Wellington Water

WET WEATHER OVERFLOWS FROM WELLINGTON WASTEWATER NETWORKS:

Assessment of Environmental Effects

PART 2 REPORT

May 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
UOP	Uncontrolled Overflow Point
USGS	United States Geological Survey
WNO Reduction Plan	Wastewater Network Overflow Reduction Plan
WNO Response Plan	Wastewater Network Overflow Response Plan
WNO	Wastewater network overflow
WOMP	Wastewater Overflow Monitoring Plan
WNORP	Wastewater Network Overflow Response Plan
WWTP	Wastewater Treatment Plant
WWL	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 Limited's (WWL) application to consent wet weather overflows from the wastewater network in the Wellington and Karori 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 and sub-catchments 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 has been used to prepare AEE's for the Hutt, Wainuiomata and Porirua, wastewater networks.
Section 3	Provides an assessment of effects of wet weather overflow discharges to various receiving environments within the Wellington (Moa Point) and Karori (Western) WWTP 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 WNOs, receiving water values, and level of adverse effects
Appendix B	Predicted 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 Wellington and Karori wastewater network and catchments.

2.1 Characterisation of wastewater overflows

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, objectionable mixture of dissolved and suspended solids, containing human wastes with the potential for disease transmission. Municipal wastewater contains faeces and urine as well as the water from baths, showers, domestic waste disposal machines, basins, dishwashers and washing machines. Wastewater 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.

For Wellington City the trade waste component is typically around 8.5% of the entire wastewater flows to the two WWTPs. The largest trade waste input is from the Taylor Preston Abattoir which contributes approximately 4.5% of the Moa Point WWTP volume. The Taylor Preston wastewater is pre-treated by a dissolved air floatation process which reduces concentrations of solids, oils, and greases. The remainder of the trade waste input is from landfill leachate, breweries, supermarkets, restaurants/cafes, ground water discharge from construction sites and several industrial sites like aluminium manufacturing, powder coating etc.

Wastewater flows to the Moa Point and Western WWTP's are characterised in Table 2-1. The quality of untreated wastewater is determined from daily samples collected over 5 years from August 2017 and August 2022 (n = 1815). Faecal coliform and enteric virus values are from a generic characterisation of wastewater quality of influent to New Zealand WWTPs.

Table 2-1: Wastewater flows to Moa Point and Western WWTPs and untreated wastewater average quality (90th percentile values are shown in brackets)

Aspect	Moa Point WWTP	Western WWTP
Residential population	177,304 residents	13,930 residents
Average daily flow	76,100 m^3/day or 884 L/s	4,791 m^3/day or 56 L/s
Peak wet weather flow	4,093 L/s	230 L/s
BOD_5	239 g/m^3 (350 g/m^3)	201 g/m^3 (370 g/m^3)
Total suspended solids (TSS)	398 g/m^3 (617 g/m^3)	302 g/m^3 (594 g/m^3)
Total Nitrogen (n = 17)	36 g/m^3 (46 g/m^3)	37 g/m^3 (46 g/m^3)
Ammoniacal Nitrogen (n = 17)	22 g/m^3 (28 g/m^3)	24 g/m^3 (30 g/m^3)
Total Phosphorus (n = 17)	5.1 g/m^3 (6.5 g/m^3)	4.6 g/m^3 (5.8 g/m^3)
Faecal coliform bacteria	10^6 to 10^7 cfu per 100mL	10^6 to 10^7 cfu per 100mL
Enteric viruses	10^3 to 10^4 per 100mL	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) represents overflow discharge quality using the 90th percentile concentration of a range of constituents measured in influent to Watercare's Mangere Wastewater Treatment Plant

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 Wellington assessment. Table 2-2 indicates that contaminant concentrations in influent to Mangere WWTP are mostly higher than those received at the Moa Point and Western WWTPs, except for TSS, making this a particularly conservative approach.

Table 2-2: Wastewater overflow discharge quality adopted for this assessment based on 90th percentile concentrations in influent to Mangere WWTP (from NIWA 2013)

Constituent	90th Percentile Concentration		
	Mangere WWTP	Moa Point WWTP	Western WWTP
Total suspended solids (g/m^3)	531	617	594
BOD_5 (g/m^3)	550	350	370
Total ammonia nitrogen (g/m^3)	47	28	30
Total nitrogen (g/m^3)	78	46	46
Total phosphorus (g/m^3)	7.9	6.5	5.8
Sulphide (g/m^3)	5	No data	No data
Copper (g/m^3)	0.096	No data	No data
Zinc (g/m^3)	0.31	No data	No data
Norovirus (n per L)	10^6	No data	No data
E. coli (n per 100mL)	4×10^6	No data	No data

The list of contaminants in Because the NIWA methodology is based on the Mangere data the same values have been adopted for the Wellington assessment. Table 2-2 indicates that contaminant concentrations in influent to Mangere WWTP are mostly higher than those received at the Moa Point and Western WWTPs, except for TSS, making this a particularly conservative approach.

Table 2-2 above is not exhaustive. Wastewater may contain traces of other categories of contaminants. Of particular interest is a range of emerging organic contaminants (EOCs) that are not commonly monitored in wastewater or in the receiving environment but 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 the 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).

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
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

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 little 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 wastewater 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)
- Plasticiser metabolites (monoethylhexyl phthalate acid ester, Bisphenol-A) and
- Estrogenic steroids (17α-ethynylestradiol, 17β-estradiol, estrone).

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 Wellington Harbour where contaminants can bind 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.

Sediment monitoring sites located in Evans Bay, Lambton Harbour and near the mouths of Kaiwharawhara and Ngauranga stream are influenced by stormwater runoff from urban Wellington and by intermittent overflows from the wastewater network. Site LB-1, within Lambton Harbour, was the most impacted, where 10 of the 29 EOCs tested were detected. The substances that were detected are the flame retardants TPP (2.7 µg/kg dry weight) and TCPP (13.6 µg/kg dry weight), the plasticisers BBP (40.4 µg/kg) and Bisphenol A (4.8 µg/kg), the surfactant technical nonylphenol equivalents (96.2 µg/kg), the insecticide Bifenthrin (0.64 µg/kg) and the steroid estrogen Estrone (1.53 µg/kg) and the personal care products triclosan (1.53 µg/kg) and methyltriclosan (2.1 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 Proposed Natural Resources Plan (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, 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). 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 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.

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 volumes 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 (WWL, 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 (pNRP) and any relevant appeal outcomes.

2.3.2 Overflow types

For the purposes of this report, wastewater network overflow points (WNOs) are categorised into the following types:

- Type 1: Associated with pump stations
- Type 2: Constructed gravity network reliefs
- Type 3: Uncontrolled overflows (confirmed)
- Type 5: Uncontrolled modelled overflows (unconfirmed).

Unconfirmed modelled overflows (Type 5) have not been considered in this assessment as these overflows are considered fictitious until further investigations verify overflow locations. A list of Type 5 WNOs and their associated modelled risks are provided in Appendix C.

2.3.3 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.

2.3.4 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 the 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 occur 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: Methodology overview for assessing the level of adverse effects from wet weather overflows.

2.3.5 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 nine 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)
- Land.

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).

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.

c) A “Land” type has been added to represent the direct contact hazard associated with uncontrolled overflows from surcharging manholes or gully traps within residential properties or in public spaces such as footpaths, carparks and roads.

Receiving environment types and size thresholds are otherwise the same as those used by Moores et al. (2013).

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 – Kaiwharawhara Stream:

Kaiwharawhara Stream is a 4th order watercourse which runs approximately 11 kilometres from its headwaters in the Zealandia Wildlife Sanctuary to the coastal marine area in Wellington Harbour at Kaiwharawhara. The stream has a total catchment area of 16.7 square kilometres of which nearly 39% is in urban land cover and an estimated 18% has impervious surfaces.

Table 2-4 summarises the results of monthly RWQE monitoring in Kaiwharawhara Stream at Ngaio Gorge and WWL monitoring at Cummings Park and Otari Park. The results show a moderately high degree of faecal contamination throughout. Kaiwharawhara Stream is in NPS-FM attribute band E (red) for *E. coli* and fails to meet PNRP Objective O18. The predicted average risk of infection is >7% for full contact recreation users (although full contact recreation is unlikely in this watercourse).

Table 2-4: Summary statistics and NPS-FM Attribute State for E. coli (GWRC/WWL data 2017/2018 to 2020/2021)

Site Name	N Samples	% Exceedance over 540 cfu/100mL	% Exceedance over 260 cfu/100mL	Median Concentration cfu/100mL	95th Percentile cfu/100mL	NPS-FM Attribute State	PNRP O18 (95th %ile ≤540)
Koromiko Stream at Cummings Park	33	36	58	320	4,960	E	Not meeting
Kaiwharawhara Stream @ Otari Park*	33	33	61	408	5,580	E	Not meeting
Kaiwharawhara Stream @ Gorge*	55	67	87	1,200	10,600	E	Not meeting

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

Receiving Environment Name	Type	Recreation/occupation	Ecology	Cultural	Aesthetic
Kaiwharawhara Stream	Medium waterway[1]	Class 2 (contact recreation may occur)	Class 1 (High value ecological site)	Class 1 (Very important)	Class 1 (High value)

Step 4 Determination of WNO Characteristics

Determination of WNO characteristics is based on either monitoring data or output from modelling of the wastewater network. It includes estimates of 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 (600m³ and 6000m³) have been adjusted downwards from those used by Watercare (1000m³ and 10,000m³). The rationale is that the lower thresholds better reflect the recorded spread of overflow volumes from the Wellington network (five WNO were high volume, eight were medium volume and 97 were low volume).

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

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 Porirua network (Three WNO operated at high frequency, 18 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 – Kaiwharawhara Stream

A summary of wastewater network overflow characteristics for Kaiwharawhara Stream is given in Table 2-7.

Table 2-7: Summary of Wastewater Network Overflow Characteristics

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
107	Direct	-	Low	0	Low	Operative	Wellington Water Overflow Forms 2018-2021
18	Direct	-	Low	2	Low	Operative	Stantec Overflow Model 2021
4, 5	Direct	-	Low	-	Low	Operative	Customer recorded overflow
36	Direct	-	Low	-	Low	Operative	No data recorded

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 – Kaiwharawhara Stream

Kaiwharawhara Stream is assessed as a watercourse in which "contact recreation may occur" having 'Class 2 recreational value'[2]. '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 2-8. The combination of the magnitude of the event and the frequency of occurrence determines the

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

overall level of effect. In this case, the magnitude of effect is moderate, but the frequency of overflow is low, giving a low level of adverse effect overall (Table 2-9).

Table 2-8: Magnitude of public health effects from overflows to Kaiwharawhara Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for activities on land. This effect is predominantly linked to the discharge faecal material on land where direct physical contact is likely.	**Effects Score of 3 (Moderate)** for activities on land in the vicinity of uncontrolled overflow, because a public space is affected.
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 shellfish have the potential to filter pathogens and metals from water and sediments.
Loss of suitability for harvesting watercress	**Effects Score of 3 (Moderate)**, because watercress can be a hydraulic trap for particulate contaminants.

Table 2-9: Overall level of adverse effect

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall Level of Public Health Effect
107	Direct	**Moderate**	Low	**Low**
18	Direct	**Moderate**	Low	**Low**
4, 5	Direct	**Moderate**	Low	**Low**
36	Direct	**Moderate**	Low	**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 – Kaiwharawhara Stream

Individual overflows into Kaiwharawhara Stream have a ‘low’ volume and frequency. These discharges to a medium waterway with ‘Class 1’ ecological value are assessed as having a ‘high’ magnitude of ecological effect.

The overall level of ecological effect is determined from the combination of the magnitude of effect and frequency of occurrence. In this case the frequency of overflow events is in the ‘Low’ range and the overall level of ecological effects is assessed as ‘Moderate’.

Table 2-10: Magnitude of ecological effects of overflows to Kaiwharawhara 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 2-11: Level of ecological effects in Kaiwharawhara Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall Level of Ecological Effect
107	Direct	**High**	Low	**Moderate**
18	Direct	**High**	Low	**Moderate**
4, 5	Direct	**High**	Low	**Moderate**
36	Direct	**High**	Low	**Moderate**

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 – Kaiwharawhara Stream

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

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 – Kaiwharawhara:

Kaiwharawhara Stream is assessed as having a '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 adverse effect is assessed as being 'Low'
(Table 2-14, 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 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 – Kaiwharawhara:

All five overflows in the Kaiwharawhara Stream catchment are of 'Low' volume and 'Low' frequency, discharging to different tributaries of Kaiwharawhara Stream. The risk of cumulative effects in the stream is assessed as 'Low' and is no higher than the risk associated with either individual overflow point.

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 – Kaiwharawhara Stream:

Summary table for the Kaiwharawhara 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 magnitude and overall level of effects for Kaiwharawhara Stream

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	Moderate	Low
Aquatic ecology	High	Moderate
Cultural	Moderate	Low
Aesthetic	High	Low

Table 2-17: WNOs assessed as having a Moderate or High level of adverse effect

WNO number	Asset_ID	Assessed Frequency Range	Assessed Volume Range	Direct RE	Level of Public Health Effect	Level of Ecological Effect	Level of Cultural Effect	Level of Aesthetic Effect	Combined Score	Level of adverse effect
34	WCC_WW026938	High	Medium	Lambton Harbour	5	3	4	4	16	High / significant
40	WCC_WW030078	High	Medium	Lambton Harbour	5	3	4	4	16	
114	Western WWTP (UOP)	Medium	Medium	Land/Karori Stream	4	4	3	3	14	
28	WCC_WW020948	Medium	High	Evans Bay	4	4	3	3	14	
52	WCC_WW035569	High	Low	Lambton Harbour	4	2	4	4	14	
85	WCC_WWPS023	Medium	Medium	Evans Bay	4	4	3	3	14	
99	WCC_WWPS037	Medium	High	Island Bay / Houghton Bay	4	4	3	3	14	
113	Western WWTP (COP)	Medium	High	Karori Stream	3	4	3	3	13	Moderate / more than minor
11	WCC_WW012046	Medium	Low	Karori Stream	3	4	3	3	13	
98	WCC_WWPS036	Medium	Medium	Island Bay / Houghton Bay	4	3	3	3	13	
102	WCC_WWPS040	Medium	Medium	Island Bay / Houghton Bay	4	3	3	3	13	

WNO number	Asset_ID	Assessed Frequency Range	Assessed Volume Range	Direct RE	Level of Public Health Effect	Level of Ecological Effect	Level of Cultural Effect	Level of Aesthetic Effect	Combined Score	Level of adverse effect
1	WCC_WW004696	Medium	High	Lambton Harbour	4	2	3	3	12	
23	WCC_WW019626	Medium	Low	Evans Bay	3	3	3	3	12	
32	WCC_WW023985	Medium	Low	Evans Bay	3	3	3	3	12	
56	WCC_WW038277	Medium	High	Lambton Harbour	4	2	3	3	12	
64	WCC_WWPS002	Medium	High	Lambton Harbour	4	2	3	3	12	
65	WCC_WWPS003	Medium	Medium	Lambton Harbour	4	2	3	3	12	

2.3.6 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 nine 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 Wellington City and Karori stream catchments; identifies potential effects of wet weather overflows on those values; assesses the potential magnitude of those effects which, in combination with frequency, determines the overall level of adverse to the receiving environment (and the identified values). Maps provided for each sub-catchment present the location of overflow points 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).

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. Uncontrolled overflows may occur from surcharging manholes onto a road, for instance, then channelled into waterways via the stormwater network, but as shown in Figure 3-1 there are few overflows of this type in the Wellington and Karori catchments.

For the purposes of this report, wastewater network overflow points (WNOs) are categorised into[3]:

- Type 1: Associated with pump stations
- Type 2: Gravity network reliefs
- Type 3: Uncontrolled overflows (confirmed)
- Type 5: Modelled uncontrolled overflows (fictitious)

This assessment has identified 111 WNOs in nine sub-catchments, discharging to 10 receiving environments as shown in Table 3-1. 50 WNOs are associated with pump stations (Type 1), 54 are controlled overflows from network relief points (Type 2) and the remaining six sites are uncontrolled overflow points to land prior entering the stormwater network (Type 3). Twenty overflows are direct to a freshwater stream or river, while the remaining 90 discharge to coastal water bodies.

A list of WNOs (Type 1, 2 and 3) in the Wellington City network and their respective receiving environment is provided in Appendix A. Unconfirmed modelled overflows (Type 5) have not been considered as part of this assessment as these overflows are considered fictitious until further investigations verify overflow locations. A list of Type 5 WNOs and their associated modelled risks are provided in Appendix C.

3.1 Wastewater Catchments and Sub-catchments

The catchments for the Western and Moa Point WWTPs include the urban areas of Karori and central Wellington which are described in this report as nine sub-catchments, all of which include a local authority wastewater network. The sub-catchments mostly correspond with stream catchments, except the flat coastal area around Miramar Peninsula which has no significant streams, and which is combined into a 'coastal' sub-catchment. The sub-catchments, and their PNRP scheduled values are listed in Table 3-1 and Table 3-2, and illustrated in Figure 3-1.

[3] Note, WNO 113 is unique in this report in that it is an overflow of treated wastewater from the Western WWTP, which doesn't fit well into any of these categories.

Table 3-1: WNOs and their Receiving Environments

Sub-catchment	Overflow Point	Receiving Environment		
		Direct	Secondary	Ultimate
Karori	6, 10, 11, 12, 27, 45, 113, 114	Karori Stream	n/a	Wellington South Coast
Owhiro	35, 100, 101	Owhiro Bay	n/a	Wellington South Coast
Island/Houghton	13, 35, 37, 48, 61, 98, 99, 102	Island Bay/ Houghton Bay/ Princess Bay	n/a	Wellington South Coast
Lyall	14, 57, 81, 84, 93, 96, 97, 116	Lyall Bay	n/a	Wellington South Coast
Miramar Peninsular	62, 87, 88, 89, 91, 94, 95, 103	Miramar East Coast	n/a	Wellington South Coast and Harbour entrance
Evans Bay	9, 15, 20, 23, 26, 28, 32, 43, 46, 49, 58, 76, 77, 78, 79, 80, 85, 86, 92	Evans Bay	n/a	Wellington Harbour
Lambton	1, 2, 7, 8, 16,17, 19, 22, 30, 33, 34, 38, 39, 40, 41, 42, 50, 51, 52, 54, 55, 56,60, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 82, 83, 90, 104, 105, 111, 112	Lambton Harbour and Oriental Bay	n/a	Wellington Harbour
Kaiwharawhara	4, 5, 18, 36, 107, 115	Kaiwharawhara Stream	North Harbour	Wellington Harbour
North Harbour	24, 29, 31, 109, 110	Ngauranga Stream	North Harbour	Wellington Harbour
	3, 53, 106, 108	North Harbour	n/a	Wellington Harbour

Table 3-2: The wastewater sub-catchments and pNRP values

Sub-catchment	Catchment Area (km^2)	Local Authority Wastewater Network?	PNRP Schedules								
			A	F1	F1b	F2	F3	F4	F5	H1	I
Karori	31.0	yes		✓							✓
Owhiro	9.7	yes		✓	✓	✓		✓	✓	✓	
Island/Houghton	6.0	yes				✓		✓	✓	✓	
Lyall	2.8	yes				✓			✓	✓	
Miramar Peninsular	2.9	yes				✓			✓	✓	
Evans Bay	9.5	yes				✓				✓	
Lambton	13.7	yes				✓				✓	
Kaiwharawhara	16.6	yes		✓	✓	✓		✓			✓
North Harbour	15.8	yes				✓			✓		

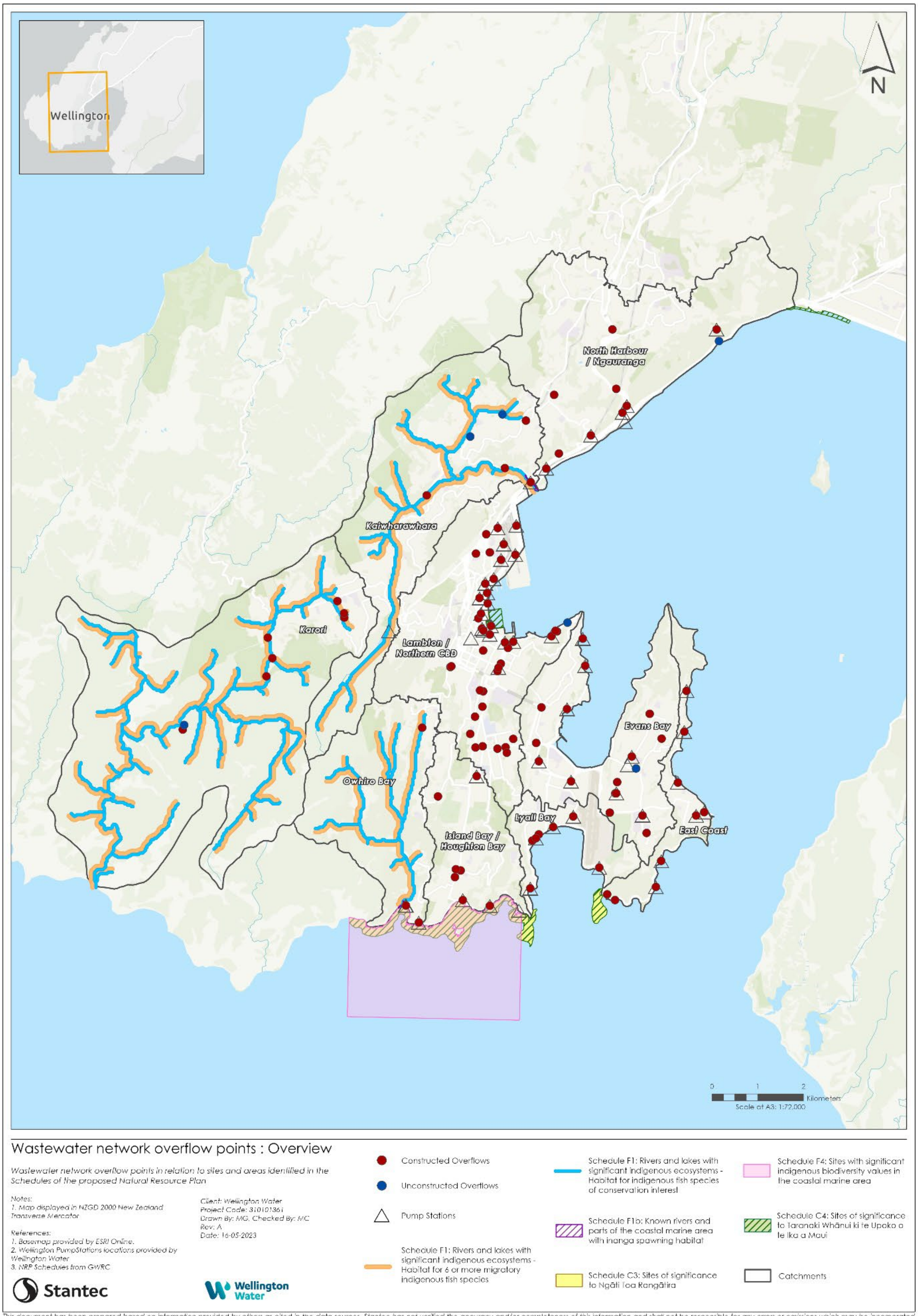

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Figure 3-1: Overview of Wellington and Karori WNOs

3.2 Karori Stream

3.2.1 Description of the Receiving Environment

Karori Stream is a 3rd order watercourse[4] which runs approximately 10 kilometres from its headwaters in urban Karori to the coastal marine area near Tongue Point on Wellington's south coast. The stream has a total catchment area of 30.9 square kilometres, a maximum elevation of 460m above sea level, and an estimated mean flow of 1,200 L/s. The River Environment Classification (REC) is 'cool wet climate/low elevation/hard sedimentary geology/pasture scrub and urban landcover'.

The upper stream is urbanised with an extensive stormwater network largely replacing natural headwater streams. Urban Karori is predominantly residential, but with significant commercial and community infrastructure (supermarkets, shops, schools, swimming pool, service stations, bus depot, restaurants and bars, etc.). Closed landfills are located at Futuna Retreat (Friend Street) and Ben Burn Park, but none are currently operating. The Western WWTP is located downstream of the urban area on South Karori Road. Treated wastewater is piped to Wellington's South coast near the Karori Stream mouth. The middle and lower reaches of Karori Stream run through scrub, plantation forestry and production pasture.

GWRC maintains a River Water Quality and Ecology (RWQE) monitoring site on Karori Stream Makara Peak Mountain Bike Park located a short distance below the urban area but upstream of the WWTP. WWL conducts SMP monitoring at two sites upstream in urban Karori and sites upstream and downstream of the WWTP. Table 3-3 summarises the results of GWRC and WWL *E. coli* monitoring between 2017 and 2022, showing a high degree of faecal contamination at all sites close to the urban area. Karori Stream is in NPS-FM attribute band E (red) for *E. coli* and fails to meet PNRP Objective O18. The predicted average risk of infection is >7% for full contact recreation users (although full contact recreation is unlikely in this watercourse).

Table 3-3: Karori Stream E. coli summary statistics and NPS-FM Attribute State

Site name	N samples	% Exceedance over 540 cfu/100mL	% Exceedance over 260 cfu/100mL	Median concentration cfu/100mL	95th percentile cfu/100mL	NPS-FM Attribute State	PNRP O18 (95th %ile ≤540)
@Campbell Street**	53	42%	64%	480	8,980	E	Not meeting
@Friend Street**	53	75%	87%	1,300	34,400	E	Not meeting
@Makara Peak*	55	95%	98%	1,900	9,600	E	Not meeting
100m upstream Western WWTP	54	17%	37%	135	1,550	E	Not meeting
100m downstream Western WWTP	54	20%	35%	170	2,195	E	Not meeting

*GWRC monthly monitoring from June 2017 to December 2021

**WWL fortnightly monitoring from February 2020 to July 2022

[4] 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 increases 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.

During 2018 WWL conducted additional water quality monitoring in Karori Stream downstream of the WWTP to identify any dry weather leakage that might have been occurring from the main outfall pipeline between the WWTP and the coast (Fountain & Cameron, 2018). The results of *E. coli* monitoring at 12 sites on three occasions during February and March 2018 are summarised in Table 3-4. The results confirmed that during the sampling period, most of the faecal contamination occurred within urban Karori and at the WWTP, with little additional contamination caused by leakage from the main outfall pipeline or runoff from agricultural land. However, in July 2022 a localised slope stability failure ruptured the outfall pipeline and resulted in 100% of the treated wastewater being discharged to the lower reaches of Karori Stream. The repairs had not been completed at the time of writing.

Table 3-4: *E. coli* Concentrations (cfu per 100mL) at 12 sites in Karori Stream (Fountain & Cameron, 2018)

Site Code	Site Name	15 February 2018 (dry conditions)	14 March 2018 (dry conditions)	27 March 2018 (light rain)
K1	Lower alluvial plain	Stream dry	80	180
K2	Upper alluvial plain	60	32	160
K3	Lower gorge	56	110	330
K4	Middle gorge	60	180	480
K5	Middle/upper gorge	40	110	230
K6	Upper gorge	96	92	220
K7	Lower pine plantation	110	120	250
K8	Upper pine plantation	88	100	300
K9	Lower Karori branch	100	88	320
K10	Downstream of WWTP	1430	140	1030
K11	Upstream of WWTP	100	88	920
K12	Makara Peak MBP	1300	2500	6200

RWQE monitoring at the Makara Peak site on Karori Stream also show elevated concentrations of dissolved inorganic nitrogen, dissolved reactive phosphorus, dissolved copper, and dissolved zinc, all exceeding ANZG (2018) default guideline values indicating a risk of adverse effects on stream ecology.

The ecological component of the RWQE program 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 3-5. PNRP Objective O19 for periphyton cover is achieved.

Table 3-5: 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)
Karori Stream @Makara Peak	35	43.5	1	meeting

Macroinvertebrate community monitoring results from annual samples taken from years 2016/2017 to 2020/2021 indicate that the community immediately downstream of urban Karori is in poor condition and does not achieve the PNRP Objective O19 for MCI or QMCI (Table 3-6).

Table 3-6: Macroinvertebrate community metrics for Karori Stream (2016/17 to 2020/21)

Site name	substrate	River class	Significant rivre	N samples	Taxa richness	%EPT (3-yr median)	MCI (5-yr median)	QMCI (5-yr median)	PNRP O19 - MCI	PNRP O19 - QMCI	Meeting O19
Karori Stream @ Makara Peak	Hard	2	No	5	5	21.7	90.8	2.9	≥ 105	≥ 5.5	Not meeting

Fountain & Cameron (2018) also conducted synoptic studies of benthic macroinvertebrate and fish communities of Karori Stream. The invertebrate community was sampled at 12 stream locations during February 2018. The results are summarised in Table 3-7. The most degraded macroinvertebrate community by far was at the Makara Peak site (K12) at the downstream edge of urban Karori. The poor state of the benthic fauna is attributed to contaminants delivered by stormwater runoff and wastewater network overflows from an intensively urbanised catchment, as well as changes to the flow regime caused by a large area of impervious surface in the contributing catchment.

By contrast, the least degraded macroinvertebrate communities were found at sites K11 and K10, approximately 3.7 km and 3.9 km further downstream. Sites K11 and K10 are located immediately upstream and downstream of the Western WWTP, respectively. The strong improvement in the condition of the benthic fauna between sites K12 and K11 is attributed primarily to a change from urban land-use to one dominated by regenerating native forest.

Downstream of Site K10 the quality of macroinvertebrate communities gradually declines, likely in response to reduced integrity of riparian vegetation and an increased proportion of agricultural land use.

Table 3-7: Invertebrate metric score at 12 sites on Karori Stream (February 2018)

Site Code	Site Name	Number of taxa	Number of EPT taxa	%EPT taxa	MCI	SQMCI	Dominant Taxa
K1	Lower alluvial plain	-	-	-	-	-	Stream was dry
K2	Upper alluvial plain	19	10	53	107	5.1	Deleatidium, Potamopyrgus, Aoteapsyche
K3	Lower gorge	17	6	35	88	5.2	Aoteapsyche
K4	Middle gorge	18	10	56	109	4.6	Aoteapsyche
K5	Middle/upper gorge	17	8	47	102	4.5	Aoteapsyche
K6	Upper gorge	20	11	55	107	5.4	Deleatidium, Aoteapsyche
K7	Lower pine plantation	19	12	63	117	5.4	Aoteapsyche, Pycnocentrodes
K8	Upper pine plantation	24	13	54	110	6.0	Deleatidium
K9	Lower Karori branch	19	10	53	109	6.9	Deleatidium
K10	Downstream WWTP	24	14	58	121	7.4	Deleatidium
K11	Upstream WWTP	18	10	56	122	6.2	Deleatidium
K12	Makara Peak MBP	14	5	36	97	3.2	Orthocladiinae

Perrie (2008) reported the results of a series of fish surveys conducted in 2002, 2003 and 2007 in Karori Stream the vicinity of the Makara Peak Mountain Bike Park, approximately 11 km from the sea. Fish communities at that location were dominated by longfin eels and kōaro, with shortfin eels, brown trout, upland bullies, and koura found on some sampling occasions but normally in low numbers.

The New Zealand Freshwater Fish Database (NZFFD) includes records from earlier fish surveys conducted in 1977, 1981, 1983, 1986 and 2002, which indicate a core fish community of longfin eel and Kōaro, but includes records of īnanga, banded kōkopu, lamprey and koura.

As these earlier fish surveys were nearly all conducted upstream of the WWTP, WWL commissioned Stantec in 2017 to undertake additional surveys in the stream reach between the WWTP and the coast. The sampling locations are sites K1 to K12 shown in Table 3-7. In total eight fish species have been recorded, three of which (longfin eel, īnanga and kōaro) are identified as being “at risk” from declining population numbers (Dunn, et al., 2017). The lamprey is a threatened species (national vulnerable), however information about its presence in Karori Stream is extremely sparse, consisting of a single record dated 1977.

In summary, the lower stream is dominated by longfin eel, shortfin eel, upland bully, īnanga and kōaro, the middle stream by longfin eel, upland bully and kōaro, and headwater tributaries by longfin eel, upland bully and banded kōkopu. The PNRP Objective O19 for fish IBI is achieved in the middle and upper stream, although the data is now dated. Objective O19 is not achieved, marginally, in the lower stream, based on recent data.

Significant values associated with Karori Stream as scheduled in the PNRP are summarised in Table 3-9and categorised for the wastewater network overflow assessment in Table 3-10.

Table 3-8: Distribution of fish species in Karori Stream

Species	Conservation Status (Dunn, et al., 2017)	Lower Stream Downstream of WWTP (Cameron, 2018)	Middle Stream Makara Peak - Regenerating Native Bush (Perrie, 2008)	Upper Stream & Headwater Tributaries (NZFFD)[5]
Longfin eel	At risk (declining)	+++	++	++
Shortfin eel	Not threatened	++	+	-
Lamprey	Threatened (nationally vulnerable)	-	-	+
Īnanga	At risk (declining)	++	-	-
Upland bully	Not threatened	+++	++	++
Kōaro	At risk (declining)	++	+++	+
Banded kōkopu	Not threatened	-	-	++
Brown trout	Introduced and naturalised	-	+	+
Fish index of biotic integrity (F-IBI)		36 (fair)	38 (good)	50 (very good)
PNRP Objective O19 (F-IBI ≥ 38)		Not meeting	Meeting	Meeting

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

[5] Stoffels R (2022). New Zealand Freshwater Fish Database (extended). The National Institute of Water and Atmospheric Research (NIWA).

Table 3-9: Environmental and cultural values identified for the Karori Stream in Schedules of the PNRP

Schedule	Category	Significant sites
B	Nga Taonga Nui a Kiwi	Raukawa Moana (Cook Strait)
F1	Rivers and lakes with significant indigenous ecosystems	Karori Stream has significant indigenous values including habitat for indigenous threatened or at-risk fish, and habitat for more than six species of indigenous migratory fish.
I	Important trout fishery river and spawning waters	Main stem of Karori Stream below urban area

Table 3-10: Karori Stream receiving environment characteristics

Receiving environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Karori Stream	Medium waterway[6]	Class 2 (contact recreation may occur)	Class 1 (High value)	Class 2 (Important)	Class 1 (High value)

3.2.2 Summary of Overflow Characteristics

Based on monitoring and/or modelling observations, five out of eight overflow sites (WNO site 6, 10, 12, 27 and 45) are 'Low' volume and 'Low' frequency overflow discharges directly to the Karori Stream. WNO site 11 is a 'Low' volume and 'Medium' frequency overflow discharging directly to Karori Stream. WNO site 113 is a 'High' volume and 'Medium' frequency discharge (of treated wastewater from the Western WWTP) and WNO site 114 is a 'Medium' volume and 'Medium' frequency discharge. The overflow characteristics are summarised in Table 3-11.

Table 3-11: Summary of overflow characteristics, Karori Stream

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
6	Direct	-	Low	1	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
11	Direct	380	Low	3	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
113	Direct	12,900	High	6	Medium	Operative	HAL Karori Wastewater Network Options Assessment May 2021
114	Direct to land	1,600[7]	Medium	3[7]	Medium	Operative	HAL Karori Wastewater Network Options Assessment May 2021
10, 27, 45	Direct	-	Low	2	Low	Operative	Stantec Overflow Model 2021
12	Direct	-	Low	-	Low	Operative	No data recorded

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

[7] It is noted that this overflow volume and frequency is based on a Long Time Series simulation by HAL and that the overflows coming from WNO site 114 is not monitored. It is recommended that monitoring is implemented at this site so that there is confidence around the overflow volume and frequencies coming from this site.

3.2.3 Potential Public Health Effects

The Karori Stream is assessed as a water body where contact recreation may occur. 'High' volume discharges to medium waterways with a Class 2 recreational value are assessed as having a 'High' potential effect on all recreational activities as shown in Table 3-12.

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 3-13. The overall level of public health effect at this location is assessed as 'High'.

As already noted, WNO Site 113 is not an overflow from the wastewater network, rather it is a wet weather overflow of treated wastewater from the Western WWTP at times when the capacity of the WWTP or main outfall pipeline is exceeded. This is the only discharge of treated wastewater covered in this assessment and accordingly the methodology has been adjusted by reducing the magnitude and level of public health effects from 'High' to 'Moderate' to reflect the improved discharge quality.

Table 3-12: Magnitude of public health effects from overflows to Karori Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for activities on land. This effect is predominantly linked to the discharge faecal material on land where direct physical contact is likely.	**Effects Score of 2 (Low)** for activities on land in the vicinity of uncontrolled overflow, because public access is limited.
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 3-13: Overall level of public health effects in Karori Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public Health Effect	Overflow Frequency Range	Overall level of Public Health Effect
6	Direct	Moderate	Low	Low
11	Direct	Moderate	Medium	Moderate
113	Direct	Moderate	Medium	Moderate
114	Direct to land	**High**	Medium	**High**
10, 27, 45	Direct	Moderate	Low	Low
12	Direct	Moderate	Low	Low

3.2.4 Potential Ecological Effects

Karori Stream is assessed as a watercourse with high ecological values. 'High' volume discharges to a medium watercourse with Class 1 ecological values are assessed as having predominantly 'Very High' potential effects on ecological values, as shown in Table 3-14.

The assessment of WNO Site 113 has been adjusted because this is a wet weather overflow of treated wastewater from the Western WWTP at times when the capacity of the WWTP or main outfall pipeline is exceeded. Accordingly, the methodology has been adjusted by reducing the magnitude and level of ecological effects from 'Very High' to 'High' to reflect the improved discharge quality.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-15. The overall level of ecological effect at this location is assessed as 'High'.

Table 3-14: Magnitude of ecological effect from overflows to Karori 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 above background levels (up to 10-fold for nutrients and 20-fold for toxicants).
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 3-15: Overall level of ecological effect in Karori Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall level of Ecological Effect
6	Direct	High	Low	Moderate
11	Direct	**High**	Medium	**High**
113	Direct	**High**	Medium	**High**
114	Direct	**High**	Medium	**High**
10, 27, 45	Direct	High	Low	Moderate
12	Direct	High	Low	Moderate

3.2.5 Potential Cumulative Effects

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

- There is one direct discharge of 'High' volume (WNO site 113) and one direct discharge of 'Medium' volume (WNO site 114).
- There are three direct overflows of 'Medium' frequency.

For a spatially cumulative effect to arise, most of the direct 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 effects and 'Very High' ecological effects. However, as the 'High' volume overflow is a wet weather wastewater overflow from the Western WWTP at times when the capacity of the WWTP or main outfall pipeline is exceeded, the ecological effects was reduced from a 'Very High' to 'High'. As this discharge has already been assessed in earlier parts of the AEE as having potentially 'High' potential effects individually, the cumulative effect would not result in a different assessment category.

3.2.6 Potential Cultural Effects

Karori Stream is assessed as having 'Important' cultural values (Class 2).

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

3.2.7 Potential Aesthetic Effects

Karori Stream is assessed as having a 'High' aesthetic value[8]. 'High' volume discharges to such an environment have a 'High' potential to affect these values. However, because the overflows occur at a range from 'Low' to 'High' frequency, the overall level of aesthetic effect is assessed as being 'Moderate'.

3.2.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-16.

Table 3-16: Summary of magnitude and overall level of adverse effects for Karori Stream

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	High	High
Aquatic ecology	High	High
Cultural	Low	Moderate
Aesthetic	High	Moderate

[8] '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".

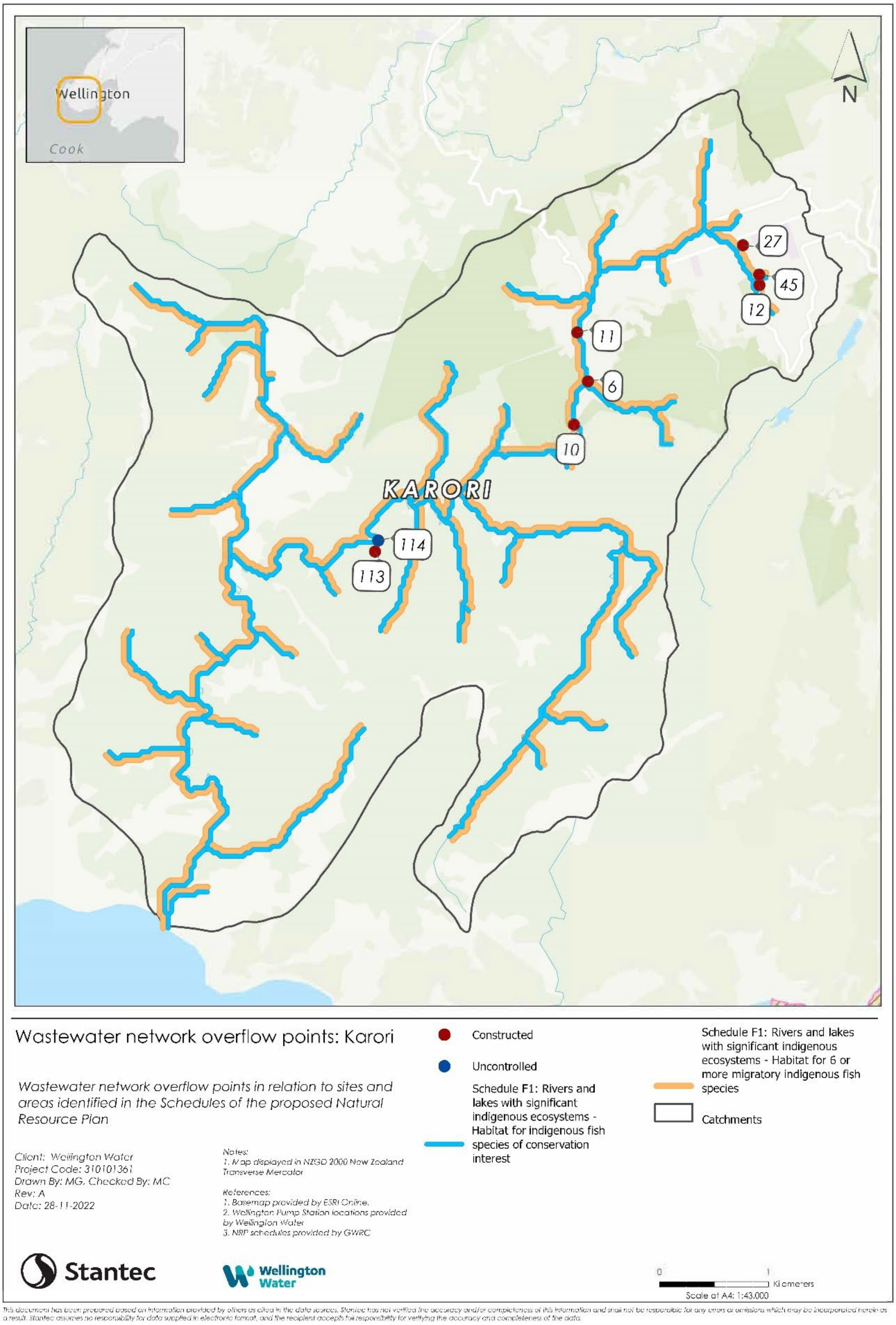

Figure 3-2: WNOs in the Karori Stream catchment

3.3 Owhiro Stream

3.3.1 Description of the Receiving Environment

Owhiro Stream is a 3rd order watercourse which runs approximately 5 kilometres from its headwaters in urban Brooklyn to Owhiro Bay on Wellington's south coast. The stream has a total catchment area of 9.4 square kilometres with a maximum elevation of 400m above sea level, and an estimated mean flow of 240 L/s. The River Environment Classification (REC) is 'cool wet climate/low elevation/hard sedimentary geology/pasture scrub and urban landcover'.

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

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

Table 3-17 summarises the results of WWL/GWRC monitoring in Owhiro Stream at sites on the middle and lower stream. The results show a moderate to high degree of faecal contamination. Owhiro Stream in the lowest NPS-FM attribute band for *E. coli*, E (red), and fails to meet PNRP Objective O18 for *E. coli*. The predicted average risk of infection is >7% for full contact recreation users (although full contact recreation is unlikely in this watercourse).

Table 3-17: Summary statistics and NPS-FM Attribute State for *E. coli* (WWL data Feb 2020 to April 2022)

Site Name	N Samples	% Exceedance over 540 cfu/100mL	% Exceedance over 260 cfu/100mL	Median Concentration cfu/100mL	95th Percentile cfu/100mL	NPS-FM Attribute State	PNRP O18 (95th %ile ≤540)
Owhiro Stream above T&T Landfill	35	37	57	400	8,659	E	Not meeting
Owhiro Stream above Owhiro Bay Parade	41	71	85	1,040	5,000	E	Not meeting
Owhiro Stream at Owhiro Bay Parade	23	83%	96%	1,500	7,700	E	Not meeting

Table 3-18: 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)
Owhiro Stream at Owhiro Bay Parade	15	75.50	4	Not meeting

Table 3-19: Macroinvertebrate community metric scores for Owhiro Stream (2016/17 to 2020/21)

Site Name	Substrate	River class	Significant rivre	N samples	Taxa richness	%EPT (3-yr median)	MCI (5-yr median)	QMCI (5-yr median)	PNRP O19 - MCI	PNRP O19 - QMCI	Meeting O19
Owhiro Stream at Owhiro Bay Parade	Hard	2	No	2	17	11.7	80.3	2.8	≥105	≥5.5	Not meeting

Table 3-20: Record of fish species in Owhiro Stream, data from NZFFD (Stoffels, 2022)

Species	Conservation Status (Dunn, et al., 2017)	Lower Stream (<2km from coast)	Upper Stream (>2km from coast)
Longfin eel	At risk (declining)	+++	++
Shortfin eel	Not threatened	++	++
Redfin bully	Not threatened	++	-
Banded kōkopu	Not threatened	+	+
Īnanga	At risk (declining)	++	-
Grey mullet	Not threatened	+	-
Salmonid (unid.)		+	-
Fish index of biotic integrity (F-IBI)		48	38
PNRP Objective O19 (F-IBI ≥ 38)		Meeting	Meeting

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

Table 3-21: Environmental and cultural values identified for the Owhiro Stream in Schedules of the PNRP

Schedule	Category	Significant sites
F1	Rivers and lakes with significant indigenous ecosystems	Owhiro Stream has significant indigenous values including habitat for indigenous threatened or at-risk fish, and habitat for more than six species of indigenous migratory fish.
F1b	Īnanga Spawning Habitat:	Lower reach of Owhiro Stream
F2	Indigenous Bird Habitat:	Wellington South Coast
F4	Indigenous Biodiversity Coastal:	Taputeranga Marine Reserve

Table 3-22: Owhiro Stream receiving environment characteristics

Receiving environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Owhiro Stream	Medium Waterway	Class 2 (contact recreation may occur)	Class 3 (highly modified channel, partially piped)	Class 2 (Important)	Class 1 (High value)

3.3.2 Summary of Overflow Characteristics

WNO site 35 is a 'Low' volume and 'Low' frequency discharge directly into the Owhiro Stream, as summarised in Table 3-23.

Table 3-23: Summary of overflow characteristics, Owhiro Stream

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
35	Direct	23	Low	2	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021

3.3.3 Potential Public Health Effects

Owhiro Stream is a water body in which full contact recreation 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 3-24.

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 3-25. 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 3-24: Magnitude of public health effects from overflows to Owhiro 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 shellfish have the potential to filter pathogens and metals from water and sediments.
Loss of suitability for harvesting watercress	**Effects Score of 3 (Moderate)**, because watercress can be a hydraulic trap for particulate contaminants.

Table 3-25: Overall level of public health effects in Owhiro Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall level of Public Health Effect
35	Direct	**Moderate**	Low	**Low**

3.3.4 Potential Ecological Effects

Owhiro Stream 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 3-26.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-27. 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 3-26: Magnitude of ecological effect from overflows to Owhiro 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 1 (Very Low)**, because the lack of BOD enrichment provides little opportunity for the growth of these organisms.

Table 3-27: Level of ecological effect from overflows to Owhiro Stream

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

3.3.5 Potential Cumulative Effect

For Owhiro Stream, cumulative effects are not expected as there is only one known direct overflow that discharges at a frequency where pathogens would not normally persist in the receiving environment.

3.3.6 Potential Cultural Effects

Owhiro Stream 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’

3.3.7 Potential Aesthetic Effects

Owhiro Stream 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’.

3.3.8 Summary

Table 3-28: Summary of potential magnitude and level effect in Owhiro Stream

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	Moderate	Low
Aquatic ecology	Low	Very Low
Cultural	Low	Low
Aesthetic	High	Low

3.4 Owhiro Bay, Island Bay, Houghton Bay and Princess Bay

3.4.1 Description of the Receiving Environment

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

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

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

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

Table 3-29 summarises the results of GWRC & WCC recreational water quality monitoring on the south coast over five-year period to March 2022. Owhiro Bay did not achieve the PNRP Objective O18 enterococci standard for enterococci in any of the last three compliance periods (pink shading), indicating an ongoing issue and an elevated health risk for contact recreation activities in the area. Island Bay did not meet O18, at the Derwent Street site over the 2018/2021 period or at the Reef Street site over the 2019/2022 period. Island Bay at the Surf Club met O18 in all three compliance periods. Princess Bay had very high water with enterococci not detected in the majority of samples.

Table 3-29: Summary statistics for enterococci at Wellington South Coast (GWRC data 2017-2022)

Site Name	N Samples	% over 140 cfu/100m	% Over 500 cfu/100mL	Median cfu/100mL	95th percentile cfu/100mL (3 years)			PNRP O18 95th percentile
					2017/20	2018/21	2019/22	
Owhiro Bay	124	23	10	20	598	642	806	≤500
Island Bay @ Derwent	112	13	5	8	456	518	234	≤500
Island Bay @ Reef	89	13	7	8	427	445	624	≤500
Island Bay @ Surf club	184	11	4	8	280	373	408	≤500
Princess Bay	48	0	0	<2	No data	No data	23	≤500

Table 3-30 provides an assessment of against PNRP Objective O19. Significant values associated with Owhiro Bay as scheduled in the PNRP are summarised in Table 3-31 and categorised for the wastewater network overflow assessment in Table 3-32.

Table 3-30: Assessment of Owhiro, Island, Houghton and Princess bays against PNRP Objective O19

	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	A range of measures are monitored by the Department of Conservation to determine ecosystem health within the Taputeranga Marine Reserve. The 2016 Marine Reserve Report Card identifies the landfills within Owhiro Stream catchment and the closed Houghton Bay landfill site as potential sources of contamination. It notes however that diverse habitats ranging from offshore rocky reefs to rock pools support a wide variety of marine life. Kelp forests provide places for rock lobster, paua and kina to live, as well as many fish. Monitoring has shown that by 2016 blue cod and rock lobster had become more plentiful and larger inside the marine reserve than outside it. On the other hand, the unwanted Asian kelp *Unidaria pinnatifida* was well established in the reserve. The overall assessment is that the objectives in PNRP Table 3.8 are very likely achieved. There are, however, ongoing water quality issues associated with contaminant inputs from Owhiro Stream and stormwater outlets at Island Bay and Houghton Bay.			

Table 3-31: Environmental and cultural values identified for Owhiro, Island, Houghton and Princess bays in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Raukawa Moana (Cook Strait)
C3	Sites with significant mana whenua values	Tapu te Ranga – Owhiro – Haewai. Taranaki Whānui ki te Upoko o te Ika a Mau and Ngāti Toa Rangātira
F1b	Īnanga spawning habitat	Owhiro Stream
F2	Indigenous bird habitat	Wellington South Coast
F4	Indigenous biodiversity habitat	Taputeranga Marine Reserve. It protects a unique and richly varied mixture of warm, cold, temperate, and subantarctic fauna and flora. The area is representative of the North Cook Strait bioregion's habitats and ecosystems
F5	Habitats with significant indigenous biodiversity values in the coastal marine area	Giant kelp, kelp beds, subtidal rock reefs

Table 3-32: Receiving environment characteristics

Receiving environment Name	Type	Recreation	Ecology	Cultural	Aesthetic
Owhiro Bay, Island Bay, Houghton Bay, and Princess Bay	Open coast	Class 1	Class 1	Class 1	Class 1

3.4.2 Summary of Overflow Characteristics

Based on overflow monitoring and Network Engineering Team observations, there are nine potential direct overflows and one indirect overflow to the Owhiro, Island, Houghton and Princess Bays.

Six out of the ten overflows (WNO sites 35, 37, 48, 61, 100 and 101) are 'Low' volume and 'Low' frequency discharges. WNO site 13 has an increased volume range of 'Medium' and a 'Low' frequency of discharge. WNO sites 98 and 102 occur more frequently falling into the 'Medium' frequency and 'Medium' volume range. WNO site 99 has a 'Medium' volume range with an average yearly recorded volume of 697 m^3 and a 'Medium' frequency of discharge.

Overflow volumes for some sites are unavailable however their associated volume range has been assumed based on the duration of time the overflow occurred for. Overflow characteristics are summarised in Table 3-33.

It should be noted that different monitoring methodologies were used by Mott MacDonald resulting in different amounts of available information for the monitored sites. For example, some overflows were monitored for volume and duration while others were only recorded by volume. To reflect this, sites have been separated into corresponding rows based on the information available.

Table 3-33: Summary of overflow characteristics to Owhiro, Island, Houghton and Princess bays

Overflow ID	Direct/ Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
101	Direct	-	Low	-	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
48, 100	Direct	23 - 277	Low	2	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
13	Direct	-	Medium	2	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
98	Direct	697	Medium	4	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
102	Direct	-	Medium	3	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
99	Direct	-	High	4	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
37, 61	Direct	-	Low	-	Low	Operative	No data recorded
35	Indirect	23	Low	2	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021

3.4.3 Potential Public Health Effects

Direct overflows to Owhiro, Island, Houghton and Princess Bays range from 'Low' volume to 'High' volume discharges with 'Low' to 'Medium' frequency discharges. To reflect this situation the volume range input is categorised as 'High' and the frequency range 'Medium'.

'High' volume discharges to open coast with Class 1 recreational values are assessed as having a 'High' potential magnitude effect on all recreational activities, as shown in Table 3-34.

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 3-35. The assessed overall level of public health effect at Owhiro, Island, Houghton and Princess Bays is 'High'.

Table 3-34: Magnitude of public health effects from overflows to Owhiro, Island, Houghton and Princess bays

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 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 harvesting seaweed	**Effects Score of 4 (High)**, because seaweed can be a hydraulic trap for particulate contaminants.

Table 3-35: Overall level of public health effects in Owhiro, Island, Houghton and Princess Bays

Overflow ID	Direct/Indirect	Potential Magnitude of Public Health Effect	Overflow Frequency Range	Overall level of Public Health effect
101	Direct	Moderate	Low	Low
48, 100	Direct	Moderate	Low	Low
13	Direct	**High**	Low	Moderate
98	Direct	**High**	Medium	**High**
102	Direct	**High**	Medium	**High**
99	Direct	**High**	Medium	**High**
37, 61	Direct	Moderate	Low	Low
35	Indirect	Moderate	Low	Low

3.4.4 Potential Ecological Effects

Direct overflows to Owhiro, Island, Houghton and Princess Bays range from ‘Low’ volume to ‘High’ volume discharges with ‘Low’ to ‘Medium’ frequency discharges. To reflect this situation the volume range input is categorised as ‘High’ and the frequency range ‘Medium’.

‘High’ volume discharges to beaches with Class 1 ecological values are assessed as having predominantly ‘High’ potential effects on ecological values, as shown in Table 3-36. While open coasts are likely to have high dilution rates the ‘High’ volume overflows are likely to have some effect. The overall level of ecological effects is summarised in Table 3-37. In this case the frequency of overflow events is in the ‘Medium’ range and the assessed overall level of ecological effect is ‘High’.

Table 3-36: Magnitude of ecological effects from overflows to Owhiro, Island, Houghton and Princess bays

Potential Effect	Magnitude of Ecological 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, and nitrate.	**Effects Score of 4 (High)**, because nutrient concentrations and toxicants are likely to 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 2 (Low)**, because the limited extent of changes in physico-chemical habitat suitability is unlikely to generate behavioural changes.

Potential Effect	Magnitude of Ecological Effect
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 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.

Table 3-37: Overall level of ecological effects in Owhiro, Island, Houghton and Princess bays

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall level of Ecological Effect
101	Direct	Low	Low	Very Low
48, 100	Direct	Low	Low	Very Low
13	Direct	Moderate	Low	Low
98	Direct	Moderate	Medium	Moderate
102	Direct	Moderate	Medium	Moderate
99	Direct	**High**	Medium	**High**
37, 61	Direct	Low	Low	Very Low
35	Indirect	Low	Low	Very Low

3.4.5 Potential Cumulative Effects

For the Owhiro Bay, Island Bay, Houghton Bay and Princess Bay receiving environments, cumulative effects are considered likely because:

- There are nine direct overflows, although these are spatially well separated.
- One direct discharge (WNO site 99) of a ‘High’ volume.
- Three discharges occur at ‘Medium’ frequency, raising the possibility of temporal cumulative effects, where any lasting effect from one discharge is exacerbated by the next one.

For a spatially cumulative effect to arise, most of the direct 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 effects and ‘High’ 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 ‘High’ potential public health effects individually, the cumulative effect would not result in a different assessment category.

3.4.6 Potential Cultural Effects

Owhiro, Island, Houghton and Princess Bays are assessed as having ‘Very Important’ cultural values (Class 1). The overflow discharges range from ‘Low’ to ‘High’ volume; cultural effects are assessed as ‘Very High’. Because the overflows occur at a ‘Low’ to ‘Medium’ frequency, the overall level of cultural effect is assessed as ‘Moderate’.

3.4.7 Potential Aesthetic Effects

Owhiro, Island, Houghton and Princess Bays are 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 at a 'Low' to 'Medium' frequency, the overall level of adverse effect is assessed as being 'Moderate'.

3.4.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-38.

Table 3-38: Summary of potential magnitude and level of effect for Owhiro Bay, Island Bay, Houghton Bay and Princess Bay

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	High	High
Aquatic ecology	High	High
Cultural	Very High	Moderate
Aesthetic	High	Moderate

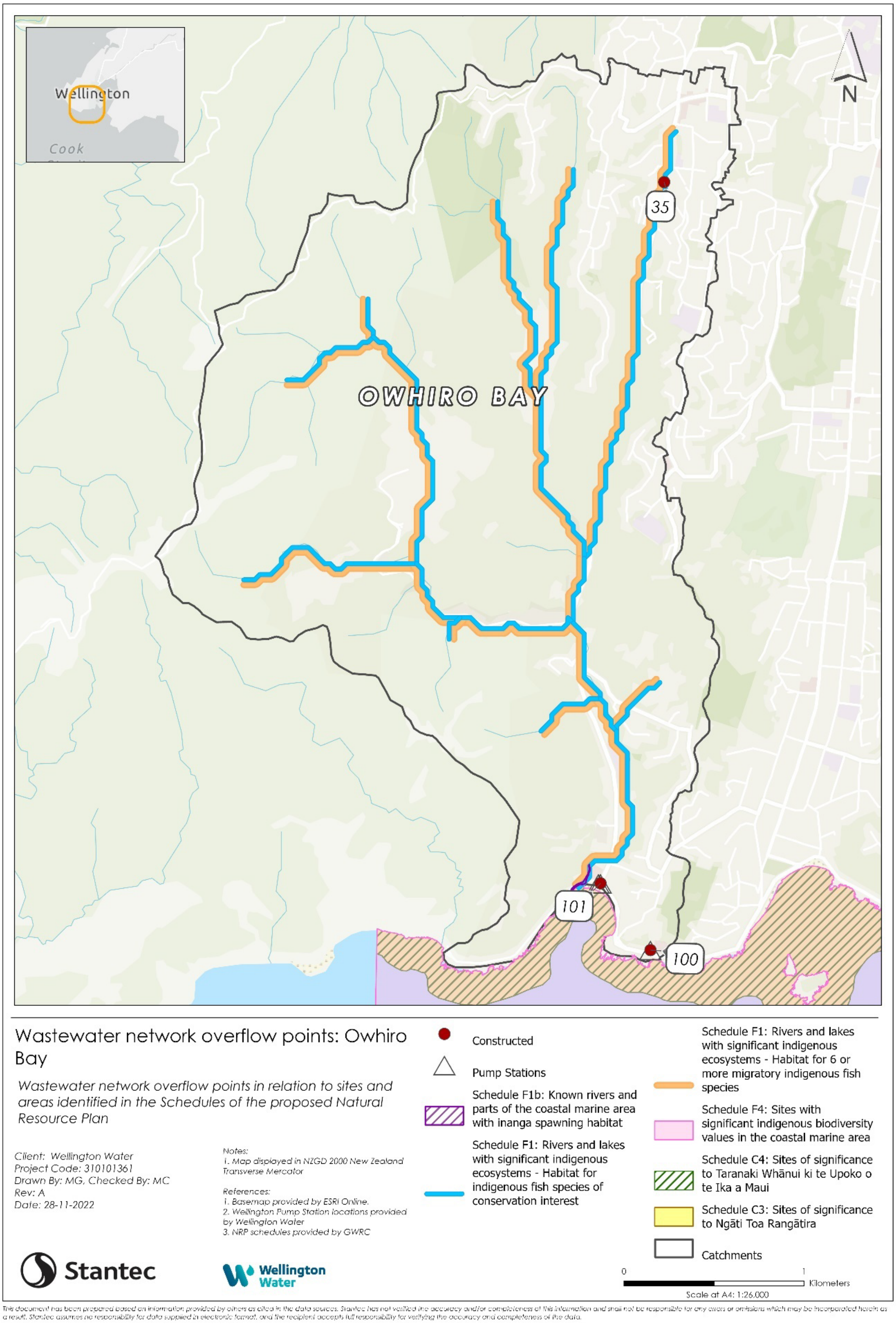

Figure 3-3: WNOs in the Owhiro Bay catchment

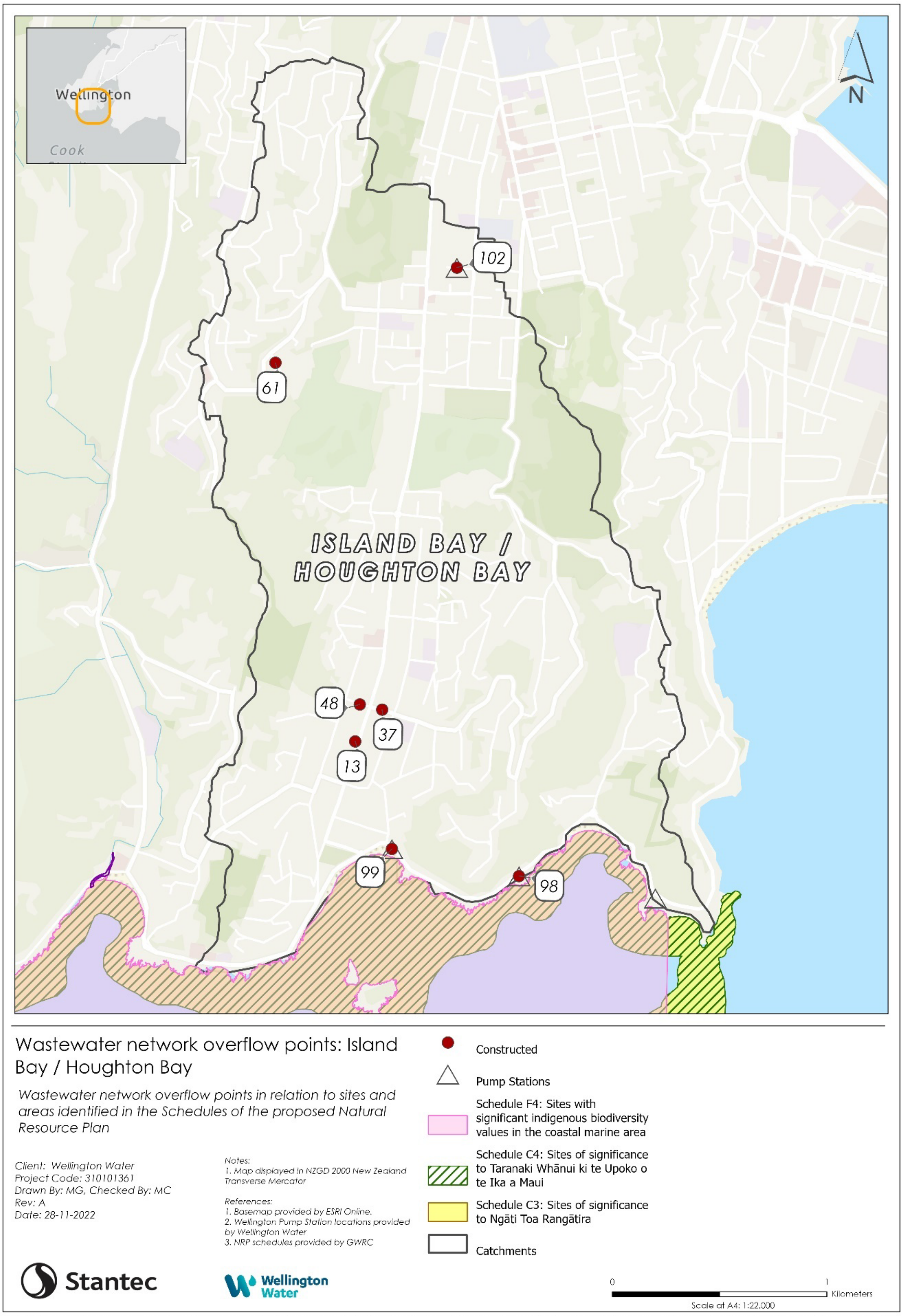

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Figure 3-4: WNOs in the Island Bay/Houghton Bay catchment

3.5 Lyall Bay

3.5.1 Description of the Receiving Environment

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

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

Table 3-39 summarises the results of GWRC & WCC recreational water quality monitoring at Lyall Bay over five-year period to March 2022. Lyall Bay achieved the PNRP Objective O18 enterococci Objective at all three sites (green shading) except for the Tirangi Road site in the 2019 to 2022 compliance period (pink shading). These results indicate a local source of faecal contamination in the eastern Lyall Bay.

Table 3-39: Summary statistics for enterococci at Lyall Bay (GWRC data 2017-2022)

Site name	N samples	% Over 140 cfu/100mL	% Over 500 cfu/100mL	Median cfu/100mL	95th percentile cfu/100mL (3 years)			PNRP O18 95th percentile
					2017/20	2018/21	2019/22	
Lyall Bay @Queens	83	4	0	8	108	120	148	≤500
Lyall Bay @Onepu	83	4	0	4	62	64	77	≤500
Lyall Bay @Tirangi	184	10	4	8	330	500	520	≤500

The marine ecology of Lyall Bay is described by James, et al, (2016) in an AEE prepared for Wellington International Airport Ltd. The authors reported a low overall abundance of epifaunal communities (animals living on the surface of the seabed), as would be expected with a dynamic, exposed, highly mobile fine sand dominated habitat. The macrofauna living within the sediment were also not abundant, which is also expected in that environment.

Rocky reef habitats are found all along the exposed southern Wellington coast supporting a rich and diverse community of brown, red and green macroalgae which in turn support a rich reef community of a range of fauna including gastropods, paua, kina and rock lobsters (MacDiarmid, et al, 2015). James et al (2016) observed that communities found on the reefs off the southern end of the runway are typical of those found along the Wellington coastline. Large strap-like canopy-forming macro-algal species (e.g. *Lessonia variegata* and *Macrocystis pyrifera*) were common in the sub-tidal parts of all transects, except the one directly off the end of the runway. Crusting and turfing red algae occurred intertidally along most transects except the one off the end of the runway. The transect off the end of the runway was dominated by fine-branched red algae.

James et al (2016) observed that the artificial substrates (e.g., Akmons) in the inter-tidal and sub-tidal zones along the edge of the runway provide habitat for a range of species including green tubular “ulva” like algae and/or the red algae Pyropia. Broken rubble habitats (cobbles-gravel-sand) supported more red algae and bryozoans. Small patch reefs (<2m^2) with macroalgae holdfasts of giant kelp (*Macrocystis pyrifera*) were also observed in the centre of Lyall Bay at depths of 10-13 m. Sponges, bryozoans and ascidians were common in the subtidal zones along all reefs with sponges more common in the mid or lower parts of transects and acidians very common on reefs off the breakwater. Over 40 other species were found on the reefs at low densities. Barnacles were the most common taxa intertidally along with periwinkles and limpets while sea-urchins occurred subtidally. Paua and rock lobster were uncommon but paua were associated with both natural bedrock and artificial substrate. A range of invertebrate taxa were found on concrete structures in the intertidal zone including periwinkles, snails, limpets, chitons and barnacles (MacDiarmid et al. 2015). Barnacles and snails were more common on rougher surfaces and chitons on smooth surfaces.

Lyall Bay has a moderately diverse fish community with 27 species of reef fish predicted to occur, none are nationally threatened. In order of increasing abundance these 27 species include blue dot triple fin, common conger eel, Yaldwyns's triplefin, leather jacket, sea perch, rock cod, scaly head triplefin, scarlet wrasse, variable triplefin, spectacled triplefin, red moki, butterfish, red-banded perch, yellow-black triplefin, banded triplefin, blue moki, marble fish, blue-eyed triplefin, common triplefin, common roughy, tarakihi, blue cod, banded wrasse, oblique-swimming triplefin, butterfly perch, and spotty (MacDiarmid et al. 2015). The most abundant species during dive surveys were spotties and banded wrasse which occurred on all transects and the number and type of species showed good agreement with the predicted distributions from models of distribution around the New Zealand coastline. Along with tarakihi and blue cod these species are common on reefs throughout Lyall Bay and the south coast.

Forty-four demersal species are predicted to occur in Lyall Bay but only 11 species are likely to be common. The 11 species likely to be commonly found in Lyall Bay are barracouta, blue cod, leatherjacket, lemon sole, red cod, spiny dogfish, spotty, silver warehou, tarakihi, common warehou, and witch. No species is confined to Lyall Bay and all species are ubiquitous throughout the region (MacDiarmid et al. 2015). It should be noted that the modelling of fish distributions and abundance is based on a very large and comprehensive data set of diver observations and trawl surveys.

Table 3-40 provides an assessment of against PNRP Objective O19. Significant values associated with Lyall Bay as scheduled in the PNRP are summarised in Table 3-41 and categorised for the wastewater network overflow assessment in Table 3-42.

Table 3-40: Assessment of Lyall Bay 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	James et al (2016) describes a relatively sparse benthic fauna in Lyall Bay which is consistent with the dynamic, exposed, highly mobile fine sand dominated habitat. Macro-algal species associated with rock reef habitat were common off the southern end of airport runway, while crusting and turfing red algae occurred intertidally along most transects except the one off the end of the runway. The transect off the end of the runway was dominated by fine-branched red algae. The authors described moderately diverse fish community in Lyall Bay including 27 species of reef fish, but none that are nationally threatened. Although James et al (2016) did not specifically address Mahinga kai species, the assessment indicates that all four of the O19 objectives listed above are likely to be met.			

Table 3-41: Environmental and cultural values identified for Lyall Bay in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Raukawa Moana (Cook Strait)
C3	Sites with significant mana whenua values	Hue te Taka Peninsula and Te Raekaihau Point Reef Taranaki Whānui ki te Upoko o te Ika a Mau and Ngāti Toa Rangātira
F2	Indigenous bird habitat	South Coast
F5	Habitats with significant indigenous biodiversity values in the coastal marine area	Giant kelp, kelp beds, subtidal rock reefs

Table 3-42: Lyall Bay receiving environment characteristics

Receiving environment	Type	Recreation	Ecology	Cultural	Aesthetic
Lyall Bay	Open coast	Class 1	Class 1	Class 1	Class 1

3.5.2 Summary of Overflow Characteristics

There are eight direct overflows to Lyall Bay, all of which are 'Low' volume and 'Low' frequency discharges as detailed in Table 3-43.

Table 3-43: Summary of overflow characteristics, Lyall Bay

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	number	Range		
57	Direct	14	Low	1	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
96	Direct	-	Low	-	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
116	Direct	323	Low	-	Low	Operative	Wellington Water Overflow Forms 2018-2021
14, 81, 84, 93, 97	Direct	-	Low	-	Low	Operative	No data recorded

3.5.3 Potential Public Health Effects

'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 3-44. 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 3-45. The assessed overall level of public health effect at Lyall Bay is 'Low'.

Table 3-44: Magnitude of public health effects from overflows to Lyall Bay

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 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 harvesting seaweed	**Effects Score of 3 (moderate)**, because seaweed can be a hydraulic trap for particulate contaminants.

Table 3-45: Overall level of public health effect from overflows to Lyall Bay

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall level of Public Health Effect
57	Direct	**Moderate**	Low	**Low**
96	Direct	**Moderate**	Low	**Low**
116	Direct	**Moderate**	Low	**Low**
14, 81, 84, 93, 97	Direct	**Moderate**	Low	**Low**

3.5.4 Potential Ecological Effects

All direct overflows to Lyall Bay are 'Low' volume and 'Low' frequency discharges. 'Low' volume discharges to beaches with Class 1 ecological values are assessed as having 'Very Low' to 'Low' potential effects on ecological values, as shown in Table 3-46. Beaches are likely to have high dilution rates and are generally able to absorb 'Low' volume overflows.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-47. In this case the frequency of overflow events is in the 'Low' range and the overall level of ecological effects is 'Very Low'.

Table 3-46: Magnitude of ecological effects from overflows to Lyall Bay

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, and nitrate.	**Effects Score of 2 (Low)**, because the dilution of overflows means that nutrient concentrations and toxicants 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.
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.

Table 3-47: Overall level of ecological effect from overflows to Lyall Bay

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall Level of Ecological Effect

57	Direct	**Low**	Low	**Very Low**
96	Direct	**Low**	Low	**Very Low**
116	Direct	**Low**	Low	**Very Low**
14, 81, 84, 93, 97	Direct	**Low**	Low	**Very Low**

3.5.5 Potential Cumulative Effects

For the Lyall Bay receiving environment, cumulative effects are considered to be unlikely as all eight overflows are of 'Low' volume and 'Low' frequency.

3.5.6 Potential Cultural Effects

Lyall Bay is assessed as having 'Very Important' cultural values (Class 1). The overflow discharges are 'Low' volume; cultural effects are assessed as 'Moderate'. Because the overflows occur at a 'Low' frequency, the overall level of cultural effects is assessed as 'Low'.

3.5.7 Potential Aesthetic Effects

Lyall Bay is assessed as being a 'High' aesthetic value (Class 1). 'Low' volume discharges into such an environment have 'High' potential to affect these values. However, because the overflows occur with 'Low' frequency, the overall level of adverse effect is assessed as being '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 3-48.

Table 3-48: Summary of potential magnitude and overall level of adverse effect in Lyall Bay

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	Moderate	Low
Aquatic ecology	Low	Very Low
Cultural	Moderate	Low
Aesthetic	High	Low

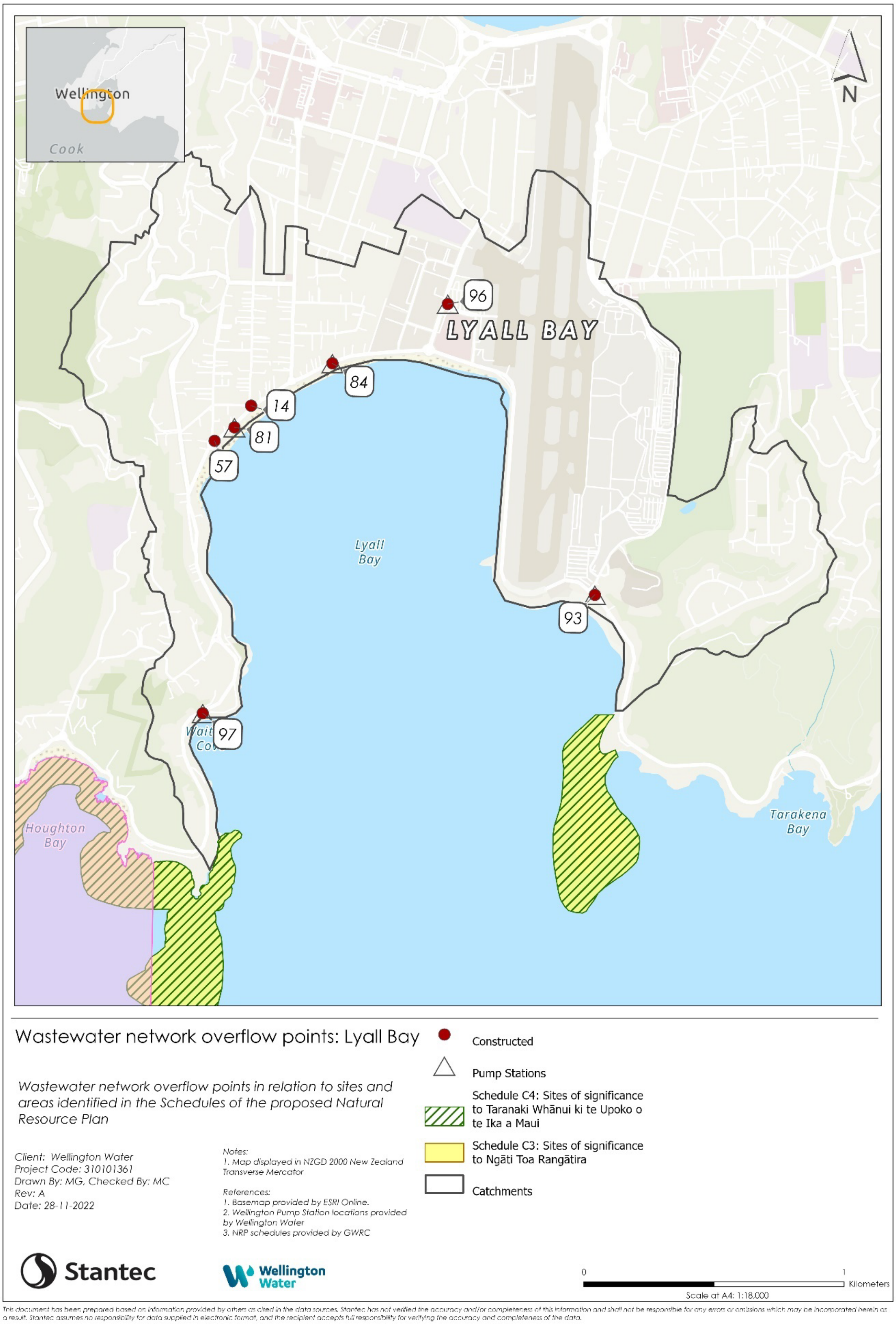

Figure 3-5: WNOs in the Lyall Bay catchment

3.6 Miramar Peninsula East Coast

3.6.1 Description of the Receiving Environment

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

The stormwater catchment does not form a single drainage area but rather a series of minor catchments, which have a limited stormwater collection system, or none at all. To the north and south, stormwater discharges through a series of small outfalls along the coast or in overland flow.

The southern end of the Miramar Peninsula, from Hue te Taka Point to Point Dorset, consists of very exposed rocky reef, which is subject to extreme wave action and is characterised by dramatic geomorphology with many deep clefts and cuts in the rock (MWH, 2003). The Southeast Coast is suitable for walking, picnicking, watching ships enter and leave the harbour, and admiring the ocean views. Breaker Bay is a picturesque sandy cove is part of the Oruaiti Reserve. Tracks lead from the beach to the escarpment, cliffs and ridgeline. The Eastern Walkway begins nearby and has excellent views of the harbour entrance and Pencarrow Head.

North of Point Dorset, from Seatoun to Scorching Bay, the coastline varies from rocky shore to sandy beaches. Worser Bay Beach is a large, sandy inner-harbour beach with views of the Orongorongo Range across the harbour, Steeple Rock and Seatoun Beach. In summer, its calm waters make it a popular destination for families, and it is also well- used by the local yacht club. A large area of sand dunes at the southern end of the beach planted with marram and pingao is an attractive feature of the beach.

The northern end of the beach is the site of the Worser Bay Lifesaving Club (established in 1910) and the Worser Bay Boating Club (established in 1926). The bay was the site of a pilot station in the 1860s and was given its name after pilot James Heberley's frequent comment that the weather was getting 'worser'. Eventually the bay became known as old Worser's Bay (Diffuse Sources, 2014).

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

Table 3-49 summarises the results of GWRC & WCC recreational water quality monitoring along the eastern bays of Miramar Peninsula over five-year period to March 2022. The lack of urban development at the southern and northern ends of the Peninsular and strong tidal flushing from Cook Strait are reflected in very low concentrations of faecal indicator bacteria in these coastal waters. Sites at Breaker Bay, Seatoun Beach and Worser Bay all comfortably achieving the PNRP O18 Objective for enterococci.

Table 3-49: Summary statistics for enterococci at Miramar Peninsula east coast (GWRC data 2017-2022)

Site Name	N Samples	% Over 140 cfu/100mL	% Over 500 cfu/100mL	Median cfu/100mL	95th percentile cfu/100mL (3 years)			PNRP O18 95th percentile
					2017/20	2018/21	2019/22	
Breaker Bay	83	1.2	1.2	<2	76	35	19	≤500
Seatoun@Inglis	87	5.7	0	<2	92	78	220	≤500
Seatoun@Wharf	84	4.8	0	4	89	77	162	≤500
Worser Bay	85	5.9	0	4	141	120	166	≤500

Table 3-50 provides an assessment of against PNRP Objective O19. Significant values associated with the Miramar coast as scheduled in the PNRP are summarised in Table 3-51 and categorised for the wastewater network overflow assessment in Table 3-52.

Table 3-50: Assessment of Miramar Peninsula east coast 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	We have not sighted any marine ecology information relating specifically to Miramar east coastal waters. However, given the relatively low density of urban development in east Miramar catchments and the consistently high water quality, it is reasonable to assume that the rocky reef habitat will support a rich and diverse community of brown, red and green macroalgae which in turn support a rich reef community of a range of fauna including gastropods, paua, kina and rock lobsters.			

Table 3-51: Environmental and cultural values identified for Miramar east coast in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Te Whanganui a Tara (Wellington Harbour)
C3	Sites with significant mana whenua values	Te Tangihanga a Kupe (Barrett Reef) Taranaki Whānui ki te Upoko o te Ika a Mau and Ngāti Toa Rangātira
F2	Indigenous bird habitat	South Coast & Wellington Harbour
F5	Habitats with significant indigenous biodiversity values in the coastal marine area	Giant kelp, kelp beds, subtidal rock reefs

Table 3-52: Miramar Peninsula east coast receiving environment characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
Miramar Peninsula east coast	Outer Harbour	Class 1	Class 1	Class 1	Class 1

3.6.2 Summary of Overflow Characteristics

There are eight direct overflows to the Miramar Peninsula area, all of which are 'Low' volume and 'Low' frequency discharges as detailed in Table 3-53.

Table 3-53: Summary of overflow characteristics, Miramar Peninsula east coast

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
62, 88	Direct	-	Low	2	Low	Operative	Stantec Overflow Model 2021
87, 89, 91, 94, 95, 103	Direct	-	Low	-	Low	Operative	No data recorded

3.6.3 Potential Public Health Effects

'Low' volume discharges to Harbours with Class 1 recreational values are assessed as having a 'Low' potential effect on all recreational activities, as shown in Table 3-54. 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 3-55. The assessed overall level of public health effect at Miramar Peninsula is 'Very Low'.

Table 3-54: Magnitude of public health effects from overflows to Miramar Peninsula east coast

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 fishing	
Loss of suitability for collecting shellfish	
Loss of suitability for harvesting seaweed	

Table 3-55: Overall level of public health effect in Miramar Peninsula east coast

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall level of Public Health Effect
62, 88	Direct	**Low**	Low	**Very Low**
87, 89, 91, 94, 95, 103	Direct	**Low**	Low	**Very Low**

3.6.4 Potential Ecological Effects

All direct overflows to the Miramar Peninsula area are 'Low' volume and 'Low' frequency discharges. 'Low' volume discharges to harbours with Class 1 ecological values are assessed as having 'Low' potential effects on ecological values, as shown in Table 3-56.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-57. In this case the frequency of overflow events is in the 'Low' range and the assessed overall level of ecological effect is 'Very Low'.

Table 3-56: Magnitude of ecological effects of overflows to Miramar Peninsula east coast

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, and nitrate.	**Effects Score of 2 (Low)**, because the dilution of overflows means that nutrient concentrations and toxicants 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 1 (Very low)**, because the dilution of overflows means that nutrient concentrations and temperature 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.

Table 3-57: Overall level of ecological effects in Miramar Peninsula east coast

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall level of ecological Effect
62, 88	Direct	**Low**	Low	**Very Low**
87, 89, 91, 94, 95, 103	Direct	**Low**	Low	**Very Low**

3.6.5 Potential Cumulative Effects

For the Miramar Peninsula East Coast receiving environment, cumulative effects are considered to be unlikely as because all the eight direct overflows are of ‘Low’ volume and ‘Low’ frequency.

3.6.6 Potential Cultural Effects

The Miramar Peninsula is assessed as having ‘Very Important’ cultural values (Class 1).

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

3.6.7 Potential Aesthetic Effects

The Miramar Peninsula is assessed as having a ‘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 adverse effect is assessed as being ‘Low’.

3.6.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-58.

Table 3-58: Summary of potential magnitude and level of adverse effects for Miramar Peninsula east coast

Value category	Potential magnitude of effect	Overall level of adverse effect
Public health	Low	Very Low
Aquatic ecology	Low	Very Low
Cultural	Moderate	Low
Aesthetic	High	Low

Figure 3-6: WNOs in the Miramar Peninsula East Coast catchment

3.7 Evans Bay

3.7.1 Description of the Receiving Environment

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

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

Table 3-59 summarises the results of GWRC & WCC recreational water quality monitoring in Evans Bay over five-year period to March 2022. All three sites in Evans Bay comfortably achieved the PNRP O18 Objective for enterococci.

Table 3-59: Summary statistics for enterococci at Evans Bay (GWRC data 2017-2022)

Site name	N samples	% Over 140 cfu/100mL	% Over 500 cfu/100mL	Median cfu/100mL	95th percentile cfu/100mL (3 years)			PNRP O18 95th percentile
					2017/20	2018/21	2019/22	
Shark Bay	87	7	0	4	150	144	150	≤500
Hataitai Beach	85	6	1	4	208	250	192	≤500
Balaena Bay	86	7	1	4	117	140	305	≤500

The marine ecology of Evans Bay is described by Morrisey et al. (2019). Side scan images in Evans Bay show few features, results consistent with a uniform, soft mud substratum. Inshore near Kio Bay and Greta Point the scans show coarser sediments with bedrock, boulders and cobbles. Analysis of core samples revealed that the abundance and diversity of animals within sediments was much higher in Evans Bay than in the more homogenous muds of the main harbour.

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

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

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

noted that these new species belong to genera in need of taxonomic and molecular reassessment, and it is not surprising to discover this diversity when samples are sequenced. These species are also likely to occur in other localities in Wellington Harbour and further afield.

GWRC's most recent Wellington harbour marine sediment quality investigations (Cummings, et al., 2021) in Evans Bay. Sediments at site WH1B in eastern Evans Bay exceeded the ANZG (2018) DGV for mercury, ARC red for lead and ARC amber (early warning)for copper and zinc. Sediments at WH2B at northern Evans Bay and EB2 in southern Evans Bay exceeded the ANZG (2018) DGV for mercury and ARC amber for lead. It is likely that mercury and lead are legacy contaminants while copper and zinc continue to be discharged to the marine environment via stormwater runoff. Cummings, et al. (2021) conclude that the high number of exceedances demonstrate that there is reason for concern about contamination in Wellington Harbour sediments. Arsenic, cadmium, chromium, nickel and total PAH were, however, below concentration ANZG (2018) DGV guidelines at all sites.

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

Fish species historically important to iwi in the Wellington Harbour have included red cod (*Pseudophycis bachus*), snapper (*Pagrus auratus*), gunard (*Chelidonichthys kumu*), kahawai (*Arripis trutta*),tarakihi (*Nemadectylus macropterus*), john dory (*Zeus faber*), wrasse (*Notolabrus facicola*), travelly (*Pseudocaranx dentex*), rig (spotted smooth hound) (*Mustelus lenticulatus*), batfish species, various species of shark, and flatfish (e.g. flounder *Rhombosolea plebeia*) (Rob Greenaway & Associates, 2016; Tonkin & Taylor Ltd, 2016).

Kahawai, snapper, tarakihi, cod and gurnard are the most commonly caught recreational fish, though there is also a wide variety of less common species such as elephant fish, skate, leather jackets and kingfish.[9]

Table 3-60: Assessment of Evans Bay 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	Morrisey et al. (2019) describe diverse and abundant assemblages of plants and animals in Evans Bay including the *Adamsiella* beds which are recognised in schedule F5 of the PNRP as having significant biodiversity values in the coastal marine area. We have not sighted information relating to Mahina kai species of Evans Bay. On balance the available information suggests that Objective O19 is at least partially met.			

Significant values associated with Miramar's east coastal as scheduled in The Natural Resources Plan are summarised in Table 3-61 and categorised for the wastewater network overflow assessment in Table 3-62.

[9] https://stevesfishingshop.co.nz/pages/tips-n-info August 2018

Table 3-61: Environmental and cultural values identified for Evans Bay in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Te Whanganui a Tara (Wellington Harbour)
F2	Indigenous bird habitat	Wellington Harbour
F5	Habitats with significant indigenous biodiversity values in the coastal marine area	*Adamsiella* beds

Table 3-62: Evans Bay receiving environment characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
Evans Bay	Inner Harbour	Class 1	Class 1	Class 1	Class 1

3.7.2 Summary of Overflow Characteristics

There are 17 direct overflow points into the Evans Bay receiving environment. Of these, 13 are assessed to be 'Low' volume and 'Low' frequency occurrences, two with 'Low' volume and 'Medium' frequency, one with 'Medium' volume and 'Medium' frequency and one with 'Medium' volume and 'High' frequency. Overflow characteristics are summarised in Table 3-63.

Table 3-63: Summary of overflow characteristics, Evans Bay

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
23, 32	Direct	65 - 537	Low	5 - 9	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
85	Direct	1197	Medium	4	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
28	Direct	-	High	4	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
20, 43, 46, 58, 76, 77, 78, 79, 80, 86	Direct	-	Low	2	Low	Operative	Stantec Overflow Model 2021
9	Direct to land	-	Low	-	Low	Operative	Customer Recorded Overflow
15, 92	Direct	-	Low	-	Low	Operative	No data recorded

3.7.3 Potential Public Health Effects

'High' volume discharges to inner harbour areas with Class 1 recreational values are assessed as having a 'High' potential effect on all recreational activities, and a high overall level of adverse effects as shown in Table 3-64 and Table 3-65.

Table 3-64: Magnitude of public health effects from overflows to Evans Bay

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for activities on land. This effect is predominantly linked to the discharge faecal material on land where direct physical contact is likely.	**Effects Score of 5 (Very High)** for activities on land in the vicinity of an uncontrolled overflow, because a residential property is affected.
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 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 harvesting seaweed	**Effects Score of 4 (High)**, because seaweed can be a hydraulic trap for particulate contaminants.

Table 3-65: Overall level of public health effects in Evans Bay

Overflow ID	Direct/Indirect	Potential Magnitude of Public Health Effect	Overflow Frequency Range	Overall level of Public Health Effect
23, 32	Direct	Moderate	Medium	Moderate
85	Direct	**High**	Medium	**High**
28	Direct	**High**	Medium	**High**
20, 43, 46, 58, 76, 77, 78, 79, 80, 86	Direct	Moderate	Low	Low
9	Direct to land	**Very High**	Low	**High**
15, 92	Direct	Moderate	Low	Low

3.7.4 Potential Ecological Effects

'High' volume discharges to an inner harbour area with Class 1 ecological values are assessed as having predominantly 'High' potential effects on ecological values, as shown in Table 3-66. Inner harbours provide some dilution and/or flushing.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarized in Table 3-67. In this case the magnitude of effect is 'High' and the frequency of overflow is 'Medium', resulting in an overall level effect of 'High'.

Table 3-66: Magnitude of ecological effects of overflows to Evans Bay

Potential Effect	Magnitude of Ecological 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, and nitrate.	**Effects Score of 4 (High)**, because nutrient concentrations and toxicants are likely to 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.

Potential Effect	Magnitude of Ecological Effect
Behavioural changes in fin fish	**Effects Score of 2 (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 4 (High)**, because elevated nutrient concentrations are likely to stimulate plant growth.
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 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.

Table 3-67: Level of ecological effects in Evans Bay

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall level of Ecological Effect
23, 32	Direct	Moderate	Medium	Moderate
85	Direct	**High**	Medium	**High**
28	Direct	**High**	Medium	**High**
20, 43, 46, 58, 76, 77, 78, 79, 80, 86	Direct	Moderate	Low	Low
9	Direct	Moderate	Low	Low
15, 92	Direct	Moderate	Low	Low

3.7.5 Potential Cumulative Effects

For the Evans Bay receiving environment, cumulative effects are likely to occur because:

- There are a comparatively large number of overflow points that could potentially discharge (17direct overflows), although these are spatially well separated.
- Although most overflows are of 'Low' volume and 'Low' frequency, there are four overflows which have a 'Medium' frequency with volumes ranging from 'Low' to 'High'.
- WNO sites 23, 28, 32 and 85 have been historically recorded to operate more than four times in an average 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 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 effects and 'High' ecological effects. As these discharges have already been assessed in earlier in this AEE as having potentially 'High' magnitude of potential public health and ecological effects individually, the cumulative effect would not be notably different.

3.7.6 Potential Cultural Effects

Evans Bay is assessed as having 'Very Important' cultural values (Class 1).

The overflow discharges are 'Low' to 'Medium' volume; cultural effects are assessed as 'High'. Because the overflows range from 'Low' to 'High' frequency, the overall level of cultural effects is assessed as 'High'.

3.7.7 Potential Aesthetic Effects

Evans Bay is assessed as having a 'High' aesthetic value. 'Medium' volume discharges to such an environment have a 'High' potential to affect these values. As the overflows range from 'Low' to 'High' frequency, the overall level of adverse effect is assessed as being 'High'.

3.7.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-68.

Table 3-68: Summary of potential magnitude and overall level of effects for Evans Bay

Value Category	Potential Magnitude of effect	Overall Level of Adverse Effect
Public health	High	High
Aquatic ecology	High	High
Cultural	High	High
Aesthetic	High	High

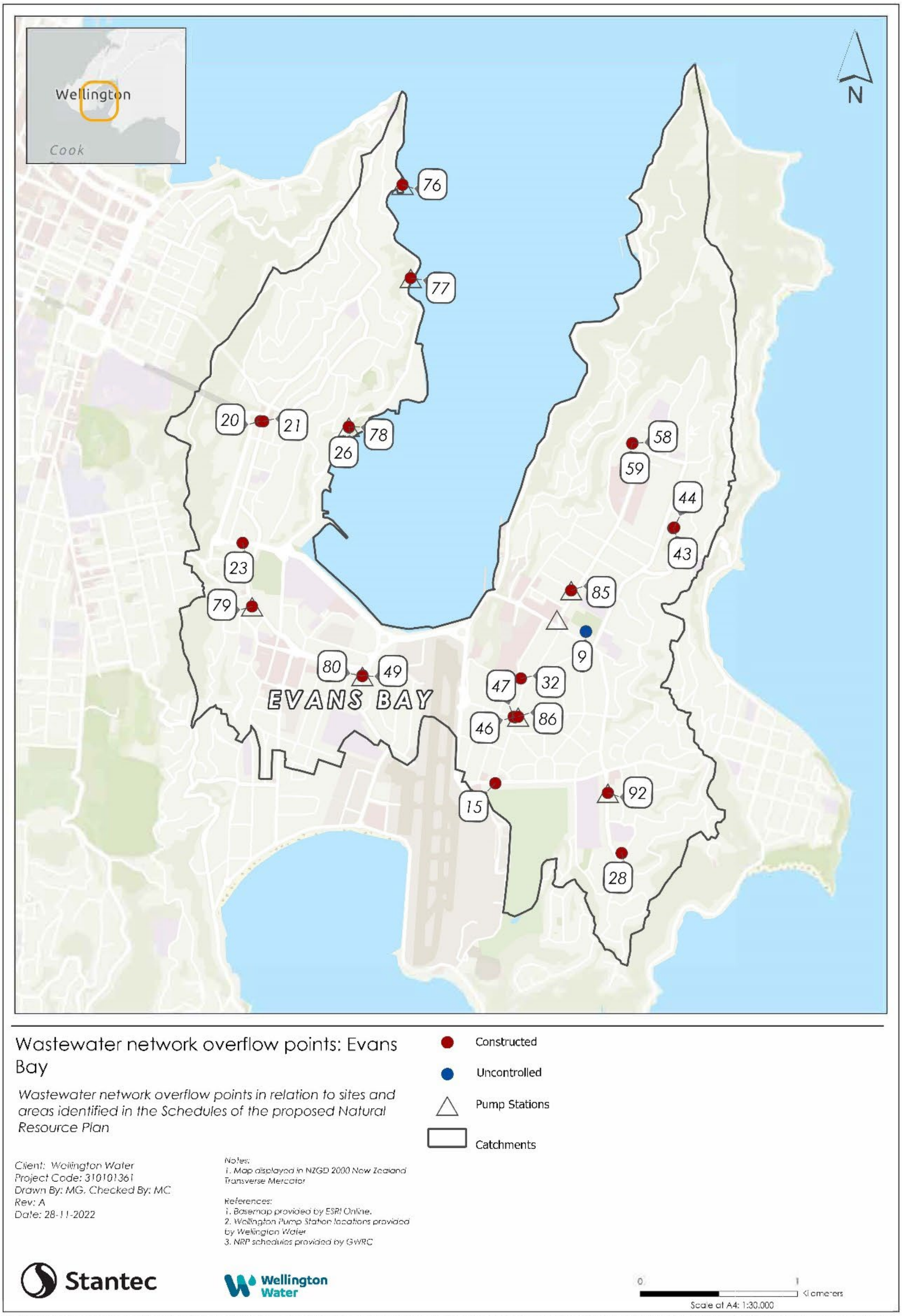

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Figure 3-7: WNOs in the Evans Bay catchment

3.8 Wellington CBD Streams

The urbanisation of the Lambton Harbour catchment has resulted in only 31% of the land area remaining as open space. The remaining 69% of the catchment is built-up and consists of the Wellington CBD and surrounding hill suburbs.The watercourses are highly modified, with all streams having all or most of their lengths piped (Figure 3-8). No watercourses flow freely to the ocean as open channels, and the remnant open sections typically occur in the remaining vegetated open space encompased by the Town Belt, reserves, and Botanic Gardens. Many of the remnant open channels are ephemeral overland flow paths with no or limited aquatic fauna. However James (2015) identified several permanently flowing streams where banded kōkopu and/or koura are present, including Papawai Stream, Motturoa Stream and Waimapihi Stream.

The great majority of WNO's in the Lambton Harbour catchment discharge into the stormwater network and are piped to the harbour. Those WNO's are addressed in the following section.

Figure 3-8: Wellington CBD streams are piped for most or all their length, except for some headwaters

3.9 Lambton Harbour and Oriental Bay

3.9.1 Description of the Receiving Environment

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

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

Table 3-69 summarises the results of GWRC & WCC recreational water quality monitoring in Oriental Bay and Lambton Harbour over five-year period to March 2022. All sites except the Taranaki Street dive platform site achieved the PNRP O18 enterococci objective. The dive platform is close to the outlet from the Taranaki Street stormwater culvert which has a history of faecal contamination.

Table 3-69: Summary statistics for enterococci at Lambton Harbour (GWRC data 2017-2022)

Site Name	N Samples	% Over 140 cfu/100mL	% Over 500 cfu/100mL	Median cfu/100mL	95th percentile cfu/100mL (3 years)			PNRP O18 95th percentile
					2017/20	2018/21	2019/22	
Oriental Bay @Rotunda	91	13	1	4	281	263	437	≤500
Oriental Bay @WW	186	10	1	8	270	290	258	≤500
Oriental @Freyberg	88	5	0	2	65	53	94	≤500
Wellington Harbour @ Taranaki St dive platform	100	26	16	48	979	987	2140	≤500
Whairepo Lagoon	97	10	2	12	310	193	348	≤500
Wellington Harbour @ Shed 6	85	16	2	8	268	277	333	≤500

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

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

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

Such effects are not always observed near outfalls. At Queens Wharf, in the vicinity of the Harris Street and Waring Taylor Street outfall, surveys in 1995 found benthic communities were (relatively) stable and did not exhibit signs of ecological stress or pollution-induced disturbance (Anderlini & Wear 1995). Both these outfalls discharge stormwater from relatively small catchments, so possibly stormwater effects were difficult to distinguish from other perturbations and stressors close to the wharves.

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

As part of the 2020 Wellington Harbour subtidal sediment sampling programme, Cummings, et al. (2021b) trialled two benthic health models (BHM) which had previously been used to track the health of New Zealand's intertidal estuarine benthic communities in response to increased surface sediment mud content ('BHMmud'), and lead, copper and zinc contamination ('BHMmetal').

The intertidal mud model was checked against the percentage mud concentrations measured at each of the subtidal sites and, as they did not fit the model well, it was deemed inappropriate to run the mud model for Wellington Harbour. The BHMmetal model, checked against the actual concentrations of copper, lead and zinc at the Wellington Harbour sites, revealed a reasonable fit with the intertidal model. The output from the BHMmetal model is that the majority of the Wellington Harbour sites were categorised as 'good', with only EB2 (in southern Evans Bay) in the 'moderate' category.

Fish species historically important to iwi in the Wellington Harbour have included red cod (*Pseudophycis bachus*), snapper (*Pagrus auratus*), gunard (*Chelidonichthys kumu*), kahawai (*Arripis trutta*),tarakihi (*Nemadectylus macropterus*), john dory (*Zeus faber*), wrasse (*Notolabrus facicola*), travelly (*Pseudocaranx dentex*), rig (spotted smooth hound) (*Mustelus lenticulatus*), batfish species, various species of shark, and flatfish (e.g. flounder *Rhombosolea plebeia*) (Rob Greenaway & Associates, 2016; Tonkin & Taylor Ltd, 2016). Kahawai, snapper, terakihi, cod and gurnard are the most commonly caught recreational fish, though there is also a wide variety of the more unusual species such as elephant fish, skate, leather jackets and kingfish[10].

Table 3-70 provides an assessment of against PNRP Objective O19. Significant values associated with Lambton Harbour as scheduled in the PNRP are summarised in Table 3-71 and categorised for the wastewater network overflow assessment in Table 3-72.

[10] https://stevesfishingshop.co.nz/pages/tips-n-info August 2018

Table 3-70: Assessment of Lambton Harbour 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	The studies referenced above, although now dated, indicate a poor condition of the ecological community in Lambton Harbour near wharves and major stormwater outlets, which likely would not meet the O19 objectives. However, community health is much improved outside of these areas.			

Table 3-71: Environmental and cultural values identified for Lambton Harbour in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Te Whanganui a Tara (Wellington Harbour)
C3	Sites with significant mana whenua values	Te Aro pā Ngāti Toa Rangātira
E	Historic heritage structure	Oriental Bay Seawall, Clyde Quay Boat Harbour, Taranaki Street Wharf & Terminal Breastwork, Queens Wharf, Waterloo Quay Wharf, Railway Wharf, Glasgow Wharf
F2	Indigenous bird habitat	Wellington Harbour
Policies P12, P13	Commercial Port Area	Lambton Harbour

Table 3-72: Lambton Harbour receiving environment characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
Lambton Harbour	Inner Harbour	Class 1	Class 3	Class 1	Class 1

3.9.2 Summary of Overflow Characteristics

There are 43 direct overflows into Lambton Harbour. Of these 30 are assessed to be 'Low' volume and 'Low' frequency overflows. The remaining overflows range from 'Low' to 'High' volumes and 'Low' to 'High' frequencies.

Table 3-73: Summary of overflow characteristics, Lambton Harbour

Overflow ID	Direct/ Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
19	Direct	-	Low	-	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
66, 73	Direct	-	Low	0 - 1	Low	Operative	Wellington Water Overflow Forms 2018-2021

Overflow ID	Direct/ Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
33, 38, 50, 72	Direct	7 - 95	Low	3 - 4	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
52	Direct	310	Low	11	High	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
65	Direct	-	Medium	3	Medium	Operative	Wellington Water Overflow Forms 2018-2021
34, 40	Direct	2,101 – 2,623	Medium	12 - 21	High	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
1	Direct	-	High	9	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
56	Direct	10,118	High	5	Medium	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
64	Direct	-	High	3	Medium	Operative	Wellington Water Overflow Forms
2, 63, 68	Direct	-	Low	2	Low	Operative	Modelled
7	Direct to land	-	Low	-	Low	Operative	Observed
8, 16, 17, 22, 30, 39, 41, 42, 51, 54, 55, 60, 67, 69, 70, 71, 74, 75, 82, 83, 90, 104, 105, 112	Direct	-	Low	-	Low	Operative	No data

3.9.3 Potential Public Health Effects

Lambton Harbour and Oriental Bay is a highly valued recreational area that includes significant water recreational use and several popular bathing areas. ‘High’ volume discharges to inner harbour areas with Class 1 recreational values are assessed as having a ‘High’ potential effect on all recreational activities, as shown in Table 3-74.

The overall level of public health effects is determined from the magnitude of effect and frequency of occurrence, as summarised in Table 3-75. In this case, the frequency of overflow events is in the ‘Moderate’ to ‘High’ range and the assessed overall level of effects is ‘Very High’.

Table 3-74: Magnitude of public health effects from overflows to Lambton Harbour

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for activities on land. This effect is predominantly linked to the discharge faecal material on land where direct physical contact is likely.	**Effects Score of 3 (Moderate)** for activities on land in the vicinity of uncontrolled overflow, because a public space is affected.
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 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 harvesting seaweed	**Effects Score of 4 (High)**, because seaweed can be a hydraulic trap for particulate contaminants.

Table 3-75: Overall level of public health effects in Lambton Harbour

Overflow ID	Direct/Indirect	Potential Magnitude of Public Health Effect	Overflow Frequency Range	Overall level of Public Health Effect
19	Direct	Moderate	Low	Low
66, 73	Direct	Moderate	Low	Low
33, 38, 50, 72	Direct	Moderate	Medium	Moderate
52	Direct	Moderate	High	High
65	Direct	**High**	Medium	High
34, 40	Direct	**High**	High	**Very High**
1	Direct	**High**	Medium	High
56	Direct	**High**	Medium	High
64	Direct	**High**	Medium	High
2, 25, 63, 68	Direct	Moderate	Low	Low
7	Direct to land	Moderate	Low	Low
8, 16, 17, 22, 30, 39, 41, 42, 51, 54, 55, 60, 67, 69, 70, 71, 74, 75, 82, 83, 90, 104, 105, 112	Direct	Moderate	Low	Low

3.9.4 Potential Ecological Effects

The great majority of WNO sites in the Lambton Harbour catchment discharge into the stormwater network and are piped to the inner harbour. ‘High’ volume discharges to an inner harbour area with Class 3 ecological values are assessed as having predominantly ‘Low’ potential effects on ecological values, as shown in Table 3-76.

Table 3-76: Magnitude of ecological effects of overflows to Lambton Harbour

Potential Effect	Magnitude of Ecological Effect
Change in physical habitat suitability	**Effects Score of 2 (Low)**, because of the high degree of background disturbance.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**Effects Score of 2 (Low)**, because nutrient concentrations and toxicants are unlikely to increase above background levels.
Change in community structure/loss of sensitive species	**Effects Score of 2 (Low)**, because of the high degree of background disturbance.
Behavioural changes in fin fish	**Effects Score of 1 (Very low)**, because of the high degree of background disturbance.
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 high degree of background disturbance.
Reduced quantities of shellfish	**Effects Score of 2 (Low)**, because of the high degree of background disturbance

Table 3-77: Overall level of ecological effects in Lambton Harbour

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall Level of Ecological Effect
19	Direct	Very Low	Low	Very Low
66, 73	Direct	Very Low	Low	Very Low
33, 38, 50, 72	Direct	Very Low	Low	Very Low
52	Direct	Very Low	High	Low
65	Direct	**Low**	Medium	Low
34, 40	Direct	**Low**	High	**Moderate**
1	Direct	**Low**	Medium	Low
56	Direct	**Low**	Medium	Low
64	Direct	**Low**	Medium	Low
2, 25, 63, 68	Direct	Very Low	Low	Very Low
7	Direct	Very Low	Low	Very Low
8, 16, 17, 22, 30, 39, 41, 42, 51, 54, 55, 60, 67, 69, 70, 71, 74, 75, 82, 83, 90, 104, 105, 112	Direct	Very Low	Low	Very Low

3.9.5 Potential Cumulative Effects

For the Lambton Harbour and Oriental Bay receiving environment, cumulative effects are considered likely because:

- There are a comparatively large number of overflow points that could potentially discharge (43 direct overflows).
- 30 of these overflows occur at a 'Low' volumes and 'Low' frequency.
- Five overflows (WNO sites 33, 38, 50, 52 and 72) occur with 'Low' volumes and frequencies ranging from 'Medium' to 'High'.
- The remaining eight overflows range from 'Medium' to 'High' volumes with 'Medium' to 'High' frequencies.

For spatial cumulative effects to arise, most of the discharges would need to occur at the same time, which is indeed likely. This would result in the total volume of wastewater discharges 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 discharges have already been assessed in earlier parts of the AEE as having 'Very High' potential health effects and 'Moderate' ecological effects individually, the cumulative effects would not be notably different from the assessment earlier in this AEE.

3.9.6 Potential Cultural Effects

Lambton Harbour and Oriental Bay are assessed as having 'Very Important' cultural values (Class 1).

The overflow discharges range from 'Low' to 'High' volumes; cultural effects are assessed as 'Very High'. Because the overflows occur also range from 'Low' to 'High' frequency, the overall level of cultural effects is assessed as 'High'.

3.9.7 Potential Aesthetic Effects

Lambton Harbour is assessed as having a 'High' aesthetic value. 'High' volume discharges to such an environment have a 'High' potential to affect these values. As the overflows also occur with 'High' frequency, the overall level of adverse effect is assessed as being 'High'.

3.9.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-78.

Table 3-78: Summary of potential magnitude and levels effect for Lambton Harbour

Value Category	Potential Magnitude of effect	Overall Level of Adverse Effect
Public health	High	Very High
Aquatic ecology	Low	Moderate
Cultural	Very High	High
Aesthetic	High	High

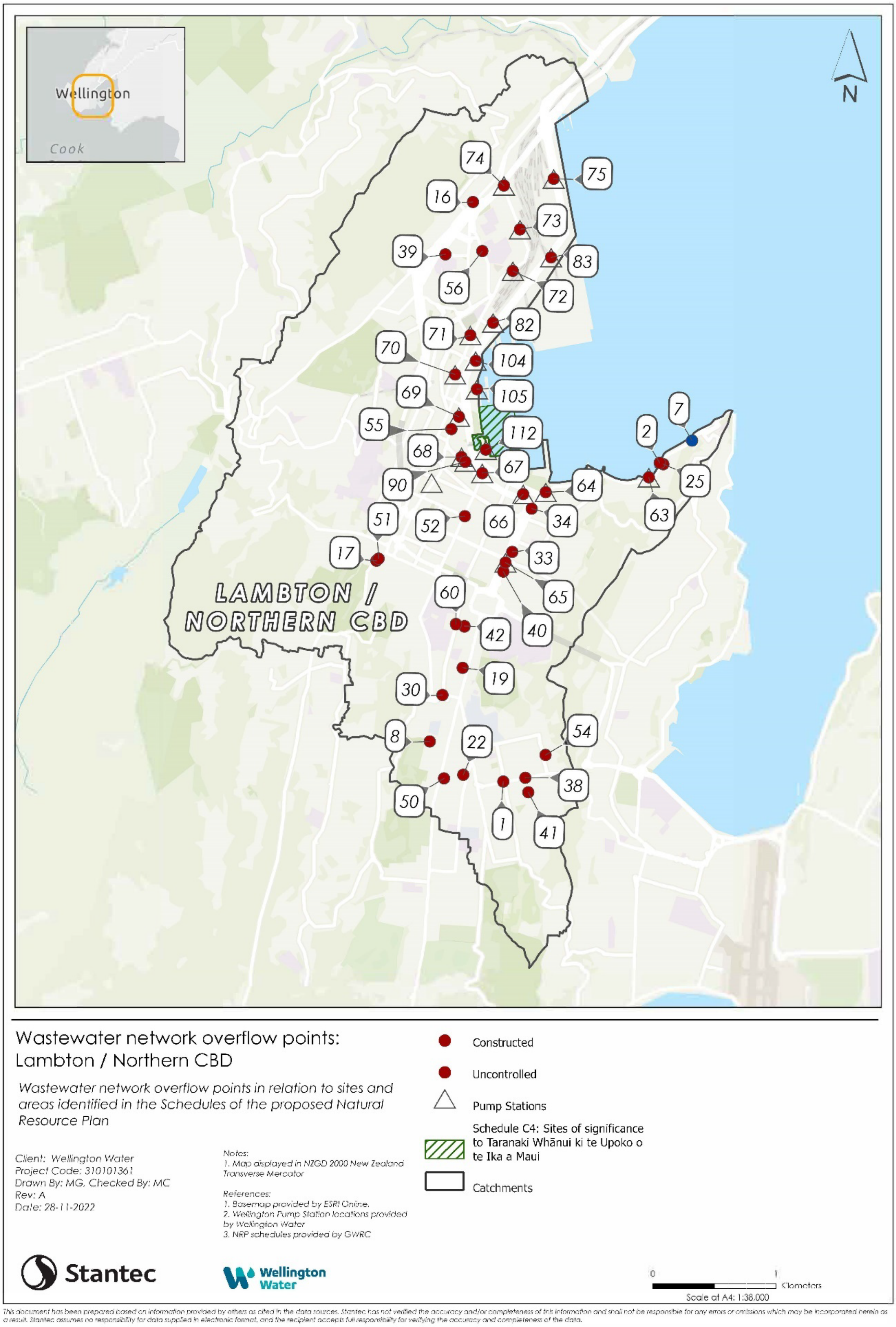

Figure 3-9: WNOs in the Lambton Harbour and Oriental Bay catchment

3.10 Kaiwharawhara Stream

3.10.1 Description of the Receiving Environment

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

Table 3-79 summarises the results of monthly RWQE monitoring in Kaiwharawhara Stream at Ngaio Gorge and WWL monitoring at Cummings Park and Otari Park. The results show a high degree of faecal contamination throughout. Kaiwharawhara Stream is in NPS-FM attribute band E (red) for *E. coli* and fails to meet PNRP Objective O18. The predicted average risk of infection is >7% for full contact recreation users (although full contact recreation is unlikely in this watercourse).

Table 3-79: Summary statistics for *E. coli* in Kaiwharawhara Stream (GWRC/WWL data 2017/2018 to 2020/2021)

Site Name	N Samples	% Exceedance over 540 cfu/100mL	% Exceedance over 260 cfu/100mL	Median Concentration cfu/100mL	95th Percentile cfu/100mL	NPS-FM Attribute State	PNRP O18 (95th %ile ≤540)
Koromiko Stream at Cummings Park	33	36	58	320	4,960	E	Not meeting
Kaiwharawhara Stream @ Otari Park*	33	33	61	408	5,580	E	Not meeting
Kaiwharawhara Stream @ Gorge*	55	67	87	1,200	10,600	E	Not meeting

*WWL monthly data from Feb 2020 to May 2022

RWQE monitoring at Kaiwharawhara Stream also show elevated concentrations of dissolved inorganic nitrogen, dissolved reactive phosphorus, dissolved copper and dissolved zinc, all exceeding ANZG (2018) default guideline values indicating a risk of adverse effect on stream ecology.

The ecological component of RWQE monitoring at the Ngaio Gorge site 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 3-80. PNRP Objective O19 for periphyton cover is achieved.

Table 3-80: 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)
Kaiwharawhara Stream at Ngaio Gorge	35	31.6	0	meeting

Macroinvertebrate community monitoring results from annual samples taken on years 2016/2017 to 2020/2021 indicate that the community is in poor condition and does not achieve the PNRP Objective O19 (Table 3-81).

Table 3-81: Macroinvertebrate community metric scores for Kaiwharawhara Stream (2016/17 to 2020/21)

Site name	ubstrate	River class	Significant rivre	N samples	Taxa richness	%EPT (3-yr median)	MCI (5-yr median)	QMCI (5-yr median)	PNRP O19 - MCI	PNRP O19 - QMCI	Meeting O19
Kaiwharawhara Stream at Ngaio Gorge	Hard	2	No	5	6	23.1	92.4	3.0	≥ 105	≥ 5.5	Not meeting

The New Zealand Freshwater Fish Database (NZFFD) includes records from other fish surveys conducted in 2002, 2004, 2006, 2009 and 2018, which indicate a diverse fish community including six at risk species and one threatened (Nationally Vulnerable) species, the latter being the shortjaw kōkopu (Table 3-82). The PNRP Objective O19 for fish biotic integrity is achieved (although most of the fish monitoring data is now quite dated).

Table 3-82: Fish species recorded in Kaiwharawhara Stream

Species	Conservation status (Dunn, et al., 2017)	Lower	Middle
Longfin eel	At risk (declining)	++	++
Shortfin eel	Not threatened	++	+
Īnanga	At risk (declining)	+	-
Kōaro	At risk (declining)	+	-
Banded kōkopu	Not threatened	++	++
Giant kōkopu	At risk (declining)	+	-
Shortjaw kōkopu	Threatened - Nationally Vulnerable	+	-
Giant bully	At risk (declining)	+	-
Redfin bully	Not threatened	+	-
Bluegill bully	At risk (declining)	+	-
Common bully	Not threatened	+	-
Brown trout	Introduced and naturalised	++	+
Fish index of biotic integrity (F-IBI)		60	50
PNRP Objective O19 (F-IBI ≥ 38)		Achieved	Achieved

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

Significant values associated with Kaiwharawhara Stream as scheduled in the PNRP are summarised in Table 3-83 and categorised for the wastewater network overflow assessment in Table 3-84.

Table 3-83: Environmental and cultural values identified for Kaiwharawhara Stream in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Te Awa o Kaiwharawhara (Taranaki Whānui ki te Upoko o te Ika)
E5	Historic heritage freshwater sites	Karori Gold Mining Sites
F1	Rivers and lakes with significant indigenous ecosystems	Kaiwharawhara Stream has significant indigenous values including habitat for indigenous threatened or at-risk fish, and habitat for more than six species of indigenous migratory fish.
F1b	Īnanga Spawning Habitat:	Lower reach of Kaiwharawhara Stream
F2	Indigenous Bird Habitat:	Wellington-Hutt Road (Kaiwharawhara section)
F4	Indigenous Biodiversity Coastal:	Kaiwharawhara Estuary provides habitat, specifically passage to and from the catchment, for 7 threatened indigenous fish species: longfin eel, giant kōkopu, shortjaw kōkopu, kōaro, īnanga, redfin bully, bluegill bully
I	Important trout fishery river and spawning waters	Main stem of Kaiwharawhara Stream below urban area
Policies P12, P13	Commercial Port Area	Lambton Harbour

Table 3-84: Kaiwharawhara Stream receiving environment characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
Kaiwharawhara Stream	Medium waterway[11]	Class 2 (contact recreation may occur)	Class 1 (High value)	Class 1 (Very important)	Class 1 (High value)

3.10.2 Summary of Overflow Characteristics

There are six direct overflows to Kaiwharawhara Stream all of which are assessed to be 'Low' volume and 'Low' frequency.

Table 3-85: Summary of overflow characteristics, Kaiwharawhara Stream

Overflow ID	Direct/Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
107	Direct	-	Low	0	Low	Operative	Wellington Water Overflow Forms 2018-2021
18	Direct	-	Low	2	Low	Operative	Stantec Overflow Model 2021
4, 5	Direct to land	-	Low	-	Low	Operative	Customer recorded overflow
36, 115	Direct	-	Low	-	Low	Operative	No data recorded

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

3.10.3 Potential Public Health Effects

'Low' volume discharges to medium waterways with Class 2 recreational values are assessed as having a 'Moderate' potential effect on all recreational activities, as shown below.

Table 3-86: Magnitude of public health effects from overflows to Kaiwharawhara Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for activities on land. This effect is predominantly linked to the discharge faecal material on land where direct physical contact is likely.	**Effects Score of 3 (Moderate)** for activities on land in the vicinity of uncontrolled overflow, because a public space is affected.
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 shellfish have the potential to filter pathogens and metals from water and sediments.
Loss of suitability for harvesting watercress	**Effects Score of 3 (Moderate)**, because watercress can be a hydraulic trap for particulate contaminants.

Table 3-87: Level of public health effects in Kaiwharawhara Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall Level of Public Health Effect
107	Direct	**Moderate**	Low	**Low**
18	Direct	**Moderate**	Low	**Low**
4, 5	Direct to land	**Moderate**	Low	**Low**
36, 115	Direct	**Moderate**	Low	**Low**

3.10.4 Potential Ecological Effects

'Low' volume discharges to medium waterways with Class 1 ecological values are assessed as having predominantly 'High' magnitude of effect on ecological values, as shown in Table 3-88.

The overall level of ecological effects is determined from the combination of the magnitude of effect and frequency of occurrence, as summarised in Table 3-89. In this case the frequency of overflow events is in the 'Low' range and the overall level of ecological effects is assessed as 'Moderate'.

Table 3-88: Magnitude of ecological effects of overflows to Kaiwharawhara 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 3-89: Level of ecological effects in Kaiwharawhara Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall Level of Ecological Effect
107	Direct	**High**	Low	**Moderate**
18	Direct	**High**	Low	**Moderate**
4, 5	Direct	**High**	Low	**Moderate**
36, 115	Direct	**High**	Low	**Moderate**

3.10.5 Potential Cumulative Effects

All six overflows in the Kaiwharawhara Stream catchment are of ‘Low’ volume and ‘Low’ frequency, discharging to different tributaries of Kaiwharawhara Stream. The risk of cumulative effects in the stream is assessed as ‘Low’ and is no higher than the risk associated with either individual overflow point.

3.10.6 Potential Cultural Effects

Kaiwharawhara Stream is assessed as having ‘Very Important’ cultural values (Class 1).

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

3.10.7 Potential Aesthetic Effects

Kaiwharawhara Stream is assessed as having a ‘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 adverse effect is assessed as being ‘Low’.

3.10.8 Summary

The potential magnitude and overall level of effects of wastewater overflows to this receiving environment are summarised in Table 3-90.

Table 3-90: Summary of potential magnitude and overall level of effects for Kaiwharawhara Stream

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	Moderate	Low
Aquatic ecology	High	Moderate
Cultural	Moderate	Low
Aesthetic	High	Low

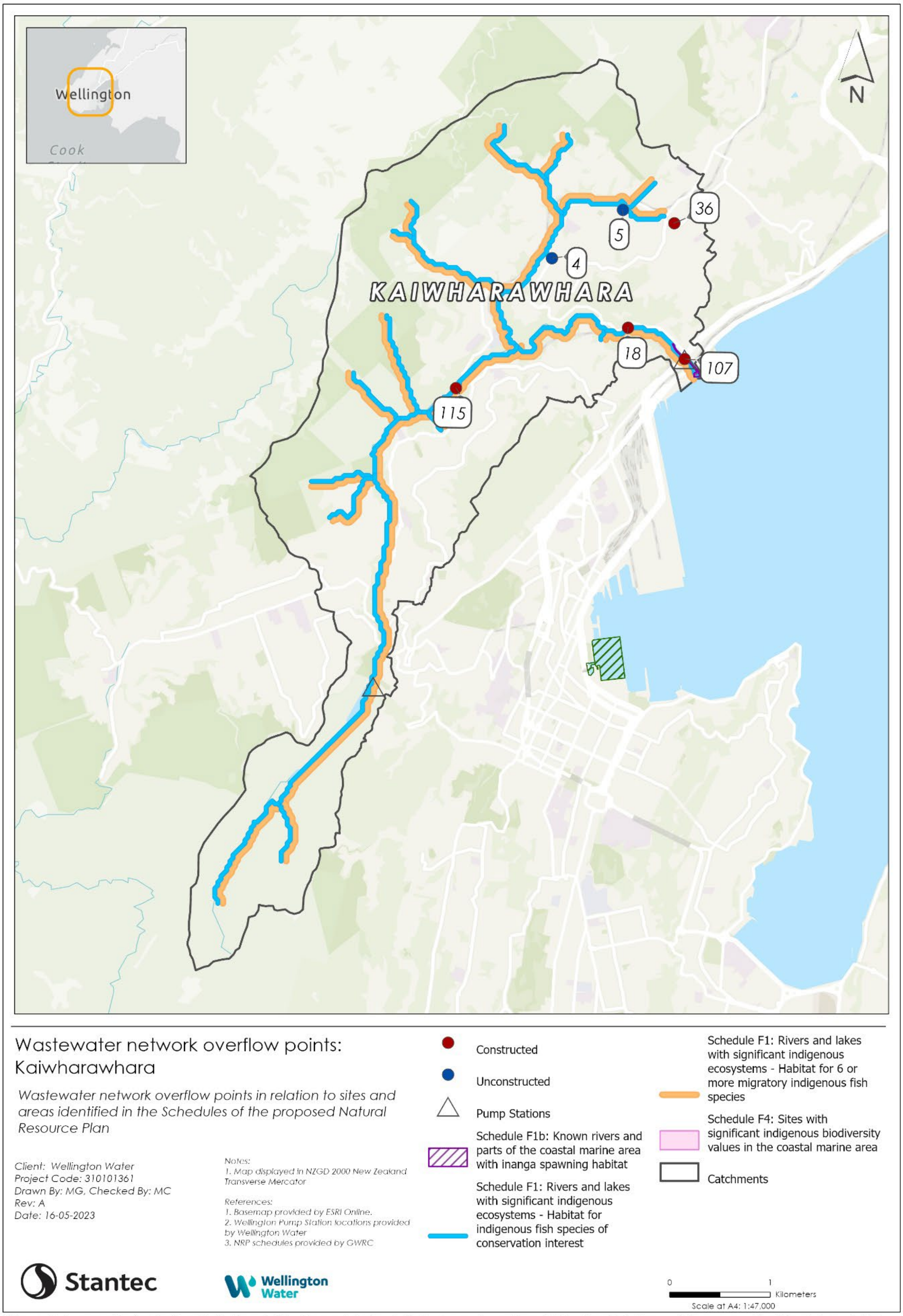

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Figure 3-10: WNOs in the Kaiwharawhara Stream catchment

3.11 Ngauranga/Waitohi Stream

3.11.1 Description of the Receiving Environment

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

Table 3-91 summarises the results of monthly monitoring by WWL at four locations in Waitohu Stream. The results show a very high degree of faecal contamination, especially in the upper reaches. Waitohu is in the lowest NPS-FM attribute band for *E. coli*, E (red), and fails to meet PNRP Objective O18. The predicted average risk of infection is >7% for full contact recreation users (although full contact recreation is most unlikely in this watercourse).

Table 3-91: Summary statistics and NPS-FM Attribute State for *E. coli* (WWL data August 2020 to May 2022)

Site Name	N Samples	% Exceedance over 540 cfu/100mL	% Exceedance over 260 cfu/100mL	Median Concentration cfu/100mL	95th Percentile cfu/100mL	NPS-FM Attribute State	PNRP O18 (95th %ile ≤540)
Newlands at Gorge	39	100%	100%	13,500	1,072,000	E	Not meeting
Tyers Stream at Gorge	31	82%	68%	1,043	23,300	E	Not meeting
Waitohu Stream at Gorge	37	100%	95%	2,700	7,500	E	Not meeting
Waitohu Stream near harbour	31	91%	62%	925	8,491	E	Not meeting

The New Zealand Freshwater Fish Database (NZFFD) includes records from fish surveys conducted in Tyres Stream (the Khandallah branch of Waitohi Stream) during 2009 and 2016. A total of four fish species were recorded (Table 3-92). The PNRP Objective O19 for fish biotic integrity is achieved (although most of the monitoring data is now quite dated).

Table 3-92: Fish species recorded in Tyers Stream

Species	Conservation status (Dunn, et al., 2017)	Tyers Stream (a tributary of Ngauranga Stream)
Shortfin eel	Not threatened	+
Longfin eel	At risk (declining)	++
Kōaro	At risk (declining)	++
Banded kōkopu	Not threatened	+
Fish index of biotic integrity (F-IBI)		42
PNRP Objective O19 (F-IBI ≥ 38)		Good

No significant environmental or cultural values associated with Ngauranga/Waitohi Stream are scheduled in the PNRP. Receiving environment characteristics are categorised for the wastewater network overflow assessment in Table 3-93.

Table 3-93: Ngauranga Stream receiving environment characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
Ngauranga Stream	Medium waterway[12]	Class 3 (Contact recreation is unlikely)	Class 3 (Highly modified channel, partially piped).	Class 2 (Important)	Class 1

3.11.2 Summary of Overflow Characteristics

There are five direct overflows to Ngauranga Stream all of which are assessed to be 'Low' volume and 'Low' frequency.

Table 3-94: Summary of overflow characteristics, Ngauranga Stream

Overflow ID	Direct/ Indirect	Volume (m³)		Frequency (per year)		Status	Data Source
		(m³)	Range	number	Range		
29	Direct	0.5	Low	0.5	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
31, 110	Direct	-	Low	2	Low	Operative	Stantec Overflow Model 2021
24, 109	Direct	-	Low	-	Low	Operative	No recorded data

3.11.3 Potential Public Health Effects

'Low' volume discharges to moderate waterways with Class 3 recreational values are assessed as having a 'Very Low' potential effect on all recreational activities as shown in Table 3-95.

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 3-96.

Table 3-95: Magnitude of public health effects from overflows to Ngauranga Stream

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for contact or partial contact recreation	**Effects Score of 1 (Very Low)** 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.
Loss of suitability for fishing	
Loss of suitability for harvesting watercress	

Table 3-96: Overall level of public health effects in Ngauranga Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Public health Effect	Overflow Frequency Range	Overall level Public Health Effect
29	Direct	**Very Low**	Low	**Very Low**
31, 110	Direct	**Very Low**	Low	**Very Low**
24, 109	Direct	**Very Low**	Low	**Very Low**

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

3.11.4 Potential Ecological Effects

'Low' volume discharges to medium waterways with Class 3 ecological values are assessed as having a range of 'Very Low' to 'Low' potential effects on ecological values, as shown in Table 3-97.

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 '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 3-98. In this case the frequency of overflow events is in the 'Low' range and the overall level of ecological effects is assessed as 'Very Low'.

Table 3-97: Magnitude of ecological effects of overflows to Ngauranga 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 1 (Very low)**, because the lack of BOD enrichment provides little opportunity for the growth of these organisms.

Table 3-98: Overall level of ecological effects in Ngauranga Stream

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall level of Ecological Effect
29	Direct	**Low**	Low	**Very Low**
31, 110	Direct	**Low**	Low	**Very Low**
24, 109	Direct	**Low**	Low	**Very Low**

3.11.5 Potential Cumulative Effects

All overflows in the Ngauranga/Waitohi Stream catchment are of 'Low' volume and 'Low' frequency. The risk of cumulative effects in the stream is assessed as 'Low' and is no higher than the risk associated with either individual overflow point.

3.11.6 Potential Cultural Effects

Ngauranga/Waitohi Stream is assessed as having 'Important' cultural values (Class 2). 'Low' volume discharges to such an environment have a 'Low' potential effect on these values.

Because all overflows have a 'Low' frequency the overall level of cultural effects is assessed as being 'Low'.

3.11.7 Potential Aesthetic Effects

Ngauranga/Waitohi Stream as assessed as having 'High' aesthetic value. 'Low' volume discharges to such an environment have a 'High' potential effect on these values. As the overflows occur at a 'Low' frequency, the overall level of adverse effect is assessed as being 'Low'.

3.11.8 Summary

The potential magnitude and overall level of effects of wastewater overflows to this receiving environment are summarised in Table 3-99.

Table 3-99: Summary of potential magnitude and overall level of effects for Ngauranga Stream

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	Very Low	Very Low
Aquatic ecology	Low	Very Low
Cultural	Low	Low
Aesthetic	High	Low

3.12 North Harbour

3.12.1 Description of the Receiving Environment

The north harbour catchment lies between Kaiwharawhara Stream to the southwest and Korokoro Stream to the northeast. It includes two watercourses: the Ngauranga Stream, which is described in the previous section, and Horokiwi Stream which is a minor watercourse carrying mostly rural runoff.

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

These coastal receiving waters are not monitored for microbiological quality.

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

Recent mapping of *M. pyrifera* along the adjacent Te Ara Tupua project footprint shows a band of macroalgae between 5-10m from MHWS along the shore from Ngauranga to Petone, which is visible from the surface.

GWRC's most recent Wellington harbour marine sediment quality investigations include two sites (AQ1 and AQ2) offshore of Kaiwharawhara Stream mouth, and three sites (WH5, WH9, WH10) offshore between Kaiwharawhara and Ngauranga (Cummings, et al., 2021). Sediments at sites AQ1, AQ2, WH5, WH9, and WH10 all exceeded the ANZG (2018) DGV for mercury, and ARC amber (early warning) guideline for lead. Sites AQ1 and AQ2 also exceeded the ARC amber guideline for HMW PAH. It is likely that mercury and lead are legacy contaminants. Arsenic, copper, cadmium, chromium, nickel, zinc and total PAH were all below concentration guidelines at these sites.

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

Fish species historically important to iwi in the Wellington Harbour have included red cod (*Pseudophycis bachus*), snapper (*Pagrus auratus*), gunard (*Chelidonichthys kumu*), kahawai (*Arripis trutta*),tarakihi (*Nemadectylus macropterus*), john dory (*Zeus faber*), wrasse (*Notolabrus facicola*), travelly (*Pseudocaranx dentex*), rig (spotted smooth hound) (*Mustelus lenticulatus*), batfish species, various species of shark, and flatfish (e.g. flounder *Rhombosolea plebeia*) (Rob Greenaway & Associates, 2016; Tonkin & Taylor Ltd, 2016). Kahawai, snapper, terakihi, cod and gurnard are the most commonly caught recreational fish, though there is also a wide variety of the more unusual species such as elephant fish, skate, leather jackets and kingfish.[13]

Table 3-100 provides an assessment against PNRP Objective O19. Significant values associated with North Harbour as scheduled in the PNRP are summarised in Table 3-101 and categorised for the wastewater network overflow assessment in Table 3-102.

[13] https://stevesfishingshop.co.nz/pages/tips-n-info August 2018

Table 3-100: Assessment of the north coast of Wellington Harbour 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	The studies reviewed above indicate the potential for adverse effects associated with the high mud content and metal contamination of marine sediments. Nevertheless, these habitats support an unexpectedly high abundance and diversity of macrofauna. The available information suggests that Objective O19 may be met in respect of macroalgae and invertebrates but there not sufficient information to determine compliance with the objectives for mahinga kai and fish.			

Table 3-101: Environmental and cultural values identified for North Harbour in Schedules of the PNRP

Schedule	Category	Significant Sites
B	Nga Taonga Nui a Kiwi	Te Whanganui a Tara (Wellington Harbour)
F2	Indigenous bird habitat	Wellington Harbour

Table 3-102: North Harbour receiving environment characteristics

Receiving Environment	Type	Recreation	Ecology	Cultural	Aesthetic
North Harbour	Outer Harbour	Class 1 (a known fishing site)	Class 1 (Important)	Class 1 (Very important)	Class 1 (High value)

3.12.2 Summary of Overflow Characteristics

There are three direct overflows to the North Harbour receiving environment and 10 indirect overflows. The three direct overflows have been assessed to have both 'Low' volumes and 'Low' frequencies.

Table 3-103: Summary of overflow characteristics, North Harbour

Overflow ID	Direct/ Indirect	Volume (m^3)		Frequency (per year)		Status	Data Source
		(m^3)	Range	Number	Range		
106, 108	Direct	-	Low	1	Low	Operative	Wellington Water Overflow Forms 2018-2021
3	Direct to land	-	Low	-	Low	Operative	Customer Recorded Overflow
53, 111	Indirect	-	Low	-	Low	Operative	No data recorded
107	Indirect	-	Low	0	Low	Operative	Wellington Water Overflow Forms 2018-2021
18	Indirect	-	Low	2	Low	Operative	Stantec Overflow Model 2021

Overflow ID	Direct/ Indirect	Volume (m³)		Frequency (per year)		Status	Data Source
		(m³)	Range	Number	Range		
4, 5	Indirect	-	Low	-	Low	Operative	Customer recorded overflow
36	Indirect	-	Low	-	Low	Operative	No data recorded
29	Indirect	0.5	Low	0.5	Low	Operative	Mott MacDonald Overflow Monitoring Reports 2018 - 2021
31, 110	Indirect	-	Low	2	Low	Operative	Stantec Overflow Model 2021
24, 109	Indirect	-	Low	-	Low	Operative	No data recorded

3.12.3 Potential Public Health Effects

'Low' volume discharges to harbours with Class 1 recreational values are assessed as having a 'Low' magnitude of effect on all recreational activities as shown in Table 3-104.

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 3-105. In this case the frequency of overflow events is in the 'Low' range and the overall level of public health effects is 'Very Low'.

Table 3-104: Magnitude of public health effects from overflows to North Harbour

Potential Effect	Magnitude of Public Health Effect
Loss of suitability for activities on land. This effect is predominantly linked to the discharge faecal material on land where direct physical contact is likely.	Effects Score of 2 (Low) for activities on land in the vicinity of uncontrolled overflow, because public access is limited.
Loss of suitability for contact or partial contact recreation	Effects Score of 2 (Low) on all recreational activities (contact or partial contact recreation, shellfish collecting, fishing and/or seaweed collecting), because harbours provide dilution and flushing and are generally able to absorb low volume overflows.
Loss of suitability for fishing	
Loss of suitability for collecting shellfish	
Loss of suitability for harvesting seaweed	

Table 3-105: Overall level of public health effects in North Harbour

Overflow ID	Direct/Indirect	Potential Magnitude of Public Health Effect	Overflow Frequency Range	Overall Level of Public Health Effect
106, 108	Direct	**Low**	Low	**Very Low**
3	Direct to land	**Low**	Low	**Very Low**
53, 111	Indirect	**Low**	Low	**Very Low**
4, 5, 18, 36, 107	Indirect	**Low**	Low	**Very Low**
24, 29, 31, 109, 110	Indirect	**Low**	Low	**Very Low**

3.12.4 Potential Ecological Effects

'Low' volume discharges to harbours with Class 1 ecological values are assessed as having predominantly 'Low' potential effects on ecological values, as shown in Table 3-106. 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 considered to be 'Very Low'.

Table 3-106: Magnitude of ecological effects of overflows to North 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.
Relatively frequent toxic concentrations of NH_4, sulphide, metals, and nitrate.	**Effects Score of 2 (Low)**, because the dilution of overflows means that nutrient concentrations and toxicants are unlikely to increase above background levels.
Change in community structure/loss of sensitive species	**Effects Score 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.

Table 3-107: Level of ecological effects in North Harbour

Overflow ID	Direct/Indirect	Potential Magnitude of Ecological Effect	Overflow Frequency Range	Overall Level of Ecological Effect
106, 108	Direct	**Low**	Low	**Very Low**
3	Direct	**Low**	Low	**Very Low**
53, 111	Indirect	**Low**	Low	**Very Low**
4, 5, 18, 36, 107	Indirect	**Low**	Low	**Very Low**
24, 29, 31, 109, 110	Indirect	**Low**	Low	**Very Low**

3.12.5 Potential Cumulative Effects

Cumulative effects to the North Harbour receiving environment is considered unlikely. This is due to the large spatial separation between the direct and indirect overflows which will contribute towards dilution and the overflows are assessed as 'Low' volume and 'Low' frequency overflows.

3.12.6 Potential Cultural Effects

North Harbour is assessed as having 'Very Important' cultural values (Class 1).

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

3.12.7 Potential Aesthetic Effects

North Harbour is assessed as having a '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 adverse effects is assessed as being 'Low'.

3.12.8 Summary

The potential magnitude and overall level of adverse effects of wastewater overflows to this receiving environment are summarised in Table 3-108.

Table 3-108: Summary of potential magnitude and overall level of effects for North Harbour

Value Category	Potential Magnitude of Effect	Overall Level of Adverse Effect
Public health	Low	Very Low
Aquatic ecology	Low	Very Low
Cultural	Moderate	Low
Aesthetic	High	Low

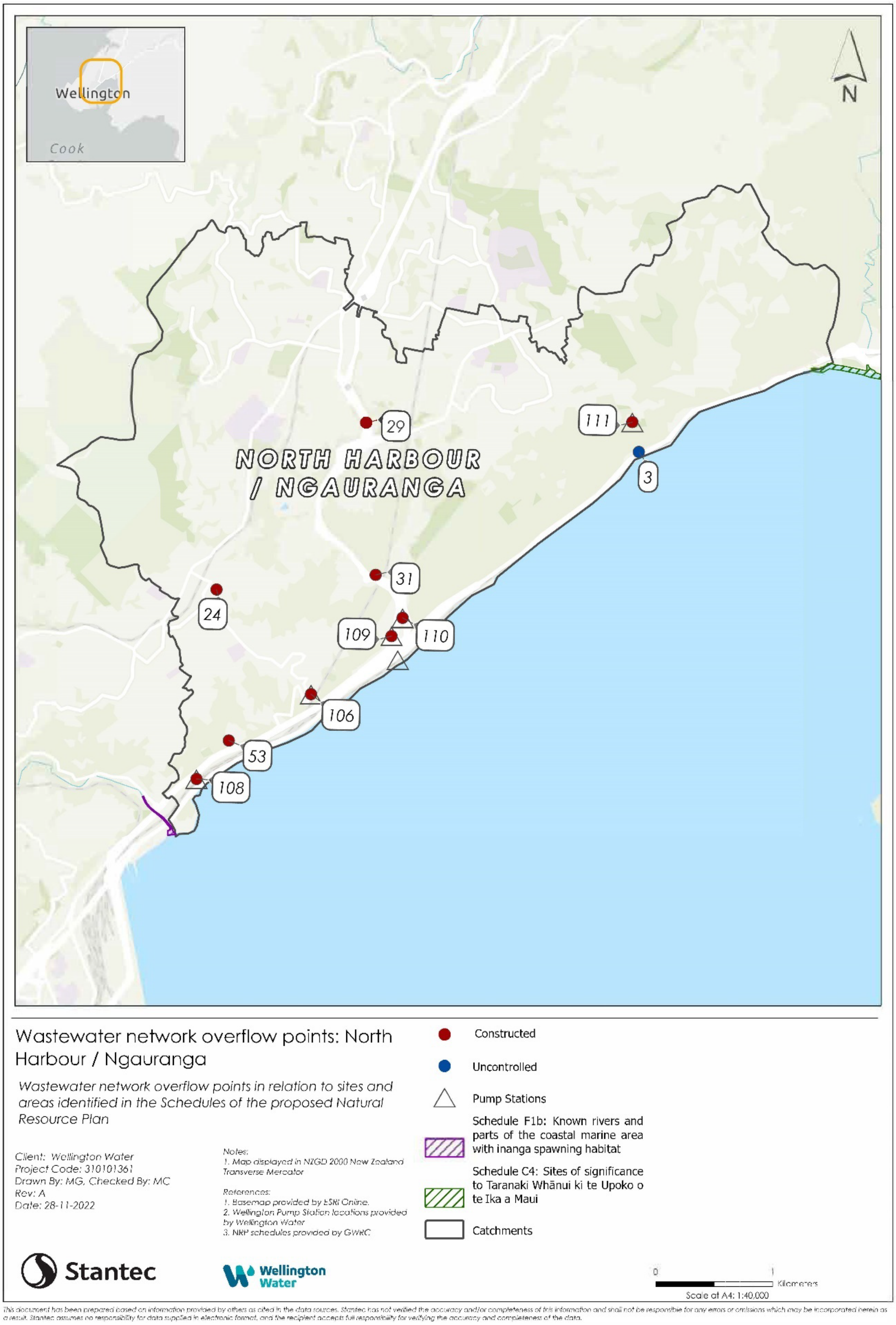

Figure 3-11: WNOs in the North Harbour catchment

3.13 Assessment Against pNRP Policy P93 Criteria

A generic assessment of WNO discharges against pNRP Policy P93 water quality guidelines is provided in Table 3-109. The assessment is made by reference to WNO characteristics summarised in Appendix A and nine representative discharge scenarios summarised in Appendix C (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 Wellington and Karori wastewater networks there are no sites which stand out as unlikely to meet P93 guidelines. Karori Stream is probably at the greatest risk, but analysis below in Table 3-109 suggests that the guidelines are substantially achieved.

Table 3-109: 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 moderate/high volume, moderate/high frequency WNO discharges to a medium sized waterway, such as WNOs 113 and 114 to Karori Stream could potentially contribute to the poor macroinvertebrate community health. However, the available monitoring data does not bear this this out. The QMCI score from a site located immediately downstream of WNOs 113 and 114 is the highest recorded at 12 locations on Karori Stream. Evidently these discharges are not sufficiently frequent to exert a sustained effect on the stream ecology. (a)(ii) WNO discharges contain elevated levels of suspended solids. Moderate or high-volume discharges have the potential to reduce water clarity in small or medium sized waterways by more than 30% for the duration of the discharge. This potential is evident for the Karori Stream at the Western WWTP where WNO 113 operates on average 6 times each year at an annual volume of 12,900m^3 and WNO 114 operates on average 3 times a year at an annual volume of 1,600m^3. This risk is reduced, however, because the 113 discharge is of treated wastewater which has relatively low suspended solids content, and probably lower than in receiving waters during a high rainfall event. The overall assessment is that if WNO discharges cause more than a 30% reduction of water clarity in Wellington or Karori streams such events would be of brief duration and occur infrequently. (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.

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**
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* *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)(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. (b)(v) A high frequency of WNO discharges (>10 per year) 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 routine monthly sampling. Conversely, a moderate or low frequency of discharge (<10 per year) is unlikely to cause non-compliance with the (b)(v) criteria. The conclusion of this assessment is that, based on the recent frequency of WNO discharges to streams in in the Wellington or Karori catchments, it is most unlikely the WNOs would cause an exceedance of the (b)(v) criteria. (b)(vi) The assessment and conclusion provided above for nitrate-N would also apply for ammonia-N.

Note: there are no WNO discharges from Wellington or Karori networks to class 1 rivers or rivers identified as having high macroinvertebrate community health in Schedule F1.

4. RANKING OF WNO SITES AND SUBCATCHMENTS

4.1 Site Rankings

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 ranks the WNO 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). A complete list of all COPs is provided in Appendix A

Of the 110 WNOs, 93 were assessed as a having a low or very low level of adverse effect. The remaining 17 were assessed as having a moderate or higher level of adverse effect and should therefore be considered for a management response.

Table 4-1: WNOs assessed as having a Moderate or High level of adverse effect

WNO number	Asset_ID	Assessed Frequency Range	Assessed Volume Range	Direct RE	Level of Public Health Effect	Level of Ecological Effect	Level of Cultural Effect	Level of Aesthetic Effect	Combined Score	Level of adverse effect
34	WCC_WW026938	High	Medium	Lambton Harbour	5	3	4	4	16	High / significant
40	WCC_WW030078	High	Medium	Lambton Harbour	5	3	4	4	16	
114	Western WWTP (UOP)	Medium	Medium	Land/Karori Stream	4	4	3	3	14	
28	WCC_WW020948	Medium	High	Evans Bay	4	4	3	3	14	
52	WCC_WW035569	High	Low	Lambton Harbour	4	2	4	4	14	
85	WCC_WWPS023	Medium	Medium	Evans Bay	4	4	3	3	14	
99	WCC_WWPS037	Medium	High	Island Bay / Houghton Bay	4	4	3	3	14	
113	Western WWTP (COP)	Medium	High	Karori Stream	3	4	3	3	13	Moderate / more than minor
11	WCC_WW012046	Medium	Low	Karori Stream	3	4	3	3	13	
98	WCC_WWPS036	Medium	Medium	Island Bay / Houghton Bay	4	3	3	3	13	
102	WCC_WWPS040	Medium	Medium	Island Bay / Houghton Bay	4	3	3	3	13	
1	WCC_WW004696	Medium	High	Lambton Harbour	4	2	3	3	12	
23	WCC_WW019626	Medium	Low	Evans Bay	3	3	3	3	12	
32	WCC_WW023985	Medium	Low	Evans Bay	3	3	3	3	12	
56	WCC_WW038277	Medium	High	Lambton Harbour	4	2	3	3	12	
64	WCC_WWPS002	Medium	High	Lambton Harbour	4	2	3	3	12	
65	WCC_WWPS003	Medium	Medium	Lambton Harbour	4	2	3	3	12	

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.

4.2 Sub-catchment Rankings

Table 4-2 ranks sub-catchments by considering all individual sites in combination to address the potential cumulative effect of multiple WNO sites discharging at the same time to the same receiving environment. This brings together the 'level of effects' scores calculated for each sub-catchment in Section 3.

WNOs in the Lambton and Evan Bay sub-catchments stand out as having a high level of adverse effect on water of the inner harbour. The Karori and Island/Houghton sub-catchments have a moderate level of adverse effect on their receiving environments.

Table 4-2: Level of adverse effect by sub-catchment

Sub-catchment	Direct Receiving environment	WNO number	Public Health effects	Ecological Effects	Cultural Effects	Aesthetic Effects	Overall Effects Score	Level of adverse effect
Karori	Karori Stream	6, 10, 11, 12, 27, 45, 113, 114	4	4	3	3	14	Moderate
Owhiro	Owhiro Stream	35	2	1	2	2	7	Very Low
	Owhiro Bay	100, 101	2	2	3	3	10	Low
Island/Houghton	Island Bay	13, 35, 37, 48, 61, 98, 99, 102	4	4	3	3	14	Moderate
	Houghton Bay	98	4	3	3	3	13	Moderate
Lyall	Lyall Bay	14, 57, 81, 84, 93, 96, 97, 116	2	1	2	2	7	Very Low
Miramar Peninsular East Coast	Moa Point	62	1	1	2	2	6	Very Low
	Palmer Bay	95	1	1	2	2	6	Very Low
	Eve Bay	94	1	1	2	2	6	Very Low
	Point Dorset	87, 103	1	1	2	2	6	Very Low
	Worser Bay	88, 89	1	1	2	2	6	Very Low
	Scorching Bay	91	1	1	2	2	6	Very Low
Evans Bay	Balaena Bay	76	2	2	2	2	8	Low
	Kio Bay	77	1	2	2	2	8	Low
	Evans Bay	9, 15, 20, 23, 26, 28, 32, 43, 46, 47, 49, 58, 59, 78, 79, 80, 85, 86, 92	4	4	4	4	16	High
Lambton	Oriental Bay	2, 7, 25, 63, 64	4	2	4	4	14	High
	Lambton Harbour	1, 8, 16, 17, 19, 22, 30, 33, 34, 38, 39, 40, 41, 42, 50, 51, 52, 54, 55, 56, 60, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 82, 83, 90, 104, 105, 111, 112	5	3	4	4	16	High
	Aotea Quay	16, 39, 56, 72, 73 74, 82, 83	4	2	4	4	14	High
Kaiwharawhara	Kaiwharawhara Stream	4, 5, 18, 36, 107, 115	2	3	2	2	9	Low
North Harbour	Waitohi Stream	24, 29, 31, 109, 110	1	1	2	2	6	Very Low
	Wellington Harbour	3, 106, 108	2	1	2	2	7	Very Low

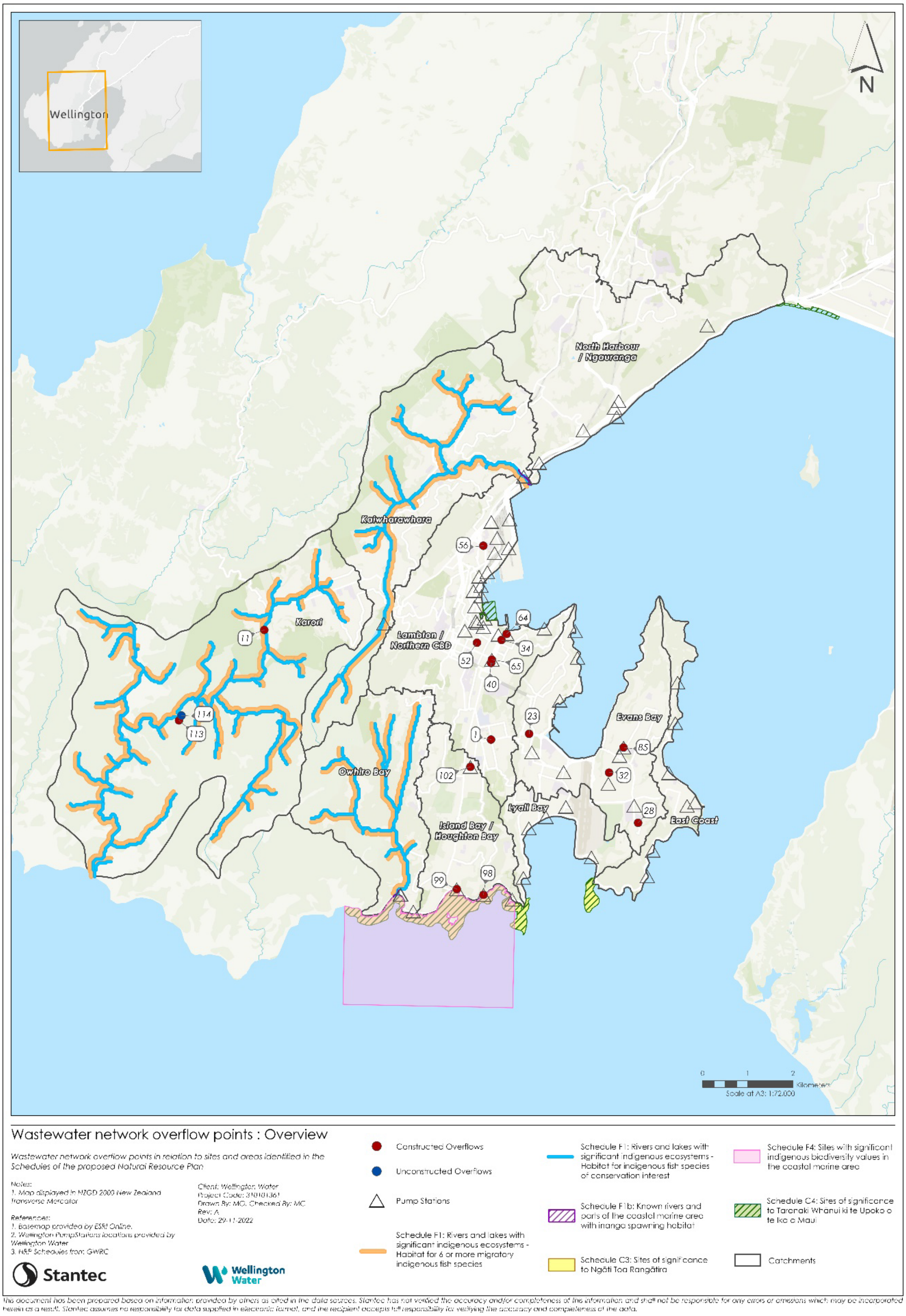

Figure 4-1: WNOs assessed has having a moderate or high level of adverse effect

4.3 Synthesis

4.3.1 Karori

The Karori sub-catchment includes 8 WNO sites which discharge directly to Karori Stream. Three of these are identified as having a moderate or high level of adverse effect on Karori Stream. These are WNO 11, 113, and 114. They all operate at medium frequency, between 3 and 10 times each year, with the largest annual volume of more than 12,900m^3 per year occurring at WNO Site 113.

It is noted, however, that WNO Site 113 is not an overflow from the wastewater network, rather it is a wet weather overflow of treated wastewater from the Western WWTP at times when the capacity of the WWTP or main outfall pipeline is exceeded. This is the only discharge of treated wastewater covered in this assessment (the methodology was adjusted to reflect the better discharge quality). In combination the level of adverse effects on the environment from WNOs in the Karori sub-catchment is assessed as moderate.

A Karori WNO options assessment (HAL, 2021) considered these WNO's and recommends network improvements to reduce overflow volumes and frequency.

4.3.2 Owhiro

The Owhiro sub-catchment includes 1 WNO discharging Owhiro Stream and two discharges to Owhiro Bay. All are low volume and low frequency discharges. None are identified as having more than a low level of adverse effect, either individually or cumulatively.

4.3.3 Island/Houghton

The Island/Houghton sub-catchment includes seven WNO's, three of which are identified as having a moderate or higher level of adverse effect on their receiving environments.

These are WNO 98 (Brighton Street), 99 (The Esplanade, Houghton Bay) and 102 (Te Wharepouri Street). They all operate at medium frequency, between 3 and 10 times each year, with an annual volume exceeding 6000 m^3 at the Houghton Bay site. In combination WNO discharges from the Island/Houghton Bay sub-catchment are assessed has having a moderate level of adverse effect on the receiving environment.

4.3.4 Lyall

The Lyall sub-catchment includes seven WNO's discharging the Lyall Bay beach and one discharging at the Moa Point short outfall. All are low volume and low frequency discharges. None are identified as having more than a low level of adverse effect, either individually or cumulatively.

4.3.5 Miramar East Coast

The Miramar East Coast sub-catchment includes one WNO discharging to each of Moa Point, Palmer Bay, Eve Bay, and Scorching Bay, and two discharging to each of Point Dorset and Worser Bay. All are low volume and low frequency discharges. None are identified as having more than a low level of adverse effect, either individually or cumulatively.

4.3.6 Evans

The Evans sub-catchment includes one WNO discharging to each of Balaena and Kio bays, and 21 WNO's discharging to the remainder of Evans Bay. Of these, four are identified as having a moderate or higher level of adverse effect on their receiving environment. These are WNO 28 (Elphinstone Avenue), 85 (Byron Street), 23 (Wellington Road) and 32 (Southampton Road). These WNO's all operate at medium frequency, between 3 and 10 times each year. The annual volume from Elphinstone Avenue site exceeds 6000 m^3. In combination WNO discharges from the Evans Bay sub-catchment are assessed has having a high level of adverse effect on the receiving environment.

4.3.7 Lambton

The Lambton sub-catchment includes 5 WNO's discharging to Oriental Bay, 30 discharging to Lambton Harbour and 8 discharging at Aotea Quay. Of these, seven are identified as having a moderate or high level of adverse effect on their receiving environment. They are WNO 1 (Daniel Street), 34 (Kent Terrace), 40 (Kent Terrace), 65 (Kent Terrace), 52 (Taranaki Street), 56 (Murphy Street), and 64 (Oriental Parade).

Several of these WNO's (at Kent Terrace and Taranaki Street) operate more than 10 times each year. The largest annual volume of more than 10,000 m^3 per year occurs at Murphy Street, discharging to the inner Harbour via the Davis Street culvert. In combination WNO discharges from the Lambton Harbour sub-catchment are assessed as having a high level of adverse effect on the receiving environment.

4.3.8 Kaiwharawhara

The Kaiwharawhara sub-catchment includes six WNOs discharging to Kaiwharawhara Stream. All are low volume and low frequency discharges. None are identified as having more than a low level of adverse effect, either individually or cumulatively.

4.3.9 North Harbour

The North Harbour sub-catchment includes five WNOs discharging to Waitohi Stream and three discharging directly to Wellington Harbour. All are low volume and low frequency discharges. None are identified as having more than a low level of adverse effect, either individually or cumulatively.

5. CONCLUSIONS

This AEE Part 2 Report has been prepared to support WWLs application to consent wet weather overflows from the wastewater network in the Wellington and Karori 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 across the Wellington sub-region.

The assessment of wastewater overflows from networks in the Wellington and Karori catchments has identified the Lambton and Evans Bay sub-catchments has having the potential to cause a High (significant) level of adverse effect in the receiving environment, and the Karori and Island/Houghton Bay sub-catchments with the potential to cause a Moderate (more than minor) level of adverse effect. WNOs in the five other sub-catchments presented a relatively low risk of having adverse effects on their receiving environments.

The application proposes to resolve these adverse effects through a Wastewater Network Overflow Reduction Plan, as detailed in Section 4 of the Part 1 Report. The WNO Reduction Plan Overflow is a key tool 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 WNO Reduction Plan 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 WNOs, Receiving Water Values, and Risk of Adverse Effects

Table A1: Summary of overflow sites, receiving environment (RE) value classes, magnitude of potential effect, and risk of adverse effects

WNO number	Asset_ID	Overflow Type	Facility Name	Ref X	Ref Y	Catchment	Direct Receiving Environment	Receiving Environment Type	Volume Range	Frequency Range	RE Potential Public Health Effect	RE Potential Public Health Effect	RE Potential Ecological Effect	RE Potential Ecological Effect	RE Potential Cultural Effect	RE Potential Cultural Effect	RE Potential Aesthetic Effect	RE Potential Aesthetic Effect	Overall Effects Score	Level of Adverse Effect
34	WCC_WW026938	2	KENTWAKE	1749416.0	5427142.4	Lambton	Lambton Harbour	Harbour (inner)	Medium	High	Very High	5	Moderate	3	High	4	High	4	16	High
40	WCC_WW030078	2	60 KENT	1749185.7	5426631.8	Lambton	Lambton Harbour	Harbour (inner)	Medium	High	Very High	5	Moderate	3	High	4	High	4	16	High
114		3	Western WWTP - To Stream			Karori	Karori Stream	Medium waterway	Medium	Medium	High	4	High	4	Moderate	3	Moderate	3	14	High
28	WCC_WW020948	2	5 ELPHINSTONE	1752442.7	5423091.6	Evans Bay	Evans Bay	Harbour (inner)	High	Medium	High	4	High	4	Moderate	3	Moderate	3	14	High
52	WCC_WW035569	2	TARAGHUZ	1748873.0	5427081.2	Lambton	Lambton Harbour	Harbour (inner)	Low	High	High	4	Low	2	High	4	High	4	14	High
85	WCC_WWPS023	1	PS 23 - Byron Street			Evans Bay	Evans Bay	Harbour (inner)	Medium	Medium	High	4	High	4	Moderate	3	Moderate	3	14	High
99	WCC_WWPS037	1	PS 37 - 230 The Esplanade			Island / Houghton	Island Bay / Houghton Bay	Beach	High	Medium	High	4	High	4	Moderate	3	Moderate	3	14	High
113		2	Western WWTP - To Stream			Karori	Karori Stream	Medium waterway	High	Medium	Mod	3	High	4	Moderate	3	Moderate	3	13	Moderate
11	WCC_WW012046	2	62 STHKARORI	1744161.0	5427365.9	Karori	Karori Stream	Medium waterway	Low	Medium	Moderate	3	High	4	Moderate	3	Moderate	3	13	Moderate
98	WCC_WWPS036	1	PS 36 - 126 The Esplanade			Island / Houghton	Island Bay / Houghton Bay	Beach	Medium	Medium	High	4	Moderate	3	Moderate	3	Moderate	3	13	Moderate
102	WCC_WWPS040	1	PS 40 - Cowan			Island / Houghton	Island Bay / Houghton Bay	Beach	Medium	Medium	High	4	Moderate	3	Moderate	3	Moderate	3	13	Moderate
1	WCC_WW004696	2	47 CONSTABLE	1749185.8	5424934.1	Lambton	Lambton Harbour	Harbour (inner)	High	Medium	High	4	Low	2	Moderate	3	Moderate	3	12	Moderate
23	WCC_WW019626	2	WELLWALMER	1750030.4	5425062.4	Evans Bay	Evans Bay	Harbour (inner)	Low	Medium	Moderate	3	Moderate	3	Moderate	3	Moderate	3	12	Moderate
32	WCC_WW023985	2	SOUTHAMP	1751801.0	5424202.5	Evans Bay	Evans Bay	Harbour (inner)	Low	Medium	Moderate	3	Moderate	3	Moderate	3	Moderate	3	12	Moderate
56	WCC_WW038277	2	MURPHYOF	1749015.1	5429229.9	Lambton	CBD Streams	Harbour (inner)	High	Medium	High	4	Low	2	Moderate	3	Moderate	3	12	Moderate
64	WCC_WWPS002	1	PS 2 - Oriental Parade			Lambton	Lambton Harbour	Harbour (inner)	High	Medium	High	4	Low	2	Moderate	3	Moderate	3	12	Moderate
65	WCC_WWPS003	1	PS 3 - Kent Terrace			Lambton	Lambton Harbour	Harbour (inner)	Medium	Medium	High	4	Low	2	Moderate	3	Moderate	3	12	Moderate
9	WCC_WW011711	3	Miramar Avenue	1752215.1	5424499.9	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	High	4	Low	2	Low	2	Low	2	10	Low
33	WCC_WW026930	2	38 KENT	1749258.1	5426792.5	Lambton	Lambton Harbour	Harbour (inner)	Low	Medium	Moderate	3	Very Low	1	Moderate	3	Moderate	3	10	Low
38	WCC_WW029555	2	78 CONSTABLE	1749364.0	5424964.5	Lambton	Lambton Harbour	Harbour (inner)	Low	Medium	Moderate	3	Very Low	1	Moderate	3	Moderate	3	10	Low
50	WCC_WW034419	2	12A MANLEY	1748705.0	5424959.0	Lambton	Lambton Harbour	Harbour (inner)	Low	Medium	Moderate	3	Very Low	1	Moderate	3	Moderate	3	10	Low
72	WCC_WWPS010	1	PS 10 - Thorndon South			Lambton	Lambton Harbour	Harbour (inner)	Low	Medium	Moderate	3	Very Low	1	Moderate	3	Moderate	3	10	Low
4	WCC_WW007876	3	4B Crofton Road	1748588.7	5431766.7	Kaiwharawhara	Kaiwharawhara Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
5	WCC_WW008186	3	15 Ngatoto Street	1749295.8	5432248.5	Kaiwharawhara	Kaiwharawhara Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
6	WCC_WW009644	2	115 STHKARORI	1744260.7	5426916.7	Karori	Karori Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
10	WCC_WW012009	2	Hazelwood Avenue	1744133.0	5426517.7	Karori	Karori Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
12	WCC_WW012136	2	Campbell Street	1745835.3	5427801.3	Karori	Karori Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
13	WCC_WW012580	2	270 THEPARADE	1748253.6	5422123.9	Island / Houghton	Island Bay / Houghton Bay	Beach	Medium	Low	Moderate	3	Low	2	Low	2	Low	2	9	Low
16	WCC_WW016740	2	62 Tinakori Road	1748940.2	5429627.5	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
17	WCC_WW017548	2	Nairn Street	1748156.4	5426720.2	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
18	WCC_WW017605	2	Kaiwharawhara Road	1749345.8	5431075.6	Kaiwharawhara	Kaiwharawhara Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
27	WCC_WW020568	2	225A Karori Road	1745683.8	5428165.8	Karori	Karori Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
36	WCC_WW027900	2	Clutha Avenue	1749806.1	5432116.7	Kaiwharawhara	Kaiwharawhara Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
45	WCC_WW031585	2	Scapa Terrace	1745832.3	5427897.9	Karori	Karori Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
107	WCC_WWPS046	1	PS 46 - Ngaio Gorge			Kaiwharawhara	Kaiwharawhara Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low

WNO number	Asset_ID	Overflow Type	Facility Name	Ref X	Ref Y	Catchment	Direct Receiving Environment	Receiving Environment Type	Volume Range	Frequency Range	RE Potential Public Health Effect	RE Potential Public Health Effect	RE Potential Ecological Effect	RE Potential Ecological Effect	RE Potential Cultural Effect	RE Potential Cultural Effect	RE Potential Aesthetic Effect	RE Potential Aesthetic Effect	Overall Effects Score	Level of Adverse Effect
115	WCC_WW007573	2	Wilton Bush Road Carpark			Kaiwharawhara	Kaiwharawhara Stream	Medium waterway	Low	Low	Low	2	Moderate	3	Low	2	Low	2	9	Low
15	WCC_WW016560	2	Hobart Street	1751638.2	5423535.7	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
20	WCC_WW019570	2	24 Moxam Avenue	1750143.8	5425837.7	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
26	WCC_WW020400	2	Rata Street	1750707.7	5425798.3	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
43	WCC_WW031228	2	Darlington Road	1752771.4	5425156.3	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
46	WCC_WW031812	2	Hobart/Caledonia Intersection	1751762.7	5423956.2	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
49	WCC_WW033653	2	Rongotai Road	1750793.8	5424221.8	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
58	WCC_WW038597	2	78 Miramar North Road	1752510.5	5425697.9	Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
76	WCC_WWPS014	1	PS 14 - Balaena Bay			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
77	WCC_WWPS015	1	PS 15 - Kio Bay			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
78	WCC_WWPS016	1	PS 16 - Rata Road			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
79	WCC_WWPS017	1	PS 17 - Tully Street			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
80	WCC_WWPS018	1	PS 18 - Salek Street			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
86	WCC_WWPS024	1	PS 24 - Devonshire Road			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
92	WCC_WWPS030	1	PS 30 - Strathmore Avenue			Evans Bay	Evans Bay	Harbour (inner)	Low	Low	Low	2	Low	2	Low	2	Low	2	8	Low
2	WCC_WW006114	2	308 Oriental Parade	1750454.6	5427513.5	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
3	WCC_WW006217	3	611 Hutt Road	1754030.1	5433856.2	North Harbour	North Harbour	Harbour (outer)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
7	WCC_WW010962	3	Carlton Gore Road	1750716.6	5427694.9	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
8	WCC_WW011419	2	Hall Street	1748588.2	5425259.1	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
14	WCC_WW012809	2	100 Lyall Bay Parade	1750087.1	5423058.0	Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
19	WCC_WW019192	2	DRUMMOND	1748855.6	5425855.8	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
22	WCC_WW019618	2	Colombo Street	1748861.3	5424988.8	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
30	WCC_WW021379	2	Tasman Street	1748691.8	5425635.4	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
35	WCC_WW027373	2	275 OHIRO	1747539.1	5425396.1	Owhiro	Owhiro Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
37	WCC_WW029449	2	38 Mersey Street	1748379.1	5422272.3	Island / Houghton	Island Bay / Houghton Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
39	WCC_WW029768	2	Hawkstone Street	1748715.4	5429203.2	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
41	WCC_WW030412	2	100 Owen Street	1749388.1	5424846.6	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
42	WCC_WW030444	2	Douglas Street	1748869.5	5426190.2	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
48	WCC_WW032065	2	53 MERSEY	1748274.6	5422296.3	Island / Houghton	Island Bay / Houghton Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
51	WCC_WW034453	2	Narin Street	1748173.4	5426737.3	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
54	WCC_WW036378	2	Douro Ave	1749527.6	5425148.7	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
55	WCC_WW037134	2	Victoria Street	1748763.8	5427787.9	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
57	WCC_WW038331	2	LYALLQUEENS	1749946.7	5422922.9	Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
60	WCC_WW040905	2	Ranfurly Terrace	1748801.0	5426207.3	Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
61	WCC_WW042127	2	4 Brendon Grove	1747881.4	5423888.6	Island / Houghton	Island Bay / Houghton Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
63	WCC_WWPS001	1	PS 1 - Oriental Bay			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
66	WCC_WWPS004	1	PS 4 - Chaffers Street			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
67	WCC_WWPS005	1	PS 5 - Jervois Quay			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low

WNO number	Asset_ID	Overflow Type	Facility Name	Ref X	Ref Y	Catchment	Direct Receiving Environment	Receiving Environment Type	Volume Range	Frequency Range	RE Potential Public Health Effect	RE Potential Public Health Effect	RE Potential Ecological Effect	RE Potential Ecological Effect	RE Potential Cultural Effect	RE Potential Cultural Effect	RE Potential Aesthetic Effect	RE Potential Aesthetic Effect	Overall Effects Score	Level of Adverse Effect
68	WCC_WWPS006	1	PS 6 - Wakefield Street			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
69	WCC_WWPS007	1	PS 7 - Willeston Street			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
70	WCC_WWPS008	1	PS 8 - Featherston Street			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
71	WCC_WWPS009	1	PS 9 - Whitmore Street			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
73	WCC_WWPS011	1	PS 11 - Thorndon Middle			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
74	WCC_WWPS012	1	PS 12 - Thorndon North			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
75	WCC_WWPS013	1	PS 13 - Aotea Quay			Lambton	CBD Streams	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
81	WCC_WWPS019	1	PS 19 - Lyall Bay West			Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
82	WCC_WWPS020	1	PS 20 - Railway Station			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
83	WCC_WWPS021	1	PS 21 - Cornwell Street			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
84	WCC_WWPS022	1	PS 22 - Lyall Bay East			Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
90	WCC_WWPS028	1	PS 28			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
93	WCC_WWPS031	1	PS 31 - Moa Point			Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
96	WCC_WWPS034	1	PS 34 - Tirangi Road			Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
97	WCC_WWPS035	1	PS 35 - Arthurs Nose			Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
100	WCC_WWPS038	1	PS 38 - Island Bay			Owhiro	Owhiro Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
101	WCC_WWPS039	1	PS 39 - Owhiro Bay			Owhiro	Owhiro Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
104	WCC_WWPS042	1	PS 42 - Queens Wharf North			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
105	WCC_WWPS044	1	PS 44 - Queens Wharf			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
112	WCC_WWPS060	1	PS 60 - Wharewaka House			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
116	WCC_WW036629	2	Moa Point Short Outfall			Lyall	Lyall Bay	Beach	Low	Low	Low	2	Very Low	1	Low	2	Low	2	7	Very Low
24	WCC_WW019810	2	Tyres Stream	1750421.0	5432680.6	North Harbour	Ngauranga Stream	Medium waterway	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
29	WCC_WW020987	2	CRESSWELLOF	1751699.8	5434107.7	North Harbour	Ngauranga Stream	Medium waterway	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
31	WCC_WW022934	2	Wakely at SH1	1751781.2	5432806.8	North Harbour	Ngauranga Stream	Medium waterway	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
53	WCC_WW035935	2	4B Rangiora Avenue	1750525.7	5431394.8	North Harbour	North Harbour	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
62	WCC_WW042238	2	73 Moa Point Road	1751582.3	5421745.9	Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
87	WCC_WWPS025	1	PS 25 - Seatoun Park			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
88	WCC_WWPS026	1	PS 26 - Ferry Street			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
89	WCC_WWPS027	1	PS 27 - Worser Bay			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
91	WCC_WWPS029	1	PS 29 - Karaka Bay			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
94	WCC_WWPS032	1	PS 32 - Breaker Bay North			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
95	WCC_WWPS033	1	PS 33 - Breaker Bay South			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
103	WCC_WWPS041	1	PS 41 - Fort Dorset			Miramar	Miramar Peninsula East Coast	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
106	WCC_WWPS045	1	PS 45 - Homebush Road			North Harbour	North Harbour	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
108	WCC_WWPS047	1	PS 47 - Kaiwharawhara			North Harbour	North Harbour	Harbour (outer)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
109	WCC_WWPS048	1	PS 48 - Jarden Mile			North Harbour	Ngauranga Stream	Medium waterway	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
110	WCC_WWPS049	1	PS 49 - Ngauranga Gorge			North Harbour	Ngauranga Stream	Medium waterway	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low
111	WCC_WWPS059	1	PS 59 - Oriental Bay Toilets			Lambton	Lambton Harbour	Harbour (inner)	Low	Low	Very Low	1	Very Low	1	Low	2	Low	2	6	Very Low

Appendix B Predicted Receiving Water Quality during Overflow Events

Wastewater Constituents	Discharge characteristics					Discharge quality			We weather stream flow			Stream water quality					
	Overflow	Volume	Duration	Duration	Discharge	Conc.	load	mass load	Small	Moderate	Large	Background wet weather	Small waterway	Moderate 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-science/freshwater/tools/turbidity/peak
	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		
BOD	Low	100	1	3600	0.03	220	6.1	165	0.5	5	50	1	13	2	1.1	3	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) 80% protection
	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) 80% protection
	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 Modelled Uncontrolled Overflow Points (Type 5)

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

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
WW00336	5	2.17	2
WW00349	5	55.49	2
WW00542	5	35.64	2
WW00657	5	0.53	2
WW00793	5	5.08	2
WW02006	5	24.32	2
WW03041	5	5.96	2
WW04405	5	1.21	2
WW04639	5	0.02	2
WW04663	5	12.12	2
WW05797	5	47.68	2
WW05909	5	30.51	2
WW06217	5	354.47	2
WW07445	5	1.32	2
WW07451	5	64.54	2
WW07641	5	0.01	2
WW07876	5	34.26	2
WW07927	5	3.89	2
WW08185	5	0.87	2
WW08186	5	146.58	2
WW08417	5	130.35	2
WW08435	5	43.22	2
WW08547	5	2.62	2
WW08548	5	21.28	2
WW08554	5	13.78	2
WW09043	5	150.95	2
WW10215	5	184.98	2
WW10962	5	186.05	2
WW11639	5	0.57	2
WW11705	5	45.96	2
WW11711	5	0.05	2
WW11781	5	20.83	2
WW11786	5	0.20	2
WW11825	5	199.43	2
WW11907	5	185.45	2
WW11920	5	51.08	2
WW11924	5	586.18	2
WW12292	5	3.44	2
WW12868	5	4.95	2
WW13061	5	4.40	2
WW13068	5	0.62	2
WW13087	5	42.57	2
WW13129	5	0.11	2
WW13144	5	49.13	2
WW13566	5	10.56	2
WW14528	5	6.03	2
WW14530	5	4.14	2
WW14534	5	7.39	2
WW14876	5	6.63	2
WW15393	5	84.78	2
WW15408	5	7.94	2
WW15695	5	0.39	2
WW16383	5	7.01	2
WW17744	5	27.69	2
WW19189	5	16.35	2
WW19780	5	4.38	2

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
WW19804	5	0.10	2
WW19814	5	29.33	2
WW19883	5	1.02	2
WW19884	5	0.80	2
WW20112	5	97.26	2
WW20163	5	12.83	2
WW21756	5	19.99	2
WW21951	5	109.14	2
WW21952	5	0.04	2
WW21954	5	101.74	2
WW22198	5	23.79	2
WW22321	5	73.12	2
WW23036	5	0.34	2
WW23039	5	38.44	2
WW23534	5	39.27	2
WW24278	5	78.37	2
WW25196	5	0.43	2
WW25201	5	1.00	2
WW25411	5	8.41	2
WW25441	5	3.63	2
WW27487	5	1.05	2
WW27619	5	56.83	2
WW27679	5	33.02	2
WW27780	5	19.73	2
WW27960	5	6.30	2
WW28420	5	18.82	2
WW28807	5	5.81	2
WW29170	5	3.77	2
WW29264	5	0.78	2
WW30133	5	3.05	2
WW30182	5	10.43	2
WW31070	5	0.26	2
WW31079	5	54.92	2
WW31080	5	21.28	2
WW31113	5	3.13	2
WW31116	5	125.45	2
WW31132	5	5.33	2
WW31240	5	2.78	2
WW31243	5	100.06	2
WW31349	5	17.85	2
WW31352	5	59.17	2
WW32081	5	1.62	2
WW34002	5	0.55	2
WW34020	5	24.78	2
WW34091	5	1.37	2
WW34270	5	81.59	2
WW34646	5	10.88	2
WW36641	5	0.43	2
WW37309	5	88.46	2
WW39097	5	46.31	2
WW39098	5	66.77	2
WW39105	5	3.91	2
WW39111	5	11.96	2
WW39619	5	2.46	2
WW39620	5	6.31	2
WW40194	5	44.14	2
WW40195	5	1.29	2
WW42218	5	0.58	2
710001R00102	5	38.58	2
710001R00184	5	15.57	2
710001R00434	5	39.61	2
710001R00440	5	10.23	2
710001R00520	5	229.14	2
710001R00765	5	30.47	2

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
710002R00378	5	24.29	2
710002R00771	5	9.87	2
710003R00674	5	100.08	2
710003R00685	5	27.96	2
710003R00730	5	26.82	2
710004R00117	5	66.84	2
710004R00144	5	0.43	2
710004R00176	5	99.74	2
710004R00306	5	0.67	2
710004R00612	5	34.24	2
710005R00142	5	7.27	2
710005R00260	5	0.59	2
710005R00361	5	5.30	2
710005R00648	5	46.59	2
710005R00681	5	0.16	2
710006R00170	5	1.25	2
710006R00627	5	1.39	2
710008R00117	5	2.23	2
710008R00139	5	55.68	2
710008R00142	5	21.92	2
710008R00255	5	83.78	2
710008R00307	5	1.83	2
710008R00652	5	0.08	2
710009R00628	5	0.79	2
710010R00216	5	64.14	2
710010R00252	5	47.57	2
710010R00679	5	34.23	2
710011R00517	5	11.30	2
710011R00675	5	6.65	2
710012R00252	5	21.67	2
710012R00377	5	38.29	2
710013R00291	5	52.35	2
710013R00494	5	18.90	2
710013R00681	5	102.04	2
710014R00546	5	11.85	2
710015R00182	5	11.25	2
710015R00377	5	23.57	2
710015R00484	5	62.11	2
710015R01000	5	12.02	2
710016R00291	5	0.44	2
710017R00100	5	0.61	2
710017R00171	5	61.34	2
710017R00252	5	2.35	2
710017R00484	5	61.56	2
710017R00579	5	4.87	2
710018R00524	5	4.35	2
710018R00552	5	23.39	2
710018R00554	5	17.18	2
710018R00765	5	20.56	2
710019R00146	5	3.18	2
710020R00361	5	114.08	2
710020R00767	5	14.84	2
710024R00169	5	26.34	2
710024R00554	5	138.69	2
710026R00552	5	33.76	2
710030R00554	5	52.73	2
710031R01102	5	0.00	2
710037R00412	5	7.34	2
710040R00433	5	181.61	2
710056R00551	5	237.41	2
710063R00216	5	4.23	2
710074R00216	5	10.00	2
710077R00216	5	5.56	2
710084R00165	5	23.71	2

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
710122R01102	5	4.03	2
710124R00173	5	1.84	2
710139R00165	5	3.50	2
710152R00216	5	3.47	2
710161R00216	5	39.75	2
750071R00543	5	7.19	2
750074R00543	5	14.30	2
760011R00679	5	228.39	2
810005R00216	5	270.40	2
810015R00410	5	2.45	2
ROPS_dummy	5	0.00	2
XXXX000542	5	2.04	2
710001R00931	5	18.97	2
710001R00955	5	8.63	2
710002R00949	5	26.94	2
710008R00856	5	18.68	2
710010R00909	5	11.21	2
710010R00949	5	35.51	2
710011R00845	5	1.41	2
710011R00909	5	13.66	2
710011R00913	5	16.09	2
710013R00913	5	0.08	2
710014R00949	5	14.67	2
710019R00955	5	18.09	2
710020R00955	5	13.62	2
710024R00921	5	0.81	2
710028R00896	5	19.79	2
710029R00896	5	1.03	2
710043R00959	5	13.09	2
750088R00959	5	35.26	2
841001P00232	5	0.84	2
XXXX000186	5	24.50	2
BLUEB0012SM	5	7.03	2
BLUEB0018SM	5	0.01	2
CASSI0006SM	5	16.84	2
CASSI0007SM	5	3.63	2
DELLE0015SM	5	89.83	2
FERGU0352SM	5	11.58	2
FIELD0002SM/3	5	9.96	2
GENTI0002SM	5	0.14	2
KIRTO0001SN	5	0.59	2
MAYMO0004SM	5	32.78	2
MAYMO1176SM/2	5	3.63	2
PHMS 0008SM	5	1027.11	2
PHMS 0009SM	5	664.80	2
PHMS 004SM	5	63.86	2
PINEH0027SM/1	5	2.83	2
PINEH0038LH	5	4.15	2
PINEH0058SM	5	8.68	2
PLATE0035SM	5	37.54	2
TCDB 0014SM	5	4.13	2
S0124806	5	117.17	2
S0127601	5	101.13	2
S030402	5	148.79	2
S041003	5	11.08	2
S050203	5	15.88	2
S050204	5	0.01	2
S070209	5	338.69	2
S070403	5	0.38	2
S070404	5	0.11	2
S070405	5	0.00	2
S070408	5	1.49	2
S072003	5	11.27	2
S072011	5	0.94	2

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
S080215	5	12.04	2
S080220	5	14.34	2
S090411	5	7.74	2
S090414	5	11.53	2
S090415A	5	9.14	2
S091402	5	25.55	2
S111602	5	4.26	2
S111603	5	0.04	2
S126001	5	0.24	2
S126002	5	10.21	2
S154404	5	7.19	2
S154406	5	18.53	2
S154409	5	0.07	2
S20A0414	5	56.36	2
S20A1409	5	111.48	2
S20A1412	5	0.16	2
S20A3402	5	10.38	2
S20A3409	5	0.20	2
S20A3501	5	105.94	2
S20A6401	5	2.46	2
S20B0202A	5	86.78	2
S20B0234	5	16.14	2
S20B0235	5	2.16	2
S20B0423	5	2262.91	2
S20B0424	5	411.96	2
S20C0208	5	0.28	2
S20C0426	5	15.78	2
S20C0427	5	33.67	2
S20C0627	5	79.05	2
S20C0628	5	163.37	2
S20D0201	5	140.16	2
S20D0218	5	0.75	2
S20D0433	5	211.95	2
S20D0445	5	113.43	2
S20D4812	5	18.18	2
S20D4813	5	6.73	2
S20E0222	5	9.53	2
S20E0469	5	112.95	2
S20E3005	5	31.08	2
S20E4401	5	51.75	2
S20E4402	5	4.50	2
S20F11601	5	35.28	2
S20F4202	5	4.28	2
S20F4204A	5	91.04	2
S20F4205	5	15.21	2
S20F4801	5	36.56	2
S20F4808	5	2.22	2
S20G0203	5	111.45	2
S20G0205	5	1.26	2
S20G2009	5	1.13	2
S20G4601	5	0.29	2
S20G4602	5	0.52	2
S20H0202	5	169.45	2
S20H0204	5	63.17	2
S20H7201	5	3.50	2
S20N0202	5	46.21	2
S20N0218	5	470.41	2
S20S0520	5	1.17	2
S20S0530	5	0.15	2
S20S0534	5	95.75	2
S20S0537	5	23.94	2
S20S0538	5	7.92	2
S20S0540	5	2.24	2
S20S1401	5	5.20	2

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
S20S7801	5	11.65	2
S290201	5	567.23	2
S290204	5	56.22	2
S290206	5	84.93	2
S294001	5	3.21	2
S300201	5	9.88	2
S300601	5	5.54	2
S3317606	5	48.68	2
S3317612	5	2.62	2
S3317614	5	3.05	2
S331801	5	13.54	2
S3319001	5	1.69	2
S3319401	5	10.66	2
S3323002	5	222.09	2
S332401	5	9.00	2
S350603	5	0.46	2
S351603	5	4.11	2
S351604	5	0.09	2
S3536201	5	8.24	2
S354212	5	249.00	2
S381605	5	43.49	2
S381607	5	23.05	2
S383801	5	32.26	2
S384201	5	29.34	2
S6A0203	5	1.45	2
S6A0204	5	8.37	2
S6A2604B	5	6.42	2
S6A2801	5	0.98	2
S6BRM07	5	15.82	2
S6BRM09	5	6403.98	2
S6BRM10	5	76.22	2
S6BRM11	5	6.06	2
S6BRM12	5	0.00	2
S6BRM13	5	1.00	2
WW02400	5	17.71	2
WW02402	5	2.83	2
WW05279	5	1.09	2
WW10544	5	13.68	2
WW15780	5	147.93	2
WW15781	5	6.22	2
WW15785	5	0.72	2
WW15787	5	11.17	2
WW15789	5	36.98	2
WW15805	5	14.52	2
WW15806	5	80.70	2
WW15809	5	53.79	2
WW15886	5	13.08	2
WW17170	5	1.80	2
WW17972	5	10.29	2
WW17984	5	81.26	2
WW18186	5	2.03	2
WW18265	5	1.99	2
WW18269	5	98.02	2
WW18360	5	7.64	2
WW18362	5	11.43	2
WW18364	5	179.41	2
WW19408	5	6.11	2
WW19410	5	22.17	2
WW19412	5	5.95	2
WW20687	5	18.94	2
WW20691	5	12.43	2
WW20847	5	18.46	2
WW22953	5	176.61	2
WW25899	5	7.73	2

Node ID	Overflow Type	Overflow Rate (m3/s)	Frequency (spills/yr)
WW25901	5	3.20	2
WW25904	5	0.89	2
WW25915	5	10.93	2
WW30299	5	56.81	2
WW30923	5	11.87	2
WW32665	5	17.63	2
WW32708	5	62.73	2
WW32794	5	3.28	2
WW32845	5	4.40	2
WW32925	5	33.34	2
WW32927	5	3.72	2
WW33107	5	26.19	2
WW33250	5	48.04	2
WW33375	5	21.46	2
WW34207	5	22.40	2
WW34208	5	9.55	2
WW35317	5	163.73	2
WW35728	5	0.05	2
WW35861	5	120.55	2
WW36919	5	7.03	2