WET WEATHER OVERFLOWS FROM THE HUTT VALLEY AND WAINUIOMATA WASTEWATER NETWORKS:

Assessment of Environmental Effects

PART 2 REPORT

February 2023

Our water, our future.

QUALITY CONTROL

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Abbreviations

ANZECC	Australian and New Zealand Water Quality Guidelines (2000)
ANZG	Australian and New Zealand Water Quality Guidelines (2018)
ARI	Average Recurrence Interval
BOD_5	Five-day biochemical oxygen demand
CMA	Coastal Marine Area
CIA	Cultural Impact Assessment
CMA	Coastal Marine Area
CCTV	Closed circuit television
COP	Constructed Overflow Point
E. coli	*Escherichia coli*
EOC	Emerging organic contaminant
GWRC	Greater Wellington Regional Council
HCC	Hutt City Council
I&I	Inflow and Infiltration
LTP	Long Term Plan
MCI	Macroinvertebrate community index
MFE	Ministry for the Environment
NIWA	National Institute of Water and Atmosphere
NOEC	No observable effects concentration
NES-F	National Environmental Standard Freshwater 2020
NPS-FM	National Policy Statement for Freshwater Management 2020
NZWERF	New Zealand Water Environment Research Foundation
PNEC	Predicted No Effect Concentration
pNRP	Proposed Natural Resources Plan, Appeals version 2019
PNEC	Predicted No Effects Concentration
PS	Pump Station
QMRA	Quantitative Microbiological Risk Assessment
RE	Receiving Environment
REC	River Environment Classification
RMA	Resource Management Act 1991
RPH	Regional Public Health
RWQE	River Water Quality and Ecology
SCADA	Supervisory Control and Data Acquisition
SMP	Stormwater Monitoring Plan
TSS	Total Suspended Solids
UHCC	Upper Hutt City Council
USGS	United States Geological Survey

Strategic Reduction Plan	Wastewater Network Overflow Strategic Reduction Plan
Sub-catchment Reduction Plan	Wastewater Network Overflow Sub-catchment Reduction Plan
WNO Response Plan	Wastewater Network Overflow Response Plan
WNO	Wastewater network overflow
WOMP	Wastewater Overflow Monitoring Plan
WWTP	Wastewater Treatment Plant
Wellington Water	Wellington Water Limited
UHCC	Upper Hutt City Council

1. INTRODUCTION

1.1 Purpose of this document

This Assessment of Environmental Effects (AEE) – Part 2 Report is the companion document to the Applications for Resource Consent and Assessment of Environmental Effects - Part 1 Report and has been prepared to support Wellington Water Ltd.'s (Wellington Water) application to consent overflows from the wastewater network in the Hutt Valley and Wainuiomata catchments.

The purpose of this document is to outline the methodology that has been developed for the assessment of wet weather overflows and describe how the methodology has been applied to assess the level of adverse effect and to determine a ranking of overflow sites with the greatest potential to adversely impact the receiving environment.

This Part 2 Report covers the relevant information required under clause 6 (Information required in assessment of environmental effects) and clause 7 (Matters that must be addressed by assessment of environmental effects) of Schedule 4 of the Resource Management Act (RMA). The Part 1 Report covers all other information required under Schedule 4 of the RMA.

1.2 Structure of the AEE Report

This AEE (Part Two) is structured as follows:

Section 1	Describes the purpose of this report.
Section 2	Provides an overview of the methodology used to prepare this assessment. The same methodology will also be used to prepare AEE's for the Porirua, Wellington and Karori wastewater networks.
Section 3	Provides an assessment of effects of wet weather overflow discharges to various receiving environments within the Hutt Valley and Wainuiomata catchments. It summarises the receiving environment values, overflow characteristics, potential magnitude and level of public health, ecological, cultural, and aesthetic effects.
Section 4	Provides an overall summary for all overflow locations and ranks the sites with the greatest potential to cause adverse effects on the receiving environment.
Section 5	Conclusion.
Appendix A	Summary of COPs, receiving water values, and level of adverse effects.
Appendix B	Mass balance calculations of receiving water quality during overflow events
Appendix C	Summary of uncontrolled overflow points.

2. METHODOLOGY

This section summarises the methodology used to prepare the Assessment of Effects (AEE) in Section 3 and Section 4 of this application document. It details the key factors which were taken into consideration when adapting an existing and proven methodology to apply it in the context of the Hutt Valley and Wainuiomata wastewater network and catchments.

2.1 Characteristics of municipal wastewater

The wastewater system uses a large volume of water to carry a small quantity of solid and liquid wastes. A typical design dry weather flow for a sewage system is around 225 litres per person per day, generating sewage (wastewater) with a solids content of around 0.1%.

Although municipal wastewater is dilute, it is also an unstable, offensive mixture of dissolved and suspended solids, containing human wastes with the potential for disease transmission. Municipal wastewater consists of faeces and urine as well as the water from baths, showers, domestic waste disposal machines, basins, dishwashers and washing machines. It also contains trade wastes from hotels, restaurants, shops, offices, laundries, and industries; and any other liquids people pour into or allow to enter the wastewater system.

During the 2019/20 year the trade waste component in the Seaview wastewater catchment comprised on average 4.7% of total wastewater volume received at Seaview WWTP (George, 2020). The average trade waste volume in the catchment has steadily decreased from 4,500 m^3/day in 2002/03 to 2,660 m^3/day in 2019/20. Trade wastes are received from 550 food premises, 80 automotive businesses, 6 breweries, a distillery, 2 landfills, paint manufacturers, electroplaters, laundries, and a range of other commercial sources. The two landfills are the highest volume contributors, influenced by rainfall and groundwater flows. The Silverstream Landfill is currently operational while the Wainuiomata Landfill was closed in 2012 and leachate strength is now tracking downwards. Biosolids extracted from wastewater at the Seaview WWTP contain relatively low levels of heavy metals indicating modest influent loads. Monitoring has shown a drop in most metals over the last six years and a sustained drop in copper and zinc since May 2017 (George, 2020).

Wastewater influent to the Seaview WWTP is characterised below. The quality of untreated wastewater received at Seaview WWTP is determined daily samples from April 2020 to August 2022 (n = 800). The faecal coliform and enteric virus values are from a generic characterisation of wastewater quality of influents to New Zealand WWTPs (Table 2-1).

Table 2-1: Wastewater Flows to Seaview WWTP and Characterisation of Untreated Wastewater Quality

Aspect	Parameter	Estimated Number/Volume/Concentration
Residential population		163,461 residents (as of 2022)
Average daily flow		64,190 m^3/day or 744 L/s
Peak wet weather flow		3000 L/s
Average wastewater quality	BOD_5	160 g/m^3
	Total suspended solids (TSS)	220 g/m^3
	Total nitrogen	32 g/m^3
	Ammonia nitrogen	21 g/m^3
	Total phosphorus	3.9 g/m^3
	Faecal coliform bacteria	10^6 to 10^7 per 100ml
	Enteric viruses	10^3 to 10^4 per 100ml

The methodology developed by NIWA for the generic assessment of effects for Auckland's wastewater network overflows (detailed further in Section 2.3 below) represents overflow discharge quality using the 90th percentile concentration of a range of constituents measured in influent to Watercare's

Mangere Wastewater Treatment Plant (Table 2-2). The rationale is that those concentrations are appropriate for situations in which a 'plug' of relatively undiluted wastewater may be discharged at the onset of an overflow event. While actual concentrations are likely to be considerably lower most of the time, it was considered appropriate to adopt a conservative approach in the assessment of wastewater network overflows. Because the NIWA methodology is based on the Mangere data the same values have been adopted for the Seaview assessment. Table 2-2 indicates that contaminant concentrations in influent to Mangere WWTP are more than 50% higher than those received at Seaview WWTP, making this a particularly conservative approach.

Table 2-2: Comparison 90th Percentile Concentrations in Influent to Mangere WWTP and Seaview WWTP

Constituent	90th Percentile Concentration	
	Mangere WWTP	Seaview WWTP
Total suspended solids (g/m^3)	531	300
BOD_5 (g/m^3)	550	220
Total ammonia nitrogen (g/m^3)	47	26
Total nitrogen (g/m^3)	78	40
Total phosphorus (g/m^3)	7.9	5.1
Sulphide (g/m^3)	5	No data
Copper (g/m^3)	0.096	No data
Zinc (g/m^3)	0.31	No data
Norovirus (n per L)	10^6	No data
E. coli (n per 100ml)	4×10^6	No data

The list of wastewater contaminants in Table 2-2 above is not exhaustive. A range of emerging organic contaminants (EOCs) that are not commonly monitored in wastewater or in the receiving environment are known to be present in untreated wastewater.

There are multiple definitions of emerging organic contaminants however a widely accepted definition from the United States Geological Survey (USGS) defines emerging contaminants as:

> *"…any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects. In some cases, environmental effect has likely occurred for a long time, but may not have been recognised until new detection methods were developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of EC's." (USGS 2011, cited in Tremblay et al. 2011, p114).*

There are many known EOCs (and potentially many more which have not yet been identified), which makes it difficult to identify and analyse all possible EOCs existing in the environment. Analytical methods are also currently not available for some EOCs or are still in their infancy (and therefore highly expensive and restricted to advanced research laboratories).

Examples of substances containing EOCs include chemicals used in industrial and domestic cleaning products, textile manufacturing, paints, inks and surface treatments, kitchen and laundry detergents, personal care products, cosmetics, pharmaceuticals, and medicines. Products and medicines containing EOCs are used daily by the human population and enter domestic wastewater from bathing, laundry, and toileting activities. Treated urban wastewater is one of the major sources of EOCs to the environment in New Zealand.

Recent studies of EOC concentrations in wastewater include the municipal wastewater systems at Porirua City (Northcott, 2019) and Gisborne City (Stewart, 2020), while Olsen (2017) examined EOCs in subtidal sediments of Wellington Harbour.

Three samples of Porirua WWTP influent and treated wastewater were tested for a total of 85 individual EOCs by Northcott Research consultants Ltd in 2019. A total of 45 EOCs were detected in the influent samples over the three sampling occasions (Table 2-3). Northcott (2019) conducted a risk assessment for the twenty-three EOCs measured in the Porirua wastewater for which 'Predicted No Effect Concentration' (PNEC) values are available. The concentration of all but six EOCs in the influent fell below their respective PNEC values, indicating they present no risk to aquatic organisms exposed to undiluted network overflows. The remaining six EOCs exceeded their respective PNEC values, indicating potential risk to aquatic organisms exposed to a network overflow. These include technical nonylphenol, TBEP, triclosan, bisphenol-A, 17β-estradiol and estrone. The calculated dilution required for these substances to present no risk to aquatic organisms in receiving waters is 36-fold, which is about the same level of dilution required to avoid toxic effects from ammonia nitrogen.

The Gisborne study identified 22 priority EOCs in Gisborne wastewater including many of those also detected in Porirua wastewater. Those contaminants that ranked as high risk across both the Porirua and Gisborne studies include:

- Industrial alkyphenols (technical nonylphenol)
- Phenolic antimicrobials (triclosan)
- Alkylphosphate flame retardants (TBEP, TCPP)
- Plasticer metabolites (monoethylhexyl phthalate acid ester, Bisphenol-A) and
- Estogenic steroids (17α-ethynylestradiol, 17β-estradiol, estrone).

Table 2-3: Concentration of EOCs in the Influent to Porirua WWTP (from Northcott 2019); those Shaded Pink Required Dilution to Achieve No Risk of Toxicity

Emerging Organic Chemical	Influent Concentrations (ng/L)			PNEC/NOEC (ng/L)	Dilution Required for no Risk	Source
	min	median	max			
Industrial alkylphenols						
Technical nonylphenol	470	494	573	330	1.7-fold	European Union 2002
Alkylphosphate Flame Retardants						
TnBP	237	261	426	660,000	none	Verbruggen 2005
TiBP	182	186	187	150,000	none	Verbruggen 2005
TBEP	7965	27324	40920	1,300	31.5-fold	Verbruggen 2005
TCEP	368	443	500	460,000	none	Verbruggen 2005
TCPP	3476	3640	3937	160,000	none	Verbruggen 2005
TDCP	636	666	718	1,300	none	Env Canada 2016
TPP	134	136	137	740	none	Verbruggen 2005
Phenolic Antimicrobials						
Triclosan	165	197	210	100	2.1-fold	WFD-UKTAG 2009
Polycyclic musks						
Galaxolide	3227	3317	4002	68,000	none	Hera 2004
Tonalide	92.3	96	110	3,500	none	Hera 2004
Pharmaceuticals						
Carbamazepine	626	684	846	9000	none	Zhao et al 2017
Diclofenac	382	502	556	9800	none	Zhao et al 2017
Ibuprofen	5538	7146	9323	13875	none	Ortez de Garcia, 2014
Naproxen	45.3	2620	2953	14,199	none	Ortez de Garcia, 2014
Salicylic acid	204	515	1151	118,700	none	Ortez de Garcia, 2014

Emerging Organic Chemical	Influent Concentrations (ng/L)			PNEC/NOEC (ng/L)	Dilution Required for no Risk	Source
	min	median	max			
Plasticisers						
Bisphenol-A	800	1446	2167	60	36.1-fold	Wright-Walters, 2011
Benzyl butyl phthalate	227	288	329	51,000	none	Staples 2000
Di-n-butyl phthalate	513	735	890	10,000	none	Staples 2011
Diethyl phthalate	6549	7322	7356	940,000	none	Staples 2000
Dimethyl phthalate	210	317	287	3,251,000	none	Staples 2000
Estrogenic steroid hormones						
17β-estradiol	1	28.3	34.5	2	17.3-fold	Caldwell et al 2012
Estrone	68.9	79	83	6	13.8-fold	Caldwell et al 2012

Adverse effects associated with EOCs in the water column and sediments from overflows to streams are likely to be relatively minor because erosional conditions during wet weather overflows are more likely to transport these contaminants downstream, resulting in temporary, short-term exposure (NIWA 2013). The risks associated with EOCs are higher in downstream depositional environments such as estuaries and sheltered harbours where contaminants become associated with particulates and may accumulate in marine sediments.

The Wellington Harbour Subtidal Sediment Quality Survey conducted in 2016 included analyses of a wide range of EOCs in surface sediments at ten sites (Olsen, 2017). Chemical analyses included perfluorinated and polyfluorinated compounds, glyphosate and AMPA, flame retardants including polybrominated diphenyl ethers, plasticisers including Bisphenol A, musk fragrances, selected pharmaceuticals, steroid estrone, selected personal care products, preservatives and pyrethroid insecticides. In total 23 EOCs were tested.

Wellington Harbour sediment monitoring site WH15 is located near the mouth of the Hutt River and is influenced by wastewater overflows within the Hutt River catchment. At site WH15, 18 of the 23 EOCs tested were not detected. The substances that were detected are the flame retardant TPP (1.63 µg/kg dry weight), the plasticiser BBP (8.33 µg/kg), the surfactant technical nonylphenol equivalents (83.8 µg/kg), the insecticide Bifenthrin (0.62 µg/kg) and the steroid estrogen Estrone (2.85 µg/kg). Olsen (2017) concluded that levels of EOCs observed in subtidal sediments of Wellington Harbour were all low compared with levels observed at other sites in New Zealand, or in other countries.

2.2 Values of the receiving environments

Schedules of the pNRP identify sites with significant cultural, recreational, heritage and biodiversity values that require particular recognition or protection. Classification of receiving environment values, which is the first stage of this assessment of effects as detailed in the next section, was guided primarily by the pNRP Schedules, and further informed by relevant technical reports and consultation with key stakeholders.

2.3 Methodology for assessment of effects of wet weather overflows

This assessment of effects on the environment has been conducted in accordance with the 'Methodology for the Assessment of Wet Weather Wastewater Overflows' (Wellington Water 2020) which is included as Attachment 3 to the proposed resource consent conditions. The methodology has been specifically developed to allow for the comparative assessment of public health, ecological, cultural and aesthetic effects on aquatic receiving environments that may occur following a wet weather wastewater overflow.

The Methodology is an important component of Wellington Water's overall approach to managing wastewater overflows from the public wastewater network (the Network) and prioritisation of Network improvement works. It provides a consistent, repeatable, and auditable process for broadly assessing the potential magnitude and overall level of public health, ecological, cultural, and aesthetic effects of network overflows during wet weather. It caters for a diverse range of aquatic receiving environments and considers the two most important characterises of wet weather overflows, namely frequency and volume. By adopting a generic approach that allows for a comparative assessment, the methodology serves as a key tool for the prioritisation of network improvement works.

The assessment process utilises existing information and data and recognises that the amount and quality of information on wastewater overflow characteristics and receiving environments varies significantly across the network and may be quite limited in some instances. It allows for the consideration of site-specific information while generating outputs that are comparable between individual overflow points as well as catchments.

2.3.1 Information required

Specific reference information is required to implement the Methodology and complete an aquatic Receiving Environment (RE) assessment:

1) Overflow location, volume, and frequency data. This may be modelled information or monitored (SCADA) data and can be obtained from the Wellington Water Wastewater Networks Overflow Database.
2) Receiving water quality monitoring data, flow monitoring data (Wellington Water, GWRC, LAWA, and NZ River Maps, https://shiny.niwa.co.nz/nzrivermaps), benthic ecology data (periphyton, invertebrates), and fish records from the New Zealand Freshwater Fish Database (NZFFD) and technical reports.
3) The NIWA report entitled 'Auckland-wide Wastewater Network Discharge Consent Applications - Generic Assessment of Ecological and Recreational Effects' (Moores, et al., 2013), to provide background and guidance for determining the potential public health and ecological effects associated with wet weather wastewater overflows.
4) The tables of public health and aquatic ecology effects from the NIWA report which score the magnitude of effects and provide a brief description of those effects for each permutation of overflow characteristics, receiving environment type and receiving environment values.
5) Recent aerial imagery and maps.
6) Wellington Water ArcGIS Online (Regional Water, Stormwater, Wastewater; Wastewater Overflows Dashboard).
7) The Proposed Natural Resources Plan (and any relevant appeal outcomes).

2.3.2 Outline of the process

The Methodology used to assess the environmental effects of overflow discharges is described in detail in Attachment 3 to the proposed consent conditions.

A high-level overview is presented in Figure 2-1 below. In general terms the assessment for each individual overflow point includes identification of the relevant receiving environment (including direct, secondary, and ultimate), establishment of receiving environment type (small waterway, medium waterway, large waterway, lake, estuary, inner harbour, outer harbour, beach), identification of receiving environment values (recreational, ecological, cultural and aesthetic), determination of overflow characteristics (volume and frequency), assessment of potential magnitude of adverse effects and determination of an overall level of adverse effect (public health, aquatic ecology, cultural values and aesthetic). The methodology also includes an assessment of potential cumulative effects.

Scores were assigned by expert judgement, supported by prior knowledge of the physical, chemical, and biological processes and interactions operating in receiving waters. Ultimately each receiving environment is assigned a level of public health and ecological effects rating, and a pre-written assessment prepared by Moores, et al., (2013) for each permutation of the factors outlined above.

2.3.3 pNRP objectives and policies

An assessment of the current state of the receiving environment against pNRP Objective O18 (suitability for contact recreation) and Objective 019 (biodiversity, aquatic ecosystem health and mahinga kai) has been conducted for each sub-catchment, using existing information and data. It is recognised, however, that the amount and quality of information varies significantly across the wastewater catchment and is quite limited in some instances.

A generic assessment, rather than a site-specific assessment, has been conducted against pNRP Policy P93 water quality guidelines. Policy P93 is well suited to a continuous point-source discharge to a river where an upstream reference site, downstream impact site and intermediate mixing zone can be defined, and a routine monitoring programme can be implemented. Wet weather overflow discharges from a wastewater network are not of this type. They are more similar in character to a diffuse discharge, occurring at multiple locations for a short period in response to a rainfall event, repeating intermittently over time. Identification of an upstream reference site, a zone of reasonable mixing, and implementation of a water quality monitoring programme are all problematic for this type of discharge. For these reasons the assessment against Policy P93 guidelines has been based on a series of representative discharge scenarios.

Figure 2-1: Overview of the methodology for assessing the level of adverse effects from wet weather overflows

2.3.4 Assessment steps

An explanation of the assessment steps is provided below.

Step 1 Identify receiving environment

Step 1 is the identification of the receiving environment for each individual overflow. It involves tracing the discharge from the wastewater network overflow point to the receiving environment. This step is automated in GIS and then checked visually by mapping.

Step 2 Establishment of receiving environment type

Once the receiving environment for each overflow is determined it is then classified as one of eight types. The receiving environment type is an important factor in determining the available dilution and potential magnitude of adverse effect. The receiving environment types are:

- Small waterway (order 1 or 2, <100 L/s)
- Medium waterway (order 3 or 4, 100 to 1000 L/s)
- Large waterway (order 5 or greater, >1000 L/s)
- Lake
- Estuary
- Beach (including open coast)
- Inner Harbour (sheltered, partially enclosed)
- Outer harbour (semi exposed).

These receiving environment types are based on those proposed by Moores et al (2013) for Auckland, but several amendments have been made to better represent the Wellington situation:

a) A “Medium Waterway” type has been added to the “Small” and “Large” categories to better represent the wider size range of waterways in Wellington (there are no 5th order waterways in the Mangere catchment while Wellington has several 5th order rivers).

b) The “Harbour” type has been split into “Inner Harbour” and “Outer Harbour” to represent the difference between the more enclosed waters of Evans Bay and Lambton Harbour, compared to areas more directly connected to Cook Strait.

Receiving environment types and size thresholds are otherwise the same as those used by Watercare in Auckland.

Step 3 Classification of receiving environment values

Information is compiled for each receiving environment from a variety of sources and used to describe the physical characteristics and current state of the environment. Where data allows the current state is benchmarked against pNRP objectives and NPS-FM attribute states. The environment is then rated in respect of recreational, ecological, cultural, and aesthetic values.

Worked example - Waiwhetū Stream:

The Waiwhetū Stream is a low elevation 4th order watercourse which runs for a distance of 9.4km from the bush covered Eastern Hutt Hills, through urban areas of Naenae, Epuni, Waterloo, Waiwhetū and Gracefield, to its confluence with the Hutt River Estuary at Seaview, etc.

Summary statistics for *E. coli* concentrations and assessment against NPS-FM attribute state is given in Table 2-4. An overall summary of receiving environment characteristics and values is given in Table 2-5.

Table 2-4: Summary statistics for E. coli in the Waiwhetū stream at Whites Line East (data 2015-2020)

Site name	N samples	% Exceeding 540 cfu/100ml	% Exceeding 260 cfu/100m	Median concentration cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State
Whites Line East	65	57	77	700	10,800	E

Table 2-5: Summary of Waiwhetū stream receiving environment characteristics and values

Receiving Environment Name	Type	Recreation value	Ecology value	Cultural value	Aesthetic value
Waiwhetū Stream	Medium waterway	Class 3 (Full contact recreation is not likely)	Class 3 (Highly modified)	Class 1 (Very important)	Class 1 (High value)

Step 4 Determination of WNO Characteristics

Determination of WNO characteristics is based in either monitoring data or output from modelling of the wastewater network. It includes the following:

a. Overflow volume and frequency (high, medium, low) as summarised in Table 2-6.

b. Spatial distribution of overflow points (receiving waters affected by single or multiple overflow points).

Table 2-6: Overflow volume and frequency ranges

Overflow range	Volume Definition	Frequency Definition
High	Actual or estimated annual volume of 6,000m³ or greater.	More than 10 overflow events per year.
Medium	Actual or estimated annual volume of between 600 and 6,000m³.	Between 3 and 10 overflow events per year.
Low	Actual or estimated annual volume of less than 600m³, including zero volume.	2 or fewer overflow events per year.

The volume threshold values defining high, medium, and low volumes (600m^3 and 6000m^3) have been adjusted downwards from those used by Watercare (1000m^3 and 10,000m^3). The rationale is that the lower thresholds better reflect the recorded spread of overflow volumes from the Seaview network: 3 WNO's were high volume, 12 were medium volume and the remainder were low volume.

The frequency threshold value between high and medium number of overflows has also been adjusted downward from 12 to 10 events per year. The rationale for this is again that these thresholds better reflect the frequency distribution of overflow events in the Seaview network: 1 WNO operated at high frequency, 11 were at medium frequency and the remainder were low frequency overflows.

Lower thresholds could result in a slightly more conservative assessment of the 'level of adverse effect' at some WNO locations than was proposed by NIWA (2013), for instance where it causes a 'low' overflow volume/frequency to be reclassified as a 'medium'. In practice very few WNO sites are caught in this way and the overall effect on the assessment effects is negligible.

Worked example – asset ID 8, Waiwhetū Stream

A summary of wastewater network overflow characteristics for WNO 8 on the Waiwhetu Stream is given in Table 2-7.

Table 2-7: Summary of Wastewater Network Overflow Characteristics, Waiwhetū Stream

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
(8)	Direct	-	Medium	12	High	Operative	Wellington Water Scada 2012-2020, Seaview Strategic Wastewater Model

Note: There are multiple WNOs to Waiwhetū Stream but for simplicity only WNO (8) is shown.

Step 5 Assessment of Potential Effects

5(a) Public Health Effects

The methodology for assessing public health effects is based on an approach developed by Moores, et al, (2013) and Watercare (2013) specifically for the purpose of determining the potential effects of wet weather overflows from the wastewater network on aquatic receiving environments. The assessment methodology focuses on contaminant load and concentration, and is based on a three-step process that:

a. Considers the potential physical, chemical and biological changes generated by wastewater overflows.

b. Determines the potential magnitude of effect which arises from these changes and the characteristics (type and values) of the receiving environment. A NIWA expert panel identified, assessed, and scored each of the potential effects. In total there are 54 variations of public health effects, which have been summarised as pre-written text in Appendix B of the Assessment of Effects Methodology included with the consent conditions.

c. Determines the overall level of adverse effect by combining the magnitude of effect and frequency of occurrence, the latter based on historic data and/or modelling.

Worked example – Waiwhetū Stream

Waiwhetū Stream is a water body in which full contact recreation activities are unlikely to occur, i.e., it has 'Class 3 recreational value'[1]. A 'Medium' volume discharge to a 'Medium waterway' with 'Class 3 recreational values' is assessed as having a 'Low' potential effect on all recreational activities, as detailed in Table 2-8. The above combination of factors automatically determines the 'magnitude of public health effect' assessment score and text included in Table 2-8.

Table 2-8 describes the potential magnitude of effect from a single overflow event but does not consider the frequency of occurrence. The combination of the magnitude of the event and the frequency of occurrence determines the overall level of effect. In this case, although the magnitude of effect is 'Low', overflows have historically occurred very frequently at site 8, resulting in an overall level of public health effect of 'Moderate'.

[1] Class 1 recreational value is 'high', Class 2 is 'moderate' and Class 3 is 'low'.

Table 2-8: Magnitude of Public Health Effects from Overflows to Waiwhetū Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact, partial contact recreation, fishing or harvesting watercress	**Low potential effect (Effects Score of 2)** on all recreational activities, because the value categorisation indicates that contact or partial contact recreation, shellfish collecting, fishing and/or watercress collecting are unlikely to occur.

Table 2-9: Overall level of Public Health Effects in Waiwhetū Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall Level of Public Health Effect
4, 5, 9, 10, 12	Direct	Very low	Low	Very low
(8)	Direct	**Low**	High	**Moderate**
6, 7, 72, 73	Direct	Very low	Low	Very low
11	Direct	**Low**	Medium	Low
78	Direct	Very low	Low	Very low

5(b) Assessment of Magnitude of Ecological Effects

The assessment methodology for ecological effects is similar to that described above for public health effects. It focuses on contaminant load and concentration, and is based on a three-step process which:

a. Considers the potential physical, chemical and biological changes generated by wastewater overflows.

b. Determines the potential magnitude effect which arises from these changes and the characteristics (type and values) of the receiving environment. In total 54 variations of ecological effects have been determined by an expert panel (Moores, et al, 2013), which are summarised as pre-written text in Appendix C of the Methodology report.

c. Determines the overall level of adverse effect by combining the magnitude of effect and frequency of occurrence, the latter based on historic data and/or modelling.

Worked example – Waiwhetū Stream

Waiwhetū Stream is assessed as a highly modified/disturbed water body. 'Medium' volume discharges to 'Medium' waterways, with Class 3 ecological values, are assessed as having a range of Very Low to Low magnitude of effect on ecological values, as shown in Table 2-10

In situations where potential magnitude of ecological effect range across more than one effects score, the overall magnitude of effect (for a single discharge) is determined by the dominant (highest) effects score, which is then combined with overflow frequency to generate the overall level of effect. In this case, the magnitude of ecological effect is 'Low'. The above combination of factors automatically determines the effects assessment text included in Table 2-10.

The overall level of ecological effect is summarised in Table 2-11. The overall level of effect is defined as the combination of the magnitude and likelihood (frequency) of an event. In this case the magnitude is low but the frequency of overflow is high, giving an overall level of ecological effect of 'Moderate'.

Table 2-10: Magnitude of Ecological Effects of Overflows to Waiwhetū Stream

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low)**, because of the high degree of background disturbance in these streams.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low)**, because of the high degree of background disturbance in these streams.
Behavioral changes in fin fish	**Effects Score of 1 (Very Low)**, because of the high degree of background disturbance in these streams.
Increase in nuisance plants	**Effects Score of 1 (Very Low)**, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Growth of sewage fungus/Beggiatoa	**Effects Score of 2 (Low),** because BOD enrichment is unlikely to add to the potential for the growth of these organisms.

Table 2-11: Overall level of Ecological Effects in Waiwhetū Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecology Effect	Frequency Range	Overall level of Ecological Effect
4, 5, 6, 7, 9, 10, 12	Direct	**Low**	Low	Very Low
8	Direct	**Low**	High	**Moderate**
6, 7, 72, 73	Direct	**Low**	Low	Very Low
11	Direct	**Low**	Medium	Low
78	Direct	**Low**	Medium	Low

5(c) Assessment of Potential Cultural Effects

Potential cultural effects are determined from receiving environment cultural value class (1 or 2) and overflow volume range (low, medium, or high). The overall level of cultural effects is directly linked to overflow frequency (i.e., if the overflow frequency is high the level of adverse effect is high).

Worked example – Waiwhetū Stream

Waiwhetū Stream is assessed as having 'Very Important' cultural values (Class 1), the overflow discharges are 'Medium' volume, and the magnitude of cultural effects for a single discharge are assessed as 'High' (Table 2-12). Because the overflows occur at a 'High' frequency, the overall level of cultural adverse effects is also assessed as 'High' (Table 2-13).

Table 2-12: Cultural Effects Scale

Overflow Volume Range	Cultural Receiving Environment Class	
	Class 1: Very Important	Class 2: Important
High	Very High	High
Medium	High	Moderate
Low	Moderate	Low

Table 2-13: Overall Level of Cultural Effects

Overflow Frequency Range	Potential Cultural Effect			
	Very High	High	Moderate	Low
High	High	High	High	High
Medium	Moderate	Moderate	Moderate	Moderate
Low	Low	Low	Low	Low

5(d) Assessment of Potential Aesthetic Effects

The assessment of effects on aesthetic values relates to the loss of aesthetic enjoyment because of clearly visible and identifiable residue from wastewater overflows (visual effects) and readily detectable smell (odour effects). Visual and odour effects are primarily experienced by people and therefore these effects relate to public access. Where the location of the overflow is directly accessible or adjacent to a residential area there is potential for aesthetic effects to occur. The assessment is limited to two aesthetic value classes based on the level of public access – high or low (aesthetic effects only occur if people are there to experience them).

a. The assessment of the magnitude of effects is based on receiving environment aesthetic value class (level of public access) & overflow volume range.
b. The overall level of effect is determined from magnitude of effect and the frequency range.

Worked example – Waiwhetū Stream:

Waiwhetū Stream is assessed as having 'high' aesthetic value as the level of public access in high. 'Medium' volume discharges to such an environment have a 'high' potential to affect these values. Because overflows occur with a 'high' frequency, the overall level of effect is assessed as being 'high' (Table 2-14 and Table 2-15).

Table 2-14: Aesthetic Effects Scale

Overflow Volume Range	Aesthetic Receiving Environment Class	
	Class 1: High Value	Class: Low Value
High	High	Low
Medium	High	Low
Low	High	Low

Table 2-15: Overall Level of Aesthetic Effects

Overflow Frequency Range	Potential Magnitude of Aesthetic Effect	
	High	Low
High	High	Low
Medium	Moderate	Low
Low	Low	Low

Step 6 Assessment of Potential Cumulative Effects

For the purpose of this methodology, cumulative effects apply to public health and ecological effects, and have been interpreted to mean effects arising in combination with other effects, namely when several wastewater overflows in close proximity to each other are likely to occur at the same time and together generate a larger volume than a single overflow would.

In many cases the overall level of effects score will not change where the cumulative effect is generated by one high volume and several low volume overflows, because the individual assessment is already based on a high-volume overflow. However, there may be instances where several low volume discharges overflow together and would increase the total volume of wastewater in the receiving environment to the medium volume range. In such cases the medium volume effects score is assigned to determine the potential cumulative effects.

Worked example – Waiwhetū Stream:

For the Waiwhetū Stream receiving environment, cumulative effects are considered possible because:

There are a comparatively large number of overflow points that could potentially discharge (2 direct and 7 indirect overflows), although these are spatially separated.

All of the overflows except sites 8 and 11 occur at a 'Low' frequency, while overflow 8 occurs at a 'High' frequency and overflow 11 occurs at a 'Medium' frequency.

For spatial cumulative effects to arise, most of the discharges would need to occur at the same time, which is indeed likely. However, the available information is that total volume of wastewater discharges would remain in the 'Medium' volume range and cumulative effects would not be notably different from those assessed for site 8 alone. The outcome is that the cumulative effects assessment does not change the level of effects already determined from individual WNO's.

Step 7 Summary of Magnitude and Overall Level of Effects

The summary of the assessment of effects is provided in two ways, by receiving environment and by discharge point, as follows:

a. An effects score for the four key values and brief narrative at the end of each receiving environment assessment that focuses on the most significant effects, and

b. A table at the end of each wastewater catchment report listing overflow ID, the receiving environment, the volume and frequency range and the overall level of adverse effect assessed for public health, ecology, cultural values and aesthetic values.

Worked example – Waiwhetū Stream:

Summary table for the Waiwhetū Stream receiving environment (Table 2-16) and summary list of constructed overflow points based on the assessed level of adverse effect (Table 2-17).

Table 2-16: Summary of Potential Effects for Waiwhetū Stream

Value category	Potential magnitude of effect	Level of adverse effect
Public health	Low	Moderate/more than minor (3)
Aquatic ecology	Low	Moderate/more than minor (3)
Cultural	Moderate	High/significant (4)
Aesthetic	High	High/significant (4)

Table 2-17: Summary of the Overall Level of Adverse Effects for Each COP

Overflow ID	Volume Range	Frequency Range	Facility Name	Receiving Environment (RE)	Level of Public Health Effect	Level Ecological Effect	Level of Cultural Effect	Level of Aesthetic Effect	Combined Score	Level of adverse effect
56	Medium	High	Main Road	Black Creek	5	3	4	4	16	High / significant
8	Low	High	Rossiter Ave	Waiwhetu Stream	3	3	4	4	14	
18	High	Medium	Barber Grove	Hutt River	5	3	3	3	14	
28	High	Medium	Silverstream S Tank	Hutt River	5	3	3	3	14	
64	High	Medium	Wainuiomata S Tank	Wainuiomata River	5	3	3	3	14	
68	Medium	Medium	Wainuiomata Landfill PS COP	Wainuiomata River	5	3	3	3	14	
40	Medium	Medium	Te Marua	Mangaroa River	4	3	3	3	13	Moderate / more than minor
58	Medium	Medium	23 Rowe Parade	Black Creek	4	2	3	3	12	
61	Medium	Medium	50 Fraser Street	Black Creek	3	2	3	3	11	

2.3.5 Ground truthing of AEE methodology

The methodology adopted for the assessment of effects of WNO's relies on a matrix in which the potential effects are scored from very high to very low for each of eight types of receiving environment, taking into account variations in receiving environment values, volume of discharges and dilution. Scores were assigned by expert judgement, supported by prior knowledge of the physical, chemical, and biological processes and interactions operating in receiving waters.

A sense check of this approach was conducted by mass balance calculation for several key contaminants, assuming low, medium, and high-volume discharges to small, moderate and large waterways, comparing calculated contaminant concentrations against water quality guideline criteria, and checking these values against the generic AEE output (Appendix B). This process provides some assurance that the level of effects indicated by the AEE methodology alignments reasonably well with the outcomes indicated by monitoring results and expert opinion.

For several of the impacted stream reaches routine monthly monitoring data is available, and while that monitoring is not specifically focused on wet weather overflow events, some of the upper percentile values correlate with overflow events. Monitoring data, where available, is discussed for each of the sub-catchments included in this report and is considered in combination with the generic assessment.

3. ASSESSMENT OF EFFECTS OF WET WEATHER OVERFLOWS

This section describes the values of freshwater and coastal receiving environments that lie within and adjacent to the Hutt and Wainuiomata river catchments and identifies the potential magnitude and overall level of adverse effect of wet weather overflows on those values. Maps present the location of COPs in relation to the receiving environment and pNRP scheduled values. This assessment is undertaken in accordance with the *Methodology for the Assessment of Effects of Wet Weather Wastewater Overflows* (Wellington Water, 2020), which forms part of the proposed consent conditions.

Wastewater overflows from pumping stations and purpose-built overflow structures are typically channelled into waterways including freshwater streams, rivers, and coastal environments. Constructed overflows have been designed to mitigate the risk of overflows to private properties, buildings, footpaths, and roadways.

For the purposes of this report, constructed overflow points (COPs) are categorised into:

- Type 1: Associated with pump stations
- Type 2: Gravity network reliefs.

Eighty-three COPs have been identified within the Hutt Valley and Wainuiomata wastewater network. Of these, 55 are associated with pump stations (Type 1). The remaining 28 are overflows from network relief points (Type 2). Forty-three overflows are direct to a freshwater stream or river, 12 are direct to coastal water and 28 are into the stormwater network for conveyance to a freshwater or coastal water body. A list of COPs in the Hutt Valley and Wainuiomata network and their respective receiving environments is provided in Appendix A.

The 83 COPs discharge directly to ten distinct receiving environments as shown below in Table 3-1, noting that a discharge in the upper catchment can have a direct impact on the immediate receiving waters and an indirect impact on downstream receiving waters.

Table 3-1: COPs and their Receiving Environments

Overflow Point	Receiving Environment			
	Direct	Secondary	Tertiary	Ultimate
2 and 3	Korokoro Stream	Korokoro Estuary	n/a	Wellington Harbour
4, 5, 6, 7, 8, 9, 10, 11,12, 67, 70, 76	Waiwhetū Stream	Hutt Estuary	n/a	Wellington Harbour
13 and 37	Hulls Creek	Hutt River	Hutt Estuary	Wellington Harbour
16 and 17	Te Mome Stream	Hutt Estuary	n/a	Wellington Harbour
21 and 40	Mangaroa River	Hutt River	Hutt Estuary	Wellington Harbour
41, 42 and 43	Collins Stream	Mangaroa River	Hutt River	Wellington Harbour
1,15, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 33, 36, 38, 39, 68, 69, 72, 74, 75, 77	Hutt River	Hutt Estuary	n/a	Wellington Harbour
14, 32, 35, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 78, 79,80	Petone and East Harbour Beaches	Wellington Harbour	n/a	Wellington Harbour
14, 30, 32, 35, 45, 46, 47, 48, 49, 50, 51, 52, 53 and 54;	Wellington Harbour	n/a	n/a	Wellington Harbour
55, 56, 57, 58, 59, 60, 61, 62, 71, 73, 81, 82, 83	Black Creek	Wainuiomata River	Wainuiomata Estuary	Palliser Bay
63, 64, 65 and 66	Wainuiomata River	Wainuiomata Estuary	n/a	Palliser Bay

The linear concept of discharge point → immediate receiving environment (direct) → secondary receiving environment (indirect) → ultimate receiving environment can be illustrated by consideration of overflows 4 to 12 which discharge directly into Waiwhetū Stream but then flow downstream into the Hutt River Estuary and eventually Wellington Harbour, the ultimate receiving environment. The potential for adverse effect from a given overflow point is most pronounced in the immediate receiving environment and attenuates with distance downstream due to increased dilution.

It is known that in extreme wet weather events wastewater could overflow at uncontrolled discharge points such as surcharging manholes, in addition to the COPs described here. However, the proportion of wastewater discharged in that way is thought to be very low in the Hutt Valley and Wainuiomata catchment because nearly all potential overflow points are engineered to overflow in a controlled manner. A list of modelled uncontrolled discharge points are included in Appendix C for reference, these overflows are considered fictitious until further investigation is completed to verify overflow locations. The cumulative effect is adequately assessed by the following assessment of wet weather overflows from COPs. The outcomes of the effects assessment are presented in the following sections for each receiving environment and summarised in Appendix A.

3.1 Wastewater catchment and sub-catchments

The catchment for the Seaview Wastewater Treatment Plant includes the urban areas of the Hutt Valley and the Wainuiomata, which are described in this report as 19 sub-catchments, 16 of which include a local authority wastewater network. The sub-catchments mostly correspond with stream catchments, except the Hutt River which is broken into smaller sub-catchments (or management units), and flat coastal areas without significant streams which are combined into 'coastal' catchments. The catchments, and their NRP scheduled values are listed in Table 3-2 and illustrated in Figure 3-1.

Table 3-2: The Wastewater Sub-catchments

Sub-catchment	Catchment Area (Km^2)	Local Authority Wastewater Network?	NRP Schedules						
			A	F1	F1b	F2	F3	F4	F5
1. Korokoro	16.5	yes		✓		✓		✓	
2. Speedys	11.7	yes		✓					
3. Waiwhetu	19.1	yes		✓	✓	✓		✓	
4. Stokes Valley	12.2	yes		✓					
5. Hulls	16.7	yes		✓					
6. Lower Hutt South	17.9	yes		✓	✓	✓	✓		
7. Lower Hutt North	15.8	yes		✓		✓	✓		
8. Upper Hutt- South	28.2	yes		✓		✓	✓		
9. Upper Hutt- North	19.2	yes		✓		✓	✓		
10. Hutt -Whakatiki	80.2	yes		✓			✓		
11. Hutt Akatarawa	118.1	yes		✓			✓		
12. Hutt Headwater	115.4	**no**	✓	✓			✓		
13. Hutt Pakuratahi	81.2	**no**		✓			✓		
14. Hutt Mangaroa	103.5	yes							
15. Eastbourne	14.5	yes	✓	✓		✓		✓	✓
16. Black Creek	18.7	yes		✓			✓		
17. Wainuiomata-iti	17.7	**no**		✓			✓		
18. Wainuiomata	60.3	yes		✓	✓	✓	✓	✓	
19. Morton	40.5	yes	✓	✓			✓		

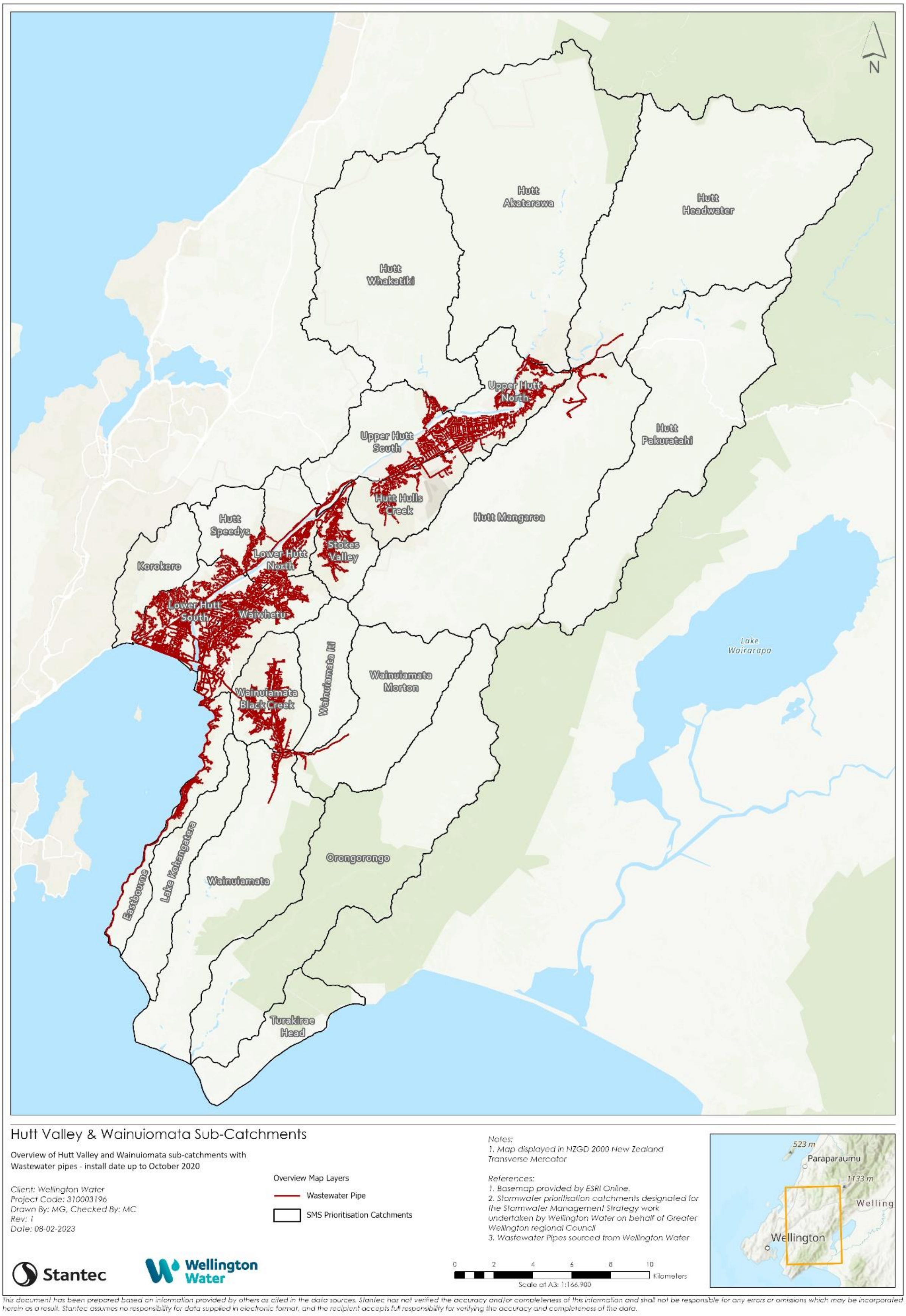

Figure 3-1: Wastewater pipe network and sub-catchments

3.2 Korokoro Stream

3.2.1 Description of the Receiving Environment

The Korokoro Stream is a 3rd order watercourse[2] which runs approximately 7.8 km from its headwaters to Wellington Harbour. It drains a moderately sized catchment with a total area of 15.7 km^2 situated within Belmont Regional Park on the western hills of the Hutt Valley (Figure 3-2). Most of the catchment is in regenerating and mature indigenous forest and scrub, including the last significant stand of rimu-rata-tawa-kohekohe in the southwest of the Wellington Region. Only the lower reach near the stream mouth is affected by urban development, estimated at 4.7% of the catchment area (Wellington Water, 2017).

Table 3-3 summarises the results of HCC monthly *E. coli* monitoring in the Korokoro Stream over the four-year period from January 2013 to December 2016 (Korokoro Stream is not included in GW's River Water Quality and Ecology (RWQE) programme). Over this period the stream achieved the highest NPS-FM Attribute (State A) indicating a low level of faecal contamination and low risk to water users. While two COPs are located within the catchment, they have not operated often enough to be detected by monthly monitoring in Korokoro Stream.

Table 3-3: Summary Statistics and NPS-FM Attribute State for *E. coli* in Korokoro Stream (HCC data 2013-2016)

Site Name	N Samples	% Exceedance over 540 cfu/100ml	% Exceedance over 260 cfu/100m	Median Concentration cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State	pNRP O18 (95th %ile ≤540)
Korokoro Stream @The Esplanade	42	2	7	43	300	A	Meeting

Although no routine ecological monitoring is conducted on Korokoro Stream, some indication of macroinvertebrate community health can be obtained from KMA (2005). KMA surveyed the invertebrate community at three stream locations, in an upper reach, a lower reach and at the stream mouth. Metric scores show "excellent" invertebrate community quality at the upstream reach, decreasing to "fair/good" in the lower reach and "poor/fair" near the stream mouth. The stream mouth site is downstream of a culverted section that passes under the urban areas of Cornish Street and the Hutt Road.

Table 3-4 lists eleven native fish species recorded in the Korokoro Stream between 2007 and 2019: (NZFFD 2020). All except shortfin eel, banded kokopu, common bully and common smelt are classified as either at risk or threatened (Dunn, et al., 2017). Brown trout are the only introduced sports fish found in the stream. The pNRP Objective O19 for fish IBI is achieved in both the lower and upper stream, although it should be noted that some of records are now dated.

Significant values associated with Korokoro Stream as scheduled in the pNRP are summarised in Table 3-5 and categorised for the wastewater network overflow assessment in Table 3-6.

Table 3-4: Records of fish in Korokoro Stream, data from NZFFD (Stoffels, 2022)

Species	Conservation status	Lower stream (<2km from coast)	Upper stream (>2km from coast)
Longfin eel	At risk (declining)	+++	++
Shortfin eel	Not threatened	++	+

[2] Stream order is the numerical position of a tributary or section of a river within the entire network. Headwater streams are assigned a stream order of 1. When two tributaries of the same stream order meet, the order increments by one for the next section downstream. However, if two sections meet where one section has higher order than the other, the next section downstream has the same order as the highest upstream section.

Species	Conservation status	Lower stream (<2km from coast)	Upper stream (>2km from coast)
Inanga	At risk (declining)	++	+
Redfin bully	Not threatened	+++	++
Bluegill bully	At risk (declining)	+++	+
Common bully	Not threatened	++	+
Koaro	At risk (declining)	+++	-
Banded kokopu	Not threatened	+	++
Giant kokopu	At risk (declining)	+	-
Dwarf galaxias	At risk (declining)	-	+
Common smelt	Not threatened	+	-
Brown trout	Introduced and naturalised	+++	+
Koura	Not threatened	++	+
Fish index of biotic integrity (F-IBI)		60	50
pNRP Objective O19 (F-IBI ≥ 38)		Meeting	Meeting

Table 3-5: Environmental and Cultural Values Identified for the Korokoro Stream in Schedules of the pNRP

Schedule	Category	Significant sites
B	Nga Taonga Nui a Kiwi	Korokoro Stream to Wellington Harbour
C	Sites with significant mana whenua values	Korokoro Stream mouth
E	Sites with Significant historic heritage values	Petone Woollen Mills Weir
F1	Rivers and lakes with significant indigenous ecosystems	Korokoro Stream has significant indigenous values including habitat for indigenous threatened or at-risk fish, and habitat for more than six species of indigenous fish, and habitat for migratory fish
F4	Indigenous Biodiversity – Coastal	Korokoro Stream mouth has significant indigenous biodiversity values in the CMA
I	Important trout fishery and spawning waters	Korokoro mainstem

Table 3-6: Korokoro Stream Receiving Environment Characteristics

Receiving environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Korokoro Stream	Medium waterway[3]	Class 2 (contact recreation may occur)	Class 1 (High value)	Class 1 (Very important)	Class 1 (High value)

3.2.2 Summary of Overflow Characteristics

Based on monitoring and/ or Network Engineering Team observations, overflows 2 and 3 are both low volume and low frequency discharges to unnamed tributaries of Korokoro Stream.[4] The overflow characteristics are summarised in Table 3-7.

[3] Defined here as a stream order 3 or 4 and median flow from 100 to 1000 L/s.

[4] Monitoring information characterises network performance over the last 5 to 10 years. The Hutt Valley wastewater catchment model, which is currently under development, should provide the ability to make forward projections of network performance. As detailed in the

Table 3-7: Summary of Overflow Characteristics, Korokoro Stream

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
2, 3	Direct	-	Low[5]	-	Low[6]	Operative	None

3.2.3 Potential Public Health Effects

Korokoro Stream is assessed as a water body where contact recreation activities may occur. Low volume discharges to medium waterways with Class 2 recreational values are assessed as having a Moderate magnitude of effect on all recreational activities, as shown in Table 3-8.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-9. The overall level of public health effect at this location is assessed as Low.

Table 3-8: Magnitude of Public Health Effects from Overflows to Korokoro Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	Effects Score of 3 (Moderate), because microbial pathogen indicator contact recreation guidelines may be exceeded.
Loss of suitability for fishing	Effects Score of 3 (Moderate), because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for harvesting watercress	Effects Score of 3 (Moderate), because watercress can be a hydraulic trap for particulate contaminants.

Table 3-9: Overall Level of Public Health Effects in Korokoro Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Level of Public Health Effect
2, 3	Direct	**Moderate**	Low	**Low**

3.2.4 Potential Ecological Effects

Korokoro Stream is assessed as a waterbody with high ecological values. Low volume discharges to a medium watercourse with Class 1 ecological values are assessed as having predominantly 'High' potential effects on ecological values, as shown in Table 3-10.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-11. The overall level of ecological effect at this location is assessed as Moderate.

Part 1 report, proposed consent conditions would require the model to be re-run every six years so as to track network performance in the future.

[5] 'Low' annual overflow volume is defined as less than 600 m^3.

[6] 'Low' annual overflow frequency is defined as 2 or fewer overflows per year.

Table 3-10: Magnitude of Ecological Effects of Overflows to Korokoro Stream

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 4 (High)** because of the extent of physical and chemical changes resulting from a wastewater overflow.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**Effects Score of 4 (High)**, because nutrient concentrations and toxicants are likely to increase up to 20-fold above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 4 (High)**, because changes in physico-chemical habitat are likely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 3 (Moderate)**, because there may be changes in physico-chemical habitat suitability
Increase in nuisance plants	**Effects Score of 2 (Low)**, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 4 (High)**, because changes in physio-chemical habitat suitability are likely
Growth of sewage fungus/Beggiatoa	**Effects Score of 3 (Moderate)**, because BOD enrichment is likely to stimulate the growth of these organisms.

Table 3-11: Overall Level of Ecological Effects in Korokoro Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Level of Ecological Effect
2, 3	direct	**High**	Low	**Moderate**

3.2.5 Cumulative Effect

The two overflows are of 'Low' volume[7] and 'Low' frequency[8], discharging to different tributaries of Korokoro Stream. The cumulative effect in Korokoro Stream is assessed as Low and is no higher than the level of effect associated with either individual overflow point.

3.2.6 Potential Cultural Effects

Korokoro Stream is assessed as having Very Important cultural values (Class 1).

The overflow discharges are low volume; the potential magnitude of cultural effects is Moderate. Because the overflows occur at a Low frequency, the overall level of cultural effects is assessed as Low.

3.2.7 Potential Aesthetic Effects

Korokoro Stream is assessed as having High aesthetic value. Low volume discharges to such an environment have a High potential to affect these values. However, because the overflows occur with Low frequency, the overall level of aesthetic effect is assessed as Low.

3.2.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-12.

[7] 'Low' annual overflow volume is defined as less than 600 m^3.
[8] 'Low' annual overflow frequency is defined as 2 or fewer overflows per year.

Table 3-12: Summary of potential effects for Korokoro Stream

Value category	Potential magnitude of effect	Overall level of adverse effect
Public health	Moderate	Low/minor
Aquatic ecology	High	**Moderate/more than minor**
Cultural	Moderate	Low/minor
Aesthetic	High	Low/minor

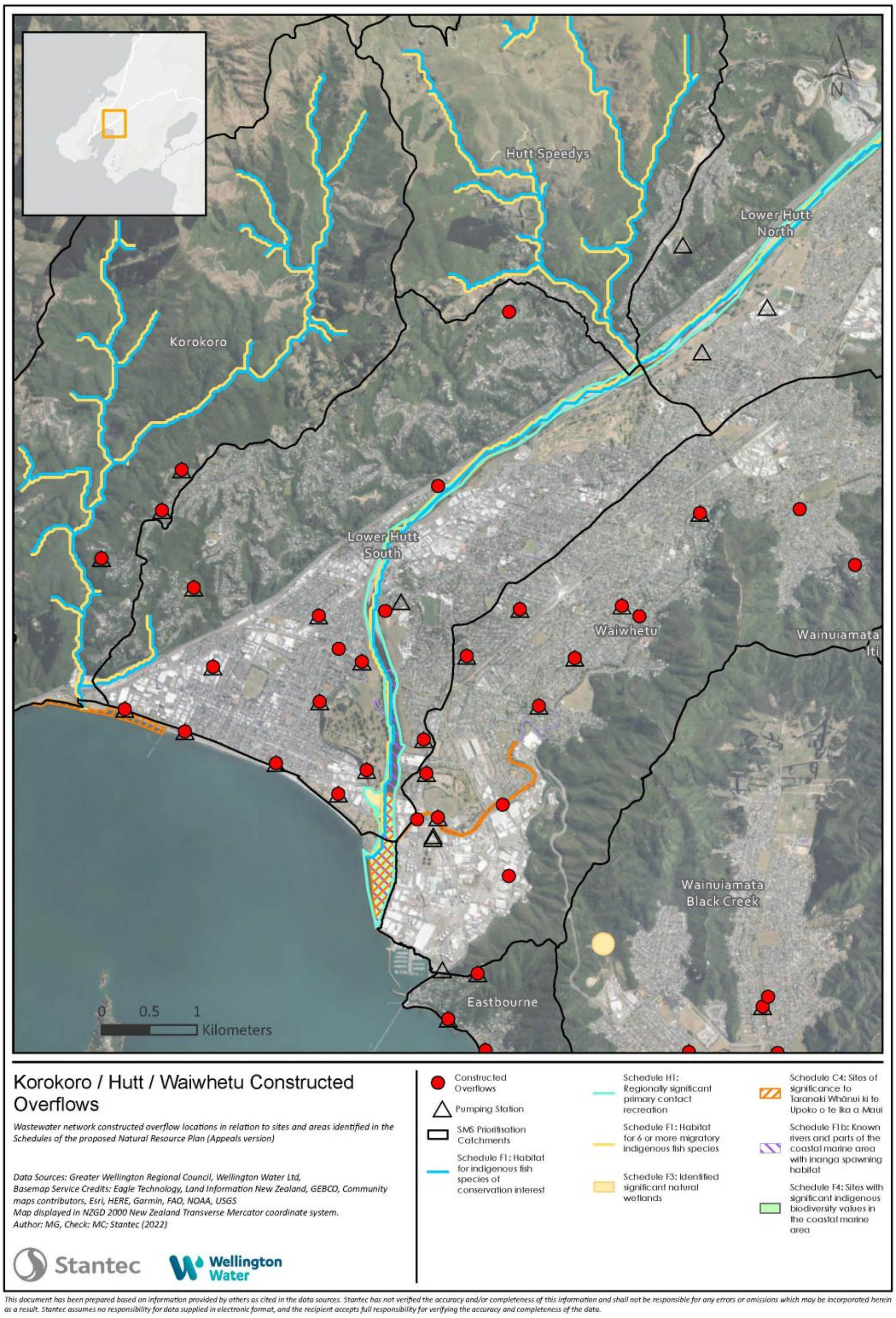

Figure 3-2: COPs in the Korokoro, Waiwhetu and lower Hutt catchments

3.3 Waiwhetū Stream

3.3.1 Description of the Receiving Environment

The Waiwhetū Stream is a low elevation 4th order watercourse which runs 9.4km from the bush covered Eastern Hutt Hills, through urban areas of Naenae, Epuni, Waterloo, Waiwhetū and Gracefield, to its confluence with the Hutt River Estuary at Seaview (Figure 3-2). It has a total catchment area of about 18.6 km^2 of which approximately 53% is in urban land-use, 42% is in indigenous forest, exotic forest and scrub, and the balance is in low productivity pasture. The stream has a stony bed in its upper reaches but for most of its length the bed substrate is soft.

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

Historically the lower estuarine reach was situated within a much wider area of saltmarsh and low-lying wetland at the Hutt River mouth, although the Waiwhetū Stream Estuary would have had relatively small areas of intertidal flats and saltmarsh. However, over the last 100 years the stream corridor and estuary has been extensively modified by flood protection works, reclamation, and removal of the natural vegetated margin. Over the same period the Waiwhetū Stream has received an extensive range of contaminant inputs from stormwater runoff, industrial discharges, and sewage overflows. Sediments in the lower reaches of the stream have historically been highly contaminated with heavy metals. GWRC's River Water Quality and Ecology (RWQE) monitoring indicates that copper and zinc frequently exceed ANZG (2018) trigger values in the water column.

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

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

Table 3-13 summarises the results of GWRC monthly *E. coli* monitoring in the Waiwhetū Stream at Whites Line East over the five-year period to March 2020. The results indicate a high degree of faecal contamination, giving an NPS-FM Attribute State "E". The NPS-FM (2020) narrative for attribute state E is: "*For more than 30% of the time the estimated risk is ≥50 of 1000 (>5% risk). The predicted average infection rate is >7%*". Faecal source tracking conducted on samples collected at this site during 2013 and 2014 indicate a predominantly human source, but dog, wildfowl and ruminant sources were also detected (Milne & Watts, 2008).

Table 3-13: Summary Statistics and NPS-FM Attribute State for *E. coli* in the Waiwhetū Stream at Whites Line East (GWRC data, 2015-2020)

Site name	N samples	% Exceeding 540 cfu/100ml	% Exceeding 260 cfu/100m	Median Concentration cfu/100m	95th Percentile cfu/100ml	NPS-FM Attribute State	pNRP O18 (95th %ile ≤540)
Whites Line East	65	57	77	700	10,800	E	Not meeting

The ecological component of the RWQE program includes monthly monitoring of periphyton cover and annual monitoring of macroinvertebrate communities in the stream at Whites Line East. Periphyton weighted composite cover (WCC) results from monthly sampling over three years are summarised in Table 3-14. The pNRP Objective O19 for periphyton cover is achieved. The pNRP Objective for macroinvertebrate community health is not achieved.

Table 3-14: Periphyton weighted composite cover (WCC) results from monthly sampling 2018/19 to 2020/21

Site name	N samples	Max WCC (%cover)	n ≥ 40% cover	pNRP O19 (no more than 8% of samples ≥40% cover)
Whites Line East	35	0.0	0	meeting

Table 3-15: Macroinvertebrate community metrics for Waiwhetu Stream (2016/17 to 2020/21)

Site name	substrate	River class	Significant river	N samples	Taxa richness	%EPT (3-yr median)	MCI (3-yr median)	QMCI (3-yr median)	pNRP O19 – MCI	pNRP O19 – QMCI	Meeting O19
Whites Line East	Soft	2	No	3	0	0.0	69.1	2.6	≥ 105	≥ 5.5	Not meeting

The NZFFD has records for ten native fish species in the Waiwhetū Stream from surveys conducted between 2004 and 2020 (Table 3-16). Of these, the longfin eel, inanga, giant kokopu and giant bully are classified as at risk (Dunn, et al., 2017). The pNRP Objective O19 for fish IBI is achieved, indicating a relatively healthy and diverse freshwater fish population.

Significant values associated with the Waiwhetū Stream as scheduled in the pNRP are summarised in Table 3-17 and categorised for the wastewater network overflow assessment in Table 3-18.

Table 3-16: Records of Fish in the Waiwhetu Stream, data from NZFFD (Stoffels, 2022)

Species	Conservation status	Lower stream (<2km from coast)	Mid/upper stream (>2km from coast)
Longfin eel	At risk (declining)	++	+++
Shortfin eel	Not threatened	+++	+++
Inanga	At risk (declining)	+++	+++
Common bully	Not threatened	-	++
Giant bully	At risk (declining)	+	+
Banded kokopu	Not threatened	-	+
Giant kokopu	At risk (declining)	+	+
Common smelt	Not threatened	+	-
Yelloweye mullet	Not threatened	-	+
Fish index of biotic integrity (F-IBI)		42	52
pNRP Objective O19 (F-IBI ≥ 38)		Meeting	Meeting

Note: - = not recorded, + = rare (1-3), ++ = common (4-10), and +++ = abundant (10+)

Table 3-17: Environmental and Cultural Values Identified for Waiwhetū Stream in Schedules of the pNRP

NRP Schedule	Category	Location
C	Sites with significant mana whenua values	Waiwhetū Stream from Hutt River mouth to Wainui Road
F1b	Inanga spawning habitat	Waiwhetū Stream from Hutt River mouth to Wainui Road potentially provides inanga spawning habitat
F4	Indigenous Biodiversity – Coastal	Waiwhetū Stream mouth has significant indigenous biodiversity values in the CMA

Table 3-18: Summary of Waiwhetū Stream Receiving Environment Characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Waiwhetū Stream	Medium waterway	Class 3 (Full contact recreation is not likely)	Class 3 (Highly modified)	Class 1 (Very important)	Class 1 (High value)

3.3.2 Summary of Overflow Characteristics

Based on modelled information, monitoring and/ or Network Engineering Team observations, overflows 4, 5, 6, 7, 8, 9 10, 11, 12, 72, 73 and 78 are all 'Low' volume discharges to the Waiwhetū Stream, and all occur at a 'Low' frequency with the exception overflow 8 at Rossiter Avenue. WNO 8 has historically occurred frequently, on average 12 times each year. Overflow volume is not available for site 8 but given the 'High' frequency and its location in close proximity to overflow 6, it is considered that these two sites should be considered as a single overflow with a 'Medium' volume.[9] Overflow characteristics are summarised in Table 3-19.

Table 3-19: Summary of overflow characteristics, Waiwhetū Stream

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
4, 5, 9, 10, 12	Direct	<5 – 81	Low	<1 – 2	Low	Operative	Wellington Water Scada varies
(8)	Direct	-	Medium	12	High	Operative	Wellington Water Scada 2012-2020, Seaview Strategic Wastewater Model System Performance Assessment March 2022
6, 72, 73	Direct	0	Low	0	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
7	Direct	500	Low	1	Low	Operative	Seaview Strategic Wastewater Model System Performance

[9] Monitoring information characterises network performance over the last 5 to 10 years. The Hutt Valley wastewater catchment model, should provide the ability to make forward projections of network performance. As detailed in the Part 1 report, proposed consent conditions would require the model to be re-run every six years so as to track network performance in the future.

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
							Assessment March 2022
11	Direct	1,600	Medium	4	Medium	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
78	Direct	500	Low	3	Medium	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.3.3 Potential Public Health Effects

Waiwhetū Stream is a water body in which full contact recreational activities are unlikely to occur. 'Medium' volume discharges to a medium waterway with Class 3 recreational values are assessed as having a 'Low' potential magnitude of effect (Effects Score of 2) on all recreational activities as detailed in Table 3-20.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-21. Although the magnitude of effect is 'Low', overflows have occurred very frequently at site 8, resulting in an overall level public health effect of Moderate.

Table 3-20: Magnitude of Public Health Effects from Overflows to Waiwhetū Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact, partial contact recreation, fishing or harvesting watercress	**Low potential effect (Effects Score of 2)** on all recreational activities, because the value categorisation indicates that contact or partial contact recreation, shellfish collecting, fishing and/or watercress collecting are unlikely to occur.

Table 3-21: Overall Level of Public Health Effects in Waiwhetū Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Public Health
4, 5, 9, 10, 12	Direct	Very low	Low	Very low
(8)	Direct	Low	High	**Moderate**
6, 7, 72, 73	Direct	Very low	Low	Very low
11	Direct	Low	Medium	Low
78	Direct	Very low	Low	Very low

3.3.4 Potential Ecological Effects

Waiwhetū Stream is assessed as a highly modified/disturbed water body. 'Medium' volume discharges to medium waterways with Class 3 ecological values are assessed as having a range of Very Low to Low magnitude of effect on ecological values, as shown in Table 3-22.

In situations where potential ecological effects range across more than one effects score, the magnitude of effect is determined by the dominant (highest) effects score. In this case, the magnitude of ecological effect is 'Low'.

The overall level of ecological effect is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-23. Although the magnitude of effect is 'Low', overflows have occurred very frequently at site 8, resulting in an overall level effect of Moderate.

Table 3-22: Magnitude of Ecological Effects of Overflows to Waiwhetū Stream

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low)**, because of the high degree of background disturbance in these streams.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low)**, because of the high degree of background disturbance in these streams.
Behavioural changes in fin fish	**Effects Score of 1 (Very Low)**, because of the high degree of background disturbance in these streams.
Increase in nuisance plants	**Effects Score of 1 (Very Low)**, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Growth of sewage fungus/Beggiatoa	**Effects Score of 2 (Low),** because BOD enrichment is unlikely to add to the potential for the growth of these organisms.

Table 3-23: Level of Ecological Effect in Waiwhetū Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecology Effect	Frequency Range	Level of Ecological Effect
4, 5, 6, 7, 9, 10, , 12	Direct	Low	Low	Very Low
8	Direct	Low	High	**Moderate**
6, 7, 72, 73	Direct	Low	Low	Very Low
11	Direct	Low	Medium	Low
78	Direct	Low	Medium	Low

3.3.5 Potential Cumulative Effects

For the Waiwhetū Stream receiving environment, cumulative effects are considered possible because:

- There are a comparatively large number of overflow points that could potentially discharge (2 direct and 7 indirect overflows), although these are spatially separated
- All of the overflows except sites 8 and 11 occur at a 'Low; frequency, while overflow 8 occurs at a 'High' frequency and overflow 11 occurs at a 'Medium' frequency.

For spatial cumulative effects to arise, most of the discharges would need to occur at the same time, which is indeed likely. However, the available information is that total volume of wastewater discharges would remain in the 'Moderate' volume range and cumulative effects would not be notably different from those assessed for site 8 alone.

3.3.6 Potential Cultural Effects

Waiwhetū Stream is assessed as having 'Very Important' cultural values (Class 1). The overflow discharges are 'Medium' volume; cultural effects are assessed as 'High'. Because the overflows occur at a 'High' frequency, the overall level of cultural effect is assessed as 'High'.

3.3.7 Potential Aesthetic Effects

Waiwhetū Stream is assessed as having a 'High' aesthetic value[10]. 'Medium' volume discharges to such an environment have a 'High' potential to affect these values. Because overflows occur with a 'High' frequency, the overall level of adverse effect is assessed as 'High'.

3.3.8 Summary

The potential magnitude and overall level of adverse effect of wastewater overflows to this receiving environment are summarised in Table 3-24.

Table 3-24: Magnitude and Level of Effects for Waiwhetū Stream

Value category	Potential magnitude of effect	Level of adverse effect
Public health	Low	Moderate/more than minor
Aquatic ecology	Low	Moderate/more than minor
Cultural	Moderate	High/significant
Aesthetic	High	High/significant

3.4 Hulls Creek

3.4.1 Description of Receiving Environment

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

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

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

Water quality in the catchment during 2006 and 2007 was described as "impaired" with frequent exceedance of guideline values for water temperature, dissolved oxygen, turbidity, indicator bacteria, and dissolved reactive phosphorus (Warr 2007).

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[10] 'High' aesthetic value is defined as "Directly adjacent to publicly accessible open space and/or areas where people live, with direct access to waterways or coastal areas".

In July 2020 GWRC/ Wellington Water commenced routine water quality monitoring in Hulls Creek adjacent to Reynolds Bach Drive. There is not yet sufficient data to compare against NPS-FM attribute criteria, nevertheless, summary statistics from four monthly samples collected to date indicate slightly to moderately elevated nutrients and turbidity, and significantly elevated faecal indicator bacteria (Table 3-25).

Table 3-25: Water Quality Summary Statistics for Hulls Creek and Reynolds Bach Drive (July –November 2020)

Statistic	Temp. (°C)	DRP (mg/L)	NH_4-N (mg/L)	NNN (mg/L)	Black disc (m)	Turbidity (NTU)	*E. coli* (cfu/100ml)
median	11.7	0.013	0.013	0.265	1.83	4.8	750
maximum	13.9	0.019	0.022	0.36	2.62	8.0	1,300

The New Zealand Freshwater Fish Database (NZFFD) includes records for of eight species of fish within the Hulls Creek catchment, including four "at risk" species: longfin eel, giant kokopu, inanga and redfin bully (Table 3-26). Although not listed in the NZFFD, banded kokopu have been caught in the upper catchment above Rimutaka Prison (Cameron, 2014), and brown trout and bluegill bully have been recorded in the lower stream (Warr, 2007). A range of fish including inanga, smelt, redfin bully, bluegill bully and brown trout have been recorded in the stream at the confluence with the Hutt River but not upstream of the Eastern Hutt Road, and may be prevented from progressing further by two weirs located downstream of the road (Warr, 2007). The pNRP Objective O19 for fish IBI is achieved in the lower but not the upper stream.

The pNRP schedules do not identify Hull Creek as having any environmental, recreational or cultural values of particular significance . Key receiving environment characteristics are summarised in Table 3-27.

Table 3-26: Records of fish in Hulls Creek (Silverstream Creek), data from NZFFD (Stoffels, 2022)

Species	Conservation status	Lower stream (<2km from Hutt River)	Mid/upper stream (>2km from Hutt River)
Longfin eel	At risk (declining)	+	+
Inanga	At risk (declining)	+	-
Banded kokopu	Not threatened	-	+
Giant kokopu	At risk (declining)	-	+
Common bully	Not threatened	+	+
Redfin bully	Not threatened	+	+
Bluegill Bully	At risk (declining)	+	-
Common smelt	Not threatened	+	-
Fish index of biotic integrity (F-IBI)		48	36
pNRP Objective O19 (F-IBI ≥ 38)		Meeting	Not meeting

Note: - = not recorded, + = rare (1-3), ++ = common (4-10), and +++ = abundant (10+)

Table 3-27: Summary of Hull Creek Receiving Environment Characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Hulls Creek	Medium waterway	Class 2 (Moderate value)	Class 3 (Highly modified)	Class 2 (Important, but not an identified cultural site)	Class 1 (High Value)

3.4.2 Summary of Overflow Characteristics

Overflows 13 and 37 are historically 'Low' volume and 'Low' frequency discharges into the stormwater network and then into Hull Creek, as summarised in Table 3-28.

Table 3-28: Summary of Overflow Characteristics, Hulls Creek

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
13	Indirect	-	Low	-	Low	Operative	No record
37	Indirect	0	Low	0	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.4.3 Potential Public Health Effects

Hulls Creek is a waterbody in which full contact recreational may occur. 'Low' volume discharges to 'Medium' waterways with Class 2 recreational values are assessed as having a 'Moderate' magnitude of effect (Effects Score of 3) as detailed in Table 3-29.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-30. Although the magnitude of effect is 'Moderate', overflows have occurred at a low frequency, resulting in an overall Low level of public health effect.

Table 3-29: Magnitude of public health effects from overflows to Hulls Creek

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact, partial contact recreation, fishing or harvesting watercress	**Effects Score of 3 (Moderate)** because microbial pathogen indicator contact recreation guidelines may be exceeded.

Table 3-30: Overall level public health effect in Hulls Creek

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Level of Public Health Effect
13, 37	Indirect	**Moderate**	Low	**Low**

3.4.4 Potential Ecological Effects

Hulls Creek is assessed as a highly modified water body. 'Low' volume discharges to 'Medium' waterways with Class 3 ecological values are assessed as having a range of 'Very Low' to 'Low' magnitude of effect on ecological values, as shown in Table 3-31.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-32. In this case the magnitude of effect is 'Low' and the frequency of overflow is Low, resulting in an overall level effect of Very Low.

Table 3-31: Magnitude of ecological effects of overflows to Hulls Creek

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.

Potential Effect	Magnitude of Ecological Effect
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low)**, because of the high degree of background disturbance in these streams.
Behavioural changes in fin fish	**Effects Score of 2 (Low)**, because of the high degree of background disturbance in these streams.
Increase in nuisance plants	**Effects Score of 1 (Very Low)**, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 2 (Low)**, because changes in physico- chemical habitat suitability are likely.
Growth of sewage fungus/Beggiatoa	**Effects Score of 1 (Very Low)**, because the lack of BOD enrichment provides little opportunity for the growth of these organisms.

Table 3-32: Overall Level of Ecological Effects in Hulls Creek

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of Ecological Effect
13, 37	Indirect	**Low**	Low	**Very Low**

3.4.5 Potential Cumulative Effects

For Hulls Creek, cumulative effects are not expected because there are only two indirect overflows that discharge at a frequency where pathogens would not normally persist in the receiving environment.

3.4.6 Potential Cultural Effects

Hull Creek is assessed as having ‘Important’ cultural values (Class 2). The overflow discharge has a ‘Low’ volume; cultural effects are assessed as ‘Low’. Because the overflows occur at a ‘Low’ frequency, the overall level of cultural effect is assessed as ‘Low’.

3.4.7 Potential Aesthetic Effects

Hulls Creek in the vicinity of the overflow is assessed as having a ‘High’ aesthetic value because it is located in an open space which is readily accessible to the public. ‘Low’ volume discharges to such an environment have a ‘High’ potential to affect these values. However, because the overflows occur with ‘Low’ frequency, the overall level of adverse effect is assessed as ‘Low.

3.4.8 Summary

The potential magnitude and overall level of adverse effect of wastewater overflows to this receiving environment are summarised in Table 3-33.

Table 3-33: Summary of Magnitude and Level Adverse Effects for Hulls Creek

Value category	Potential magnitude of effect	Overall level of effect
Public health	Moderate	Low/minor
Aquatic ecology	Low	Very Low/less than minor
Cultural	Low	Low/minor
Aesthetic	High	Low/minor

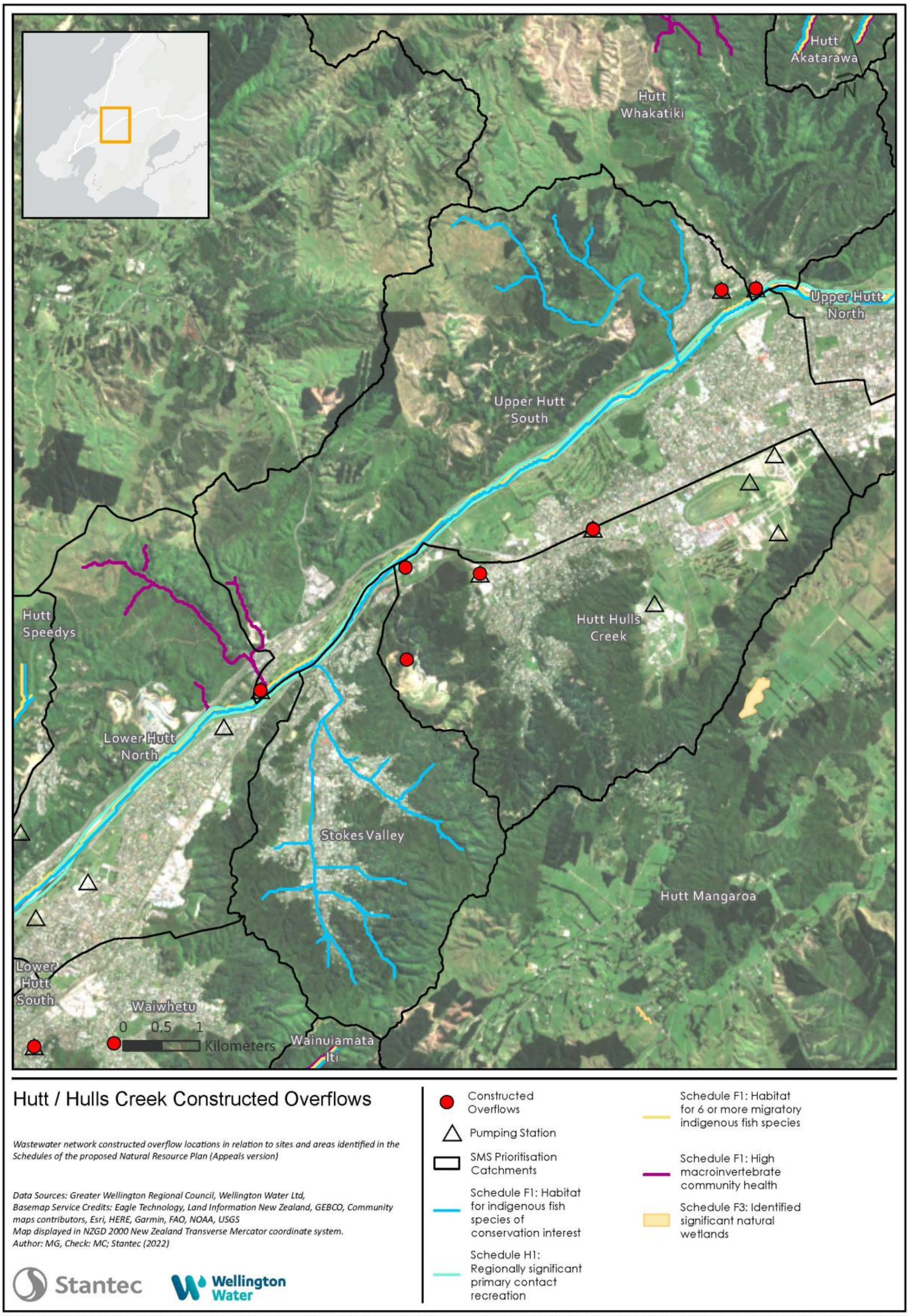

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Figure 3-3: COPs in the Hutt and Hull Creek catchments

3.5 Te Mome Stream

3.5.1 Description of Receiving Environment

Te Mome Stream is a tidally influenced former channel of the Hutt River which runs around the Shandon Golf Club to join the Hutt Estuary via a flood-gated culvert under Waione Street, approximately 100m west of the Estuary Bridge (Figure 3-2). The hydrology of the watercourse was radically altered in the early 1900's when its northern connection to the Hutt River was blocked off. The stream is 1.5 km long, up to 40m wide and up to 1.5m deep, with a tidal range of about 0.5m. The bed substrate consists of deep soft mud, which is difficult and potentially dangerous to walk on.

The surrounding catchment includes the suburbs of Ava, Petone and Alicetown, which contribute urban stormwater, including runoff from industrial sites. Stormwater and historic industrial discharges have resulted in very high concentrations of lead and antimony in both stream sediments and water near the outlet from the East Street culvert (Markland, Strange, & Van Erp, 2015).

Table 3-34 summarises the results of HCC monthly *E. coli* monitoring in Te Mome Stream at the Esplanade over the four-year period from Jan 2013 to December 2016. Over that period the stream achieved the lowest NPS-FM Attribute (State E) indicating a high level of faecal contamination.

Table 3-34: Summary statistics and NPS-FM Attribute State for *E. coli* (HCC data 2013-2016)

Site name	N Samples	% Exceeding 540 cfu/100ml	% Exceeding 260 cfu/100m	Median cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State
Te Mome Stream	42	8	8	200	2,055	E

The NZFFD does not include any records for fish in Te Mome Stream, although eels are known to be present. Te Mome Stream is not identified in the Schedules of the pNRP as having any environmental, recreational or cultural values of particular significance. The receiving environment values for Te Mome Stream have been categorised in Table 3-35.

Table 3-35: Summary of Te Mome Stream Receiving Environment Characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
Te Mome Stream	Estuary	Class 3 (contact recreation is unlikely)	Class 3 (highly modified)	Class 2 (important)	Class 1 (high value)

3.5.2 Summary of Overflow Characteristics

Historically, overflows 16 and 17 have been Low volume and Low frequency discharges to Te Mome Stream (Table 3-36).

Table 3-36: Summary of Overflow Characteristics, Te Mome Stream

Overflow ID	Direct/indirect	Volume (m^3)		Frequency		Status	Data Source
		(m^3)	Range	Number	Range		
16	Direct	-	Low	-	Low	Operative	No record
17	Direct	0	Low	0	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.5.3 Potential Public Health Effects

Te Mome Stream is assessed as an area where full contact recreation is unlikely. 'Low' volume discharges to an estuary with Class 3 recreational values are assessed as having a 'Very Low' potential effect (Effects Score of 1) on all recreational activities (Table 3-37).

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-38. The magnitude of effect is 'Very low', overflows have occurred at a Low frequency, resulting in a Very Low overall level public health effect.

Table 3-37: Magnitude of public health effects from overflows to Te Mome Stream

Potential Effect	Magnitude of Public Health Effect
Illness associated with contact or partial contact recreation, shellfish collecting, fishing and/or watercress or seaweed collecting	**Effects Score of 1 (Very Low)** because Te Mome estuary provides some dilution and/or flushing, and because the value categorisation indicates that these activities are unlikely to occur.

Table 3-38: Overall level of public health effect in Te Mome Stream

Overflow ID	Direct/Indirect	Magnitude of Public Health Effect	Frequency Range	Level of Public Health effect
16	Direct	Very Low	Low	**Very Low**
17	Direct	Very Low	Low	**Very Low**

3.5.4 Potential Ecological Effects

Te Mome Stream is classified as a highly modified/disturbed watercourse. 'Low' volume discharges to estuaries with Class 3 ecological values are assessed as having very Low magnitude of effect on ecological values, as shown in Table 3-39. The Te Mome estuary provides some dilution and regular tidal flushing.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-40. In this case the magnitude of effect is 'Very low' and overflows have occurred at a Low frequency, resulting in an overall Very Low level of adverse effect.

Table 3-39: Magnitude of Ecological Effects of Overflows to Te Mome Stream

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**1 (Very Low)** because of the high degree of background disturbance
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**1 (Very Low)** because of the high level of dilution of overflows, nutrient concentrations and toxicants are unlikely to increase above background levels
Change in community structure/loss of sensitive species	**1 (Very Low)** because of the high degree of background disturbance
Behavioural changes in fin fish	**1 (Very Low)** because of the high degree of background disturbance

Table 3-40: Overall Level Ecological Effect in Te Mome Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of Ecological Effect
16	Direct	Very Low	Low	**Very Low**
17	Direct	Very Low	Low	**Very Low**

3.5.5 Potential Cumulative Effects

For the Te Mome Stream receiving environment, cumulative effects are considered unlikely because both overflows discharge with ‘Low’ volume and frequency, and they are well separated.

3.5.6 Potential Cultural Effects

Te Mome estuary is assessed as having ‘Important’ cultural values (Class 2). The overflow discharges are of ‘Low’ volume; cultural effects are assessed as ‘Low’. Because the overflows occur at a ‘Low’ frequency, the overall level of adverse effect on cultural effects is assessed as ‘Low’.

3.5.7 Potential Aesthetic Effects

Te Mome Stream is assessed as having ‘High’ aesthetic value. ‘Low’ volume discharges to such an environment have a ‘High’ potential to affect these values. However, because the overflows occur with ‘Low’ frequency, the level of adverse effect is assessed as ‘Low’.

3.5.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-41.

Table 3-41: Summary of Magnitude and Level Adverse Effects for Te Mome Stream

Value category	Potential magnitude of effect	Level of adverse effect
Public health	Very Low	Very Low/less than minor
Aquatic ecology	Very Low	Very Low/less than minor
Cultural	Low	Low/minor
Aesthetic	High	Low/minor

3.6 Mangaroa River

3.6.1 Description of Receiving Environment

The Mangaroa River is a 4th order stream that flows approximately 20km from its headwaters to the confluence with the Hutt River at Te Marua, north of Upper Hutt (Figure 3-4). It is situated on the western side of the Remutaka Range, adjacent to the Pakuratahi River catchment. It drains a broad low gradient valley with a total area of 104 km^2. The predominant land cover is indigenous forest and scrub (53%) while pasture (31%) and exotic forestry (14%) are also extensive. Collins Stream is the largest tributary of the Mangaroa River, being a 3rd order watercourse with a catchment area of around 9 km^2. Very little urban development has occurred in the catchment which has less than 2% urban land-cover and an estimated 0.01% impervious surface.

There are two COPs on the Mangaroa River (21, 40), three on Collins Stream (41, 42, 43), and one on an unnamed tributary.

Table 3-42 summarises the results of *E. coli* monitoring conducted by GWRC in the Mangaroa River over the five-year period to March 2020. The results indicate significant faecal contamination, giving an NPS-FM Attribute State “E”. The NPS-FM narrative for attribute state E is: “*For more than 30% of the time the estimated risk is ≥50 of 1000 (>5% risk). The predicted average infection rate is >7%*”.

The predominant source of faecal contamination is likely to be runoff from an extensive area of sheep and beef grazing land in the catchment.

Table 3-42: Summary Statistics and NPS-FM Attribute State for *E. coli* (GWRC data 2015-2020)

Site name	N samples	% exceeding 540 cfu/100ml	% exceeding 260 cfu/100m	Median cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State
Mangaroa River at Te Marua	52	25	44	210	2,215	E

The ecological component of the RWQE program a includes monthly monitoring of periphyton cover and annual monitoring of macroinvertebrate communities. Periphyton weighted composite cover (WCC) results from monthly sampling over three years are summarised in Table 3-43. pNRP Objective O19 for periphyton cover is not met in the Mangaroa River.

Table 3-43: Periphyton Weighted Composite Cover (WCC) results from Monthly Sampling 2018/19 to 2020/21

Site name	N samples	Max WCC (%cover)	n ≥ 40% cover	pNRP O19 (no more than 8% of samples ≥40% cover)
Mangaroa River at Te Marua	34	70	7	Not meeting

Table 3-44 summarises RWQI macroinvertebrate community Index (MCI) scores from annual invertebrate surveys in the Mangaroa River over five summers from 2016/17 to 2020/21. The pNRP outcome is met for MCI but not for QMCI.

Table 3-44: Macroinvertebrate community metrics for Mangaroa River (2016/17 to 2020/21)

Site name	substrate	River class	Significant river	N samples	Taxa richness	%EPT (3-yr median)	MCI (5-yr median)	QMCI (5-yr median)	pNRP O19 – MCI	pNRP O19 – QMCI	Meeting O19
Mangaroa River at Te Marua	Hard	4	No	3	13	52	118.7	5.2	≥ 110	≥ 5.5	Not meeting

The New Zealand Freshwater Fish Database (NZFFD) includes records of six indigenous species of fish and the introduced brown trout within the Mangaroa River catchment Table 3-45). Of the species recorded longfin eel and inanga are considered to be at risk (Dunn, et al., 2017). The pNRP Objective O19 for fish IBI is achieved in the upper reaches of the Mangaroa River, but not in the lower river.

Mangaroa River and its tributaries are identified as important brown trout spawning area in the pNRP.

Table 3-45: Records of Fish in Mangaroa River, Data from NZFFD (Stoffels, 2022)

Species	Conservation Status	Lower Stream (<35km from coast)	Mid/Upper Stream (>35km from coast)
Longfin eel	At risk (declining)	+	+++
Shortfin eel	Not threatened	-	+
Inanga	At risk (declining)	-	+
Common bully	Not threatened	-	+++
Crans bully	Not threatened	-	+
Redfin bully	Not threatened	++	-
Brown trout	Introduced and naturalised	++	++
Fish index of biotic integrity (F-IBI)		36	48

Species	Conservation Status	Lower Stream (<35km from coast)	Mid/Upper Stream (>35km from coast)
pNRP Objective O19 (F-IBI ≥ 38)		Not meeting	Meeting

Note: - = not recorded, + = rare (1-3), ++ = common (4-10), and +++ = abundant (10+)

Significant values associated with the Mangaroa River as scheduled in The Natural Resources Plan are summarised in Table 3-46 and categorised for the wastewater network overflow assessment in Table 3-47.

Table 3-46: Environmental and Cultural Values Identified for the Mangaroa with in Schedules of the pNRP

NRP Schedule	Category	Sites Identified
F3	Significant natural wetlands	Johnsons Road wetlands, Blue Mountain Bush Swamp Forest
I	Important trout fishery and spawning water	Mangaroa River and several of its tributaries, including Collins Stream, provide important trout spawning habitat

Table 3-47: Mangaroa River Receiving Environment Characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Mangaroa River	Large waterway	Class 2	Class 1	Class 2	Class 1
Collins Stream and unnamed tributary stream	Medium waterway	Class 2	Class 1	Class 2	Class 1

3.6.2 Summary of Overflow Characteristics

Overflow sites 41, 42, and 43 are 'Low' volume and 'Low' frequency pump station overflow discharges to the Mangaroa River via Collins Stream. Overflow sites 21 and 40 are 'Low' volume/frequency and 'Medium' volume/frequency pump station overflows, respectively, discharging directly to Mangaroa River. Overflow site 44 is a 'Low' volume and 'Low' frequency pump station overflow discharge to Mangaroa River via an unnamed tributary stream.

Table 3-48: Summary of Overflow Characteristics for Mangaroa River and Collins Stream

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
41, 42, 43,	Direct to Collins Stream	-	Low	-	Low	Operative	None
21	Direct to Mangaroa River	-	Low	-	Low	Operative	None
40	Direct to Mangaroa River	1,800	Medium	6	Medium	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
44	Direct to unnamed tributary stream	400	Low	1	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
41, 42, 43	Indirect to Mangaroa River	-	Low	-	Low	Operative	None
44	Indirect to Mangaroa River	400	Low	1	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.6.3 Potential Public Health Effects

The Mangaroa River is assessed as a water body where contact recreation may occur. 'Medium' volume discharges to a large waterway with a Class 2 recreation class (Mangaroa River) are assessed as having a 'High' magnitude of effect (effects score 4) on all recreational activities in Mangaroa River. 'Low' volume discharges to a medium waterway with Class 2 recreation class (Collins Stream and unnamed tributary) are assessed as having a 'Moderate' potential effect (effects score 3), as shown in Table 3-49.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-50. The overall level of effects is assessed as 'Low' in Collins Stream and 'High' in Mangaroa River.

Table 3-49: Magnitude of public health effects of overflows to Mangaroa river and Collins Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 4 (High) on all recreational activities in Mangaroa River,** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for fishing	
Loss of suitability for harvesting watercress	**Effects Score of 3 (Moderate) on all recreation activities in Collins Stream and the unnamed tributary** because microbial pathogen indicator contact recreation guidelines may be exceeded.

Table 3-50: Overall level of public health effects in Mangaroa River, Collins Stream and the unnamed tributary stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level of Public Health effect
41, 42, 43,	Direct to Collins Stream	Moderate	Low	Low
21	Direct to Mangaroa River	Low	Low	Very Low
40	Direct to Mangaroa River	High	Medium	**High**
44	Direct to unnamed tributary stream	Moderate	Low	Low
41, 42, 43	Indirect to Mangaroa River	Low	Low	Very Low

3.6.4 Potential Ecological Effects

The Mangaroa River is assessed as having important ecological values. 'Medium' volume discharges to a Class 1 ecological area are assessed as having a 'Moderate' magnitude of effect (effects score 3) on ecological values in Mangaroa River (Table 3-51) and 'High' magnitude of effect (effects score 4) on ecological values in Collins Stream and the unnamed tributary stream.

The overall level of ecological effect is determined by the magnitude of effects and frequency of occurrence, as summarised in Table 3-52. The level of ecological effect is assessed as 'Moderate' for Mangaroa River, Collins Stream and the unnamed tributary stream.

Table 3-51: Magnitude of ecological effects of overflows to Mangaroa River, Collins Stream and the unnamed tributary stream

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 3 (Moderate**) in Mangaroa River, because there may be physical and chemical changes resulting from a wastewater overflow. **Effects Score of 4 (High)** in Collins Stream and the unnamed tributary stream because of the extent of physical and chemical changes resulting from a wastewater overflow.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 3 (Moderate)** in Mangaroa River, because toxicant concentrations may increase up to 10-fold above background levels. **Effects Score of 4 (High)** in Collins Stream and the unnamed tributary stream, because nutrient concentrations and toxicants are likely to increase up to 20-fold above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 3 (Moderate**) in Mangaroa River, because changes in physico- chemical habitat may affect sensitive species. **Effects Score of 4 (High)** in Collins Stream and the unnamed tributary stream, because changes in physico-chemical habitat are likely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 3 (Moderate)** in Mangaroa River, because there may be changes in physico-chemical habitat suitability. **Effects Score of 3 (Moderate)** in Collins Stream and the unnamed tributary stream, because there may be changes in physico-chemical habitat suitability
Increase in nuisance plants	**Effects Score of 2 (Low)** in Mangaroa River, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth. **Effects Score of 2 (Low)** in Collins Stream and the unnamed tributary stream, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 3 (Moderate)** in Mangaroa River**,** because there may be changes in physico-chemical habitat suitability. **Effects Score of 4 (High)** in Collins Stream and the unnamed tributary stream, because changes in physio-chemical habitat suitability are likely.
Growth of sewage fungus/Beggiatoa	**Effects Score of 3 (Moderate)** in Mangaroa River, because BOD enrichment may provide opportunity for the growth of these organisms. **Effects Score of 3 (Moderate)** in Collins Stream and the unnamed tributary stream, because BOD enrichment is likely to stimulate the growth of these organisms.

Table 3-52: Overall level of ecological effect in Mangaroa River, Collins Stream and the unnamed tributary stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of Ecological effect
41, 42, 43,	Direct to Collins Stream	**High**	Low	**Moderate**
21	Direct to Mangaroa River	Moderate	Low	Low
40	Direct to Mangaroa River	Moderate	Medium	**Moderate**

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of Ecological effect
44	Direct to unnamed tributary stream	**High**	Low	**Moderate**
41, 42, 43	Indirect to Mangaroa River	Moderate	Low	Low
44	Indirect to Mangaroa River	Moderate	Low	Low

3.6.5 Potential Cumulative Effects

For the Mangaroa River receiving environment, consideration of cumulative effects is considered to be appropriate because:

- There are six overflow points that could potentially discharge (2 direct and 4 indirect overflows), although these are spatially well separated.
- These overflows range between a 'Low' to 'Medium' volume and frequency.

For a spatially cumulative effect to arise, most of the direct and indirect discharges would need to occur at the same time. This could result in the total volume of wastewater overflows falling within the 'High' volume range and result in 'High' potential public health effects and 'Moderate' ecological effects. As these direct discharges have already been assessed in earlier parts of the AEE as having potentially 'High' potential effects individually, the cumulative effect would not be notably different.

3.6.6 Potential Cultural Effects

Mangaroa River is assessed as having 'Important' cultural values (Class 2). 'Medium' volume discharges to such an environment have a 'Moderate' magnitude of effect on these values.

Because all overflows arrange between 'Low' to 'Medium' frequency the overall level of cultural effects is assessed as being 'Moderate'.

3.6.7 Potential Aesthetic Effects

Mangaroa River as assessed as having 'High' aesthetic value. 'Medium' volume discharges to such an environment have a 'High' potential effect on these values.

Because all of the overflows range between a 'Low' to 'Medium' frequency the overall level of cultural effects is assessed as being 'Moderate'.

3.6.8 Summary

The potential magnitude and overall level of adverse effect from wastewater overflows to this receiving environment are summarised in Table 3-53.

Table 3-53: Magnitude and overall level of adverse effects for Mangaroa River

Value Category	Potential Magnitude of Effect	Level of Adverse Effect
Public health	High	High
Aquatic ecology	High	Moderate/more than minor
Cultural	High	Moderate/more than minor
Aesthetic	High	Moderate/more than minor

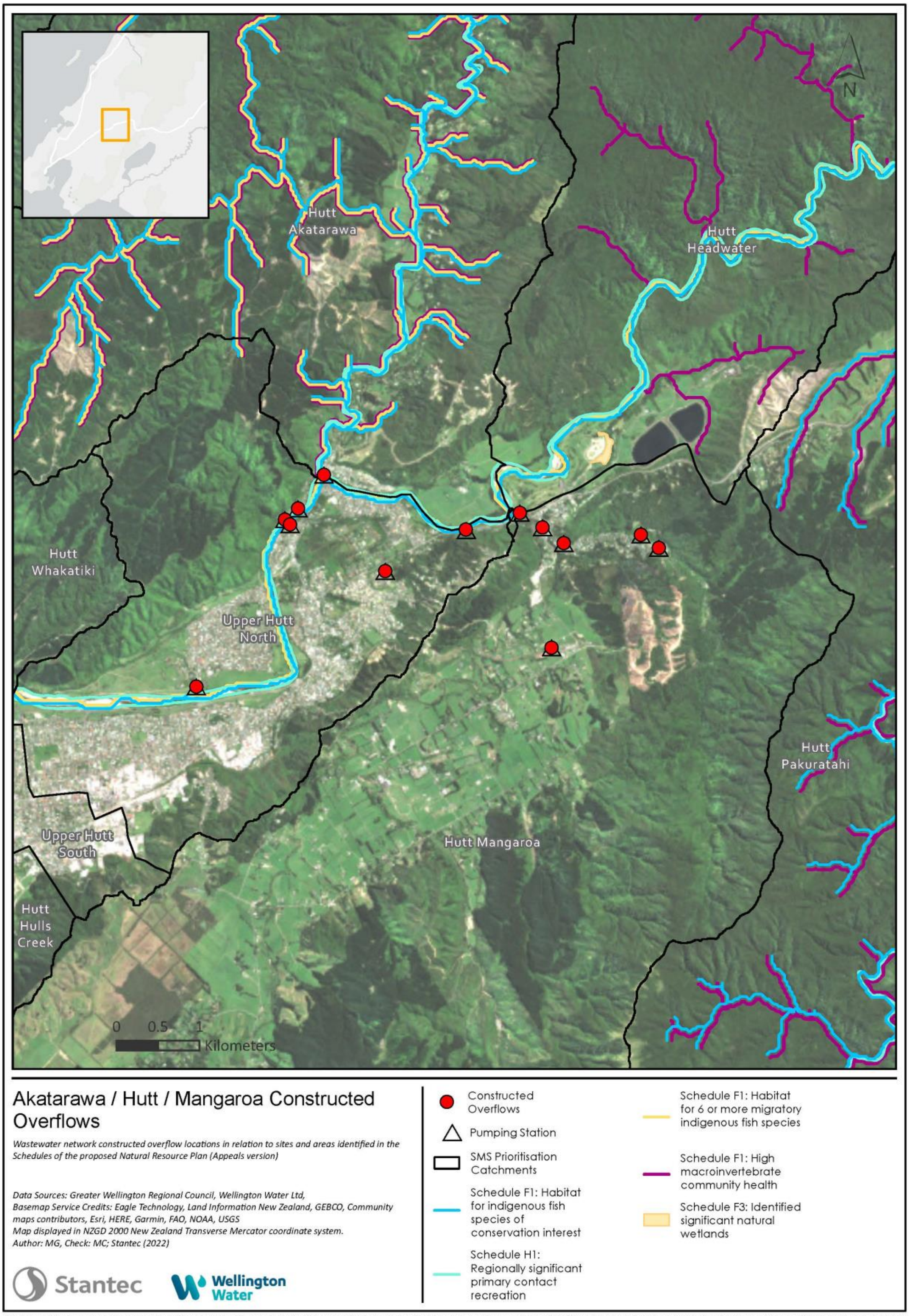

Figure 3-4: COPs in the Akatarawa, Hutt and Mangaroa catchments

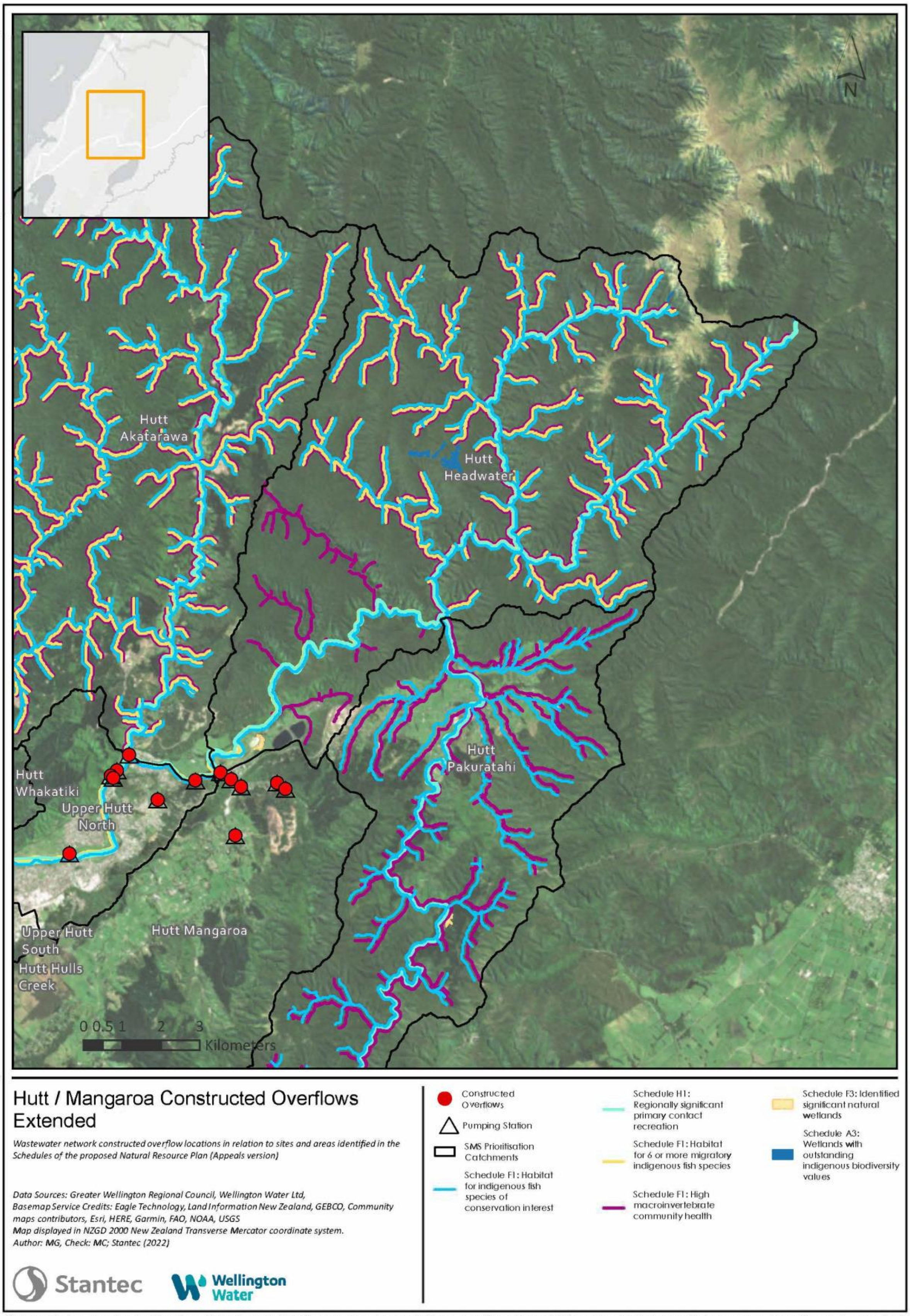

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Figure 3-5: COPs in the Akatarawa, Hutt and Mangaroa catchments, extended

3.7 Hutt River

3.7.1 Description of Receiving Environment

Te Awa Kairangi / Hutt River is the largest watercourse in the Wellington harbour catchment (Figures 3-1, 3-2 and 3-3). It is a steep gravel-bearing river which originates in the indigenous forest covered slopes of the southern Tararua Ranges and flows approximately 55 km to Wellington Harbour at Seaview. It has a catchment area of 655 km^2 of which 66% is in indigenous forest and scrub, 13% is in exotic forest, 11% is in pasture and 8% is in urban land use. It has a median flow of approximately 12.6 m^3/sec at Birchville. Its main tributaries are the Pakuratahi, Mangaroa, Akatarawa and Whakatiki Rivers. The bed gradient reduces at Kennedy Good Bridge, and again at the Ewen Bridge as the river approaches Wellington Harbour. The gravel bed load material drops out along this reach, from about Belmont, and in the Harbour adjacent to the river mouth.

The underlying Waiwhetū Aquifer provides up to 40% of the water supply for the greater Wellington Metropolitan area. The confined Waiwhetū Aquifer extends from Boulcott down-valley past Petone, continuing beneath Wellington Harbour. The Hutt River recharges the aquifer systems through seepage from a 5km stretch downstream of Taita Gorge where unconfined conditions prevail. The aquifer system is almost entirely dependent on its connection to the Hutt River.

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

The Hutt River mainstem includes the Lower Hutt South, Lower Hutt North, Upper Hutt South, Upper Hutt North and Hutt Headwater sub-catchments (see Table 3-2). There are 24 direct wastewater overflow structures adjacent to Hutt River mainstem, and a further eight indirect overflows to upstream tributaries. The most significant of these is a consented discharge from the Silverstream Storm Tank which overflows to the river 2 – 10 times each year during periods of sustained wet weather when the capacity of the storage tank is exceeded (at which time the river is usually in flood).

Table 3-54 summarises the results of GWRC *E. coli* monitoring in the Hutt River over the five-year period to March 2020. The results indicate a relatively low degree of faecal contamination, giving an NPS-FM Attribute State "B" at all sites except the Boulcott site which is rated "D". The monitoring regime at the Boulcott site is based on routine monthly sampling throughout the year compared with the weekly monitoring from November to April at the four other sites. Sampling through the wetter winter period at Boulcott may have contributed to the higher level of faecal contamination at that location. It is noted also that the Boulcott results were particularly elevated during the 2017/18 and 2018/19 years, perhaps indicating an issue which developed during that time (Figure 3-6 and Figure 3-7).

Table 3-54: Summary statistics and NPS-FM Attribute State for *E. coli* (GWRC data 2015-2020)

Site name	N samples	% exceedance over 540 cfu/100ml	% exceedance over 260 cfu/100m	Median Concentration cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State
Hutt River at Birchville	77	6	12	56	548	B
Hutt River at Maoribank	77	9	10	44	808	B
Hutt River at Poets Park	80	8	11	42	603	B
Hutt River at Boulcott	53	13	17	70	1960	D
Hutt River at Melling	81	9	11	57	900	B

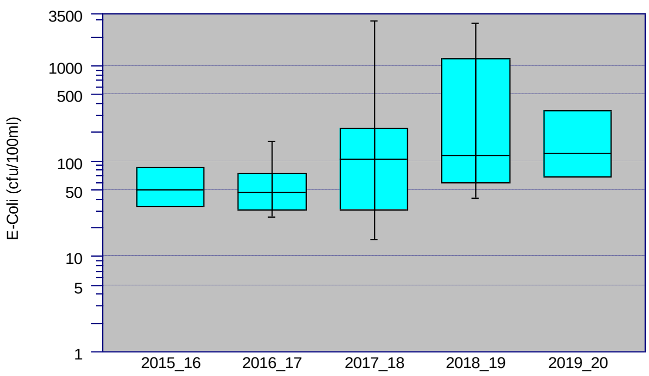

Figure 3-6: Hutt River at Boulcott (log scale)

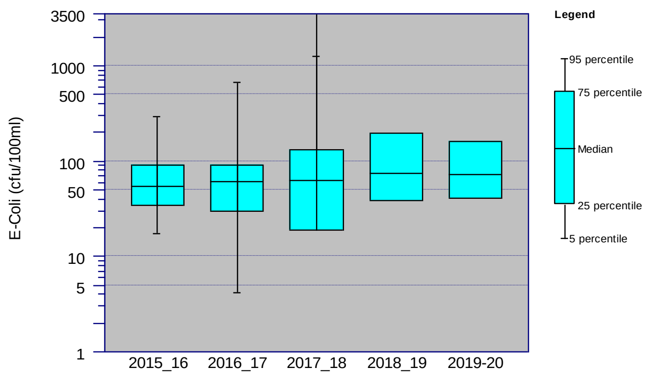

Figure 3-7: Hutt River at Melling (log scale)

The ecological component of the RWQE program a includes monthly monitoring of periphyton cover and annual monitoring of macroinvertebrate communities at three sites on the Hutt River. Periphyton weighted composite cover (WCC) results from monthly sampling over three years are summarised in Table 3-55. pNRP Objective O19 for periphyton cover is achieved at the Te Marua and Manor Park sites but is not met (marginally) at the Boulcott site on the lower river.

Table 3-55: Periphyton weighted composite cover (WCC) results from monthly sampling 2018/19 to 2020/21

Site name	N samples	Max WCC (%cover)	n ≥ 40% cover	pNRP O19 (no more than 8% of samples ≥40% cover)
Hutt River at Te Marua	35	0.1	0	Meeting
Hutt River at Manor Park	35	13.6	0	Meeting
Hutt River at Boulcott	35	75.3	3	Not meeting

Macroinvertebrate community monitoring results from annual samples taken on years 2016/2017 to 2020/2021 indicate that the community meets the pNRP Objective O19 at the Manor Park and Boulcott sites on the middle and lower river but marginally fails to meet the more stringent objective at the Te Marua site (Table 3-56). These results show a downstream decrease in ecological condition as the river transitions from a predominantly forested upper catchment to agricultural and urban land use in the middle and lower catchment.

Table 3-56: Macroinvertebrate community metrics for Hutt River (2016/17 to 2020/21)

Site name	substrate	River class	Significant river	N samples	Taxa richness	%EPT (3-yr median)	MCI (5-yr median)	QMCI (5-yr median)	pNRP O19 – MCI	pNRP O19 – QMCI	Meeting O19
Te Marua	Hard	4	Yes	5	15	59	128.2	7.9	≥130	≥6.5	Not meeting
Manor Park	Hard	4	No	5	15	54.5	120	6.7	≥110	≥5.5	Meeting
Boulcott	Hard	4	No	5	12	47.4	113.7	4.1	≥110	≥5.5	Meeting

The NZFFD includes records for thirteen native fish species in the Hutt River catchment from surveys conducted between 2000 and 2021 (Table 3-57). Six of these species are classified as at risk (Dunn, et al., 2017). The pNRP Objective O19 for fish IBI is achieved in the lower, middle and upper reaches, indicating a healthy and diverse freshwater fish population.

Inanga spawning habitat has been confirmed in the lower reaches around Sladden Park Boat Ramp (Taylor & Marshall, 2016).

Brown trout are the only introduced sports fish found in the Hutt River. The Hutt, Akatarawa, Mangaroa, Pakuratahi and Whakatikei rivers are all identified as in important trout fishery and/or spawning rivers in the pNRP.

Significant values associated with Hutt River as scheduled in the pNRP are summarised in Table 3-58 and categorised for the wastewater network overflow assessment in Table 3-59.

Table 3-57: Records of fish in the Hutt River catchment, 2000 to 2021, data from NZFFD (Stoffels, 2022)

Species	Conservation status	Lower River (<5km from coast)	Middle River (5-10km from coast)	Upper River (>10km from coast)
Longfin eel	At risk (declining)	++	++	++
Shortfin eel	Not threatened	+++	+++	+
Inanga	At risk (declining)	+++	+++	_
Koaro	At risk (declining)	-	+	-
Banded kokopu	Not threatened	+	+	++
Giant kokopu	At risk (declining)	+	+	+
Redfin bully	Not threatened	-	+	+
Bluegill bully	At risk (declining)	-	+	-
Common bully	Not threatened	+	+	++
Crans bully	Not threatened	-	+	-
Giant bully	At Risk – Naturally Uncommon	+		-
Common smelt	Not threatened	+		
Yelloweye mullet	Not threatened	+		
Brown trout	Introduced and naturalised		+++	+
Koura	Not threatened	+	+	+
Fish index of biotic integrity (F-IBI)		52	60	52
pNRP Objective O19 (F-IBI ≥ 38)		Meeting	Meeting	Meeting

Table 3-58: Environmental and cultural values identified for the Hutt River in Schedules of the pNRP

Schedule	Category	Location/value
B	Nga Taonga Nui a Kiwi	Hutt River from headwaters to Wellington Harbour
C	Sites with significant mana whenua values	Maraenuku pa, Motutawa pa
F1	Rivers and lakes with significant indigenous ecosystems	Hutt River has high macroinvertebrate community health, threatened or at river fish habitat, and migratory fish habitat
H1	Regionally significant primary contact recreation	Hutt River and tributaries from headwaters to Wellington Harbour
I	Important trout fishery and spawning waters	Hutt River and tributaries from headwaters to Wellington Harbour

Table 3-59: Hutt River receiving environment characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Hutt River	Large waterway	Class 1 (known bathing area)	Class 1 (high ecological value)	Class 1 (Very important)	Class 1 (High value)

3.7.2 Summary of Overflow Characteristics

There are 32 potential overflows to the Hutt River, 24 of which are direct overflows and 8 are indirect (Table 3-60). Recent monitoring shows that the direct overflows have historically ranged from 'Low' volume, 'Low' frequency to 'High' volume, 'Medium' frequency overflows.

Table 3-60: Summary of overflow characteristics, Hutt River

Overflow ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
1, 15, 22, 23, 25, 26, 27, 31, 33, 38, 39	Direct	-	Low	-	Low	Operative	No data
19, 20, 24, 29, 36, 70, 71, 75, 76	Direct	0	Low	<1	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
18	Direct	15,300	**High**	4	**Medium**	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
28	Direct	32,200	**High**	3	**Medium**	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
67	Direct	800	Medium	3	**Medium**	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
69	Direct	1,000	Medium	2	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
37	Indirect	0	Low	0	Low	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
40	Indirect	1,800	Medium	6	**Medium**	Operative	Seaview Strategic Wastewater Model System Performance Assessment March 2022
13, 21, 41, 42, 43	Indirect	-	Low	-	Low	Operative	No data
44	Indirect	400	Low	1	Low	Operative	System Performance Assessment March 2022

3.7.3 Review of water quality monitoring results during overflows

Water quality monitoring has been undertaken intermittently between 2007 and the present at times when the Silverstream Storm Tank overflowed to the Hutt River. Monitoring has normally included paired samples from the Hutt River at Silverstream Bridge, which is upstream of the discharge, and at the Silverstream Storm Tank overflow. At such times the Hutt River is normally in flood and its water quality is characterised by moderately elevated faecal indicator bacteria (*E. coli*) and significant elevated suspended solids (Table 3-61). Suspended solids concentrations are nearly always higher in the river than in the discharge at such times. The reverse is true for *E. coli* and ammonia which are higher in the discharge than in the river.

River water quality downstream of the overflow can be calculated by a balance on mass loads (Table 3-61). The assumptions made are that the overflow discharge rate is 0.140 m^3/s, and the Hutt River is at the 2% exceedance flow of 100 m^3/s. Under such conditions the overflow causes no change in suspended solids concentrations in the river, a slight increase in ammonia and a large increase in faecal indicator bacteria concentrations. TSS and ammonia remain in compliance with guideline values, whereas the *E. coli* concentration may exceed the NPS-FM bottom line by a large margin. Based on median values the overflow would cause an upstream *E. coli* concentration of 600 cfu/100ml to increase to 2,194 cfu/100ml, indicating an increased risk of infection for water contact recreation users for the duration of the discharge (noting that the level of contact recreation use is likely to be low at such times).

Annual macroinvertebrate community surveys are conducted in the Hutt River at Te Marua, Manor Park and Boulcott. The Manor Park site is approximately 1km downstream of the Silverstream Storm Tank discharge, while the Boulcott site is approximately 5km downstream. The rolling 3-year MCI scores show the macroinvertebrate community in the Hutt River at Manor Park consistently achieves the pNRP outcome for MCI, and that ecological health is excellent. This suggests that occasional overflows from the Silverstream Storm Tank have little effect on macroinvertebrate community health downstream of the discharge. That result is consistent with the relatively minor water quality effects predicted in Table 3-61.

Table 3-61: Summary statistics from intermittent water quality monitoring in the Hutt River (upstream) and Silverstream Storm Tank Overflow.

Site	Variable	Unit	n	Min	Median	95%ile	Max	Guideline Concentration	
Silverstream River upstream of discharge	TSS	g/m^3	60	<5	102	465	619	<1000	NIWA DSS https://niwa.co.nz/our-science/freshwater/tool
	NH_4-N	g/m^3	50	<0.01	<0.01	0.02	0.03	<0.4	NPS-FM (2020)
	E. coli	cfu/100ml	60	68	600	2650	10,000	<1200	NPS-FM (2020)
Silverstream Storm Tank overflow	TSS	g/m^3	42	17	53	125	460	n.a.	-
	NH_4-N	g/m^3	33	7.07	15	25.2	26.4	n.a.	-
	E. coli	cfu/100ml	42	<10,000	1,150,000	4,540,000	8,600,000	n.a.	-
Calculated river concentration downstream of discharge (after full mixing)	TSS	g/m^3	-	5	102	465	619	<1000	NIWA DSS https://niwa.co.nz/our-science/freshwater/tool
	NH_4-N	g/m^3	-	0.02	0.03	0.05	0.07	<0.4	NPS-FM (2020)
	E. coli	cfu/100ml	-	82	2,194	8,943	21,914	<1200	NPS-FM (2020)

3.7.4 Potential effects on the Waiwhetu Aquifer

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

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

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

Shortly after the Kaikoura earthquake in December 2016 an increasing trend of faecal indicator bacteria was detected within the bore field. From a New Zealand standpoint, the monitoring data indicated that the water supply was no longer secure (Tonkin & Taylor Ltd, 2017). This led to a decision in 2017 to manage the contamination risk by continuously chlorinating water supplied by the Waterloo WTP.

The following conclusions can be drawn from historic monitoring of water sourced from the Waiwhetu Aquifer:

- Prior to 2017 the aquifer was generally secure. Occasionally poor water quality in the Hutt River during wet weather events had minimal effect on groundwater because the rate of recharge was very low in wet conditions, and because any particulate material that entered the system (including pathogens) was removed by natural filtration processes.
- Post late 2016 there is evidence that a pathway existed (perhaps temporarily) for surface pathogen entry into the source water. However, the increased level of treatment provided since 2017, which now includes UV treatment and chlorination, ensures that safe drinking water continues to be provided to Lower Hutt customers, and ensures compliance with the Drinking Water Standards NZ.
- The intermittent occurrence of WNO’s to the Hutt River has negligible effect on the quality of groundwater within the Waiwhetu Aquifer and does not compromise the ability of Wellington Water to provide safe drinking water to its customers.

3.7.5 Potential Public Health Effects

The Hutt River is a highly valued recreational area that includes several popular bathing areas. ‘High’ volume discharges to large waterways with Class 1 recreational values are assessed as having a ‘Very High’ potential magnitude of effect on all recreational activities, as shown in Table 3-62.

The overall level of effect determined from the combination of the magnitude of effect and frequency of the event. In this case the frequency of overflow events is in the ‘Low’ to ‘Medium’ range and the overall level of effects is ‘Very High’.

Table 3-62: Magnitude of public health effects of overflows to the Hutt River

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 5 (Very High),** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for fishing	**Effects Score of 5 (Very High),** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for harvesting watercress	**Effects Score of 5 (Very High),** because watercress can be a hydraulic trap for particulate contaminants.

Table 3-63: Overall level of public health effects in the Hutt River

Overflow ID	Direct/ Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level Public Health Effect
1, 15, 22, 23, 25, 26, 27, 31, 33, 38, 39	Direct	Moderate	Low	Low
19, 20, 24, 29, 36, 70, 71, 75, 76	Direct	Moderate	Low	Low
18	Direct	**Very High**	Medium	**Very High**
28	Direct	**Very High**	Medium	**Very High**
67	Direct	**Very High**	Medium	**Very High**
69	Direct	**Very High**	Low	High
37	Indirect	Moderate	Low	Low
40	Indirect	**Very High**	Medium	**Very High**
13, 21, 41, 42, 43	Indirect	Moderate	Low	Low
44	Indirect	Low	Low	Low

3.7.6 Potential Ecological Effects

The Hutt River is identified in the pNRP as having important and extensive ecological values. ‘High’ volume discharges to large waterways with Class 1 ecological values are assessed as having a range from ‘Low’ to ‘Very High’ potential effects on ecological values, as shown Table 3-64.

In situations where potential ecological effects range across more than one Effects Score, the overall level of effect is determined by the dominant Effects Score. In this case, the overall ecological effect is ‘Moderate’, as the Very High (5) Effects Score relates to agricultural use rather than effects on ecological processes.

The overall level of ecological effects determined from the combination of the likelihood of an event and the magnitude of effect (Table 3-65). In this case the frequency of overflow events is in the ‘Medium’ range and the overall level ecological effect is assessed as ‘Moderate’.

Table 3-64: Magnitude of ecological effects of overflows to Hutt River

Potential Effect	Magnitude of Effect
Change in physical habitat suitability	**Effects Score of 3 (Moderate)**, because of the extent of physical and chemical changes resulting from a wastewater overflow.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 3 (Moderate)**, because nutrient concentrations and toxicants are likely to increase substantially above background levels.

Potential Effect	Magnitude of Effect
Change in community structure/loss of sensitive species	**Effects Score of 3 (Moderate)**, because changes in physico-chemical habitat are likely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 3 (Moderate)**, because there may be changes in physico- chemical habitat suitability.
Increase in nuisance plants	**Effects Score of 2 (Low)**, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 3 (Moderate)**, because changes in physico- chemical habitat suitability are likely.
Growth of sewage fungus/Beggiatoa	**Effects Score of 3 (Moderate)**, because BOD enrichment may provide opportunity for the growth of these organisms.

Table 3-65: Overall level of ecological effects in the Hutt River

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of ecological effect
1, 15, 22, 23, 25, 26, 27, 31, 33, 38, 39	Direct	**Moderate**	Low	Low
19, 20, 24, 29, 36, 70, 71, 75, 76	Direct	**Moderate**	Low	Low
18	Direct	**Moderate**	Medium	**Moderate**
28	Direct	**Moderate**	Medium	**Moderate**
67	Direct	**Moderate**	Medium	**Moderate**
69	Direct	**Moderate**	Low	Low
37	Indirect	**Moderate**	Low	Low
40	Indirect	**Moderate**	Medium	**Moderate**
13, 21, 41, 42, 43	Indirect	**Moderate**	Low	Low
44	Indirect	Low	Low	Very Low

3.7.7 Potential Cumulative Effects

For the Hutt River receiving environment, cumulative effects are likely to occur because:

- There are a comparatively large number of overflow points that could potentially discharge (24 direct and 8 indirect overflows), although these are spatially well separated.
- Although most overflows are of ‘Low’ volume and ‘Low’ frequency, there are four overflows which range from a ‘Medium’ to ‘High’ volume and two overflows of ‘Medium’ frequency.

For a spatially cumulative effect to arise, most of the direct and indirect discharges would need to occur at the same time. This would result in the total volume of wastewater overflows falling within the ’High’ volume range and result in ‘Very High’ potential public health effects and ‘Moderate’ ecological effects. This assessment includes ‘Medium’ and ‘High’ volume direct discharges which are the dominant contributor to a potential cumulative effect. As these direct discharges have already been assessed in earlier parts of the AEE as having potentially ‘High’ or ‘Very High’ potential public health effects individually, the cumulative effect would not be notably different.

3.7.8 Potential Cultural Effects

Hutt River is assessed as having 'Very Important' cultural values (Class 1).

The overflow discharges are of 'Low' to 'High' volume; cultural effects are assessed as 'Very High'. Because the overflows occur at a 'Medium' frequency, the overall level of cultural effects is assessed as 'Moderate'.

3.7.9 Potential Aesthetic Effects

Hutt River is assessed as having a 'High' aesthetic value. 'High' volume discharges to such an environment have a 'High' potential to affect these values. However, because the overflows occur with 'Medium' frequency, the overall level of effect is assessed as being 'Moderate'.

3.7.10 Summary

The potential magnitude and level of effects of wastewater overflows to this receiving environment are summarised in Table 3-66.

Table 3-66: Summary of magnitude and overall level of adverse effects for Hutt River

Value category	Potential magnitude of effect	Level of effect
Public health	Very High	Very High/significant
Aquatic ecology	Moderate	Moderate/more than minor
Cultural	Very High	Moderate/more than minor
Aesthetic	High	Moderate/more than minor

3.8 Hutt Estuary

3.8.1 Description of Receiving Environment

The Hutt Estuary is a 3km long "tidal river mouth" type estuary which drains into Wellington Harbour at Petone (Figure 3-2). It has been extensively reclaimed and modified, and the banks clad with large rip-rap boulders. Saltwater extends up to 3km, nearly as far as Ewen Bridge, and well upstream of the Waione Street Bridge.

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

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

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

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

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

Table 3-67 provides an assessment of against pNRP Objective O19. Significant values associated with the Hutt Estuary as scheduled in the pNRP are summarised in Table 3-67and categorised for the wastewater network overflow assessment in Table 3-68.

It is noted that the western mudflat embayment below Waione Street Bridge is identified in Schedule F3 of the NRP as a significant natural wetland.

Table 3-67: Assessment of Hutt Estuary against pNRP Objective O19, Table 3.8

	Macroalgae	Invertebrates	Mahinga kai species	Fish
pNRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by mana whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	Stevens & Forrest (2020) gave the intertidal macroalgae community a ‘moderate’ quality rating and noted that algae growths are not causing significantly degraded intertidal sediment conditions. There is, however, evidence of organically enriched and anoxic subtidal conditions in the estuary downstream of Waione Bridge, resulting from excessive nutrient driven macroalgae growth (Wear 2011; Stevens, et al, 2016). The Information reviewed here leads to an overall conclusion that pNRP Objective O19 is not fully met.			

Neither GWRC nor Wellington Water conduct routine microbiological water quality monitoring in the Hutt Estuary. Routine recreational water quality monitoring at Petone Beach to the west of the Hutt River mouth and along the Eastern Bays to the south of the river mouth (discussed in Section 3.9) indicates general compliance with the water quality criteria in Objective O18 of the pNRP.

Several waka ama clubs are based at Hikoikoi on the western side of the river mouth. These clubs utilise the estuary and harbour for training on most days of the week, with regattas held from the Beach near McEwen Park (Raukura Consultants 2021).

Both fishing and white baiting occur frequently in the Hutt Estuary.

Significant values associated with Hutt Estuary as scheduled in pNRP are summarised in Table 3-68 and categorised for the wastewater network overflow assessment in Table 3-69.

Table 3-68: Environmental and cultural values identified for the Hutt Estuary in Schedules of the pNRP

Schedule	Category	Location/value
B	Nga Taonga Nui a Kiwi	Hutt River from headwaters to Wellington Harbour
C	Sites with significant mana whenua values	Hutt River mouth, Owhiti pa, Hokoikoi pa
F1	Rivers and lakes with significant indigenous ecosystems	Hutt Estuary has high threatened or at river fish habitat, migratory fish habitat, inanga spawning habitat,
F2	Indigenous bird habitat	Hutt Estuary
F3	Significant natural wetlands	Hutt Estuary
F4	Indigenous biodiversity	Hutt Estuary/Waiwhetū Estuary
H1	Regionally significant primary contact recreation	Hutt River and tributaries from headwaters to Wellington Harbour
I	Important trout fishery and spawning waters	Hutt River and tributaries from headwaters to Wellington Harbour

Table 3-69: Hutt Estuary receiving environment characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Hutt Estuary	Estuary	Class 2	Class 1	Class 1	Class 1

3.8.2 Summary of Overflow Characteristics

There are no direct overflows from the wastewater network to the Hutt Estuary[11]. However, the estuary can potentially receive 41 indirect overflows ranging from 'Low' volume and frequency overflows to 'High' volume, 'Medium' frequency overflows (Table 3-70).

Table 3-70: Summary of overflow characteristics, Hutt Estuary

Overflow ID	Direct/ indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
1, 4, 5, 8, 9, 10, 12, 13, 15, 16, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	<1000	Low	<2	Low	Operational	SCADA (sites 7, 8 & 11)
6, 17, 72, 73	Indirect	0	Low	0	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
7	Indirect	500	Low	1	Low	Operational	Seaview Strategic Wastewater Model

[11] The occasional discharge of fully treated wastewater from the Seaview WWTP to the Waiwhetu Stream is not considered to be a wastewater network discharge (and is covered by a separate consent).

Overflow ID	Direct/ indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
							System Performance Assessment March 2022
11	Indirect	1,600	Medium	4	Medium	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
18	Indirect	15,300	High	3	Medium	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
28	Indirect	32,200	High	3	Medium	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
78	Indirect	500	Low	4	Medium	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.8.3 Potential Public Health Effects

'High' volume discharges to estuaries with Class 2 recreational values are assessed as having a 'High magnitude of effect on all recreational activities as shown in Table 3-71. The available dilution is of less relevance for 'High' volume overflows.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-72. In this case the frequency of overflow events is in the 'Medium' range and the overall level of adverse effects is 'High'.

Table 3-71: Magnitude of public health effects of overflows to the Hutt Estuary

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 4 (High),** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for collecting shellfish	**Effects Score of 4 (High),** because shellfish have the potential to filter pathogens and metals from water and sediments.
Loss of suitability for fishing	**Effects Score of 4 (High),** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for harvesting watercress	**Effects Score of 4 (High),** because watercress or seaweed can be a hydraulic trap for particulate contaminants.

Table 3-72: Overall level of effect for public health effects in Hutt Estuary

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level Public Health Effect
1, 4, 5, 8, 9, 10, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36,	Indirect	Low	Low	Very Low

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level Public Health Effect
37, 38, 39, 40, 41, 42, 43, 44				
6, 17, 72, 73	Indirect	Low	Low	Very Low
7	Indirect	Low	Low	Very Low
11	Indirect	Moderate	Medium	Moderate
18	Indirect	**High**	Medium	**High**
28	Indirect	**High**	Medium	**High**

3.8.4 Potential Ecological Effects

‘High’ volume discharges 18 and 28 to an estuary with Class 1 ecological values are assessed as having a range of ‘Low’ to ‘High’ potential effects on ecological values, as shown in Table 3-73. The Hutt Estuary provides substantial dilution and flushing.

In situations where potential ecological effects range across more than one Effects Score, the overall level of effect is determined by the dominant Effects Score. In this case, the overall ecological effect is considered to be ‘High’.

The overall level of ecological effect is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-74. In this case the frequency of overflow events is in the ‘Medium’ range and the overall level of ecological effects is assessed as ‘High’.

It is noted that the western mudflat embayment below Waione Street Bridge, which is identified in Schedule F3 of the NRP as a significant natural wetland, is located approximately 170m downstream of WNO 16. Modelling indicates that WNO 16 operates at a low frequency and low volume (less than three overflows and 600m^3 per year) and that substantial dilution is available in the tidal reach between the discharge point and the wetland. Based on that information the assessment provided for WNO 16 below in Table 3-74 remains valid. The overall level of adverse effect for WNO 16 is very low.

Table 3-73: Magnitude of ecological effects of overflows to Hutt Estuary

Potential Effect	Magnitude of Public Health Effect
Change in physical habitat suitability	**Effects Score of 4 (High)**, because physical and chemical changes resulting from a high volume wastewater overflow are likely.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 4 (High)**, because nutrient concentrations and toxicants are likely to temporary increase above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 4 (High)**, because changes in physico-chemical habitat suitability are likely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 3 (Moderate)**, because there may be changes in physico-chemical habitat suitability.
Increase in nuisance plants	**Effects Score of 4 (High)**, because elevated nutrient concentrations are likely to stimulate plant growth.
More frequent phytoplankton blooms in the water column	**Effects Score of 2 (Low),** because the dilution of overflows means that nutrient concentrations and temperature are unlikely to increase above background levels for a sustained period.
Reduced quantities of fin fish	**Effects Score of 4 (High)**, because changes in physico- chemical habitat suitability are likely
Reduced quantities of shellfish	**Effects Score of 4 (High)**, because changes in physico- chemical habitat suitability are likely

Potential Effect	Magnitude of Public Health Effect
Growth of sewage fungus/Beggiatoa	**Effects Score of 2 (Low)**, because the lack of BOD enrichment provides little opportunity for the growth of these organisms.

Table 3-74: Overall level of ecological effects in Hutt Estuary

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of ecological effect
1, 4, 5, , 8, 9, 10,, 12, 13, 15, 16, 17,, 19, 20, 21, 22, 23, 24, 25, 26, 27,, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	Low	Low	Very Low
6, 17, 72, 73	Indirect	Low	Low	Very Low
7	Indirect	Low	Low	Very Low
11	Indirect	Moderate	Medium	Moderate
18	Indirect	**High**	Medium	**High**
28	Indirect	**High**	Medium	**High**

3.8.5 Potential Cumulative Effects

For the Hutt Estuary receiving environment, consideration of cumulative effects is considered to be appropriate because:

- There are a large number of indirect overflows that could potentially discharge, although the overflow points are spatially well separated.
- Although most overflows are of ‘Low’ volume, overflow sites 18 and 28 are of ‘High’ volume and overflow site 11 is of ‘Medium’ volume.
- Overflow point 28 operates up to 10 times in a wet year, raising the possibility of temporarily cumulative effects, where any lasting effects from each discharge are exacerbated by the next one.

For a spatially cumulative effect to arise, most of the indirect discharges would need to occur at the same time. This would result in the total volume of wastewater overflows falling within the ‘High’ volume range and result in ‘High’ potential public health ecological effects. This assessment includes ‘Medium’ and ‘High’ volume indirect discharges which are the dominant contributor to a potential cumulative effect. As these indirect discharges have already been assessed in earlier parts of the AEE as having ‘High’ potential effects individually, the cumulative effect would not be notably different.

3.8.6 Potential Cultural Effects

Water is considered by tangata whenua to be a taonga and the essential element of life, therefore all natural water bodies have cultural value. Hutt Estuary is assessed as having ‘Very Important’ cultural values (Class 1).

The overflow discharges are of ‘Low’ to ‘High’ volume and cultural effects are assessed as ‘Very High’. Because the overflows occur at a ‘Low’ to ‘Medium’ frequency, the overall level of cultural effects is assessed as ‘Moderate’.

3.8.7 Potential Aesthetic Effects

Hutt Estuary is assessed as having a 'High' aesthetic value. 'High' volume discharges to such an environment have a 'High' potential to affect these values. However, because the overflows occur with at a 'Low' to 'Medium' frequency, the overall level aesthetic effects is assessed as being 'Moderate'.

3.8.8 Summary

The potential magnitude and level of effects of wastewater overflows to this receiving environment is summarised in Table 3-75.

Table 3-75: Summary of magnitude and overall level of adverse effects for Hutt Estuary

Value Category	Potential Magnitude of Effect	Level of Adverse Effect
Public health	High	High/Significant
Aquatic ecology	High	High/Significant
Cultural	Very High	Moderate/More that minor
Aesthetic	High	Moderate/More than minor

3.9 Petone and East Harbour Beaches

3.9.1 Description of Receiving Environment

COPs can potentially discharge directly to Petone Beach, and to beaches at Sorrento Bay, Lowry Bay, York Bay, Days Bay, Rona Bay, and Robinson Bay (Figure 3-2 and Figure 3-8). These locations are all popular recreation areas enjoyed by a wide range of people engaged in a variety of activities including bathing, surfing, wind/kite surfing, sailing, walking, and sunbathing.

A description of the wider northern and eastern areas of Wellington Harbour, beyond the bathing beaches, is provided in Section 3.10. Refer also to Section 3.10.1 for a description of extent to which the Hutt River, while in flood, can potentially affect the water quality of both the Petone foreshore and the Eastbourne coast.

Table 3-76 summarises the results of GWRC & HCC recreational water quality monitoring at these beaches over the five-year period to March 2020. All sites achieved the pNRP Objective O18 standard for enterococci over the last three compliance periods (green shading), indicating a relatively low health risk for contact recreation activities at East Harbour beaches.

Table 3-76: Summary statistics for enterococci at East Harbour Beaches (GWRC data 2015-2020)

Site name	N samples	% over 140 cfu/100m	% over 500 cfu/100ml	Median cfu/100ml	95th percentile cfu/100ml (3 years to May 2018, 2019 and 2020)			pNRP Objective O18 95th percentile
					2018	2019	2020	
Petone Beach @ WS Club	93	8	3	8	269	360	176	≤500
Petone Beach @ Sydney	92	9	4	8	344	290	468	≤500
Petone Beach @ Kiosk	160	11	1	8	351	372	327	≤500
Sorrento Bay	95	7	0	8	322	336	206	≤500
Lowry Bay	95	12	0	8	360	371	291	≤500

Site name	N samples	% over 140 cfu/100m	% over 500 cfu/100ml	Median cfu/100ml	95th percentile cfu/100ml (3 years to May 2018, 2019 and 2020)			pNRP Objective O18 95th percentile
					2018	2019	2020	
York Bay	95	7	1	8	272	341	275	≤500
Days Bay @ Wellesley	93	6	1	8	320	220	160	≤500
Days Bay @ Wharf	93	8	1	8	222	175	169	≤500
Days Bay @ Moana	95	7	1	4	348	300	255	≤500
Rona Bay @ CB Park	96	8	2	8	360	338	127	≤500
Rona Bay @ Wharf	96	10	1	8	302	278	189	≤500
Robinson Bay	94	11	2	4	398	300	209	≤500
Robinson Bay@Nikau	160	10	2	8	206	348	360	≤500

Note: Follow-up sampling results were removed from the dataset prior to calculation of statistics

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

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

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

Table 3-77 provides an assessment of against pNRP Objective O19. Significant values associated with the Petone and East Harbour Beaches as scheduled in the pNRP are summarised in Table 3-79 and categorised for the wastewater network overflow assessment in Table 3-78.

Table 3-77: Assessment of Petone and East Harbour intertidal areas against pNRP Objective O19, Table 3.8

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

	Macroalgae	Invertebrates	Mahinga kai species	Fish
		state of aquatic ecosystem health	ecosystem. Huanga of mahinga kai as identified by mana whenua area achieved	state of aquatic ecosystem health
Assessment	The intertidal community composition of the Eastern Bays was as expected for this general location (lower North Island) and rocky shore habitat and is similar to the rocky shore communities found elsewhere in Wellington Harbour. No taxa that are indicative of significant nutrient enrichment or fine sediment input were present in any great abundance, with exposure and substrate seeming to be the main factors influencing the communities of this area (McMertrie & Brennan, 2016). While the infauna density at Petone Beach was highly variable, when considered together with other sediment indicators, Petone Beach was judged to be in "very good" or "good" condition, based on the rating system used. High numbers of juvenile pipi recorded probably support the more extensive pipi bed that is anecdotally reported to be present in the deeper subtidal (Stevens 2018). The information reviewed here leads to an overall assessment that pNRP Objective O19 is met.			

Table 3-78: Environmental and cultural values identified for NE Wellington Harbour in Schedules of the pNRP

Schedule	Category	Location/value
B	Nga Taonga Nui a Kiwi	Wellington Harbour
C	Sites with significant mana whenua values	Petone foreshore (Pito-one pa, Hokoikoi pa), Korohiwa (East Harbour coast)
F2	Indigenous bird habitat	Wellington Harbour
F5	Habitats with significant indigenous biodiversity values in the coastal marine area	Giant kelp, kelp beds, seagrass, subtidal rock reefs

Table 3-79: Petone and east harbour beach receiving environment characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Beaches at Petone & Eastern Bays	Beaches	Class 1	Class 1	Class 1	Class 1

3.9.1 Summary of Overflow Characteristics

There are seventeen direct overflows to beaches in the northeast Wellington Harbour, all of which are Low volume and Low frequency discharges. In addition, there are 40 overflow discharges in Hutt and Korokoro catchments that could indirectly affect water quality at Wellington Harbour beaches. The indirect discharges range from Low to High volume and Low to medium frequency, but all are well removed from Petone and East Harbour beaches (Table 3-74).

Table 3-80:: Summary of overflow characteristics, Petone and East Harbour beaches

Overflow ID	Direct/ indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
14, 32, 34, 35, 48, 49, 50, 51, 53, 54, 74, 77, 82	Direct	<200	Low	2	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
45, 46, 47, 52	Direct	<1000	Low	<2	Low	Operational	No data
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15,	Indirect	<1000	Low	<2	Low	Operational	SCADA (sites 7, 8 & 11)

Overflow ID	Direct/ indirect	Volume (m³)		Frequency (per year)		Status	Data Source
		(m³)	Range	number	Range		
16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44							
18	Indirect	3,404	Medium	1.8	Low		SCADA
28	Indirect	32,200	**High**	3	**Medium**		Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.9.2 Potential Public Health Effects

All direct overflows to Petone and East Harbour Beaches are 'Low' volume, 'Low' frequency discharges. Indirect overflows include the 'High' volume discharges from the Silverstream Storm tank to the Hutt River, which is 16 km upstream of the nearest bathing beach at Petone, and the Barber Grove pump station to the Hutt River, which is 2 km upstream of Petone Beach. Both indirect discharges would receive substantial dilution prior to reaching Petone or other beaches, but still are likely to have some effect. To reflect this complex situation the volume range input is categorised as 'Low' and the frequency range 'Medium'.

'Low' volume discharges to beaches with Class 1 recreational values are assessed as having a 'Moderate' potential effect on all recreational activities, as shown in Table 3-81.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-82. In this case the frequency of overflow events is in the 'Medium' range and the overall level of adverse effects is 'Moderate'.

Table 3-81: Magnitude of public health effects of overflows to Petone and East Harbour beaches

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 3 (Moderate),** because microbial pathogen indicator contact recreation guidelines may be exceeded.
Loss of suitability for collecting shellfish	**Effects Score of 3 (Moderate),** because shellfish have the potential to filter pathogens and metals from water and sediments.
Loss of suitability for fishing	**Effects Score of 3 (Moderate),** because microbial pathogen indicator contact recreation guidelines may be exceeded.
Loss of suitability for harvesting seaweed	**Effects Score of 3 (Moderate),** because seaweed can be a hydraulic trap for particulate contaminants.

Table 3-82: Overall level of public health effects at Petone and East Harbour beaches

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level of Public Health effect
14, 32, 34, 35, 48, 49, 50, 51, 53, 54, 74, 77, 82	Direct	**Moderate**	Low	Low
45, 46, 47, 52	Direct	**Moderate**	Low	Low

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level of Public Health effect
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	**Moderate**	Low	Low
18	Indirect	**Moderate**	Low	Low
28	Indirect	**Moderate**	Medium	**Moderate**

3.9.3 Potential Ecological Effects

All direct overflows to Petone and East Harbour Beaches are ‘Low’ volume, ‘Low’ frequency discharges. Indirect overflows include the ‘High’ volume discharges from the Silverstream Storm tank to the Hutt River, which is 16 km upstream of the nearest bathing beach at Petone, and the Barber Grove pump station to the Hutt River, which is 2 km upstream of Petone Beach. Both indirect discharges would receive substantial dilution in the Hutt River and Wellington Harbour prior to reaching Petone or other beaches. For that reason, the combined discharge volume to recreational beaches is categorised as ‘Low’.

‘Low’ volume discharges to beaches with Class 1 ecological values are assessed as having ‘Very Low’ to ‘Low’ potential magnitude of effect on ecological values, as shown in Table 3-83. Beaches are likely to have high dilution rates and are generally able to absorb ‘Low’ volume overflows.

The overall level of ecological effect is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-84. In this case the frequency of overflow events is in the ‘Medium’ range and the overall level of adverse effects is ‘Moderate’.

Table 3-83: Magnitude of ecological effects of overflows to Petone and East Harbour beaches

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low),** because of the general lack of physical and chemical changes resulting from a Low volume wastewater overflow.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 2 (Low),** because the dilution of overflows means that nutrient and toxicant concentrations are unlikely to increase above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low),** because the limited extent of changes in physico- chemical habitat suitability are unlikely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 1 (Very Low),** because the limited extent of changes in physico-chemical habitat suitability is unlikely to generate behavioural changes.
Increase in nuisance plants	**Effects Score of 2 (Low),** because the dilution of overflows means that nutrient concentrations are unlikely to increase above background levels.
More frequent phytoplankton blooms in the water column	**E Effects Score of 1 (Very Low),** because the dilution of overflows means that nutrient concentrations and temperature are unlikely to increase above background levels.
Reduced quantities of fin fish	**Effects Score of 2 (Low),** because of the lack of changes in physico-chemical habitat suitability.
Reduced quantities of shellfish	**Effects Score of 2 (Low),** because of the lack of changes in physico-chemical habitat suitability.

Potential Effect	Magnitude of Ecological Effect
Growth of sewage fungus/Beggiatoa	**Effects Score of 1 (Very Low),** because the lack of BOD enrichment provides little opportunity for the growth of these organisms.

Table 3-84: Overall level of ecological effect in Petone and East Harbour beaches

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of ecological effect
14, 32, 34, 35, 48, 49, 50, 51, 53, 54, 74, 77, 82	Direct	**Low**	Low	Very Low
45, 46, 47, 52	Direct	**Low**	Low	Very Low
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	**Low**	Low	Very Low
18	Indirect	**Low**	Low	Very Low
28	Indirect	**Low**	Medium	**Low**

3.9.1 Potential Cumulative Effects

For the beaches at Petone and East Harbour, cumulative effects are possible because:

- While direct discharges to beaches are relatively few and far between, there are a large number of indirect overflows that could potentially discharge from the Hutt River catchment to impact water quality at both Petone Beach (in southerly winds) and Eastbourne coast (in calm or northerly winds).
- Although all of the direct overflows are of 'Low' volume, the indirect overflows include 'High' volume discharges.

For a spatially cumulative effect to arise, most of the indirect discharges would need to occur at the same time, which is likely at times of peak wet weather flow. This would result in the total volume of wastewater overflows falling within the 'High' volume range and result in 'High' potential public health and ecological effects. This is offset to some extent by Silverstream Storm tank discharge being 16 km upstream of the Harbour and the Barber Grove overflow being 2 km upstream. Taking account of proximity, the cumulative effect of these discharges is assessed as Moderate (3) for both recreation and ecological values. Because the frequency of overflows from the Silverstream Storm tank is 'Medium' the overall level of recreational and ecological effects is assessed as 'Moderate'.

3.9.2 Potential Cultural Effects

The Petone and East Harbour beaches are assessed as having Very Important cultural values (Class 1). The overflow discharges are of 'Low' to 'High' volume and cultural effects are assessed as 'Very High'. Because the overflows occur at a 'Low' to 'Medium' frequency, the overall level of cultural effects is assessed as 'Moderate'.

3.9.3 Potential Aesthetic Effects

The Petone and East Harbour beaches are assessed as having a 'High' aesthetic value. 'High' volume discharges to such an environment have a 'High' potential to affect these values. Taking into account the 'Medium' overflow frequency, overflows occur with medium frequency, the overall level of effect is assessed as 'Moderate'.

3.9.4 Summary

The potential magnitude and level of effects of wastewater overflows is summarised in Table 3-85.

Table 3-85: Summary of magnitude and overall level of effect for Petone and East Harbour Beaches

Value category	Potential magnitude of effect	Level of adverse effect
Public health	Moderate	Moderate/more than minor
Aquatic ecology	Moderate	Moderate/more than minor
Cultural	Very High	Moderate/more than minor
Aesthetic	High	Moderate/more than minor

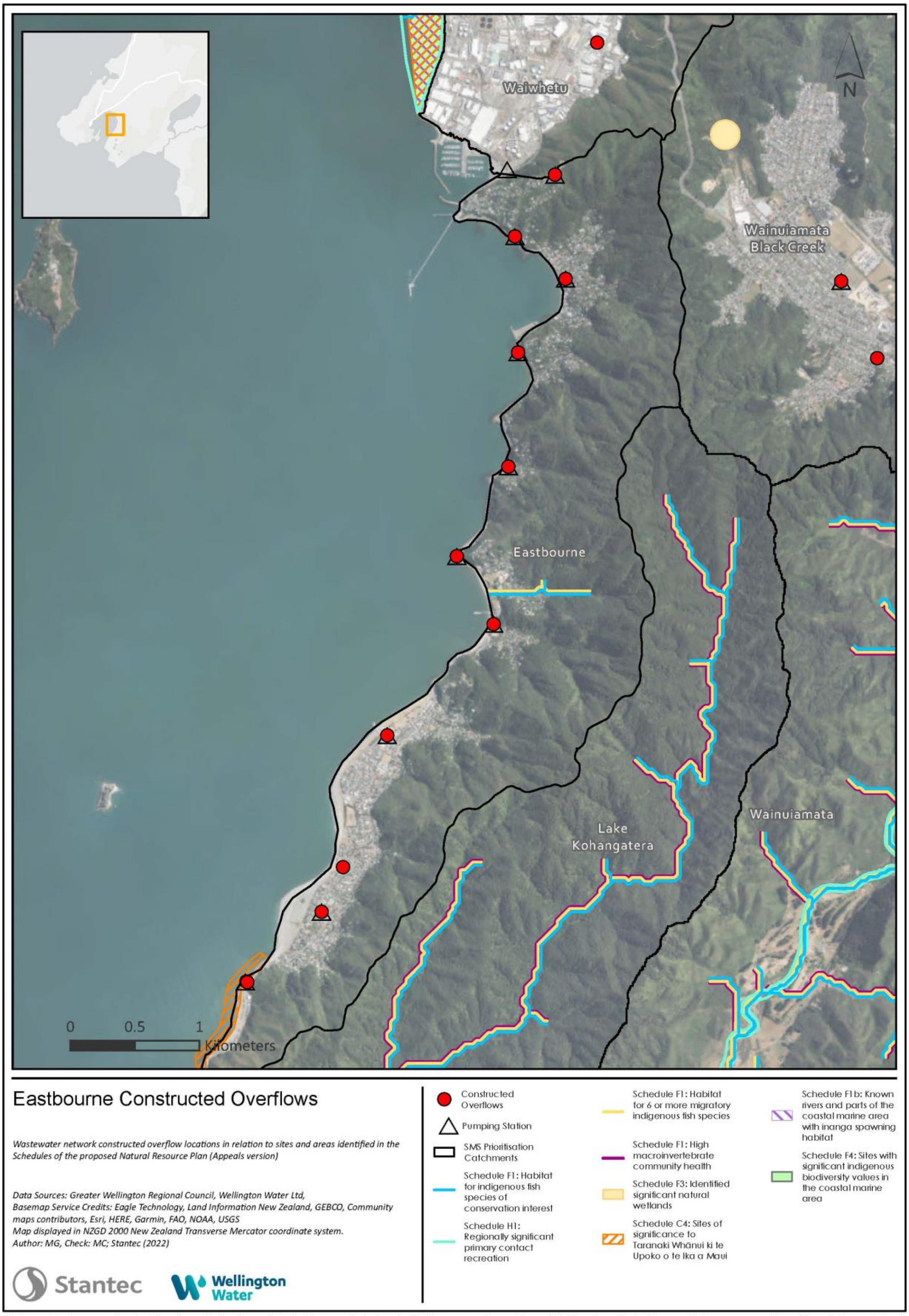

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Figure 3-8: COPs on the Eastbourne coast

3.10 Wellington Harbour

3.10.1 Description of Receiving Environment

Wellington Harbour is well flushed with a flushing time of approximately 10 days (Heath, 1977). During flood events the discharge from the Hutt River causes harbour waters to become fresher and more turbid, however at most times there is little if any influence of freshwater on harbour salinities. Tidal flow is generally in a clockwise direction on the flood tide and in an anticlockwise direction on the ebb tide (Brodie, 1958).

More recent output from modelling of the Hutt River discharge into Wellington Harbour during a major southerly storm event shows that around the arrival of the storm, in strong southerly conditions, freshwater from the Hutt River is pushed up onto the Petone foreshore (Figure 3-9). In these frames 100% freshwater is shown as maroon, 80% freshwater is yellow, and 100% harbour water is blue. During the peak of the storm (not shown) freshwater is carried to the whole of the upper harbour including Lambton Harbour and Evans Bay. Eventually, as shown in Figure 3-10, the tide and wind lead to the wider dispersal of the freshwater, including all the way down the Eastbourne coast and out through the harbour entrance (NIWA, 2014). These frames illustrate that the Hutt River can influence water quality at both the Petone foreshore and the Eastbourne Coast during storm events.

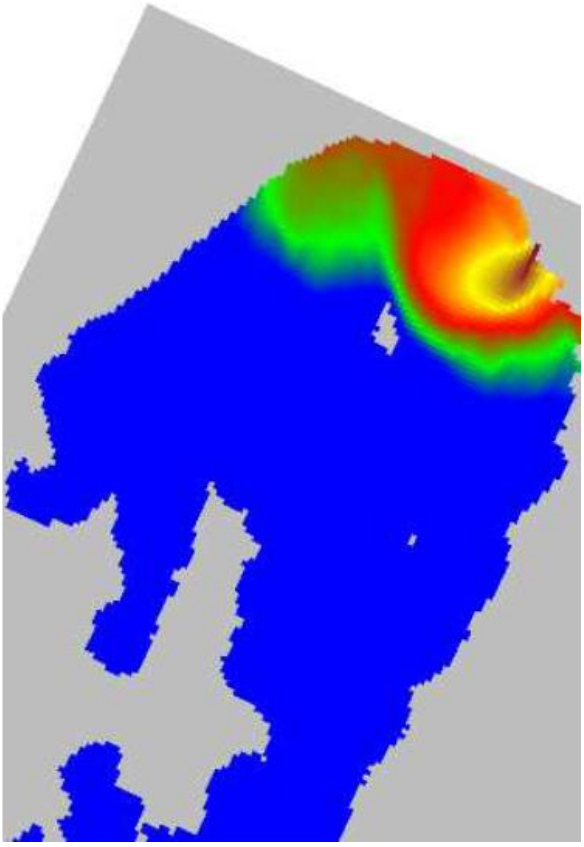

Figure 3-9: Freshwater inputs from Hutt River the Wellington Harbour in a strong southerly storm (NIWA 2014)

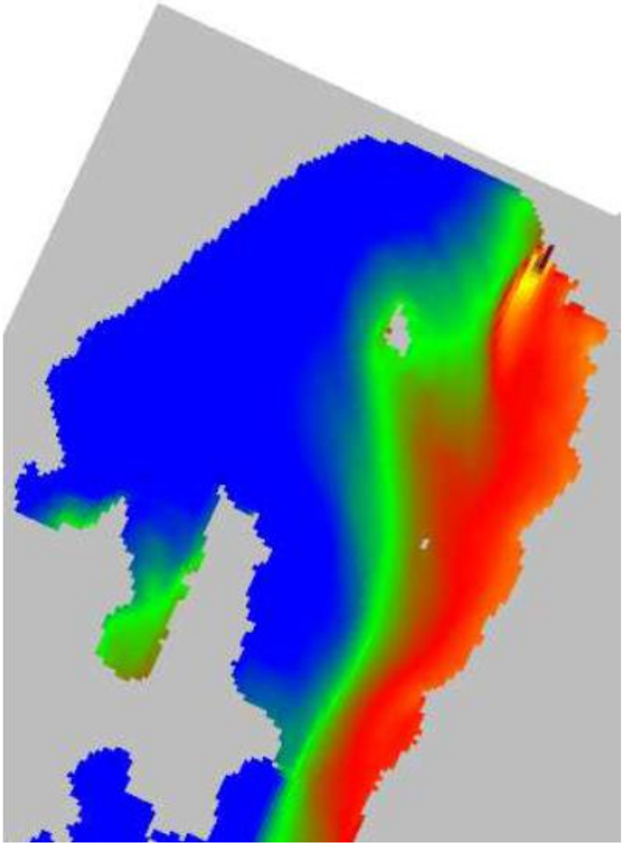

Figure 3-10: Freshwater influence of Hutt River in flood on an ebb tide after southerly winds have passed.

The harbour has a maximum tidal range of 1.5m and an average tidal range of 0.75m. The tidal zone can be classified as Low, mid and high tide and is a significant factor in the determination of biological communities inhabiting intertidal habitats.

GWRC's most recent Wellington harbour marine sediment quality investigations at 16 subtidal sites in Wellington Harbour, include three sites in the Petone/Hutt area: one offshore from Petone Beach (WH13), one site seaward of the Hutt River mouth (WH15) and one north of Ward Island (WH17) (Cummings, et al., 2021).

Sediments at the Petone/Hutt group of sites were amongst the muddiest and most organically enriched of all monitoring sites in the Harbour, however these sites also had the lowest concentrations of heavy metals and PAH. Arsenic, cadmium, chromium, lead, mercury, nickel and total PAH were all below ANZG (2018) guideline levels at sites WH15 and WH17, while a marginal exceedance was recorded for lead and mercury at site WH13. Lead and mercury exceeded guideline levels at all sites except WH15 and WH17. Lead is thought to be a legacy contaminant from its use in gasoline for cars up until 25 years ago when it was removed. It is not clear if mercury originates solely from anthropogenic inputs or from natural contributions.

Cummings, et al (2021) used benthic health assessments to assess the relative health status of the different sites. The Benthic Health Model for metals classified 14 of the 15 sites as having 'good' health when all species were included. Site EB2, in Evans Bay was categorised as 'Moderate'. The Traits Based Index, based on biological traits of the benthic taxa, classified all sites sampled in Wellington Harbour, including the Petone/Hutt group of sites, as having 'high' functional redundancy in 2020. Although a mud content of ~70- 95% in intertidal habitats is generally associated with low taxa richness and concomitantly low TBI scores, it appears that very muddy subtidal seafloor habitats in Wellington Harbour support a relatively high abundance and diversity of macrofauna. The unexpectedly high TBI scores (given the muddiness and metal contamination) may have resulted from low numbers of individuals present across a large number of taxa.

A survey of edible shellfish beds in Wellington Harbour coastline indicates that the green lipped mussel (*Perna canaliculus*) and the blue mussel (*Mytilus edulis*) are found on many of the rocky outcrops between Pencarrow Head and Point Arthur (EHEA 1997). Paua (*Haliotis iris*), kina (*Evechinus chloroticus*) and rock lobster (*Jasus edwardsii*) are found along the Pencarrow coast south of Eastbourne. Pipi (*Phaphies australis*) are found at Days Bay and Petone Beach (Stevens, B, & Robertson, 2004), while the cockle (*Austrovenus stutchbury*) is found at York Bay, Lowry Bay, Sorrento Bay, and Point Howard. Scallops are found further offshore in waters of 5 to 15m depth between Point Howard and Eastbourne. The open scallop season for Wellington runs from 15 July to 14 February.

MWH (2013) conducted a shellfish quality survey at sites in the Hutt Estuary, Petone foreshore and Sorrento / Lowry Bay during 2013. The monitoring report noted that wastewater overflows had occurred at the Silverstream Storm Tank (untreated wastewater to Hutt River), and Seaview WWTP (treated wastewater to Waiwhetu Stream), just prior to the survey (overflows had probably also occurred elsewhere in the Hutt Catchment).

The shellfish monitoring results indicated that:

- Edible shellfish were scarce at the nominated sampling locations [the Hutt River Estuary; along the western shore of Petone beach, and in Sorrento / Lowry Bay].
- Mussels were present and were collected on all three sampling occasions, including on the western side of the Hutt Estuary, near the end of Marine Parade.
- Faecal indicator bacteria and norovirus (PCR) concentrations in shellfish indicate that the Hutt Estuary, Petone Beach and Lowry Bay had recently been exposed to dilute wastewater. Indicator concentrations were highest in the Hutt Estuary.

The report recommended that: "*shellfish should not be collected for human consumption at locations between Petone Beach west and Lowry Bay less than four weeks after a planned discharge of treated wastewater to Waiwhetū Stream, or less than four weeks after a significant high flow event in the Hutt*

River or Waiwhetū Stream, which may result in the discharge of contaminated stormwater or an overflow of wastewater into these water bodies.

This restriction would likely rule out much of the year but would be consistent with the general advice previously provided by Regional Public Health, and by NZFSA [New Zealand Food Safety Authority, now part of the Ministry for Primary Industries], not to collect shellfish near urban areas because of the on-going impact of stormwater and sewage related contamination." (p13, MWH 2013).

The Cultural Impact Assessment notes that shellfish like the large pipi beds around the mouth of the Hutt River and along the beaches of the Petone coastline accumulate waste going into the river making them largely inedible at most times. It has been observed that Māori, and Pacific Islanders in particular, will still gather these shellfish at low tide.

Table 3-86 provides an assessment of against pNRP Objective O19. Significant values associated with the north-east Wellington Harbour as scheduled in the pNRP are summarised in Table 3-87 and categorised for the wastewater network overflow assessment in Table 3-88.

Table 3-86: Assessment of Petone and East Harbour intertidal areas against pNRP Objective O19, Table 3.8

	Macroalgae	Invertebrates	Mahinga kai species	Fish
pNRP Objectives	The algae community is reflective of a good state of aquatic ecosystem health with a low frequency of nuisance blooms	Invertebrate communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health	Mahinga kai species, including taonga species, are present in quantities, sizes and of a quality that is appropriate for the area and reflective of a healthily functioning ecosystem. Huanga of mahinga kai as identified by mana whenua area achieved	Fish communities are resilient, and their structure, composition and diversity are reflective of a good state of aquatic ecosystem health
Assessment	Cummings, et al (2021) report that the analysis of a variety of sediment contaminants, including heavy metals and PAHs, revealed guideline exceedances for lead and mercury (two of the most toxic heavy metals commonly found in the marine environment) at all but two sites. These sites, WH15 located SW of Seaview and WH17 NNW of Makaro/Ward Island, did not exceed guidelines for any of the contaminants measured. This is similar to findings from previous sampling dates (Hewitt 2019). The Benthic Health Model for metals classified all of the Petone/Hutt group of sites as having 'good' health Cummings, et al (2021).			

Table 3-87: Environmental and cultural values identified for Wellington Harbour in Schedules of the pNRP

Schedule	Category	Location/value
B	Nga Taonga Nui a Kiwi	Hutt River and Wellington Harbour
C	Sites with significant mana whenua values	Hutt River mouth, Owhiti pa, Hokoikoi pa
F1	Rivers and lakes with significant indigenous ecosystems	Hutt Estuary has high threatened or at river fish habitat, migratory fish habitat, inanga spawning habitat,
F2	Indigenous bird habitat	Wellington Harbour
F4	Indigenous biodiversity	Hutt River mouth
F5	Habitats with significant indigenous biodiversity values in the coastal marine area	Giant kelp, kelp beds, seagrass, subtidal rock reefs

Schedule	Category	Location/value
H1	Regionally significant primary contact recreation	Hutt River and tributaries from headwaters to Wellington Harbour
I	Important trout fishery and spawning waters	Hutt River and tributaries from headwaters to Wellington Harbour

Table 3-88: Wellington Harbour Receiving Environment Characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Wellington Harbour	Harbour	Class 1	Class 1	Class 1	Class 1

3.10.2 Summary of Overflow Characteristics

There are 50 overflows to Wellington Harbour, 13 of which are direct overflows and 37 are indirect (Table 3-89). The direct overflows are all Low volume and Low frequency overflows. Medium and High-volume overflows to the Hutt River at Barber Grove (Moera) and Silverstream are indirect discharges to the harbour which receive a considerable dilution prior to reaching the harbour and, for the purpose of assessing impacts on the harbour, are categorised as Low volume inputs.

Table 3-89: Summary of Overflow Characteristics, Wellington Harbour

Overflow ID	Direct/ indirect	Volume (m³)		Frequency (per year)		Status	Data Source
		(m³)	Range	number	Range		
32, 34, 35, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54	Direct	-	Low	-	Low	Operational	No data
1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	<1000	Low	<2	Low	Operational	SCADA (sites 7, 8 & 11)
18	Indirect	15,300	**High**	3	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
28	Indirect	32,200	**High**	3	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.10.3 Potential Public Health Effects

Wellington East Harbour includes numerous popular bathing, shellfish collection and fishing areas, making it a Class 1 recreational area. All 13 direct overflows to Wellington East Harbour are Low volume, Low frequency discharges. Low volume discharges to harbours with Class 1 recreations values are assessed as having predominantly Low potential effects on all recreational values, as shown in Table 3-90.

Indirect overflows to the Wellington Harbour include the High-volume discharge from the Silverstream Storm tank to the Hutt River (28), which is 16 km upstream of the harbour, the medium volume discharge from the Barber Grove pump station to the Hutt River (18) which is 2 km upstream of the harbour, as well as numerous Low volume discharges at other locations.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-91. The magnitude of public health effect at Wellington East Harbour is Low and the frequency of occurrence low giving an overall level of effects of Low.

Table 3-90: Magnitude of public health effects of overflows to Wellington Harbour

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 2 (Low),** because harbours provide dilution and flushing and are generally able to absorb low volume overflows.
Loss of suitability for collecting shellfish	
Loss of suitability for fishing	
Loss of suitability for harvesting seaweed	

Table 3-91: Overall level of public health effects in Wellington Harbour

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level of Public Health Effect
32, 34, 35, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54	Direct	**Low**	Low	Very Low
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	Low	Low	Very Low
18	Indirect	Low	Low	Very Low
28	Indirect	Moderate	**Medium**	**Low**

3.10.4 Potential Ecological Effects

Wellington East Harbour is assessed as having Class 1 ecological values. Low volume discharges to harbours with Class 1 ecological values are assessed as having a range of Low to High potential effects on ecological values, as shown in Table 3-92.

Harbours provide some dilution and/or flushing. In situations where potential ecological effects range across more than one Effects Score, the overall level of effect is determined by the dominant Effects Score. In this case, the overall ecological effect is assessed as Low.

The overall level of ecological effect is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-93. The magnitude of ecological effect at Wellington East Harbour is Low and the frequency of occurrence low giving an overall level of effects of Low.

Table 3-92: Magnitude of ecological effects of overflows to Wellington Harbour

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low),** because of the general lack of physical and chemical changes resulting from a low volume wastewater overflow.

Potential Effect	Magnitude of Ecological Effect
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 2 (Low),** because the dilution of overflows means that nutrient and toxicant concentrations are unlikely to increase above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low),** because the limited extent of changes in physico- chemical habitat suitability is unlikely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 1 (very Low),** because the limited extent of changes in physico-chemical habitat suitability is unlikely to generate behavioural changes.
Increase in nuisance plants	**Effects Score of 2 (Low),** because the dilution of overflows means that nutrient concentrations are unlikely to increase above background levels.
More frequent phytoplankton blooms in the water column	**Effects Score of 1 (very Low),** because the dilution of overflows means that nutrient concentrations and temperature are unlikely to increase above background levels.
Reduced quantities of fin fish	**Effects Score of 2 (Low),** because of the lack of changes in physico-chemical habitat suitability.
Reduced quantities of shellfish	**Effects Score of 2 (Low),** because of the lack of changes in physico-chemical habitat suitability.
Loss of opportunity for aquaculture	**Effects Score of 2 (Low),** because of the lack of elevated pathogen concentrations.
Growth of sewage fungus/Beggiatoa	**Effects Score of 1 (very Low),** because the lack of BOD enrichment provides little opportunity for the growth of these organisms.

Table 3-93: Overall level of ecological effects in Wellington Harbour

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of ecological effect
32, 34, 35, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54	Direct	Low	Low	Very Low
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 30, 31, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44	Indirect	Low	Low	Very Low
18	Indirect	Low	Low	Very Low
28	Indirect	**Low**	Medium	**Low**

3.10.5 Potential Cumulative Effects

For Wellington Harbour, cumulative effects are possible because:

- While direct discharges to the harbour are relatively few and are well separated, there is a large number of indirect overflows that could potentially discharge from the Hutt River catchment to impact water quality of the harbour.
- Although all direct overflows are of Low volume, the indirect overflows include Moderate volume and High-volume discharges.

For a spatially cumulative effect to arise, most of the indirect discharges would need to occur at the same time, which is likely at times of peak wet weather flow. This would result in the total volume of wastewater overflows falling within the High-volume range and result in High potential public health and ecological effects. This is offset to some extent by Silverstream Storm tank discharge being 16 km upstream of the Harbour and the Barber Grove overflow being 2 km upstream. Taking account of proximity, the cumulative effect of these discharges is assessed as Moderate (3) for both recreation and ecological values. Because the frequency of overflows from the Silverstream Storm tank is medium the overall level of both recreational and ecological effects is assessed as Moderate.

3.10.6 Potential Cultural Effects

Wellington Harbour is assessed as having Very Important cultural values (Class 1). The overflow discharges are of Low to High volume and cultural effects are assessed as Very High. Because the overflows occur at a Low to medium frequency, the overall level of cultural effects is assessed as Moderate.

3.10.7 Potential Aesthetic Effects

Wellington Harbour is assessed as having a High aesthetic value. High volume discharges to such an environment have a High potential to affect these values. However, because the overflows occur with medium frequency, the overall level of effect is assessed as being Moderate.

3.10.8 Summary

The potential magnitude and overall level of adverse effect of wastewater overflows to this receiving environment is summarised in Table 3-94.

Table 3-94: Summary of potential effects for Wellington Harbour

Value Category	Potential Magnitude Of Effect	Level Of Effect
Public health	Moderate	Moderate/more than minor
Aquatic ecology	Moderate	Moderate/more than minor
Cultural	Very High	Moderate/more than minor
Aesthetic	High	Moderate/more than minor

3.11 Black Creek

3.11.1 Description of Receiving Environment

Black Creek is a 3rd order urban stream (4th order in the lower reach) with a total catchment area of 16.8 square kilometres (Figure 3-11). It has been straightened and channelised to help manage flooding, and partially concrete lined for erosion protection. Bank vegetation and shade is limited over most of its length. It has a relatively coarse substrate which provides some hydraulic heterogeneity but, overall, the quality of stream habitat is poor.

Table 3-95 summarises the results of HCC monthly monitoring of *E. coli* in water samples from Black Creek (at Moohan Street) over the 4-year period from 2013 to 2016. The results indicate a high level of faecal contamination, achieving the lowest NPS-FM Attribute State of “E”. The NPS-FM (2020) narrative for attribute state “E” is: “*For more than 30% of the time the estimated risk is ≥50 of 1000 (>5% risk). The predicted average infection rate is >7%*”.

Table 3-95: Summary statistics and NPS-FM Attribute State for *E. coli* (HCC data Jan 2013 to Nov 2016)

Site name	N samples	% exceedance over 540 cfu/100ml	% exceedance over 260 cfu/100m	Median Concentration cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State
Black Creek at Moohan St	42	15	32	402	4,080	E

Table 3-96 summarises the results of monthly monitoring conducted during 2020 under the Wellington Water Stormwater Monitoring Plan (SMP) which is required under the Wellington Water's global stormwater discharge consent. The limited data available to date shows a high level of faecal contamination at all three monitoring sites on Black Creek, consistent with the 2013-2016 results.

Table 3-96: Summary statistics and NPS-FM Attribute State of *E. coli* (WWL SMP data Jan – Sept 2020)

Site name	N Samples	% Exceedance over 540 cfu/100ml	% Exceedance over 260 cfu/100m	Median Concentration cfu/100m	95th Percentile cfu/100ml	NPS-FM Attribute State
Black Creek at Edmond Street	7	57	57	619	2,536	E
Black Creek trib. At Fitzherbert Street	5	20	80	365	1,439	E
Black Creek at Moohan Street	5	60	80	708	1,906	E

A temporary River Water Quality & Ecology site was established on Black Creek under the SMP at the beginning of July 2020. However there is not yet sufficient data establish current ecological health. A synoptic ecology survey was conducted on Black Creek and Wainuiomata River during 2015 for HCC (Cameron, 2015). The monitoring report noted the following regarding the condition of Black Creek:

- Bank vegetation and shade is limited in the upper reaches [at the survey location] but improved downstream.
- The stream has a relatively coarse substrate which provides some hydraulic heterogeneity and habitat diversity, but an overall habitat assessment rating of 38 out of 100 indicates significantly impaired habitat quality.
- Water quality in Black Creek was "notably poorer" than in the Wainuiomata River downstream of the confluence, especially in terms of nitrogen, phosphorus, and faecal indicator bacteria levels, all of which appear to have had been sufficiently elevated to cause a downstream change in the Wainuiomata River below the confluence.
- At the time of the survey, Black Creek was "mostly free of filamentous and mat forming algae however most surfaces were covered by bryophytes (moss) and/or macrophytes".
- The invertebrate community in Black Creek was dominated by freshwater snails (Mollusca), especially *Potamopyrgus antipodarum* which was the dominant taxa. Orthoclad midges (Diptera) were also abundant.
- The average number of invertebrates counted per sample was 728 and on average 21 taxa were identified per sample. However only 10% of individuals were from the pollution sensitive 'Ephemeroptera, Plecoptera, Trichoptera' (EPT) group, and only 26% of taxa were EPT taxa. These metrics together with the MCI and QMCI scores indicated a significantly degraded macroinvertebrate fauna, of "poor" to "fair" quality".

Overall, the 2015 survey found that Black Creek:

"… which drains much of urban Wainuiomata, is significantly affected by urban land-uses within its catchment and has a notably poorer water quality, habitat quality and benthic fauna than the Wainuiomata River. The Black Creek inflow to the Wainuiomata River causes a measurable deterioration in a number of water quality indicators in the River, and modest changes to the benthic flora and fauna. The results of this study indicate that the ecological health of the Wainuiomata River stabilises in the reach downstream of the Black Creek confluence and that there is no further deterioration within the study area".

The NZFFD has no records of fish in Black Creek, but eels are almost certainly present. The values associated with Black Creek are limited by a high level of urban development in the catchment. Nevertheless, Schedule F3 of pNRP identifies the Waiau Wetland at Parkway as a significant natural wetland (Table 3-97). The receiving environment characteristics are summarised in Table 3-98.

Table 3-97: Environmental and cultural values identified for the Hutt Estuary in Schedules of the pNRP

Schedule	Category	Location/value
F3	Significant natural wetlands	Waiau Wetland, which is likely to be a natural wetland

Table 3-98: Black receiving environment characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Black Creek	Medium waterway	Class 2	Class 3	Class 2	Class 1

3.11.2 Summary of Overflow Characteristics

A total of thirteen direct wastewater overflows occur directly to Black Creek (Table 3-99). Monitoring results from 2016 to 2020 and modelled information indicate that nine of these sites are 'Low' volume and 'Low' frequency discharges, while three are 'Medium' volume and frequency, and one overflow is a 'Low' volume and 'Medium' frequency overflow.

Table 3-99: Summary of overflow characteristics, Black Creek

WNO ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
55	Direct	200	Low	2	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022[12]
56	Direct	2,800	**Medium**	4	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
57	Direct	100	Low	1	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
58	Direct	1,600	**Medium**	4	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
59	Direct	400	Low	1	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
60	Direct	800	Medium	3	Medium	Operational	No data
61	Direct	800	**Medium**	4	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022

[12] The Seaview Strategic Wastewater Model System Performance Assessment (March 2022) assumes that completed or committed works are in place and therefor reflects the benefits of those improvements.

WNO ID	Direct/indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
62, 68, 79, 80, 81	Direct	0	Low	0	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
83	Direct	200	Low	3	Medium	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022

3.11.3 Review of overflow monitoring data

Water quality monitoring has been undertaken intermittently between 2009 and 2020 at times when the Wellington Road pump station overflowed to Black Creek. Monitoring normally includes paired samples from Black Creek upstream of the discharge, and at the pump station overflow. At such times Black Creek is normally at high flow and contains significantly elevated faecal indicator bacteria (*E. coli*) and suspended solids concentrations (Table 3-99). Suspended solids concentration in the upstream river at such times are at about the same level as in the discharge, whereas ammonia and *E. coli* are much higher in the discharge than in the river.

River water quality downstream of the overflow can be calculated by a balance on mass loads (Table 3-100). The assumptions made are that the overflow discharge rate is 0.140 m^3/s and the Black Creek discharge is at the 2% exceedance flow of 2 m^3/s. Under such conditions the overflow would cause no change in suspended solids concentrations in the river, a large increase in ammonia, well above the NPS-FM bottom line for ammonia, and a very large increase in faecal indicator bacteria concentrations, also well above the NPS-FM bottom line. Based on median values the overflow would cause an upstream *E. coli* concentration of 10,250 cfu/100ml to increase to 42,000 cfu/100ml. At such times the risk of infection for water contact recreation users would be very high both upstream and downstream of the discharge.

Table 3-100: Summary statistics from intermittent water quality monitoring in Black Creek(upstream) and at the Wellington Road Pump station overflow

Site	Variable	Unit	n	Minimum	Median	95%ile	Maximum	Guideline concentration	
Black Creek upstream of discharge	TSS	g/m^3	70	<6	63.5	341	475	<1000	derived from NIWA DSS https://niwa.co.nz/our-science/freshwater/tools/turbidity/peak
	NH_4-N	g/m^3	65	<0.01	0.100	0.240	0.350	<0.4	NPS-FM (2020)
	E. coli	cfu/100ml	70	200	10,250	79,000	310,000	<1200	NPS-FM (2020)
Wellington Road PS overflow	TSS	g/m^3	68	25	56	200	437	n.a.	-
	NH_4-N	g/m^3	64	<0.01	5.35	32.4	55.9	n.a.	-
	E. coli	cfu/100ml	69	19,000	500,000	2,750,000	7,300,000	n.a.	-
Calculated river concentration downstream of discharge (after full mixing)	TSS	g/m^3	-	7	63	332	472	<1000	derived from NIWA DSS https://niwa.co.nz/our-science/freshwater/tools/turbidity/peak
	NH_4-N	g/m^3	-	0.01	0.44	2.33	3.96	<0.4	NPS-FM (2020)
	E. coli	cfu/100ml	-	1,421	42,052	252,442	763,896	<1200	NPS-FM (2020)

3.11.4 Potential Public Health Effects

'Medium' volume discharges to a medium sized waterway with Class 2 recreational values are assessed as having a 'High' potential magnitude of effect (Effects Score of 4) as shown in Table 3-101.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-102. In this case the frequency of overflow events is in the 'Medium' range and the overall level of adverse effects is 'High'.

Table 3-101: Magnitude of public health effects from overflows to Black Creek

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 4 (High)**, because microbial pathogen indicator contact recreation guidelines may be significantly exceeded
Loss of suitability for fishing	**Effects Score of 4 (High)**, because microbial pathogen indicator contact recreation guidelines may be significantly exceeded
Loss of suitability for harvesting watercress	**Effects Score of 4 (High)**, because watercress can be a hydraulic trap for particulate contaminants.

Table 3-102: Overall level of public health effect in Black Creek

WNO ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level of Public Health Effect
55, 57, 59, 62, 68, 79, 80, 81	Direct	Moderate	Low	Low
56, 58, 60, 61	Direct	**High**	Medium	**High**
83	Direct	Moderate	Medium	Moderate

3.11.5 Potential Ecological Effects

'Medium' volumes discharges to medium sized waterways with Class 3 ecological values are assessed as having 'Low' potential effects on ecological values because of the high degree of background disturbance, as detailed in Table 3-103. In this case, the overall ecological effect is considered to be 'Low'.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-104. In this case the frequency of overflow events is in the 'Medium' range and the overall level of adverse effects is 'Low'.

Table 3-103: Magnitude of ecological effects of overflows to Black Creek

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Behavioural changes in fin fish	**Effects Score of 1 (Very Low),** because of the high degree of background disturbance in these streams.
Increase in nuisance plants	**Effects Score of 1 (Very Low),** because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.

Potential Effect	Magnitude of Ecological Effect
Reduced quantities of fin fish	**Effects Score of 2 (Low),** because of the high degree of background disturbance in these streams.
Growth of sewage fungus/Beggiatoa	**Effects Score of 2 (Low),** because BOD enrichment is unlikely to add to the potential for the growth of these organisms.

Table 3-104: Overall level of ecological effect in Black Creek

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of Ecological Effect
55, 57, 59, 62, 68, 79, 80, 81	Direct	Low	Low	Very Low
56, 58, 60, 61, 83	Direct	**Low**	Medium	**Low**

3.11.6 Potential Cumulative Effects

For Black Creek, cumulative effects are likely because:

- Several direct discharges to the creek occur in close proximity that could potentially have a combined impact.
- The overflow sites include 'Low' and 'Medium' volume discharges.

For a spatially cumulative effect to arise, most of the indirect discharges would need to occur at the same time. This would result in the total volume of wastewater overflows falling within the 'High' volume range and result in 'High' potential public health and ecological effects.

3.11.7 Potential Cultural Effects

Water is considered by tangata whenua to be a taonga and the essential element of life, therefore all natural water bodies have cultural value. Black Creek is assessed as having 'Important' cultural values (Class 2). The overflow discharges range from 'Low' to 'Medium' volume and cultural effects also range from 'Low' to 'Moderate'. Because the overflows occur at a 'Low' to 'Medium' frequency, the overall level of cultural effects is assessed as 'Moderate'.

3.11.8 Potential Aesthetic Effects

Black Creek is easily accessed over much of its length and is assessed as having a 'High' aesthetic value. 'Medium' volume discharges to such an environment have a 'Moderate' potential to affect these values. Because overflows occur with a 'Medium' frequency, the overall level aesthetic effects is assessed as being 'Moderate'.

3.11.9 Summary

The potential magnitude and overall level of effects of wastewater overflows to this receiving environment is summarised in Table 3-105.

Table 3-105: Summary of magnitude and overall level effects for overflow to Black Creek

Value category	Potential magnitude of effect	Level of adverse effect
Public health	High	High/significant
Aquatic ecology	High	High/significant
Cultural	Moderate	Moderate/more than minor
Aesthetic	High	Moderate/more than minor

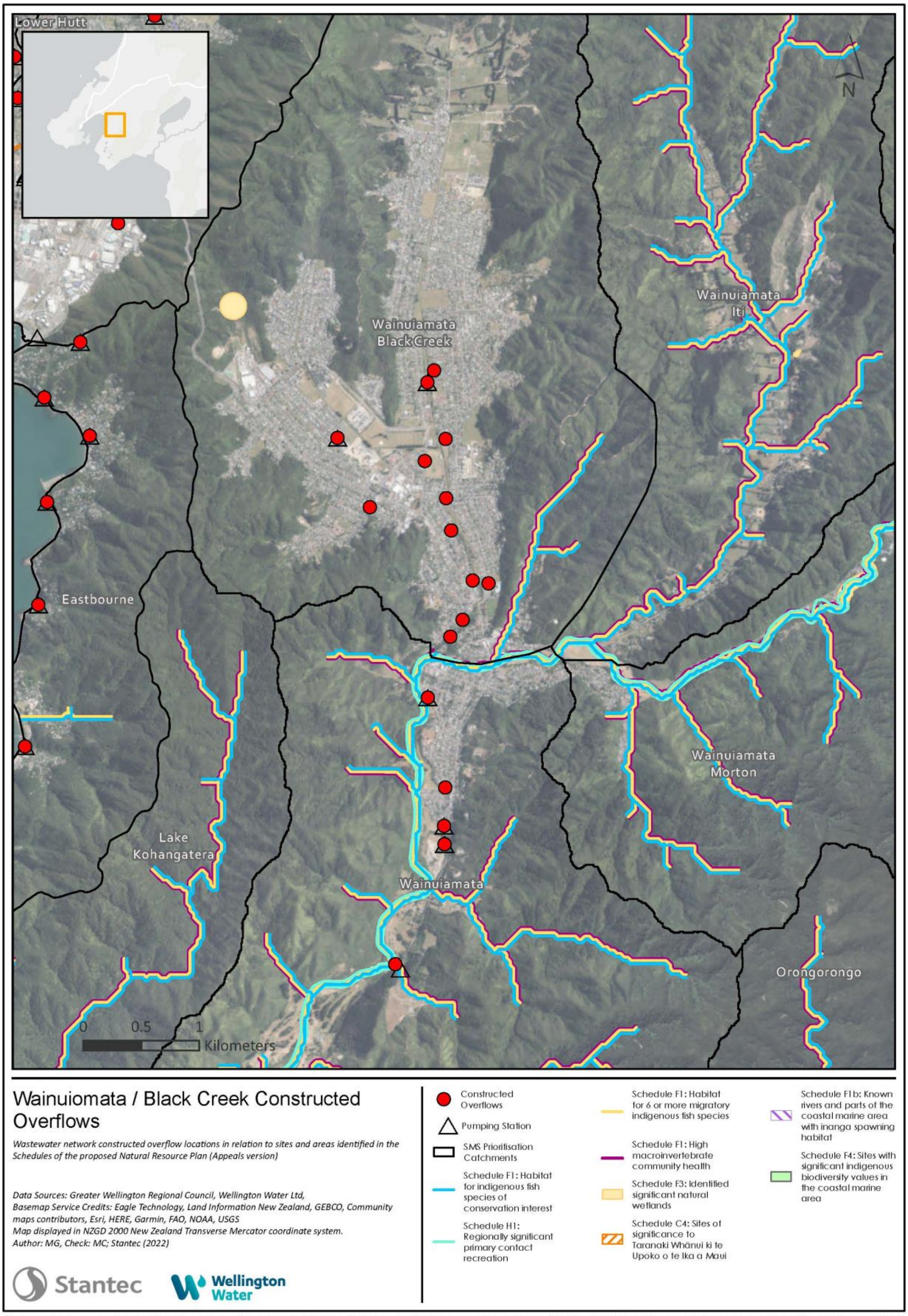

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Figure 3-11: COPs in the Black Creek and Wainuiomata River catchments, and Eastbourne coast

3.12 Wainuiomata River

3.12.1 Description of Receiving Environment

The Wainuiomata River is a 5th order watercourse which originates in a native forest catchment of the south western Rimutaka Ranges and flows southwest for a distance of approximately 38 km to Cook Strait, east of Bearing Head (Figure 3-14). Wainuiomata catchment shares a drainage divide with the Orongorongo catchment where elevations reach 800m in altitude. The catchment has a total area of 134 km^2 and has a hard-sedimentary geology and a cool-wet climate. While the upper catchment is steep the river bed gradient is fairly uniform downstream of the Wainuiomata Water Treatment Plant, dropping 5m per km in the upper part of the Wainuiomata Valley, then flattening to 2m per km near the coast.

The main tributaries of the Wainuiomata River are Skull Gully Creek, Sinclair Creek, George Creek, Wainuiomata-iti Stream, Black Creek and Catchpool Stream. The upper catchment is reserved for water supply and retains 100% indigenous forest cover. Water is taken at two locations by 'run of the river' intake galleries, one on the mainstem of the upper river and the other on Georges Creek. Two decommissioned water supply dams are located on the upper river. Although neither is now used for water supply, the lower dam continues to form a large impoundment, which has been developed as a wetland. Downstream of the water supply area the river enters the long narrow Wainuiomata Valley, bounded by the Rimutaka Ranges to the east and the Eastbourne foothills to the west. Land use includes plantation forestry, low productivity pasture, scrub and with approximately 6% under urban land-cover and an estimated 2% of the catchment is impervious surface (Wellington Water, 2017).

Table 3-106 summarises the results of GWRC *E. coli* monitoring in the Wainuiomata River over the five-year period to March 2020. The results indicate that the upper river at Manuka Track has a low level of faecal contamination, achieving an NPS-FM Attribute State "A", whereas the river at Richard Prouse Park, which is downstream of Wainuiomata-iti Stream but upstream of the confluence with Black Creek, has a higher level of faecal contamination, achieving Attribute State "C". The NPS-FM (2020) narrative for attribute state "C is: "*For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 3%*." The lower river downstream of White Bridge achieves Attribute State "B". Figure 3-12 and 3-13 show box plots on a $\log_{10}$ scale of *E. coli* concentrations by year in the upper and middle river, respectively.

Table 3-106: Summary statistics and NPS-FM Attribute State for *E. coli* (GWRC data 2015-2020); results shaded blue meet NPS-FM attribute state A, green meets attribute state B and yellow meets attribute state C

Site name	N samples	% exceeding 540 cfu/100ml	% exceeding 260 cfu/100m	Median cfu/100m	95th percentile cfu/100ml	NPS-FM Attribute State
Wainuiomata River at Manuka Track	52	0	1	9	64	A
Wainuiomata River at Richard Prouse Park	83	12	18	102	1102	C
Wainuiomata River D/S White Bridge	52	7	18	100	1000	B

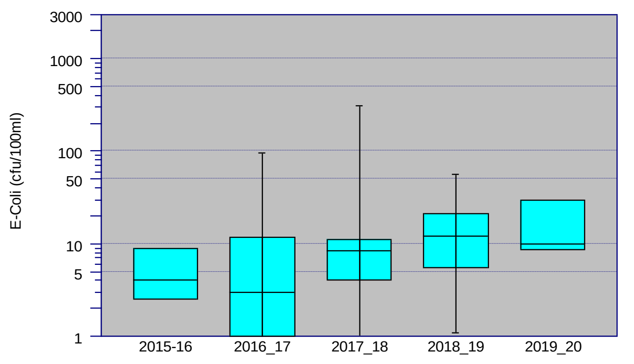

Figure 3-12: Wainuiomata River at Manuka Track

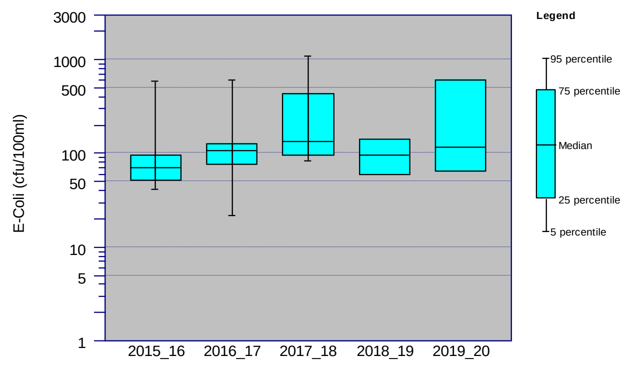

Figure 3-13: Wainuiomata River at Richard Prouse Park

The ecological component of the RWQE program a includes monthly monitoring of periphyton cover and annual monitoring of macroinvertebrate communities at one site on the Wainuiomata River. Periphyton weighted composite cover (WCC) results from monthly sampling over three years are summarised in Table 3-107. pNRP Objective O19 for periphyton cover is not met (marginally) at the White Bridge Site on the lower river.

Table 3-107: Periphyton weighted composite cover (WCC) results for Wainuiomata River 2018/19 to 2020/21

Site name	N samples	Max WCC (%cover)	n ≥ 40% cover	pNRP O19 (no more than 8% of samples ≥40% cover)
Manuka Track	35	13.3	0	Meeting
White Bridge	35	62.3	3	Not meeting

Macroinvertebrate community monitoring results from annual samples taken on years 2016/2017 to 2020/2021 indicate that the community meets the pNRP Objective O19 at the Manuka Track site on the upper river but fails to meet the more stringent objective on the lower river (Table 3-108). These results show a downstream decrease in ecological condition as the river transitions from the forested upper catchment to agricultural and urban land use in the middle and lower catchment.

Table 3-108: Macroinvertebrate community metrics for Wainuiomata River (2016/17 to 2020/21)

Site name	substrate	River class	Significant river	N samples	Taxa richness	%EPT (3-yr median)	MCI (5-yr median)	QMCI (5-yr median)	pNRP O19 – MCI	pNRP O19 – QMCI	Meeting O19
Manuka Track	Hard	2	yes	5	23	64.9	131.8	7.4	≥130	≥6.5	Meeting
White Bridge	Hard	4	no	5	12	41.4	104.8	5.4	≥110	≥5.5	Not meeting

Eleven species of native fish were found in the Wainuiomata catchment between 2000 and 2022 as listed in Table 3-109. Seven of these species are classified as either at risk or threatened (Dunn, et al., 2017).

Brown trout and rainbow are the only introduced sports fish found in the Wainuiomata River. The Wainuiomata River is identified in the pNRP as in important trout fishery and/or spawning river.

Suitable inanga spawning habitat has been confirmed in the lower reaches of the Wainiuomata River (Taylor & Marshall, 2016), however the mouth the Wainuiomata River is often closed to the sea, which could prevent successful spawning on those occasions.

Significant values associated with the Wainuiomata River scheduled in The Natural Resources Plan are summarised in Table 3-110 and categorised for the wastewater network overflow assessment in Table 3-111.

Table 3-109: Records of fish in the Wainuiomata River catchment, 2000 to 2022, NZFFD (Stoffels, 2022)

Species	Conservation status	Middle/lower River (<15km from coast)	Upper River (>15km from coast)
Longfin eel	At risk (declining)	++	++
Shortfin eel	Not threatened	-	++
Inanga	At risk (declining)	-	+
Lamprey	Threatened (nationally vulnerable)	+	+
Koaro	At risk (declining)	-	+
Banded kokopu	Not threatened	-	+
Giant kokopu	At risk (declining)	+	-
Dwarf galaxias	At risk (declining)	++	+++
Redfin bully	Not threatened	+	+
Bluegill bully	At risk (declining)	+	-
Common bully	Not threatened	+	-
Brown trout	Introduced and naturalised	+++	+++
Rainbow trout	Introduced and naturalised	+	+
Koura	Not threatened	+	+
Fish index of biotic integrity (F-IBI)		52	56
pNRP Objective O19 (F-IBI ≥ 38)		Meeting	Meeting

Table 3-110: Environmental and Cultural Values Identified for Wainuiomata River in Schedules of the pNRP

Schedule	Category	Location/value
F1	Rivers and lakes with significant indigenous ecosystems	Wainuiomata River has high macroinvertebrate health, threatened or at river fish habitat, migratory fish habitat, inanga spawning habitat,
F3	Significant natural wetlands	Wainuiomata River Bush A, Curtis Swamp
F4	Indigenous biodiversity	Wainuiomata Estuary
H1	Regionally significant primary contact recreation	Wainuiomata River from headwaters to the CMA
I	Important trout fishery and spawning waters	Wainuiomata River and Catchpool Stream from headwaters to CMA

Table 3-111: Wainuiomata River Receiving Environment Characteristics

Receiving Environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Wainuiomata River	Large waterway	Class 1	Class 1	Class 1	Class 1

3.12.2 Summary of Overflow Characteristics

There are 12 overflows to the Wainuiomata River, 4 of which are direct overflows and 8 indirect (Table 3-112). The direct overflows range from 'Low' volume, 'Low' frequency to 'High' volume, 'Medium' frequency.

Table 3-112: Summary of Overflow Characteristics, Wainuiomata River

Overflow ID	Direct/indirect	Volume (m^3)		Frequency		Status	Data Source
		(m^3)	Range	Number	Range		
63, 66	Direct	0	Low	0	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
64	Direct	17,600	**High**	3	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
65	Direct	-	Low	-	Low	Operational	Wellington Water SCADA 2013-2016
55	Indirect	200	Low	2	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
56	Indirect	2,800	Medium	4	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
57	Indirect	100	Low	1	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
58	Indirect	1,600	**Medium**	4	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
59	Indirect	400	Low	1	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
60	Indirect	800	Low	3	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
61	Indirect	800	Low	4	**Medium**	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
62, 68, 79, 80, 81	Indirect	0	Low	<1	Low	Operational	Seaview Strategic Wastewater Model System Performance Assessment March 2022
83	Indirect	200	Low	3	**Medium**	Operational	Seaview Strategic Wastewater Model System

3.12.1 Review of water quality monitoring data

There is evidence that the Black Creek inflow has at least a localised effect on the water quality of the Wainuiomata River. A 2015 ecological survey of Wainuiomata River found that the Black Creek inflow causes a measurable deterioration in several water quality indicators in the river, and modest changes to benthic flora and fauna. The survey results indicate that the ecological health of the Wainuiomata River stabilises in the reach downstream of the Black Creek confluence" (Cameron 2015).

Table 3-113 summarises the results of HCC water quality sampling at river sites upstream and downstream of the Wainuiomata storm tank. These results are from annual samples that are not timed to coincide with overflow events, i.e., they establish baseline conditions for this reach.

Table 3-113: Summary statistics from water quality monitoring at site upstream and downstream of the Wainuiomata Storm Tank discharge, HCC data includes 22 samples, 2002 to 2015 (from Cameron 2015)

Determinand	*Wainuiomata River Upstream of Wainui Storm Tank*			*Wainuiomata River Downstream of Wainui Storm Tank*			*Guideline Concentration*	
	median	*min*	*max*	*median*	*min*	*max*	Value	Source
pH	7.0	6.3	8.4	7.03	6.4	9.2	7.2 – 7.8	ANZG (2018)
Conductivity (µS/cm)	130	101	200	131	102	151	80%ile <145	ANZG (2018)
TKN (mg/L)	<0.8	<0.8	2.3	<0.8	<0.8	3.0	n.a.	
NO3-N (mg/L)	0.140	0.020	0.360	0.080	0.005	0.370	80%ile <0.170	ANZG (2018)
Ammoniacal N (mg/L)	<0.05	<0.05	0.07	<0.05	<0.05	0.06	max. <0.4	NPS-FM (2020)
DRP (mg/L)	0.011	<0.005	0.02	0.014	0.006	0.032	med. <0.01	NPS-FM (2020)
Faecal coliforms (cfu/100ml)	130	58	4500	96	17	1300	med. <130	NPS-FM (2020)
Chloride (mg/L)	24.2	18.4	27.4	23.3	16.2	27.0	n.a	
As (mg/L)	<0.001	<0.001	0.003	<0.001	<0.001	0.006	<0.024	ANZG (2018)
Cd (mg/L)	<0.0002	<0.0002	0.0007	<0.0002	<0.0002	0.001	<0.0002	ANZG (2018)
Cr (mg/L)	<0.001	<0.001	0.001	<0.001	<0.001	0.002	<0.001	ANZG (2018)
Cu (mg/L)	<0.001	<0.001	0.003	<0.001	<0.001	0.009	<0.0014	ANZG (2018)
Fe (mg/L)	0.200	0.014	0.350	0.200	0.014	0.309	n.a.	
Pb (mg/L)	<0.0005	<0.0005	0.003	<0.0005	<0.0005	0.004	<0.0034	ANZG (2018)
Mn (mg/L)	0.008	0.004	0.017	0.008	0.004	0.016	n.a.	
Ni (mg/L)	<0.0005	<0.0005	0.003	<0.0005	<0.0005	0.003	<0.011	ANZG (2018)
Hg (mg/L)	<0.0005	<0.0005	0.001	<0.0005	<0.0005	<0.0005	<0.0006	ANZG (2018)
Zn (mg/L)	0.005	<0.002	0.067	0.005	<0.002	0.135	<0.008	ANZG (2018)

Water quality monitoring has been undertaken intermittently between 2009 and the present at times when the Wainuiomata Storm Tank overflow was operating. Monitoring normally includes paired samples from Wainuiomata River upstream of the Storm Tank, and at the Storm Tank overflow. During an overflow event Wainuiomata River is normally at high flow and its water quality is characterised by significantly elevated faecal indicator bacteria (*E. coli*) and suspended solids concentration (Table 3-114). Suspended solids concentration in the upstream river at such times are at about the same as in the discharge whereas ammonia and *E. coli* are much higher in the discharge than in the upstream river.

River water quality downstream of the overflow has been calculated by a balance on mass loads in Table 3-113. The assumptions made are that the overflow discharge rate is 0.140 m^3/s and Wainuiomata River is at the 2% exceedance flow of 18 m^3/s. Under such conditions the overflow causes no change in suspended solids concentrations in the river, a slight increase in ammonia and a large increase in faecal indicator bacteria concentrations. TSS and ammonia remain in compliance with guideline values, whereas the E. coli concentration may exceed the NPS-FM bottom line by a large margin. Based on median values the overflow would cause an upstream *E. coli* concentration of 1,200 cfu/100ml to increase to 2,569 cfu/100ml, indicating a high risk of infection for water contact recreation users both upstream and downstream of the discharge.

Table 3-114: Summary statistics from monitoring in Wainuiomata River and at the Storm Tank overflow

Site	Variable	Unit	n	Minimum	Median	Maximum	Guideline concentration	
Wainuiomata River upstream of discharge	TSS	g/m^3	9	14	31	190	<1000	derived from NIWA DSS https://niwa.co.nz/our-science/freshwater/tools/turbidity/peak
	NH_4-N	g/m^3	4	0.01	0.04	0.09	<0.4	NPS-FM (2020)
	E. coli	cfu/100ml	9	300	1,200	12,000	<1200	NPS-FM (2020)
Wainuiomata Storm Tank overflow	TSS	g/m^3	9	11	23	56	n.a.	-
	NH_4-N	g/m^3	4	3.27	4.90	6.37	n.a.	-
	E. coli	cfu/100ml	9	26,000	180,000	850,000	n.a.	-
Calculated river conc. Downstream of discharge (after full mixing)	TSS	g/m^3		14	31	190	<1000	derived from NIWA DSS https://niwa.co.nz/our-science/freshwater/tools/turbidity/peak
	NH_4-N	g/m^3		0.03	0.08	0.14	<0.4	NPS-FM (2020)
	E. coli	cfu/100ml		497	2,569	18,417	<1200	NPS-FM (2020)

The macroinvertebrate communities of Wainuiomata River were examined as part of the 2015 ecological survey (Cameron, 2015). Summary statistics for macroinvertebrate metrics in Table 3-115 show that community health is moderately degraded at sites upstream and downstream of the Storm Tank overflow, but that there is no difference in community composition between the two sites. These results suggest that any impacts associated with occasional Storm Tank overflows are minor and temporary, and recovery is rapid. That conclusion is supported by the relatively minor water quality effects predicted in Table 3-114. Sub-optimal ecological health throughout this reach is attributed to upstream agricultural and urban development in Moores Valley and Wainuiomata township, including frequent wastewater network overflows to Black Creek.

Table 3-115: Summary of macroinvertebrate metrics at sites on the Wainuiomata River upstream and downstream of the Storm Tank discharge

Metric	N	Mean U/S	Mean D/S	Sum of paired difference	t-test p-value	Equivalence test (Time trends software, Jowett 2017)
Number of invertebrates	4	331	354	-22.75	0.339	Weak – inconclusive
Number of taxa	4	18.7	17.7	1.00	0.292	Weak – inconclusive
Number of ETP taxa	4	8.75	8.75	0.00	0.5	Weak – inconclusive
%EPT taxa	4	46.6	49.2	-2.50	0.121	Weak – inconclusive
Number of EPT individuals	4	181.5	169.3	12.25	0.211	Weak – inconclusive
%EPT individuals	4	54.9	48.1	6.87	0.125	Weak – inconclusive
MCI	4	103.6	104.1	-0.39	0.453	No evidence for a difference
QMCI	4	4.335	4.587	-0.251	0.040	Moderate evidence for a practically important increase

3.12.2 Potential Public Health Effects

The Wainuiomata River is assessed as having high (Class 1) recreational values. 'High' volume discharges to a large waterway with Class 1 recreational values are assessed as having a 'Very High' potential effect (Effects Score of 5) as shown in Table 3-116.

The overall level of public health effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-117. Because of the 'High' frequency of overflows to Black Creek and Wainuiomata River the assessed level public health effect in Wainuiomata River is 'Very High'.

Table 3-116: Magnitude of public health effects of overflows to the Wainuiomata River

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 5 (very High),** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for fishing	**Effects Score of 5 (very High),** because microbial pathogen indicator contact recreation guidelines may be significantly exceeded.
Loss of suitability for harvesting watercress	**Effects Score of 5 (very High),** because watercress can be a hydraulic trap for particulate contaminants.

Table 3-117: Overall level of public health effects in Wainuiomata River

WNO ID	Direct/Indirect	Potential Magnitude of Public health Effect	Frequency Range	Level of Public Health Effect
63, 66	Direct	Moderate	Low	Low
64	Direct	**Very High**	Medium	**Very High**
65	Direct	Moderate	Low	Low
55, 57, 59, 68, 79, 80, 81	Indirect	Moderate	Medium	Low
62	Indirect	Low	Low	Very Low
56, 58, 60, 61	Indirect	**Very High**	Medium	**Very High**
83	Indirect	Moderate	Medium	Moderate

3.12.3 Potential Ecological Effects

The Wainuiomata River is assessed as having high (Class 1) ecological values. 'High' volume discharges to large waterways with Class 1 ecological values are assessed as having a range from 'Low' to 'Very High' potential effects on ecological values, as shown Table 3-118. In situations where potential ecological effects range across more than one Effects Score, the overall level of effect is determined by the dominant Effects Score. In this case, the overall ecological effect is assessed as 'Moderate', as the very High (5) Effects Score relates to agricultural use rather than effects on ecological processes.

The overall level of ecological effect is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-119. Because of the 'Moderate' magnitude and 'Medium' frequency of overflows the level of ecological effect for Wainuiomata River is 'Moderate'.

Table 3-118: Magnitude of ecological effects of overflows to Wainuiomata River

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 3 (Moderate**), because of the extent of physical and chemical changes resulting from a wastewater overflow.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, nitrate	**Effects Score of 3 (Moderate),** because toxicant concentrations may increase up to 10-fold above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 3 (Moderate**), because changes in physico-chemical habitat are likely to affect sensitive species.
Behavioural changes in fin fish	**Effects Score of 3 (Moderate),** because there may be changes in physico-chemical habitat suitability.
Increase in nuisance plants	**Effects Score of 2 (Low)**, because of the generally short residence time of elevated nutrient concentrations and other constraints on plant growth.
Reduced quantities of fin fish	**Effects Score of 3 (Moderate)**, because changes in physico- chemical habitat suitability are likely.
Loss of suitability for livestock watering	**Effects Score of 5 (very High)**, because of the potentially high levels of toxicants, organic solids and BOD in the water column.
Loss of suitability for irrigation use	**Effects Score of 5 (very High)**, because of the potentially high levels of toxicants, organic solids and BOD in the water column.
Growth of sewage fungus/Beggiatoa	**Effects Score of 3 (Moderate)**, because BOD enrichment may provide opportunity for the growth of these organisms.

Table 3-119: Overall level of ecological effect in the Wainuiomata River

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Frequency Range	Level of Ecological Effect
63, 66	Direct	Moderate	Low	Low
64	Direct	**Moderate**	Medium	**Moderate**
65	Direct	**Moderate**	Low	Low
55, 57, 59, 68, 79, 80, 81	Indirect	Moderate	Low	Low
62	Indirect	Low	Low	Very Low
56, 58, 60, 61	Indirect	**Moderate**	Medium	**Moderate**
83	Indirect	**Moderate**	Low	Low

3.12.4 Potential Cumulative Effects

For the Wainuiomata River receiving environment cumulative effects are possible because:

- There is moderately high number of overflow points that could potentially influence the water quality of Wainuiomata River (four direct and 13 indirect overflows), although these are spatially well separated.
- One direct discharge of 'High' volume.

For a spatially cumulative effect to arise, most of the direct and indirect discharges would need to occur at the same time. This would result in the total volume of wastewater overflows falling within the 'High' volume range and result in 'Very High' potential public health effects and 'Moderate' ecological effects. This assessment includes 'Medium' and 'High' volume direct discharges which are the dominant contributor to a potential cumulative effect. As these direct discharges have already been assessed in earlier parts of the AEE as having potentially 'High' or 'Very High' potential public health effects individually, the cumulative effect would not result in a different assessment category (it will still be very high).

3.12.5 Potential Cultural Effects

Wainuiomata River is assessed as having 'Important' cultural values (Class 2). The overflow discharges range up to a 'High' volume and cultural effects also range up to 'High'. Because the overflows occur at a 'High' frequency, the overall level of cultural effect is assessed as 'High'.

3.12.6 Potential Aesthetic Effects

Wainuiomata River is easily accessible at many locations and is assessed as having a 'High' aesthetic value. 'High' volume discharges to such an environment have a 'High' potential to affect these values. Because overflows occur with a 'High' frequency, the overall level of aesthetic effects is assessed as 'High'.

3.12.7 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows is summarised in Table 3-120.

Table 3-120: Summary of magnitude and overall level of adverse effect for Wainuiomata River

Value category	Potential magnitude of effect	Level of adverse effect
Public health	Very High	Very High/significant
Aquatic ecology	Moderate	Moderate/more than minor
Cultural	High	High/significant
Aesthetic	High	High/significant

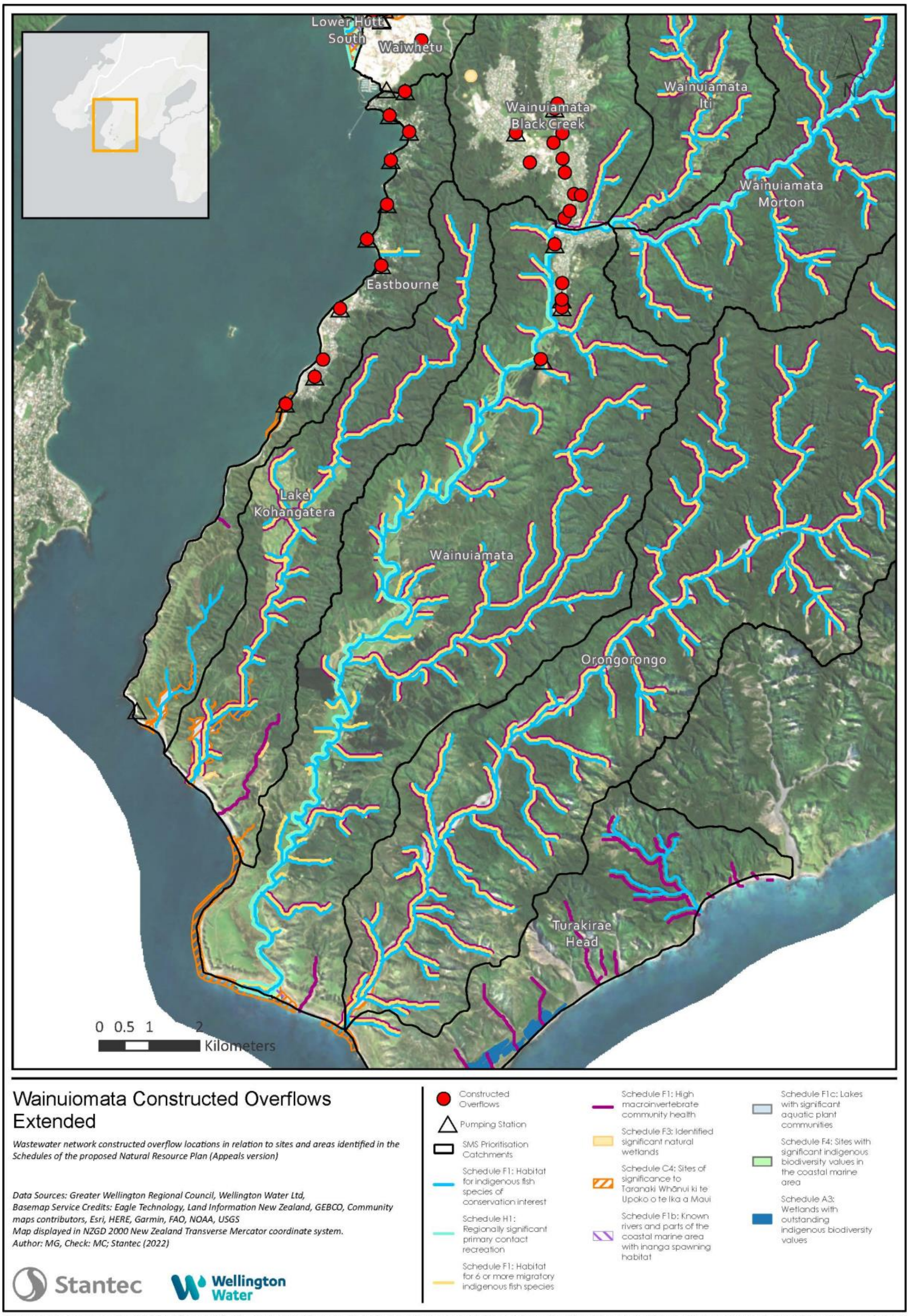

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Figure 3-14: COPs in the Black Creek and Wainuiomata River catchments, extended

3.13 Generic assessment against pNRP Policy P93 criteria

A generic assessment of WNO discharges against pNRP Policy P93 water quality guidelines is provided in Table 3-121 below. The assessment is made by reference to WNO characteristics summarised in Appendix A and nine representative discharge scenarios summarised in Appendix B (low, medium, and high-volume discharges to small, medium, and large waterways). Smaller waterways are more susceptible to adverse impacts from WNO discharges because they provide less dilution for a given discharge volume. In the Hutt/Wainuiomata wastewater network Black Creek and Waiwhetu Stream currently stand out as watercourses most likely not to meet P93 guidelines from time to time.

Table 3-121: Assessment of WNO Discharges against pNRP Policy P93 Water Quality Criteria.

P93: Quality of existing wastewater discharges to rivers. The quality of existing wastewater discharges to rivers shall be assessed in relation to the following water quality guidelines in the receiving water after reasonable mixing:	Assessment of WNO discharges against P93
a) When measured below the discharge point compared to above the discharge point: *i) A decrease in the QMCI of no more that 20%, and* *ii) A decrease in water clarity of no more than:* *1) 20% in River class 1 and in any river identified as having a high macroinvertebrate community health in Schedule F1, or* *2) 30% in any river, and* *iii) A change in temperature of no more than:* *1) 2° C in any river identified as having high macroinvertebrate health in Schedule F1, or* *2) 3° C in any other river, and*	(a)(i) Mechanisms by which WNO discharges might cause a decrease in QMCI scores include nutrient enrichment, dissolved oxygen depletion, and toxicity due to elevated ammonia or nitrate. While nutrient enrichment and oxygen depletion are unlikely in the context of an intermittent short duration WNO discharge occurring during a rainfall event, ammonia/nitrate toxicity is a possible outcome, particularly in the case of frequent medium to high volume discharges to a small or medium sized watercourse. In this context WNO discharges to Black Creek and Waiwhetu Stream very likely contribute to the poor macroinvertebrate community health in those watercourses, potentially resulting in non-compliance with the QMCI criteria. (a)(ii) WNO discharges contain elevated levels of suspended solids. Medium or high-volume discharges have the potential to reduce water clarity in small or medium waterways by more than 30% for the duration of the discharge. WNOs to Black Creek and Waiwhetu Stream very likely do not achieve the water clarity guideline from time to time. (a)(iii) WNO discharges consist partly or mostly of stormwater inflows to the wastewater network and are normally at, or close to, the ambient temperature of receiving waters. The risk of WNO discharges causing more than a 3° C temperature change is low.
b) Consider the extent to which the discharge causes the following to be exceeded: *i) The 7-day mean minimum dissolved oxygen concentration of more than 5 mg/L, and* *ii) The daily minimum dissolved oxygen concentration of no lower than 4 mg/L, and* *iii) Soluble carbonaceous biochemical oxygen demand (BOD_5) of no more than 2 mg/L at flows less than flood flows, and*	(b)(i) and (b)(ii) Oxygen Depletion is unlikely in the context of an intermittent short duration WNO discharge occurring during a rainfall event. (b)(iii) A WNO discharge to a small or medium sized watercourse has the potential to cause a soluble carbonaceous BOD_5 concentration greater than 2mg/L in receiving waters at flows less than flood flows, but such events are intermittent and of short duration. (b)(iv) A WNO discharge to a small or medium sized watercourse has the potential to cause a POM concentration greater than 5 mg/L in receiving waters, but stream flows are unlikely to be less than median at such times.

iv) Particulate organic matter (POM) of no more than 5 mg/L at flows less than median, and *v) Nitrate toxicity of no more than:* *1) 1mg/L (annual median) and 1.5mg/L (annual 95th percentile from monthly samples in outstanding water bodies (Schedule A1), River class 1 and any river identified as having high macroinvertebrate community health in Schedule F1, or* *2) 2.4mg/L (annual median) and 3.5mg/L (annual 95th percentile from monthly samples) in any other river, and* *vi) Ammonia toxicity (at pH 8 and 20° C) or no more than:* *1) 0.03mg/L (annual median) and 0.05mg/L (annual maximum from monthly samples) in outstanding water bodies (Schedule A1), River class 1 and any river identified as having high macroinvertebrate community health in Schedule F1, or* *2) 0.24mg/L (annual median) and 0.4mg/L (annual 95th percentile from monthly samples) in any other river*	(b)(v) A high frequency of WNO discharges to a small or medium sized watercourse has the potential to cause an exceedance of the annual median and/or 95th percentile nitrate-N values, based on monthly sampling. Conversely, a low frequency of discharge (<2 per year) is unlikely to cause non-compliance with (b)(v) criteria. (b)(vi) A high frequency of WNO discharges to a small or medium sized watercourse has the potential to cause an exceedance of the annual median and/or 95th percentile ammonia values, based on monthly sampling. Conversely, a low frequency of discharge (<2 per year) is unlikely to cause non-compliance.

Notes:

1. Collins Stream, a tributary of the Mangaroa River, is the only Class 1 river that is potentially affected by an overflow from the Hutt/Wainuiomata wastewater network.

2. No rivers with high macroinvertebrate community health are potentially affected by an overflow from the Hutt/Wainuiomata wastewater networks

4. RANKING OF COP SITES AND SUBCATCHMENTS

Previous sections have described WNO receiving environment values (recreational, ecological, cultural, and aesthetic values), and scored from 1 (very low) to 5 (very high) the potential magnitude and overall level of adverse effects of WNO's on those values.

Table 4-1, below, ranks the COP sites by their potential to cause adverse effects within the receiving environment. A single ranking score is achieved by combining scores for the four receiving environment value to give the following 'level of effect' rankings: Very Low (4-7), Low (8-10), Moderate (11-13), High (14-16) and Very High (17-20). COPs assessed with a moderate or greater level of adverse effects are listed in Table 4-1; a complete list of all COPs is provided in Appendix A

Of the 83 COPs, 73 were assessed as a having a very low or low level of adverse effect. The remaining ten COPs were assessed as having a moderate or high level of adverse effect and should therefore be prioritised for a management response. Four of these sites are in the Black Creek Catchment, three are in the Hutt River catchment, and one each is in the Wainuiomata, Waiwhetu, and Mangaroa catchments. The locations of these ten WNOs are shown in Figure 4-1. Further details are provided below.

Table 4-1: COPs assessed as having a Moderate or High level of adverse effects

Overflow ID	Volume Range	Frequency Range	Facility Name	Receiving Environment (RE)	Level of Public Health Effect	Level Ecological Effect	Level of Cultural Effect	Level of Aesthetic Effect	Combined Score	Level of adverse effect
56	Medium	High	Main Road	Black Creek	5	3	4	4	16	High / significant
8	Low	High	Rossiter Ave	Waiwhetu Stream	3	3	4	4	14	
18	High	Medium	Barber Grove	Hutt River	5	3	3	3	14	
28	High	Medium	Silverstream S Tank	Hutt River	5	3	3	3	14	
64	High	Medium	Wainuiomata S Tank	Wainuiomata River	5	3	3	3	14	
68	Medium	Medium	Wainuiomata Landfill PS COP	Wainuiomata River	5	3	3	3	14	
40	Medium	Medium	Te Marua	Mangaroa River	4	3	3	3	13	Moderate / more than minor
58	Medium	Medium	23 Rowe Parade	Black Creek	4	2	3	3	12	
61	Medium	Medium	50 Fraser Street	Black Creek	3	2	3	3	11	
83	Low	Medium	21 Stanley St COP	Black Creek	3	2	3	3	11	

It's important to note that a high ranking in this table does not mean that the overflow will be one of the first ones to be resolved under this application. As set out in section 4 of Part 1 of this application, Wellington Water is proposing to apply a sub-catchment approach to reducing overflows.

Figure 4-1: Location of COPs assessed with a 'moderate' or greater level of adverse effect on receiving waters

4.1 Black Creek

One site on Black Creek (WNO 56) operates at 'High' frequency and 'Medium' volume and assessed as likely to cause a significant adverse effect. A further three sites on Black Creek (WNOs 58, 61 and 63) are likely to cause a more than minor adverse effect. These results are consistent with the findings of the Wainuiomata System Performance Assessment report (HAL 2020) which concluded that there are significant issues with inflow and infiltration in the Wainuiomata wastewater network, with multiple locations not meeting the target level of service. The report identified the Wise Park pumping stations as a system constraint, functioning as a throttle, and recommended that an option analysis be conducted to address the issues identified for the Wainuiomata Network.

The CIA prepared as part of this application has identified the four WNO's listed above as a high priority for remediation and notes that these discharges require urgent attention in all aspects from a cultural perspective.

The limited water quality and ecological monitoring data available for Black Creek indicates significantly degraded water quality and ecological health within Black Creek, and secondary effects likely further downstream in the Wainuiomata River. The conclusion of this assessment is that a management response is required.

4.2 Wainuiomata River

An engineered overflow point at the Wainuiomata Storm Tank (WNO 64) operates on average four times each year at an average annual volume of nearly 17,000m^3. The adverse effects of the Wainuiomata Storm Tank discharge are assessed in Table 4-1as significant.

The limited water quality and ecological monitoring data available for Wainuiomata River at the Storm Tank indicate that overflow events can have a marked effect on faecal indicator bacteria concentrations in the river, with associated adverse effects on recreational, cultural, and aesthetic values.

Overall, the weight of evidence is that the adverse effects of the Wainuiomata Storm Tank discharge on Wainuiomata River are more than minor and that those effects require a management response.

4.3 Waiwhetū Stream

An engineered overflow point at Rossiter Avenue (WNO 8) beside Waiwhetū Stream has historically operated at a 'High' frequency during rain events, on average 12 overflow events per year. The overflows were caused by an undersized sewer main on Rossiter Avenue including an aerial crossing of Waiwhetū Stream. Following discussions with the local community group, Wellington Water replaced the aerial stream crossing with an inverted siphon underneath the streambed. Since the replacement works in June 2018, overflow frequency has not exceeded two events per year. The reduced overflow frequency has likely improved stream water quality and reduced the risks to the aquatic ecology of Waiwhetū Stream (see Figure 4-2).

Overall, the weight of evidence is that the adverse effects of the Rossiter Avenue overflows to Waiwhetū Stream are likely to have been significant until completion of replacement work in June 2018. Since that time, the level of adverse effect is assessed as less than minor.

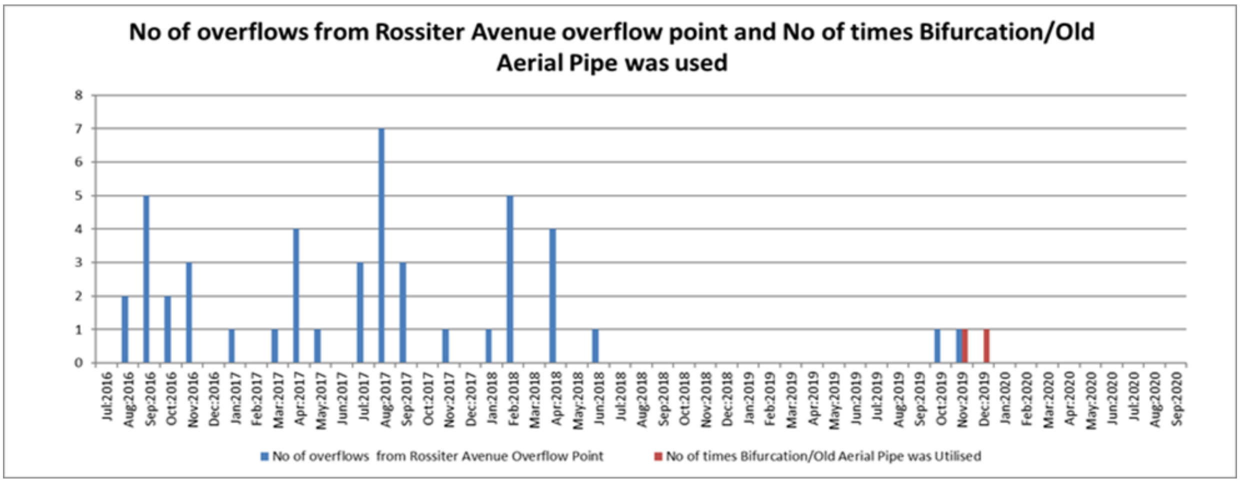

Figure 4-2: Number of overflow events from Rossiter Avenue to Waiwhetu Stream

4.4 Hutt River

An engineered overflow point at the Silverstream Storm Tank to the Hutt River (WNO 28) in the Lower Hutt North Sub-catchment, operates between two and ten times each year at an average annual volume of over 32,200m^3 which is by far the greatest overflow volume from the Hutt/Wainuiomata wastewater network. The potential adverse effects of Silverstream Storm Tank discharge are assessed as significant, especially in relation to the public health risk in the Hutt River, and in areas downstream including Hutt Estuary and potentially extending as far as Petone Beach and the Eastern Bays.

An examination of the water quality monitoring data available for the River at the Storm Tank (Section 3.6) indicates that overflow events can have a marked effect on faecal indicator bacteria concentrations in the river, indicating that the risk to public health during and immediately after an overflow event is potentially significant. That level of risk is mitigated to some extent by the low likelihood of recreation use of the Hutt River when in flood. However, the possible microbiological contamination of shellfish in the Hutt Estuary and Wellington Harbour may be sustained well beyond the duration of a single flood event. Associated adverse effects on cultural and aesthetic values are assessed as more than minor. The predicted effects on receiving water concentrations of TSS and ammonia are minor because of poor background water quality at times of flood and high level of dilution available. There is no evidence of any ecology impacts.

Further downstream, adjacent to the Hutt Estuary, WNO 18 in the Lower Hutt South sub-catchment at the Barber Grove pump station operates between zero and five time each year, at an average annual volume of 3,400 m^3. This overflow is of smaller volume and lower frequency than the Silverstream Storm Tank overflow but nevertheless does contribute to reduced water quality in the Hutt Estuary. The CIA identifies the discharge to the Hutt River from the Silverstream Storage tank as having the greatest possibility of cultural impacts, making it a high priority for remediation. The CIA considers the smaller discharge to Hutt River at Barber Grover to be a lesser priority.

Overall, the weight of evidence is that the adverse effects of discharges from the Silverstream Storm Tank and Barber Grove Pump Station on Hutt River are significant, primarily because of the potential public health risk in downstream recreational areas.

4.5 Mangaroa River

Modelling output indicates that an COP (WNO 40) from a pump station at 20 Maymorn Road has the potential to overflow with a 'Medium' volume and frequency, indicating that the potential for more than minor adverse effects. It is noted that there are no historical operational records of an issue at this site, raising the possibility that the modelled overflow is fictitious. Further information is required.

5. CONCLUSIONS

This AEE Part 2 Report has been prepared to support Wellington Water's application to consent overflows from the wastewater network in the Hutt Valley and Wainuiomata catchments. It should be read in conjunction with the AEE Part 1 Report which sets out the framework to manage the process of applying and implementing the global resource consents required for network discharges.

The assessment of wastewater overflows from networks in the Hutt Valley and Wainuiomata has identified six COPs which have the potential to cause a High (significant) level of adverse effect in the receiving environment, and a further four overflow points likely to cause a Moderate (more than minor) level of adverse effect. As six of these ten sites discharge into Black Creek in Wainuiomata, a clear conclusion of this assessment is that the wastewater network in urban Wainuiomata should be prioritised for improvement works.

The application proposes to resolve these adverse effects through the Wastewater Network Overflow Strategic Reduction Plan (Strategic Reduction Plan and the Wastewater Network Overflow Sub-catchment Reduction Plans (Sub-catchment Reduction Plans), as detailed in Sections 4 and 5 of the Part 1 Report. The Collaborative Committee is a key component for managing the wastewater network overflows through the catchment wide consents. It fulfils the following three important functions:

1) Sets containment standards for wet weather overflows, and documents the process followed in setting the containment standards.
2) Recommends for consideration in the LTP process a wastewater network overflow reduction programme and priorities to progressively achieve the overflow objectives and containment standards over the term of the consent.
3) Reports on the progress towards achieving the overflow objectives and containment standards, particularly the effectiveness of the network improvement works in reducing the frequency of wet weather overflows.

The purpose of the Strategic and Sub-catchment Reduction Plans is to develop, implement and monitor mechanisms that will ensure the wastewater network overflow objectives and the containment standards are achieved over the term of the consent (35 years). The methodology for setting the containment standards is described in Section 4 of the Part 1 Report and set out in the consent conditions.

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APPENDICES

Appendix A Summary of COPs, Receiving Water Values, and Level of Adverse Effects

Table A1: Summary of overflow sites and level of adverse effect

WNO ID	Asset ID	Volume Range	Frequency Range	Overflow Code	Overflow Type	Facility Name	Ref X	Ref Y	Receiving Environment (RE)	RE Type	Level of Public Health Effect		Level of Ecological Effect		Level of Cultural Effect		Level of Aesthetic Effect		Combined Level of adverse effect	
											Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
56	710037R00896	Medium	High	2	Network	Main Road	1763554	5429679	Black Creek	Medium waterway	Very high	5	Moderate	3	High	4	High	4	16	High / significant
8	841001P00218	Low	High	1	Pumping Station	Rossiter Ave	1761687	5435589	Waiwhetu Stream	Medium waterway	Moderate	3	Moderate	3	High	4	High	4	14	
18	841001P00206	High	Medium	1	Pumping Station	Barber Grove	1759609	5434187	Hutt River	Large waterway	Very High	5	Moderate	3	Moderate	3	Moderate	3	14	
28	890019R00186	High	Medium	2	Network	Silverstream S Tank	1767377	5442848	Hutt River	Large waterway	Very high	5	Moderate	3	Moderate	3	Moderate	3	14	
64	841001P00232	High	Medium	1	Pumping Station	Wainuiomata S Tank	1763312	5427409	Wainuiomata River	Large waterway	Very high	5	Moderate	3	Moderate	3	Moderate	3	14	
68	260011P00137	Medium	Medium	1	Pumping Station	Wainuiomata Landfill PS EOP	1762887.4	5426376.2	Hutt River	Large Waterway	Very High	5	Moderate	3	Moderate	3	Moderate	3	14	
40	SPS_20MAYMORN	Medium	Medium	1	Pumping Station	Te Marua	1778879	5448506	Mangaroa River	Large waterway	High	4	Moderate	3	Moderate	3	Moderate	3	13	Moderate / more than minor
58	710002R00936	Medium	Medium	2	Network	23 Rowe Parade	1763362	5429195	Black Creek	Medium waterway	High	4	Low	2	Moderate	3	Moderate	3	12	
61	710013R00855	Medium	Medium	2	Network	50 Fraser Street	1762669	5430310	Black Creek	Medium waterway	Moderate	3	Low	2	Moderate	3	Moderate	3	11	
83	Home	Low	Medium	2	Network	21 Stanley St EOP	1763467.6	5429340.6	Black Creek	Medium Waterway	Moderate	3	Low	2	Moderate	3	Moderate	3	11	
11	841001P00224	Medium	Medium	2	Network	Hinemoa St	1760817	5434539	Waiwhetu Stream	Medium waterway	Low	2	Low	2	Moderate	3	Moderate	3	10	Low / minor
69	890001R00548	Medium	Low	2	Network	155 Hutt Park Rd EOP	1760501.2	5432754.1	Hutt River	Large Waterway	High	4	Low	2	Low	2	Low	2	10	
2	741001P00227	Low	Low	1	Pumping Station	Maungaraki Rd	1756862	5436591	Korokoro Stream	Moderate waterway	Low	2	Moderate	3	Low	2	Low	2	9	
3	741001P00195	Low	Low	1	Pumping Station	Titiromoana Rd	1756227	5436087	Korokoro Stream	Moderate waterway	Low	2	Moderate	3	Low	2	Low	2	9	
41	SPS_191PLATEAU	Low	Low	1	Pumping Station	Te Marua	1780064	5448417	Collins Stream	Moderate waterway	Low	2	Moderate	3	Low	2	Low	2	9	
42	SPS_63PLATEAU	Low	Low	1	Pumping Station	Te Marua	1779135	5448316	Collins Stream	Moderate waterway	Low	2	Moderate	3	Low	2	Low	2	9	
43	SPS_245PLATEAU	Low	Low	1	Pumping Station	Te Marua	1780280	5448258	Collins Stream	Moderate waterway	Low	2	Moderate	3	Low	2	Low	2	9	
44	SPS_1176MAYMORN	Low	Low	1	Pumping Station	Maymorn	1778987	5447056	unnamed stream	Medium waterway	Low	2	Moderate	3	Low	2	Low	2	9	
67	710090R00543_PS	Low	Medium	1	Pumping Station	Seaview Rd PS EOP	1759540	5433348.1	Waiwhetu Stream	Medium Waterway	Very Low	1	Low	2	Moderate	3	Moderate	3	9	
1	741001P00192	Low	Low	1	Pumping Station	Kereru	1757069	5437017	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
15	710002R00176	Low	Low	2	Network	St Albans Grove	1759205	5435536	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
19	SPS_AKATARAWA	Low	Low	1	Pumping Station	Birchville Aka	1776246	5449139	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
20	SPS_49BRIDGE	Low	Low	1	Pumping Station	Birchville_49Bridge	1775935	5448734	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
21	SPS_621MAINRDNT	Low	Low	1	Pumping Station	Te Marua	1778606	5448681	Mangaroa River	Large waterway	Very low	1	Moderate	3	Low	2	Low	2	8	
22	SPS_65BRIDGE	Low	Low	1	Pumping Station	Birchville_65Bridge	1775777	5448600	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
23	SPS_BLACKBEECH	Low	Low	1	Pumping Station	Birchville_BlackBeech	1775838	5448541	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
24	MAIN 0542SM	Low	Low	1	Pumping Station	Birchville_Main	1777956	5448480	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
25	SPS_8WEIR	Low	Low	1	Pumping Station	Silverstream	1769837	5443356	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
26	SPS_39RIVERSTONE	Low	Low	1	Pumping Station	Riverstone Drive	1771525	5446489	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
27	SPS_17OPAL	Low	Low	1	Pumping Station	Timberlea	1776985	5447979	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
29	741001P00204	Low	Low	1	Pumping Station	Mary Huse Gr	1765475	5441235	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
30	741001P00193	Low	Low	1	Pumping Station	George Gee Dv	1757197	5435780	unnamed stream	Small waterway	Very low	1	Moderate	3	Low	2	Low	2	8	
31	741001P00191	Low	Low	1	Pumping Station	Victoria St	1758508	5435486	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
33	841001P00205	Low	Low	1	Pumping Station	Ava	1758960	5435003	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
36	SPS_TOTARAPARK	Low	Low	2	Network	Totara Park	1774710	5446587	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
38	SPS_RIVER123	Low	Low	1	Pumping Station	Riverstone Drive_0	1771977	5446508	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
39	SPS_RIVER123/1	Low	Low	1	Pumping Station	Riverstone Drive_1	1771974	5446509	Hutt River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	

WNO ID	Asset ID	Volume Range	Frequency Range	Overflow Code	Overflow Type	Facility Name	Ref X	Ref Y	Receiving Environment (RE)	RE Type	Level of Public Health Effect		Level of Ecological Effect		Level of Cultural Effect		Level of Aesthetic Effect		Combined Level of adverse effect	
											Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
60	710035R00909	Low	Low	2	Network	Mohan St	1763691	5429654	Black Creek	Medium waterway	Moderate	3	Very low	1	Low	2	Low	2	8	
62	841001P00231	Low	Low	1	Pumping Station	Wise Park	1762390	5430906	Black Creek	Medium waterway	Moderate	3	Very Low	1	Low	2	Low	2	8	
63	741001P002031	Low	Low	1	Pumping Station	Wood St	1763168	5428671	Wainuiomata River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
65	710001R00920	Low	Low	2	Network	Parenga	1763318	5427897	Wainuiomata River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
66	741001P00202	Low	Low	1	Pumping Station	Ngaturi Gv	1763308	5427567	Wainuiomata River	Large waterway	Low	2	Low	2	Low	2	Low	2	8	
72	710026R00756	Low	Low	2	Network	8 Kerkwall Dr EOP	1764133.1	5436018.4	Hutt River	Large Waterway	Low	2	Low	2	Low	2	Low	2	8	
74	841001P00209	Low	Low	2	Network	Espl East EOP	1758058.9	5433938	Hutt River	Large Waterway	Low	2	Low	2	Low	2	Low	2	8	
75	260035P00233	Low	Low	2	Network	Silverstream Landfill EOP	1767393.7	5441639.2	Hutt River	Large Waterway	Low	2	Low	2	Low	2	Low	2	8	
77	710053R01108	Low	Low	1	Network	Point Arthur PS EOP	1757785.5	5425482.1	Hutt River	Large Waterway	Low	2	Low	2	Low	2	Low	2	8	
14	841001P00213	Low	Low	1	Pumping Station	Marine Parade	1758712	5433616	Petone Beach	Beach	Low	2	Very low	1	Low	2	Low	2	7	Very Low / less than minor
32	841001P00210	Low	Low	1	Pumping Station	Esplanade West	1756472	5434505	Petone Beach	Beach	Low	2	Very low	1	Low	2	Low	2	7	
34	841001P00216	Low	Low	1	Pumping Station	Regent St	1757398	5434949	Petone Beach	Beach	Low	2	Very low	1	Low	2	Low	2	7	
35	841001P00208	Low	Low	1	Pumping Station	Esplanade Central	1757103	5434271	Petone Beach	Beach	Low	2	Very low	1	Low	2	Low	2	7	
37	WEIR0008SM	Low	Low	1	Pumping Station	Weir Grove	1769840	5443348	Hulls Creek	Medium waterway	Low	2	Very low	1	Low	2	Low	2	7	
45	741001P00200	Low	Low	1	Pumping Station	Sorrento Bay	1759865	5431253	Sorrento Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
46	741001P00196	Low	Low	1	Pumping Station	Howard Rd	1760175	5431731	Sorrento Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
47	741001P00197	Low	Low	1	Pumping Station	Cheviot Rd	1760257	5430924	Lowry Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
48	741001P00198	Low	Low	1	Pumping Station	Mahina Bay	1759814	5429470	Mahina Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
49	841001P00225	Low	Low	1	Pumping Station	York Bay	1759889	5430354	York Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
50	841001P00207	Low	Low	1	Pumping Station	Days Bay	1759415	5428776	Days Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
51	741001P00201	Low	Low	1	Pumping Station	Williams Park	1759699	5428250	Days Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
52	841001P00217	Low	Low	1	Pumping Station	Rona Bay	1758876	5427389	Rona Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
53	841001P00215	Low	Low	1	Pumping Station	Pukatea Street	1758368	5426022	Robinson Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
54	710013R01087	Low	Low	2	Network	Pukatea Street	1758534	5426368	Robinson Bay	Beach	Low	2	Very low	1	Low	2	Low	2	7	
55	710002R00866	Low	Low	2	Network	15 Heath Street	1763321	5430897	Black Creek	Medium waterway	Low	2	Very Low	1	Low	2	Low	2	7	
57	710011R00874	Low	Low	2	Network	38 Hyde Street	1763369	5430110	Black Creek	Medium waterway	Low	2	Very Low	1	Low	2	Low	2	7	
59	841001P00230	Low	Low	1	Pumping Station	Wellington Rd	1763164	5431384	Black Creek	Medium waterway	Low	2	Very Low	1	Low	2	Low	2	7	
71	710010R00121	Low	Low	2	Pumping Station	62 Wakefield St EOP	1758717.5	5435138.5	Black Creek	Medium Waterway	Low	2	Very Low	1	Low	2	Low	2	7	
73	810013R00546	Low	Low	2	Network	Bell Rd Sth EOP	1760436.7	5433501.9	Black Creek	Medium Waterway	Low	2	Very Low	1	Low	2	Low	2	7	
78	710016R00377	Low	Low	2	Network	Seddon St EOP	1763552.9	5436603.8	Petone Beach	Beach	Low	2	Very Low	1	Low	2	Low	2	7	
79	710003R00847	Low	Low	2	Pumping Station	20 Dunn St EOP	1763221.2	5431486.7	Robinson Bay	Beach	Low	2	Very Low	1	Low	2	Low	2	7	
80	710015R00853	Low	Low	2	Network	29 Fitzherbert EOP	1763142.4	5430706.7	Robinson Bay	Beach	Low	2	Very Low	1	Low	2	Low	2	7	
81	710003R00828	Low	Low	2	Network	15 Best St EOP	1763325.6	5430387.7	Black Creek	Medium Waterway	Low	2	Very Low	1	Low	2	Low	2	7	
82	DUMMYNODE_16	Low	Low	2	Network	Pt Arthur to MOP	1757792.9	5425476.9	Black Creek	Medium Waterway	Low	2	Very Low	1	Low	2	Low	2	7	
4	741001P00189	Low	Low	1	Pumping Station	Randwick Rd	1759636	5433831	Awamutu Stream	Small waterway	Very low	1	Very low	1	Low	2	Low	2	6	
5	710088R00543	Low	Low	2	Network	WW MH Chamber	1759757	5433369	Waiwhetu Stream	Medium waterway	Very low	1	Very low	1	Low	2	Low	2	6	
6	710025R00412	Low	High	2	Network	3 Rossiter Avenue	1761871	5435480	Waiwhetu Stream	Medium waterway	Very low	1	Very low	1	Low	2	Low	2	6	
7	841001P00212	Low	Low	2	Network	Malone Road	1761193	5435041	Waiwhetu Stream	Medium waterway	Very low	1	Very low	1	Low	2	Low	2	6	
9	741001P00288	Low	Low	1	Pumping Station	Laura Fergusson	1762506	5436561	Waiwhetu Stream	Medium waterway	Very low	1	Very low	1	Low	2	Low	2	6	
10	741001P00188	Low	Low	1	Pumping Station	Massey Ave	1760060	5435063	Awamutu Stream	Small waterway	Very low	1	Very low	1	Low	2	Low	2	6	
12	841001P00222	Low	Low	1	Pumping Station	Wilford St	1760617	5435554	Awamutu Stream	Small waterway	Very low	1	Very low	1	Low	2	Low	2	6	

WNO ID	Asset ID	Volume Range	Frequency Range	Overflow Code	Overflow Type	Facility Name	Ref X	Ref Y	Receiving Environment (RE)	RE Type	Level of Public Health Effect		Level of Ecological Effect		Level of Cultural Effect		Level of Aesthetic Effect		Combined Level of adverse effect	
											Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
13	SPS_ASHINGTON	Low	Low	1	Pumping Station	Ashington Rd	1768356	5442767	Hulls Creek	Medium waterway	Very low	1	Very low	1	Low	2	Low	2	6	
16	710011R01018	Low	Low	2	Network	Jackson Street	1759010	5433864	Te Mome Stream	Estuary	Very low	1	Very low	1	Low	2	Low	2	6	
17	841001P00220	Low	Low	1	Pumping Station	Tennyson Street	1758517	5434584	Te Mome Stream	Estuary	Very low	1	Very low	1	Low	2	Low	2	6	
70	710064R00311	Low	Low	2	Network	2 Park Gr EOP	1760503.8	5438674.7	Waiwhetu Stream	Medium Waterway	Very Low	1	Very Low	1	Low	2	Low	2	6	
76	810006R00185	Low	Low	2	Network	Melling Station EOP	1759759.3	5436846.8	Waiwhetu Stream	Medium Waterway	Very Low	1	Very Low	1	Low	2	Low	2	6	

Appendix B Wastewater and Calculated Receiving Water Quality for Low, Medium, and High-Volume Discharges

Wastewater Constituents	Discharge characteristics					Discharge quality			We weather stream flow			Stream water quality					
	Overflow	Volume	Duration	Duration	Discharge	Conc.	load	mass load	Small	Medium	Large	Background wet weather	Small waterway	Medium waterway	Large water way	Freshwater Guideline concentration	
	Type	m^3	hours	seconds	m^3/s	g/m^3	g/sec	kg	m^3/s	m^3/s	m^3/s	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	Source
TSS	Low	100	1	3600	0.08	300	24	159	0.5	5	50	100	128	103	100	1000	Derived from NIWA DSS https://niwa.co.nz/our-
	Med	3000	6	21600	0.14	300	41.7	1593	0.5	5	50	100	143	105	101		
	High	10000	16	57600	0.17	300	52.1	4248	0.5	5	50	140	181	145	141		
scBOD5	Low	100	1	3600	0.03	220	6.1	165	0.5	5	50	1	13	2	1.1	2	MfE (1992)
	Med	3000	6	21600	0.14	220	30.6	1650	0.5	5	50	1	49	7	1.6		
	High	10000	16	57600	0.17	220	38.2	4400	0.5	5	50	1	57	8	1.8		
NH4-N	Low	100	1	3600	0.03	26	0.7	14	0.5	5	50	0.1	1.5	0.2	0.1	0.4	NPS-FM (2020
	Med	3000	6	21600	0.14	26	3.6	141	0.5	5	50	0.1	5.7	0.8	0.2		
	High	10000	16	57600	0.17	26	4.5	376	0.5	5	50	0.1	6.8	1.0	0.2		
TN	Low	100	1	3600	0.03	40	1.1	23	0.5	5	50	2	4.0	2.2	2.0	3.5	NPS-FM (2020
	Med	3000	6	21600	0.14	40	5.6	234	0.5	5	50	2	10.3	3.0	2.1		
	High	10000	16	57600	0.17	40	6.9	624	0.5	5	50	2	11.8	3.3	2.1		
TP	Low	100	1	3600	0.03	5.1	0.1	2.4	0.5	5	50	0.1	0.4	0.1	0.1	NA	
	Med	3000	6	21600	0.14	5.1	0.7	24	0.5	5	50	0.1	1.2	0.2	0.1		
	High	10000	16	57600	0.17	5.1	0.9	63	0.5	5	50	0.1	1.4	0.3	0.1		
Cu	Low	100	1	3600	0.03	0.096	0.0	0	0.5	5	50	0.002	0.007	0.003	0.002	0.0025	ANZG (2018) 8
	Med	3000	6	21600	0.14	0.096	0.0	0	0.5	5	50	0.002	0.022	0.005	0.002		
	High	10000	16	57600	0.17	0.096	0.0	1	0.5	5	50	0.002	0.026	0.005	0.002		
Zn	Low	100	1	3600	0.03	0.31	0.0	0.1	0.5	5	50	0.015	0.031	0.017	0.015	0.031	ANZG (2018) 8
	Med	3000	6	21600	0.14	0.31	0.0	1	0.5	5	50	0.015	0.079	0.023	0.016		
	High	10000	16	57600	0.17	0.31	0.1	2	0.5	5	50	0.015	0.091	0.025	0.016		
Norovirus	Low	200	1	3600	0.06	1.00E+09	6.E+07	3.00E+08	0.5	5	50	0	100000000	10989011	1109878	NA	
(n/m^3)	Med	3000	6	21600	0.14	1.00E+09	1.E+08	3.00E+09	0.5	5	50	0	217391304	27027027	2770083		
	High	10000	16	57600	0.17	1.00E+09	2.E+08	8.00E+09	0.5	5	50	0	257731959	33557047	3460208		
E. coli	Low	100	1	3600	0.03	4.00E+06	1.E+05	1.20E+06	0.5	5	50	130	210649	22229	2351	1200	NPS-FM (2020
	Med	3000	6	21600	0.14	4.00E+06	6.E+05	1.20E+06	0.5	5	50	130	869667	108235	11210		
	High	10000	16	57600	0.17	4.00E+06	7.E+05	1.20E+06	0.5	5	50	130	1031024	134354	13970		

Appendix C Summary of Uncontrolled Overflow Points

Note: These uncontrolled overflows are considered fictitious spills (Type 5) until further investigations are completed to verify overflow locations.

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710015R00377	24.0	200	5
710002R00378	18.2	160	5
710017R00484	17.0	500	5
710012R00377	15.2	360	5
710010R00252	13.0	300	5
710015R00484	12.6	310	5
710001R00434	11.6	690	5
710011R00552	10.5	720	5
710010R00216	10.1	390	5
710024R00169	9.6	220	5
710013R00552	9.3	350	5
710008R00255	9.1	590	5
710084R00165	9.1	160	5
710004R00117	9.0	610	5
710161R00216	9.0	320	5
710004R00612	8.2	270	5
710005R00648	7.9	210	5
710008R00652	6.7	170	5
710008R00139	6.7	420	5
710001R00765	6.5	380	5
710020R00767	6.4	160	5
710023R00456	6.3	80	5
PHMS 0008SM	6.3	3,240	5
710008R00856	6.2	150	5
710026R00456	6.1	230	5
710002R00771	6.1	330	5
710018R00765	6.1	300	5
710001R00184	6.0	260	5
710009R00652	5.8	90	5
750011R00455	5.5	220	5
710015R00182	5.5	130	5
710013R00291	5.4	330	5
710124R00173	5.2	70	5
710017R00100	5.1	50	5
750071R00543	5.0	90	5
750074R00543	4.9	200	5
710017R00171	4.7	480	5
710012R00252	4.7	170	5
DELLE0015SM	4.7	760	5
710020R00361	4.6	530	5
710014R00546	4.5	150	5
710001R00102	4.3	430	5
710152R00216	4.3	70	5
710011R00913	4.3	210	5
710122R01102	4.2	60	5
710008R00142	4.1	120	5
710005R00446	4.0	230	5
710006R00627	4.0	80	5
PHMS 0009SM	3.9	550	5
710017R00589	3.9	110	5
710010R00909	3.9	120	5
710006R00170	3.9	50	5
710063R00173	3.8	160	5
710002R00433	3.8	270	5
710004R00144	3.8	140	5
710015R01000	3.8	90	5
710017R00579	3.8	70	5
710008R00117	3.7	50	5
710022R00456	3.7	30	5
710009R00443	3.6	60	5
710077R00216	3.6	40	5
710001R00931	3.6	160	5
710074R00216	3.5	60	5
PHMS 004SM	3.4	260	5
710064R01164	3.4	60	5
710010R00949	3.4	280	5
710014R00353	3.3	210	5
PALME0006SM	3.3	360	5
710005R00786	3.2	320	5
710011R00445	3.2	140	5
710008R00307	3.2	40	5
710001R00955	3.2	80	5
710003R00674	3.1	320	5
710014R00436	3.1	40	5
710001R00440	3.1	60	5
710005R00260	3.1	50	5
710031R00378	3.1	40	5
710010R00454	3.0	150	5
710011R00580	3.0	20	5
710017R00252	3.0	30	5
710008R00580	3.0	20	5
710002R00949	3.0	220	5
710012R00534	2.9	260	5
710013R00681	2.9	370	5
710009R00628	2.9	130	5
710019R00146	2.9	120	5
XXXX000631	2.9	20	5
710014R00949	2.9	130	5
750088R00959	2.9	280	5
710005R00142	2.8	110	5
760011R00679	2.8	880	5
710007R00109	2.8	50	5
710011R00909	2.8	80	5
710051R00656	2.7	40	5
710059R00173	2.7	30	5
710055R00378	2.7	10	5
710013R00436	2.7	10	5
710001R01158	2.7	270	5
710032R00666	2.7	520	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710012R00737	2.7	40	5
710056R00551	2.7	740	5
710018R00411	2.7	70	5
710019R00955	2.7	140	5
CASSI0006SM	2.6	220	5
710006R00433	2.6	100	5
XXXX000611	2.6	370	5
710063R00216	2.6	60	5
710003R00740	2.6	70	5
710024R00921	2.6	90	5
CASSI0007SM	2.5	120	5
710139R00165	2.5	40	5
710016R00291	2.5	40	5
710013R00913	2.5	10	5
710020R00955	2.5	100	5
710059R00666	2.5	60	5
710001R00771	2.4	60	5
710009R00139	2.4	30	5
MAYMO0004SM	2.3	40	5
710028R00896	2.3	130	5
710082R00173	2.2	20	5
710027R00967	2.2	30	5
710004R00260	2.2	10	5
710119R01102	2.1	10	5
710031R01102	2.1	10	5
XXXX000486	2.1	30	5
710003R00730	2.1	340	5
710003R00102	2.1	20	5
710004R00306	2.0	150	5
710013R00772	2.0	40	5
MAYMO0037SM	1.9	90	5
710021R00456	1.9	0	5
710010R00302	1.9	10	5
710058R01164	1.9	40	5
710032R00630	1.9	30	5
710002R00109	1.9	20	5
FIELD0002SM/3	1.8	420	5
710010R00679	1.8	30	5
710002R00628	1.8	10	5
710011R00456	1.8	10	5
710008R00552	1.8	40	5
710034R00630	1.8	20	5
710001R00377	1.8	20	5
HERET0048SM	1.8	30	5
710106R00216	1.8	90	5
810004R00186	1.7	170	5
SUTHE0015SM/1	1.7	30	5
710006R00580	1.7	10	5
710009R00404	1.7	50	5
710003R00185	1.7	50	5
710029R00100	1.7	10	5
PINEH0015SM	1.7	240	5
710094R00173	1.6	30	5
XXXX000584	1.6	20	5
710006R00117	1.6		5
710005R00420	1.6	30	5
710039R00400	1.6	10	5
710018R00295	1.6	20	5
710029R00896	1.6	30	5
710001R00365	1.6	10	5
TCDB 0014SM	1.5	60	5
710028R00169	1.5	10	5
710018R00524	1.5	80	5
710015R01074	1.5	40	5
710004R00139	1.5	10	5
710024R00554	1.5	20	5
710012R00633	1.5	50	5
710004R00171	1.4	20	5
710004R00387	1.4	70	5
710004R00393	1.4	60	5
710005R00119	1.4	20	5
710003R00420	1.4	30	5
710003R00913	1.4	20	5
710013R00494	1.4	20	5
710022R00765	1.4	10	5
710021R00765	1.4		5
710002R00391	1.3	70	5
710001R00622	1.3	30	5
710029R00377	1.3	80	5
710029R00391	1.3	10	5
710002R00435	1.3	10	5
710001R00104	1.3	30	5
710011R00888	1.3	60	5
750001R00102	1.3	10	5
710016R01000	1.3	10	5
XXXX000201	1.3	30	5
710050R00967	1.3		5
XXXX000533	1.2	40	5
710001R00908	1.2	70	5
710129R00216	1.2	10	5
710001R00141	1.2	10	5
710011R00372	1.2	10	5
710008R00443	12	0	5
710003R00493	1.2	10	5
710022R00404	1.2	20	5
710162R00216	1.2	10	5
710006R00176	1.1	50	5
XXXX000570	1.1	10	5
710140R00216	1.1	60	5
710150R00216	1.1	40	5
710004R00396	1.1	100	5
710018R00218	1.1	40	5
710006R00387	1.1	60	5
710023R00234	1.1	30	5
710002R00448	11	0	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710075R00216	1.1	10	5
710020R00410	1.1	30	5
710007R00908	1.1	20	5
710001R00915	1.1	10	5
710005R00143	1.1	10	5
4638	10	0	5
KIRTO0001SN	10	0	5
710009R00181	1.0	30	5
710031R00921	1.0	10	5
710103R00959	1.0	50	5
710010R00652	1.0	10	5
710006R00102	1	0	5
710003R00478	1.0	20	5
Home2	1.0	20	5
710021R00955	1	0	5
710020R00146	1.0	10	5
710026R00967	1	0	5
710030R00959	0.9	10	5
710009R00353	0.9	0	5
710010R00445	0.9	10	5
710006R00827	0.9	10	5
710007R00260	0.9	0	5
710064R00410	0.9	10	5
XXXX000186	0.9	20	5
710101R00414	0.9	20	5
710007R00295	0.9	10	5
710011R00503	0.9	20	5
710001R00865	0.9	10	5
710048R01102	0.9	10	5
710001R00924	0.9	10	5
710003R00109	0.9	0	5
710006R00302	0.9	0	5
710003R00872	0.8	20	5
710003R00844	0.8	10	5
710006R00234	0.8	40	5
GRANV0050SM/1	0.8	90	5
XXXX000493	0.8	0	5
710007R00112	0.8	10	5
810015R00410	0.8	80	5
710022R00378	0.8	10	5
FERGU0354SM	0.8	0	5
710001R01060	0.8	10	5
710001R00393	0.8	10	5
710004R00443	0.8	0	5
710018R00261	0.8	10	5
710004R01383	0.8	0	5
710003R00949	0.8	0	5
710031R00186	0.8	10	5
710066R00216	0.8	10	5
750021R00377	0.8	10	5
710006R00420	0.8	10	5
710012R00261	0.8	10	5
710135R00216	0.7	20	5
710006R00454	0.7	30	5
XXXX000641	0.7	130	5
810003R00353	0.7	50	5
XXXX000630	0.7	200	5
710002R00389	0.7	20	5
710008R00937	0.7	10	5
810001R00377	0.7	50	5
710001R00648	0.7	0	5
710026R00378	0.7	10	5
710006R01030	0.7	30	5
710002R00384	0.7	20	5
710011R00551	0.7	10	5
710016R00960	0.7	10	5
710010R00960	0.7	10	5
710001R00504	0.7	30	5
710014R00366	0.7	0	5
710019R00185	0.7	10	5
710004R00855	0.7	10	5
710005R00631	0.7	0	5
710001R00870	0.7	0	5
710098R00959	0.7	0	5
710001R00381	0.7	0	5
710073R00959	0.7	10	5
710002R00119	0.7	0	5
710028R00959	0.6	0	5
710007R00450	0.6	0	5
710041R00967	0.6	0	5
710004R00388	0.6	0	5
810003R00624	0.6	30	5
710009R00434	0.6	10	5
710004R00379	0.6	0	5
810001R00624	0.6	10	5
710004R00366	0.6	0	5
710007R00635	0.6	0	5
710005R00379	0.6	0	5
STREA0001SM	0.6	0	5
710055R00366	0.6	0	5
710002R00365	0.6	0	5
710003R00365	0.6	0	5
710011R00845	0.6	0	5
710013R00633	0.6	0	5
710013R00949	0.6	0	5
710015R00960	0.6	0	5
710029R00216	0.6	10	5
710004R00493	0.6	0	5
710071R00226	0.5	0	5
750054R00173	0.5	0	5
710040R00543	0.5	90	5
710098R00548	0.5	140	5
710083R00357	0.5	10	5
710030R00391	0.5	0	5
710027R00378	0.5	0	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710018R00388	0.5	0	5
710003R00255	0.5	0	5
710001R00857	0.5	0	5
710009R01140	0.5	0	5
710125R00357	0.5	0	5
710007R00125	0.5	0	5
710001R00449	0.5	0	5
710009R00760	0.5	0	5
710006R00241	0.5	0	5
710050R00468	0.5	0	5
710050R00234	0.5	0	5
710010R00868	0.5	0	5
710002R00379	0.5	0	5
710022R00186	0.5	0	5
710044R00186	0.5	0	5
710002R00653	0.5	0	5
710020R01074	0.5	0	5
710005R00923	0.5	0	5
710006R00621	0.5	0	5
710010R00820	0.5	0	5
710027R00959	0.5	0	5
710008R00582	0.5	0	5
710016R00260	0.5	0	5
710004R00400	0.5	0	5
710001R00262	0.4	10	5
710002R00262	0.4	0	5
710078R00225	0.4	0	5
710018R00551	0.4	0	5
710028R00598	0.4	0	5
710018R01116	0.4	0	5
710004R00434	0.4	0	5
WHIRI0007SM	0.4	20	5
710004R00935	0.4		5
710030R00554	0.4	0	5
710034R00121	0.4	10	5
SUTHE0001SM/1	0.4	0	5
710001R00442	0.4	0	5
710016R00455	0.4	0	5
710004R00142	0.4	0	5
710052R00468	0.4	10	5
XXXX000326	0.4	0	5
710019R00366	0.4	0	5
710009R00260	0.4	0	5
710200R00216	0.4	0	5
710002R00447	0.4	0	5
710014R00255	0.4	0	5
HERET0044SM/1	0.4	10	5
710004R00551	0.4	0	5
710024R01102	0.4	0	5
710008R00434	0.4	0	5
710001R00103	0.4	0	5
710001R00840	0.4	0	5
710002R00438	0.4	0	5
710008R00430	0.4	0	5
710012R00139	0.4	0	5
710013R00104	0.4	0	5
710018R00546	0.4	0	5
710060R00666	0.4	0	5
XXXX000571	0.4	0	5
710050R00378	0.4	0	5
710039R01186	0.4	0	5
710007R00173	0.3	0	5
710010R00902	0.3	0	5
710009R00902	0.3	0	5
ALEXA0001SM	0.3	10	5
710029R00921	0.3	0	5
710146R00216	0.3	0	5
FREYB0003SM	0.3	0	5
710046R00388	0.3	0	5
710032R00218	0.3	0	5
810002R00624	0.3	0	5
710017R00180	0.3	0	5
XXXX000576	0.3	0	5
710045R00125	0.3	0	5
710036R00180	0.3	10	5
710004R00844	0.3	0	5
710005R00844	0.3	0	5
710018R00403	0.3	0	5
XXXX000548	0.3	0	5
710008R00260	0.3	0	5
710002R00393	0.3	0	5
710003R00119	0.3	0	5
710029R00169	0.3	0	5
710006R00599	0.3	0	5
710005R00387	0.3	0	5
710024R00378	0.3	0	5
710003R00908	0.3	0	5
710001R00636	0.3	0	5
710010R00456	0.3	0	5
710052R00216	0.3	0	5
710013R00261	0.3	0	5
710028R00388	0.3	0	5
710025R00835	0.3	0	5
710114R01102	0.3	0	5
710025R00146	0.3	0	5
710042R01102	0.3	0	5
710004R00636	0.3	0	5
710010R00633	0.3	0	5
710013R01668	0.3	0	5
710004R00298	0.3	0	5
710010R00291	0.3	0	5
710019R00371	0.3	0	5
710021R00371	0.3	0	5
710053R00376	0.3	0	5
710062R00216	0.3	0	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710014R01074	0.3	0	5
710017R00366	0.3	0	5
710022R00391	0.3	0	5
710006R00908	0.3	0	5
710063R00186	0.3	0	5
710006R00432	0.3	0	5
710001R00889	0.3	0	5
710001R00959	0.3	0	5
710002R00868	0.3	0	5
710004R00420	0.3	0	5
710005R00863	0.3	0	5
710008R01158	0.3	0	5
710011R00949	0.3	0	5
710019R00666	0.3	0	5
710027R00909	0.3	0	5
710030R00388	0.3	0	5
710006R00612	0.3	0	5
710009R00291	0.3	0	5
710023R00216	0.3	0	5
710028R00370	0.3	0	5
710038R00400	0.3	0	5
XXXX000590	0.2	0	5
AKATA0166SM	0.2	0	5
710001R01005	0.2	0	5
710019R00262	0.2	0	5
750008R00171	0.2	0	5
710006R01270	0.2	0	5
810018R00410	0.2	0	5
710023R00262	0.2	0	5
710003R00598	0.2	0	5
710019R00234	0.2	0	5
710001R00598	0.2	0	5
710006R00221	0.2	0	5
XXXX000017	0.2	0	5
710007R00101	0.2	0	5
710001R00376	0.2	0	5
710002R00307	0.2	0	5
710005R00612	0.2	0	5
710008R00252	0.2	0	5
PLATE0035SM	0.2	0	5
710082R00234	0.2	0	5
710024R00236	0.2	0	5
710012R00551	0.2	0	5
710021R00767	0.2	0	5
710020R00456	0.2	0	5
710003R00400	0.2	0	5
710002R00921	0.2	0	5
710002R00272	0.2	0	5
710080R00367	0.2	0	5
710002R00831	0.2	0	5
710005R00382	0.2	0	5
BLUEB0008SM	0.2	0	5
710007R00969	0.2	0	5
710001R01044	0.2	0	5
710002R00104	0.2	0	5
710125R00367	0.2	0	5
710024R01074	0.2	0	5
710042R00173	0.2	0	5
710001R00140	0.2	0	5
710001R00438	0.2	0	5
710001R00862	0.2	0	5
710005R00921	0.2	0	5
710007R00420	0.2	0	5
710008R01062	0.2	0	5
710009R00420	0.2	0	5
710009R01062	0.2	0	5
710018R00410	0.2	0	5
710019R00100	0.2	0	5
710062R00959	0.2	0	5
KILN0047SM	0.2	10	5
710001R00612	0.2	0	5
710006R00297	0.2	0	5
710168R00216	0.2	0	5
710196R00216	0.2	0	5
ALEXA0002SM	0.1	10	5
710009R01043	0.1	0	5
710035R00921	0.1	0	5
710020R00234	0.1	0	5
710008R00453	0.1	0	5
710006R00888	0.1	0	5
710005R00943	0.1	0	5
710014R00554	0.1	0	5
710010R00139	0.1	0	5
710012R00546	0.1	0	5
710019R00260	0.1	0	5
RIVER0023SM/2	0.1	0	5
710034R00185	0.1	0	5
710125R00311	0.1	0	5
XXXX000565	0.1	0	5
710019R00370	0.1	0	5
710003R01114	0.1	0	5
710121R00173	0.1	0	5
ALEXA0003SM	0.1	10	5
FERGU0406SM	0.1	0	5
710029R00236	0.1	0	5
710005R00453	0.1	0	5
710002R00931	0.1	0	5
710025R00955	0.1	0	5
710008R00295	0.1	0	5
710008R00382	0.1	0	5
XXXX000213	0.1	0	5
710018R00552	0.1	0	5
710089R00173	0.1	0	5
710005R00598	0.1	0	5
710001R00744	0.1	0	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710007R00598	0.1	0	5
MAYMO1176SM/4	0.1	0	5
710003R00762	0.1	0	5
710034R00762	0.1	0	5
SPEAR0028SM	0.1	0	5
XXXX000376	0.1	0	5
SPEAR0042SM	0.1	0	5
710005R01405	0.1	0	5
710005R00353	0.1	0	5
710043R00959	0.1	0	5
710116R00959	0.1	0	5
710143R01186	0.1	0	5
FERGU0148SM	0.1	0	5
HERET0044SM/3	0.1	0	5
710003R00382	0.1	0	5
FERGU0348SM	0.1	0	5
FIELD0002SM/1	0.1	0	5
FIELD0008SM	0.1	0	5
PINEH0009SM/1	0.1	10	5
WHITE0016SM	0.1	0	5
710042R00600	0.1	0	5
710115R00165	0.1	0	5
710133R00216	-	-	5
710042R00246	-	-	5
710006R00902	-	-	5
710003R00967	-	-	5
710005R00952	-	-	5
710208R00216	-	-	5
710001R00454	-	-	5
710009R00967	-	-	5
710038R00188	-	-	5
710047R00225	-	-	5
710017R00182	-	-	5
710045R00376	-	-	5
710034R00173	-	-	5
710096R00225	-	-	5
MONTG0081SM	-	-	5
FERGU1158SM	-	-	5
TCDB 0013SM	-	-	5
MONTG0068SM	-	-	5
ALEXA0004SM	-	-	5
KILN0003SM/1	-	-	5
RIVER0025SM/2	-	-	5
KIRTO0011SM	-	-	5
710007R00902	-	-	5
710008R00902	-	-	5
BIRKI0003SM	-	-	5
710006R00628	-	-	5
710002R00332	-	-	5
710005R00339	-	-	5
XXXX000476	-	-	5
RIVER0025SM/3	-	-	5
XXXX000636	-	-	5
BRENT0030SM	-	-	5
710002R00626	-	-	5
710209R00216	-	-	5
710002R00252	-	-	5
710003R00384	-	-	5
710161R00173	-	-	5
710017R00921	-	-	5
710120R00173	-	-	5
710002R01052	-	-	5
GEORG0013SM	-	-	5
710005R00104	-	-	5
GRANV0050SM	-	-	5
KIRTO0009SM	-	-	5
XXXX000618	-	-	5
890005R00685_avalve	-	-	5
810012R00685	-	-	5
810014R00685	-	-	5
KIRTO0002SM	-	-	5
710001R00288	-	-	5
890005R00685	-	-	5
710005R00628	-	-	5
710058R01108	-	-	5
710001R00585	-	-	5
710033R00218	-	-	5
710034R00186	-	-	5
710006R00355	-	-	5
710026R00221	-	-	5
710029R00221	-	-	5
710003R00758	-	-	5
KIRTO0001SM	-	-	5
XXXX000619	-	-	5
710162R00173	-	-	5
710012R00259	-	-	5
890002R00685	-	-	5
710015R00361	-	-	5
810002R00327	-	-	5
710021R00772	-	-	5
710119R00311	-	-	5
MONTG0046SM	-	-	5
710080R00126	-	-	5
710023R00370	-	-	5
PALME0013SM	-	-	5
710007R01103	-	-	5
710101R01108	-	-	5
710100R01108	-	-	5
GOODS0004SM	-	-	5
710163R00173	-	-	5
810001R00335	-	-	5
710010R00309	-	-	5
810002R00583	-	-	5
710033R00345	-	-	5
GOODS0018SM	-	-	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710014R00186	-	-	5
710021R00361	-	-	5
PARK0004SM	-	-	5
710001R01114	-	-	5
710068R00345	-	-	5
810001R00281	-	-	5
710008R01123	-	-	5
710009R01087	-	-	5
710102R01108	-	-	5
710103R01108	-	-	5
710157R00173	-	-	5
710001R00520	-	-	5
710028R01102	-	-	5
710036R01164	-	-	5
TMP0001SM	-	-	5
710012R01060	-	-	5
710010R01060	-	-	5
710004R00599	-	-	5
710086R01102	-	-	5
810002R00335	-	-	5
890003R00685	-	-	5
TURON0030SM	-	-	5
710003R00232	-	-	5
710023R00309	-	-	5
710079R00126	-	-	5
710123R00311	-	-	5
FERGU0802SM	-	-	5
710001R00240	-	-	5
710001R01109	-	-	5
710011R00579	-	-	5
710029R00345	-	-	5
710031R00345	-	-	5
710053R00234	-	-	5
710156R00173	-	-	5
810001R00338	-	-	5
810003R01066	-	-	5
810006R01066	-	-	5
TAWAI0010SM	-	-	5
710029R00355	-	-	5
710160R00311	-	-	5
710003R01419	-	-	5
710011R00590	-	-	5
710015R00185	-	-	5
710020R00226	-	-	5
710026R00236	-	-	5
710026R01186	-	-	5
710028R00287	-	-	5
710030R00221	-	-	5
710031R00185	-	-	5
710031R00468	-	-	5
710046R01102	-	-	5
710050R00656	-	-	5
710062R00767	-	-	5
710074R00225	-	-	5
710104R00225	-	-	5
710113R00216	-	-	5
810001R00355	-	-	5
810007R00186	-	-	5
710005R01103	-	-	5
810004R00355	-	-	5
BLENH0016SM	-	-	5
710001R00284	-	-	5
710004R00284	-	-	5
710005R00332	-	-	5
710005R00681	-	-	5
710009R00453	-	-	5
710013R00395	-	-	5
710014R00361	-	-	5
710016R00433	-	-	5
710016R00551	-	-	5
710019R00361	-	-	5
710021R00185	-	-	5
710021R00600	-	-	5
710026R00218	-	-	5
710028R00378	-	-	5
710047R01057	-	-	5
710050R01057	-	-	5
710052R01057	-	-	5
710054R00345	-	-	5
710084R01102	-	-	5
710102R00414	-	-	5
710118R00311	-	-	5
710120R00226	-	-	5
710125R00226	-	-	5
710156R00311	-	-	5
810001R00336	-	-	5
PLATE0010SM	-	-	5
XXXX000245	-	-	5
XXXX000566	-	-	5
820005R00685	-	-	5
710003R00994	-	-	5
710004R00440	-	-	5
710004R00596	-	-	5
710005R00165	-	-	5
710005R00721	-	-	5
710007R00440	-	-	5
710013R00361	-	-	5
710014R00105	-	-	5
710015R00146	-	-	5
710018R00146	-	-	5
710024R00355	-	-	5
710025R00590	-	-	5
710025R01186	-	-	5
710028R00600	-	-	5
710047R00125	-	-	5

Node ID	Frequency (spills/yr)	Volume (m3/yr)	Overflow Type
710048R00165	-	-	5
710067R00225	-	-	5
770001R00784	-	-	5
BRENT0018SM	-	-	5
BRENT0022SM	-	-	5
CALIF0208SM	-	-	5
FERGU0808SM	-	-	5
GEMST0081SM	-	-	5
GEMST0087SM	-	-	5
GOODS0036SM	-	-	5
HIKUR0055SM	-	-	5
MCPAR0020SM	-	-	5
MERTO0026SM	-	-	5
MERTO0063SM	-	-	5
MOONS0066SM	-	-	5
MOONS0066SM/1	-	-	5
OAK0003SM	-	-	5
PARK0008SM	-	-	5
710017R00930	-	-	5
710003R00881	-	-	5
710010R00930	-	-	5
710012R00930	-	-	5
841001P00231	-	-	5
710011R00930	-	-	5
810034R01186	-	-	5
XXXX001002	-	-	5
810039R01186	-	-	5
710018R00554	-	-	5
XXXX000024	-	-	5
710095R01102	-	-	5