2	45	6	12

Table 4. Nutrient weightings

farmland %	urban greenspace %	scrub / forest %	urban impervious %	LUC e classes %	grassland stream length %
50	35	10	5	0	0

Table 5. Sediment weightings

farmland %	urban greenspace %	scrub / forest %	urban impervious %	LUC e classes %	grassland stream length %
30	20	15	0	20	15



TWT Name	P Name	Rank	Weighted Total Diff	Unweighted Total Diff	TWT industrial paved	P industrial paved
Hutt River Valley floor	Porirua at Mouth	1	0.86	2.82	1.67	0.82
Hutt River Valley floor	Lower Duck Creek at Mouth	2	1.58	5.35	1.67	0.00
Hutt River Valley floor	Taupo at Mouth	3	1.95	13.33	1.67	0.63
Waiwhetu Stream	Porirua at Mouth	1	1.80	3.14	4.10	0.82
Waiwhetu Stream	Lower Duck Creek at Mouth	2	2.41	7.40	4.10	0.00
Waiwhetu Stream	Taupo at Mouth	3	2.75	11.51	4.10	0.63

Figure 1. Example of weighted comparison table for metals

4. Proxy Catchment Results (for Expert Panel Assessments)

Following the assessment described in section 3, the ranked catchment list was reviewed by GWRC. The top ranked proxy catchments from Porirua Whaitua were available for:

- Each EPAU and their subcatchments within Wellington Whaitua, specifically for each contaminant 'grouping':
    - E.coli, sediment, nutrients and metals.

GWRC considered the top 2 proxy catchments under each of the groupings (i.e. 8 in total), within an EPAU. The proxy catchment which appeared the most frequently or was ranked the highest across all groupings was then selected. Consideration was also given to catchment size, landuse statistics, modelling results and hydrological suitability during the selection process. Some small catchments from Porirua may have been a good match from the proxy assessment but are likely to have significantly different hydrological responses than their paired (larger catchment) in Wellington Whaitua.

The catchments selected are described in Sections 4.2 to 4.4, however the modelling results tables can be found in Appendix 2 - 3.

4.1 Assumptions and Limitations

The following EPAU were excluded as no suitable proxy catchment existed from Porirua Whaitua.

- Hutt river mainstem
- Lakes
- Predominantly forest

It should be noted that while a Porirua Whaitua proxy catchment may have been defined in terms of the assessment methodology, this may not be an exact representation of the Wellington Whaitua catchments typological distribution or primary hydrological process.

For example, headwater urban catchments are not present in Porirua Whaitua, and for this reason the panel will need to consider the proxy modelling results from surface water fed predominantly urban streams and mixed rural EPAU together.

Similarly, there is little deep groundwater upwelling in Porirua to represent the groundwater/surface water fed urban streams EPAU (such as the Waiwhetu Stream subcatchment). This may have significance for flow modelling results, but maybe less importance when considering contaminants such as metals or E.coli which are primarily transported through overland and subsurface (shallow groundwater) processes. A larger catchment with greater baseflow has been selected to try to capture some greater groundwater inputs, albeit this does not replicate deep (confined/artesian) aquifer baseflows evident in parts of the Hutt Valley.

In addition, Porirua Whaitua had two large roading projects (Transmission Gully and Petone to Grenada) incorporated into the modelling, meaning certain Porirua catchments that may have been selected as a suitable proxy will have caveats applied to the results (i.e. rural catchments will not present metal results as through scenarios, Transmission Gully increased the metal load).

The Expert Panel will need to consider some of these uncertainties when working through their scenario assessments.

4.2 Surface water fed predominantly urban streams and groundwater/surface water fed predominantly urban streams

The selected proxy catchment for both these EPAU's is *'Porirua at Mouth'*. Modelling results are presented in Appendix 2. This catchment was highly ranked in both EPAU for all four contaminants, alongside Porirua at Kenepuru Drive. Observations for this catchment include;

- This is a large urban catchment (~53.5 km^2) which encompasses a range of urban growth scenarios, including infill and greenfield development.
    - 6.3% of the baseline area is developed as greenfield (2.3% of this is urban grassland)
    - There is a 2.2% increase from baseline landuse area due to infill.
- The catchment is ~48% urban landuse, 6% roads and 46% rural/scrub under the Business as Usual Scenario. This represents a heavily urbanised stream environment.

  - By comparison, Wellington Whaitua subcatchments within these two EPAU's have the following proportions of urban landuse:
    - Kaiwharawhara Stream – 36.9%
    - North West Harbour – 41.3%
    - Owhiro Stream – 17%
    - Waiwhetu Stream – 50.7%

- Petone to Grenada and Transmission Gully highways do intersect this catchment, which would increase metal loads under scenarios. However it only represents a 0.4% increase in area for roads >5000 VPD from the baseline scenario.
  - Due to the additional highway load, metal concentration decreases from mitigations in this proxy catchment are less evident. The panel will need to take this into account in their assessments.

- Porirua at Mouth catchment is approximately double the size of other urban subcatchments within these EPAU's.

There is little merit in splitting proxy catchments for the panel assessments, as Porirua at Kenepuru Drive and Porirua at Mouth had similar landuse proportions and scenario mitigations and subsequently, similar modelling results. There is limited groundwater upwellings occurring within Porirua, which does occur in some Wellington Whaitua subcatchments such as the Waiwhetu Stream. Subsequently, the modelling results only represent shallow unconfined aquifer storage and baseflow contribution.

Selecting the larger subcatchment will provide greater baseflow contributions, but will not truly capture groundwater inputs from a confined/artesian aquifer.

4.2 Mixed Rural and Mangaroa and Pakuratahi Valleys

The selected proxy catchment for both these EPAU's is '*Horokiri and Motukaraka at Mouth*'. Modelling results are presented in Appendix 3. This catchment was highly ranked in both EPAU for all four contaminants, alongside Horokiri and Motukaraka Near Pautahanui Golf Club, and Ration at Mouth. Observations for this catchment include:

- The catchment is ~ 98.8% rural/scrub/forest landuse with the rest of the area in roads and urban environment.

- The catchment area is large (33.2 km^2), and better represents some of the grassland and mixed rural Wellington subcatchments such as Makara Stream (25.4 km^2), Mangaroa Valley (52 km^2) and Pakuratahi Grass (24.1 km^2).
  - Ration at Mouth proxy catchment often ranked highly, however was excluded, as the catchment is only 6.9 km^2 and was intersected by

Transmission Gully in modelling. Due to the smaller catchment area and smaller flows, the impacts of this roading development through scenarios is more significant on loads and concentrations.

- Transmission Gully (TG) runs through *Horokiri and Motukaraka at Mouth* and results in an increase in metal loads through scenarios, despite mitigations treating a large portion of this load. The increase represents a 0.71% change in total landuse area for roads from the baseline scenario.
    - Subsequently, change in metal loads and concentrations for this proxy could be ignored by the expert panel. In reality, most of the rural and grassland subcatchments generate very low metal loads, so whilst the new highway increases the load, the impacts of this are minimal due to the low yields from the majority of existing landuses.

Whilst Horokiri and Motukaraka Near Pautahanui Golf Club was highly ranked for the Mixed Rural EPAU, the modelling results of this subcatchment were very similar to the Horokiri and Motukaraka at Mouth. Rather than provide two proxy catchments (one for each EPAU), the catchments were grouped to provide a simplified assessment approach for the expert panel.

4.3 Headwater urban streams

Headwater urban streams are not present within the Porirua Whaitua. Subsequently, finding a suitable proxy catchment to represent Karori and Wainuiomata subcatchments was difficult.

The most commonly ranked catchment was Ration at Mouth and Horokiri and Motukaraka Near Pautahanui Golf Club, both of which are primarily rural with little urban environment (when the average urban landuse area in Headwater Urban EPAU is ~8%).

Subsequently, no suitable proxy catchment was identified to represent the entire Headwater Urban EPAU. An alternative approach will be for the panel to consider the urban and rural/mixed proportions of the EPAU separately.

This will require consideration of modelling results for two selected proxy catchments representing these environments, of which the panel will then need to use their expert judgement to estimate how the scenario mitigations applied in an urban and rural/mixed environment will benefit water quality downstream.

For simplicity, the selected proxy catchments for the urban and rural/mixed environments are:

- Urban area – *Porirua at Mouth*
- Rural/Mixed (remaining catchment) - *Horokiri and Motukaraka at Mouth*

Refer to Appendix 2 and 3 for modelling results for these proxy catchments.

5. References

Jacobs 2019a. Porirua Whaitua Collaborative Modelling Project – Baseline Modelling Technical Report. *Prepared for Greater Wellington Regional Council.*

Jacobs 2019b. Porirua Whaitua Collaborative Modelling Project – Scenario Modelling Technical Report. *Prepared for Greater Wellington Regional Council.*

Appendix 1: Detailed Scenario Assumptions

Detailed assumptions adopted in scenario model setup

	Description	Areas applied	Assumptions to represent the changes
	Business as Usual scenario		
Urban development	Greenfield and infill residential development	Areas within council identified development zones[1] Development form reflects current development practice, for example mix of standalone and low-rise town houses, wide roads, no storm water capture or treatment. Represented as proportions of construction sites, roofs, paved surfaces, grassland and roads. See section 3.1.1[2]	Adopt rainfall-runoff characteristics and contaminant generation characteristics for relevant surfaces from baseline[3] Greenfield and Infill roofs assumed to utilize low-Zinc yielding materials, see section 3.3.4
Existing land and asset management	Cross connections and broken pipes remain in the wastewater network, though no additional overflows from additional population	100% of urban areas, including new urban areas	Adopt high urban *E. coli* yields[4]
Rural	Livestock exclusion	Areas identified as 'Category 1' or 'Category 2' by the NRP[5]	Load reduction factors applied, see section 3.2.1[6]
All areas	Construction sediment control practices	100% of construction areas	Load reduction factors applied, see section 3.3.5

[1] Maps are to be generated for this Whaitua where available
[2] All references for further information are to the Jacobs Scenario report (http://www.gw.govt.nz/assets/Whaitua/Freshwater-Scenario-Modelling-Techncial-Report.pdf) unless otherwise stated
[3] Described through Jacobs Baseline report http://www.gw.govt.nz/assets/Whaitua/Freshwater-Baseline-Modelling-Technical-Report.pdf
[4] Section 7 of Baseline report
[5] Appendix 2 of this memo
[6] Note that TAoP also assumed riparian vegetation so this may overestimate the changes resulting from exclusion alone.

Climate change	Anticipated effects of current regional climate change projections	All whaitua	Range reflects two scenarios used by GWRC for whaitua based projects - RCP4.5 (intermediate/low emissions scenario) and RCP 8.5 (high emissions scenario)[7,8]

	Description	Areas applied	Assumptions to represent the changes
	Improved scenario		
Urban development	Rainwater tanks on some new dwellings	50% of new greenfield and infill dwellings 2,000 litre tanks[9]	Flow reduction factors applied, see section 3.3.3
	Limited treatment of road runoff in new urban developments with bioretention	40% of roads in greenfield and infill development	Load reduction factors applied, see section 3.3.2
	Treatment of stormwater runoff in new urban developments with catchment scale devices such as wetland	All new paved and roof surfaces in greenfield and infill development areas	Load reduction factors applied, see section 3.3.2
Existing land use and asset management	Media filter treatment of runoff from paved surfaces in commercial and industrial areas	50% of paved commercial and industrial areas	Load reduction factors applied, see section 3.3.2
	Media filter treatment of runoff from major roads	50% of major roads	Load reduction factors applied, see section 3.3.2
	Treatment or replacement of existing high yielding zinc roofs	50% of existing residential, commercial and industrial roofs	Adopt low zinc roof contaminant generation characteristics, see section 3.3.4

[7] IPCC Climate change scenarios officially used by GWRC http://www.gw.govt.nz/assets/2018-uploads/EmissionsScenarioGWRCWebUpdated.pdf
[8] Whaitua Catchments Climate Change parameters https://www.gw.govt.nz/assets/Climate-change-2/WhaituaClimateChangeprojections.pdf
[9] See section 3.2.1 of Te Awarua-o-Porirua Urban Hydrology Modelling by Morphum Environmental http://www.gw.govt.nz/assets/Whaitua/Te-Awarua-o-Porirua-Collaborative-Modelling-Project-Urban-Hydrology-Modelling.pdf

	Rainwater tanks on some new dwellings	10% of existing dwellings 2,000 litre tanks[10]	Flow reduction factors applied, see section 3.3.3
	Improve wastewater network performance so that cross connections and leakage is stopped	100% of urban areas	Adopt low urban *E. coli* yields, see section 3.3.1.1
	Wastewater overflows only occur in significant rainfall events	All overflows	40 largest overflow events retained from original (assumed BAU) timeseries (average 4 per year over 10 years), see section 3.3.1.2
Rural	Livestock exclusion for all streams on land less than 15 degrees with 5m setback	All REC order 2 or greater streams with catchment slope less than 15 degrees and pastoral land cover[11]	Load reduction factors applied, see section 3.2.1
	Retirement of the steepest erosion-prone pastoral land into native woody vegetation.	LUC class 7e and 8 land with pastoral landcover[12]	Adopt native forest rainfall runoff and contaminant generation characteristics, see section 3.1.3
	Pole planting of moderately erodible pastoral slopes	LUC class 6e land with pastoral landcover[13]	Load reduction factor applied, see section 3.2.2
All areas	Construction sediment control practices	100% of construction areas	Load reduction factors applied, see section 3.3.5

[10] See section 3.2.1 of Te Awarua-o-Porirua Urban Hydrology Modelling by Morphum Environmental http://www.gw.govt.nz/assets/Whaitua/Te-Awarua-o-Porirua-Collaborative-Modelling-Project-Urban-Hydrology-Modelling.pdf
[11] These will be identified within Whaitua Te Whanganui a Tara
[12] These will be identified within Whaitua Te Whanganui a Tara
[13] These will be identified within Whaitua Te Whanganui a Tara

	Riparian planting of with a 5m width planting in native species (both sides)	All REC order 2 or greater streams with catchment slope less than 15 degrees and non-native land cover[14]	Adopt native forest rainfall runoff and contaminant generation characteristics for planted strip Load reduction factors applied, see section 3.2.1[15]
Climate change	Anticipated effects of current regional climate change projections	All whaitua	Range reflecting RCP4.5 and RCP 8.5,[16]

	Description	Areas applied	Assumptions to represent the changes
	Water sensitive scenario		
Urban development	Reduced impervious footprint in new development	100% of new greenfield and infill development	Reduced proportion of paved and roof surfaces and increased proportion of grass surfaces within new development areas, see section 3.1.1
	Rainwater tanks on new dwellings with internal reuse of water	100% of new greenfield and infill dwellings 10,000 litre tanks[17]	Flow reduction factors applied, see section 3.3.3
	Treatment of stormwater runoff in new urban developments with source control devices such as permeable paving	50% of paved surface in new greenfield dwellings and 25% of infill dwellings	Load reduction factors applied, see section 3.3.2
	Treatment of most road runoff in new urban developments with bioretention	90% of roads in greenfield and infill development	Load reduction factors applied, see section 3.3.2

[14] These will be identified within Whaitua Te Whanganui a Tara
[15] These were derived for pastoral areas. Unsure of applicability for urban areas.
[16] Whaitua Catchments Climate Change parameters https://www.gw.govt.nz/assets/Climate-change-2/WhaituaClimateChangeprojections.pdf
[17] See section 3.2.1 of Te Awarua-o-Porirua Urban Hydrology Modelling by Morphum Environmental http://www.gw.govt.nz/assets/Whaitua/Te-Awarua-o-Porirua-Collaborative-Modelling-Project-Urban-Hydrology-Modelling.pdf

	Treatment of stormwater runoff in new urban developments with catchment scale devices such as wetland	All new paved and roof surfaces in greenfield and infill development areas	Load reduction factors applied, see section 3.3.2
Existing land use and asset management	Media filter treatment of runoff from paved surfaces in industrial areas	100% of paved industrial areas	Load reduction factors applied, see section 3.3.2
	Bioretention treatment of runoff from paved surfaces in commercial areas	100% of paved commercial areas	Load reduction factors applied, see section 3.3.2
	Wetland treatment of runoff from major roads	50% of major roads	Load reduction factors applied, see section 3.3.2
	Treatment or replacement of existing high yielding zinc roofs	100% of existing residential, commercial and industrial roofs	Adopt low zinc roof contaminant generation characteristics, see section 3.3.4
	Rainwater tanks on some new dwellings	50% of existing dwellings 10,000 litre tanks[18]	Flow reduction factors applied, see section 3.3.3
	Improve wastewater network performance so that cross connections and leakage is stopped	100% of urban areas	Adopt low urban *E. coli* yields, see section 3.3.1.1
	Wastewater overflows only occur in extreme rainfall events	All overflows	20 largest overflow events retained from original (assumed BAU) timeseries (average 2 per year over 10 years), see section 3.3.1.2
Rural	Livestock exclusion for all streams on land less than 15 degrees with 10m setback	All REC order 2 or greater streams with catchment slope less than 15 degrees and pastoral land cover[19]	Load reduction factors applied, see section 3.2.1

[18] See section 3.2.1 of Te Awarua-o-Porirua Urban Hydrology Modelling by Morphum Environmental http://www.gw.govt.nz/assets/Whaitua/Te-Awarua-o-Porirua-Collaborative-Modelling-Project-Urban-Hydrology-Modelling.pdf

[19] These will be identified within Whaitua Te Whanganui a Tara similar to Appendix 2 of this memo

	Retirement of moderate and steep erosion-prone pastoral land into native woody vegetation.	LUC class 6e, 7e and 8 land with pastoral landcover[20]	Adopt native forest rainfall runoff and contaminant generation characteristics, see section 3.1.3
All areas	Construction sediment control practices	100% of construction areas	Load reduction factors applied, see section 3.3.5
	Riparian planting of with a 10m width planting in native species (both sides)	All REC order 2 or greater streams with catchment slope less than 15 degrees and non-native land cover[21]	Adopt native forest rainfall runoff and contaminant generation characteristics for planted strip Load reduction factors applied, see section 3.2.1[22]
Climate change	Anticipated effects of current regional climate change projections	All whaitua	Range reflecting RCP4.5 and RCP 8.5[23]

[20] These will be identified within Whaitua Te Whanganui a Tara
[21] These will be identified within Whaitua Te Whanganui a Tara
[22] These were derived for pastoral areas. Unsure of applicability for urban areas.
[23] Whaitua Catchments Climate Change parameters https://www.gw.govt.nz/assets/Climate-change-2/WhaituaClimateChangeprojections.pdf

Appendix 2: Proxy Modelling Results - Surface water and Groundwater/Surface water fed predominantly urban streams

Table A2- 1. Total landuse proportions (%) for *Porirua at Mouth* proxy catchment

			Total		
Scenario	Reporting EPAU	Total Area (Ha)	Urban	Roads	Rural
Baseline	GW/SW fed predominantly urban streams & SW fed predominantly urban streams	5,359	44.2%	4.7%	50.8%
BAU			47.5%	6.4%	46.1%
Improved			47.5%	6.4%	46.1%
Waster Sensitive			47.5%	6.4%	46.1%

Table A2- 2. Detailed landuse proportions (%) for *Porirua at Mouth* proxy catchment

Proxy catchment			Porirua Stream at Mouth			
Applicable Expert panel assessment units			Groundwater/surface water fed predominantly urban streams Surface water fed predominantly urban streams			
Scenario			Baseline	BAU	Improved	Waster Sensitive
Permeable	Forest	Indigenous	7.1%	7.1%	7.1%	7.1%
		Exotic	7.9%	7.8%	7.8%	7.8%
	Pasture	Farmed	29.7%	23.7%	21.1%	13.4%
		Retired	6.2%	7.4%	10.1%	17.8%
	Other		0.3%	0.4%	0.4%	0.4%
	Urban grass & parks		25.5%	25.8%	25.9%	27.0%
Residential impervious	Roads	Existing	4.3%	4.1%	4.1%	4.1%
		New	0.0%	1.6%	1.6%	1.6%
	Paved surfaces	Existing	11.1%	10.4%	10.4%	10.4%
		New	0.0%	1.3%	1.2%	0.7%
	Roofs	Existing	5.4%	5.1%	5.0%	5.1%
		New	0.0%	2.4%	2.4%	1.8%
Commercial and industrial	Paved	Commercial	0.5%	0.5%	0.5%	0.5%
		Industrial	0.9%	0.9%	0.9%	0.9%
	Roofs	Commercial	0.3%	0.3%	0.3%	0.3%
		Industrial	0.5%	0.5%	0.5%	0.5%
	Heavy traffic roads		0.4%	0.7%	0.7%	0.7%
TOTAL AREA (Ha)			5,359	5,359	5,359	5,359

Table A2- 3. E.coli NOF attribute states and concentrations (cfu/100 mL) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Baseline									BAU								
	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state
GW/SW fed Predominantly Urban streams & SW fed Predominantly Urban streams	55	80	656	4454	E	E	E	D	E	53	80	622	4175	E	E	E	D	E
	Improved									Water Sensitive								
	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state
	23	41	170	1388	D	D	D	D	D	17	36	140	979	C	D	D	B	D

Table A2- 4. E.coli concentrations (cfu/100 mL) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	Ecoli median	Ecoli 95th percentile	Ecoli median	Ecoli 95th percentile	Ecoli median	Ecoli 95th percentile	Ecoli median	Ecoli 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	656	4454	622	4175	170	1388	140	979	-5%	-6%	-74%	-69%	-79%	-78%

Table A2- 5. NH4-N NOF attribute states and concentrations (mg/L) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category
GW/SW fed Predominantly Urban streams & SW fed Predominantly Urban streams	0.013	0.958	A	C	C	0.012	0.868	A	C	C
	Improved					Water Sensitive				
	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category
	0.011	0.852	A	C	C	0.011	0.726	A	C	C

Table A2- 6. NH4-N concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	NH4 median	NH4 95th percentile	NH4 median	NH4 95th percentile	NH4 median	NH4 95th percentile	NH4 median	NH4 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.013	0.103	0.012	0.094	0.011	0.04	0.011	0.031	-8%	-9%	-15%	-61%	-15%	-70%

Table A2- 7. N03-N NOF attribute states and concentrations (mg/L) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.569	1.669	A	B	B	0.538	1.502	A	B	B
	Improved					Water Sensitive				
	0.515	1.43	A	A	A	0.507	1.312	A	A	A

Table A2- 8. N03-N concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	NO3 median	NO3 95th percentile	NO3 median	NO3 95th percentile	NO3 median	NO3 95th percentile	NO3 median	NO3 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.569	1.669	0.538	1.502	0.515	1.43	0.507	1.312	-5%	-10%	-9%	-14%	-11%	-21%

Table A2- 9. DIN concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	DIN median	DIN 95th percentile	DIN median	DIN 95th percentile	DIN median	DIN 95th percentile	DIN median	DIN 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.588	1.739	0.556	1.581	0.527	1.501	0.519	1.36	-5%	-9%	-10%	-14%	-12%	-22%

Table A2- 10. DRP concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	DRP median	DRP 95th percentile	DRP median	DRP 95th percentile	DRP median	DRP 95th percentile	DRP median	DRP 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.015	0.05	0.015	0.048	0.011	0.035	0.011	0.033	0%	-4%	-27%	-30%	-27%	-34%

Table A2- 11. Copper concentrations (mg/L) and 'proxy attribute state' for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.00109	0.00477	B	D	D	0.0012	0.00479	B	D	D
	Improved					Water Sensitive				
	0.00116	0.00404	B	C	C	0.00095	0.00396	A	C	C

Table A2- 12. Copper concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	Cu median	Cu 95th percentile	Cu median	Cu 95th percentile	Cu median	Cu 95th percentile	Cu median	Cu 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.00109	0.00477	0.0012	0.00479	0.00116	0.00404	0.00089	0.00371	10%	0%	6%	-15%	-18%	-22%

Table A2- 13. Zinc concentrations (mg/L) and 'proxy attribute state' for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.00808	0.03623	C	C	C	0.00779	0.03338	B	C	C
	Improved					Water Sensitive				
	0.00453	0.01925	B	C	C	0.00164	0.00695	A	A	A

Table A2- 14. Zinc concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	Zn median	Zn 95th percentile	Zn median	Zn 95th percentile	Zn median	Zn 95th percentile	Zn median	Zn 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	0.00808	0.03623	0.00779	0.03338	0.00453	0.01925	0.00164	0.00695	-4%	-8%	-44%	-47%	-80%	-81%

Table A2- 15. Suspended Sediment Concentrations (mg/L) and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	SSC median	SSC 95th percentile	SSC median	SSC 95th percentile	SSC median	SSC 95th percentile	SSC median	SSC 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
GW/SW fed predominantly urban streams & SW fed predominantly urban streams	5.06	149.1	5.05	137.97	4.59	92.63	4.7	102.2	0%	-7%	-9%	-38%	-7%	-31%

Table A2- 16. Suspended sediment annual average load and relative reductions (%) for *Porirua at Mouth* proxy catchment through scenarios

Description	Baseline	BAU	Improved	WSUD
Annual Average Load (tonnes/year)	2655	2329	1399	1334
% reduction	-	-12%	-47%	-50%

Table A2- 17. Flow statistics for *Porirua at Mouth* proxy catchment through scenarios

Scenario	MALF (m3/s)	Median (m3/s)	95th Percentile (m3/s)	99.8th Percentile (m3/s)	Mean Annual Discharge (ML/year)	FRE3 threshold (m3/s)	FRE3 Frequency (events per year exceeding FRE3)
Baseline	0.058	0.395	3.785	12.138	29309	1.184	10.9
BAU	0.062	0.42	3.906	12.36	30533		11.3
Improved	0.061	0.416	3.863	12.214	30165		11.1
Water Sensitive	0.057	0.383	3.604	11.454	28150.96		10.5
	Relative change (%) from baseline						
BAU	7%	6%	3%	2%	4%	-	4%
Improved	5%	5%	2%	1%	3%		2%
Water Sensitive	-2%	-3%	-5%	-6%	-4%		-4%

Appendix 3: Proxy Modelling Results – Mixed Rural and Mangaroa and Pakuratahi Valleys

Table A3- 1. Total landuse proportions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment

			Total		
Scenario	EPAU	Total Area (Ha)	Urban	Roads	Rural
Baseline	Mixed Rural and Mangaroa and Pakuratahi Valleys	3,320	0.0%	0.5%	99.5%
BAU			0.0%	1.2%	98.8%
Improved			0.0%	1.2%	98.8%
Waster Sensitive			0.0%	1.2%	98.8%

Table A3- 2. Detailed landuse proportions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment

Proxy catchment			Horokiri and Motukaraka at Mouth			
Applicable Expert panel assessment units			Mixed Rural Mangaroa and Pakuratahi Valleys			
Scenario			Baseline	BAU	Improved	Waster Sensitive
Permeable	Forest	Indigenous	11.9%	11.9%	11.9%	11.9%
		Exotic	28.0%	28.0%	28.0%	28.0%
	Pasture	Farmed	44.0%	43.4%	29.2%	20.6%
		Retired	15.5%	15.5%	29.8%	38.3%
	Other		0.0%	0.0%	0.0%	0.0%
	Urban grass & parks		0.0%	0.0%	0.0%	0.0%
Residential impervious	Roads	Existing	0.4%	0.4%	0.4%	0.4%
		New	0.0%	0.0%	0.0%	0.0%
	Paved surfaces	Existing	0.0%	0.0%	0.0%	0.0%
		New	0.0%	0.0%	0.0%	0.0%
	Roofs	Existing	0.0%	0.0%	0.0%	0.0%
		New	0.0%	0.0%	0.0%	0.0%
Commercial and industrial	Paved	Commercial	0.0%	0.0%	0.0%	0.0%
		Industrial	0.0%	0.0%	0.0%	0.0%
	Roofs	Commercial	0.0%	0.0%	0.0%	0.0%
		Industrial	0.0%	0.0%	0.0%	0.0%
	Heavy traffic roads		0.0%	0.7%	0.7%	0.7%
TOTAL AREA (Ha)			3,320	3,320	3,320	3,320

Table A3- 3. E.coli NOF attribute states and concentrations (cfu/100 mL) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Baseline									BAU								
	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state
Mixed Rural and Mangaroa and Pakuratahi Valleys	27	39	157	2621	D	D	D	D	D	23	36	127	2001	D	D	A	D	D
	Improved									Water Sensitive								
	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	% > 540 cfu/100 mL	% >260 cfu/100 mL	Median (cfu/100 mL)	95th %ile (cfu/100 mL)	Overall state
	15	26	73	1273	C	B	A	D	D	10	21	50	849	B	B	A	B	B

Table A3- 4. E.coli concentrations (cfu/100 mL) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	Ecoli median	Ecoli 95th percentile	Ecoli median	Ecoli 95th percentile	Ecoli median	Ecoli 95th percentile	Ecoli median	Ecoli 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	157	2621	127	2001	73	1273	50	849	-19%	-24%	-54%	-51%	-68%	-68%

Table A3- 5. NH4-N NOF attribute states and concentrations (mg/L) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.006	0.047	A	A	A	0.006	0.044	A	A	A
	Improved					Water Sensitive				
	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category	Median	Annual Maximum	Median Category	Annual Maximum Category	Overall Category
	0.006	0.037	A	A	A	0.006	0.032	A	A	A

Table A3- 6. NH4-N concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	NH4 median	NH4 95th percentile	NH4 median	NH4 95th percentile	NH4 median	NH4 95th percentile	NH4 median	NH4 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.006	0.032	0.006	0.03	0.006	0.026	0.006	0.022	0%	-6%	0%	-19%	0%	-31%

Table A3- 7. N03-N NOF attribute states and concentrations (mg/L) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.217	1.434	A	A	A	0.211	1.3	A	A	A
	Improved					Water Sensitive				
	0.197	1.082	A	A	A	0.186	0.898	A	A	A

Table A3- 8. N03-N concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	NO3 median	NO3 95th percentile	NO3 median	NO3 95th percentile	NO3 median	NO3 95th percentile	NO3 median	NO3 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.217	1.434	0.211	1.3	0.197	1.082	0.186	0.898	-3%	-9%	-9%	-25%	-14%	-37%

Table A3- 9. DIN concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	DIN median	DIN 95th percentile	DIN median	DIN 95th percentile	DIN median	DIN 95th percentile	DIN median	DIN 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.224	1.466	0.217	1.331	0.202	1.108	0.192	0.92	-3%	-9%	-10%	-24%	-14%	-37%

Table A3- 10. DRP concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	DRP median	DRP 95th percentile	DRP median	DRP 95th percentile	DRP median	DRP 95th percentile	DRP median	DRP 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.008	0.028	0.007	0.025	0.006	0.016	0.005	0.013	-13%	-11%	-25%	-43%	-38%	-54%

Table A3- 11. Copper concentrations (mg/L) and 'proxy attribute state' for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.00004	0.00013	A	A	A	0.00012	0.00091	A	A	A
	Improved					Water Sensitive				
	0.0001	0.00069	A	A	A	0.00006	0.00032	A	A	A

Table A3- 12. Copper concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	Cu median	Cu 95th percentile	Cu median	Cu 95th percentile	Cu median	Cu 95th percentile	Cu median	Cu 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.00004	0.00013	0.00012	0.00091	0.0001	0.00069	0.00006	0.00032	200%	600%	150%	431%	50%	146%

- Large % increases are due to Transmission Gully.

Table A3- 13. Zinc concentrations (mg/L) and 'proxy attribute state' for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Baseline					BAU				
	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category	Median	95th Percentile	Median Category	95th Percentile Category	Overall Category
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.00008	0.0003	A	A	A	0.00021	0.00158	A	A	A
	Improved					Water Sensitive				
	0.00018	0.0012	A	A	A	0.00011	0.00056	A	A	A

Table A3- 14. Zinc concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	Zn median	Zn 95th percentile	Zn median	Zn 95th percentile	Zn median	Zn 95th percentile	Zn median	Zn 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	0.00008	0.0003	0.00021	0.00158	0.00018	0.0012	0.00011	0.00056	163%	427%	125%	300%	38%	87%

- Large % increases are due to Transmission Gully.

Table A3- 15. Suspended Sediment Concentrations (mg/L) and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

EPAU	Concentrations (mg/L)								Relative change (% reduction)					
	Baseline		BAU		Improved		WSUD		BAU		Improved		WSUD	
	SSC median	SSC 95th percentile	SSC median	SSC 95th percentile	SSC median	SSC 95th percentile	SSC median	SSC 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile	% change median	% change 95th percentile
Mixed Rural and Mangaroa and Pakuratahi Valleys	4.64	98.21	4.64	95.54	4.57	77.08	4.55	74.65	0%	-3%	-2%	-22%	-2%	-24%

Table A3- 16. Suspended sediment annual average load and relative reductions (%) for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

Description	Baseline	BAU	Improved	WSUD
Annual Average Load (tonnes/year)	955	946	490	465
% reduction	-	-1%	-49%	-51%

Table A3- 17. Flow statistics for *Horokiri and Motukaraka at Mouth* proxy catchment through scenarios

Scenario	MALF (m3/s)	Median (m3/s)	95th Percentile (m3/s)	99.8th Percentile (m3/s)	Mean Annual Discharge (ML/year)	FRE3 threshold (m3/s)	FRE3 Frequency (events per year exceeding FRE3)
Baseline	0.056	0.313	2.345	9.731	20659	0.94	9.6
BAU	0.057	0.315	2.351	9.749	20807		9.6
Improved	0.056	0.313	2.29	9.502	20413		9.5
Water Sensitive	0.056	0.311	2.261	9.358	20186		9.5
	Relative change (%) from baseline						
BAU	2%	1%	0%	0%	1%	-	0%
Improved	0%	0%	-2%	-2%	-1%		-1%
Water Sensitive	0%	-1%	-4%	-4%	-2%		-1%