DRAFT Hutt & Wainuiomata/Orongorongo Water Collection Areas Management Plan

Draft 14 June 2016

Note: This is the word document version. Graphic design still to be completed before plan is finalised. Red notes in photo captions are for graphic design.

Wellington Water

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Caption: Large rata tree amongst mature forest in the Wainuiomata/Orongorongo water collection area (photo FC)

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Executive Summary

The Hutt and Wainuiomata / Orongorongo water collection areas are unique areas of old growth forest. They were chosen in the early years of European settlement for their geographic location as places of high rainfall, and then protected for water collection purposes. This protection, and ongoing active pest plant and animal management, has allowed the biodiversity of these forests and aquatic ecosystems to flourish.

Together these water collection areas annually supply approximately 65% of Wellington's water. Managing the water collection areas to ensure optimum water quality minimises the need for expensive water treatment which negatively impacts water taste for the population.

This plan focuses on management of the water catchments of the Hutt and Wainuiomata/ Orongorongo rivers **upstream of the water intakes** to address primary goals of achieving:

- Water quality which meets or exceeds drinking water standards
- Catchment management to maximise volumes of raw water
- Secondary goals of protecting and enhancing biodiversity and heritage values and providing for limited recreation opportunities.

Whilst the Parks Network Plan (2011) is the overarching management plan for the Greater Wellington Regional Council (GWRC) park network, its scope does not encompass the two water collection areas (WCA) which are managed primarily for water supply purposes. This plan is needed to identify and document key threats to achieving optimum drinking water quality and supply, and to identify the important values to be conserved, and risk management actions to be taken to achieve this. With two agencies involved, it is important that the plan identifies shared goals and objectives as the basis for collaborative management between GWRC and Wellington Water Limited (WWL).

The plan is structured as four parts:

- Section 1 and 2 introduce the plan and outline the core goals for management
- Sections 3, 4 and 5 outline the **planning context** and describe the important and **unique natural and cultural values** of the water collection areas.
- Section 6 documents the **key threats to water quality and supply** and identifies actions to minimise or mitigate them, referencing water safety plans.
- Sections 7 and 8 are operationally focused. They outline the **management framework** and **decision making responsibilities**, as well as **actions** to be achieved based on the overarching goals. Rules for permitted activities are presented in a quick reference format consistent with the Parks Network Plan.

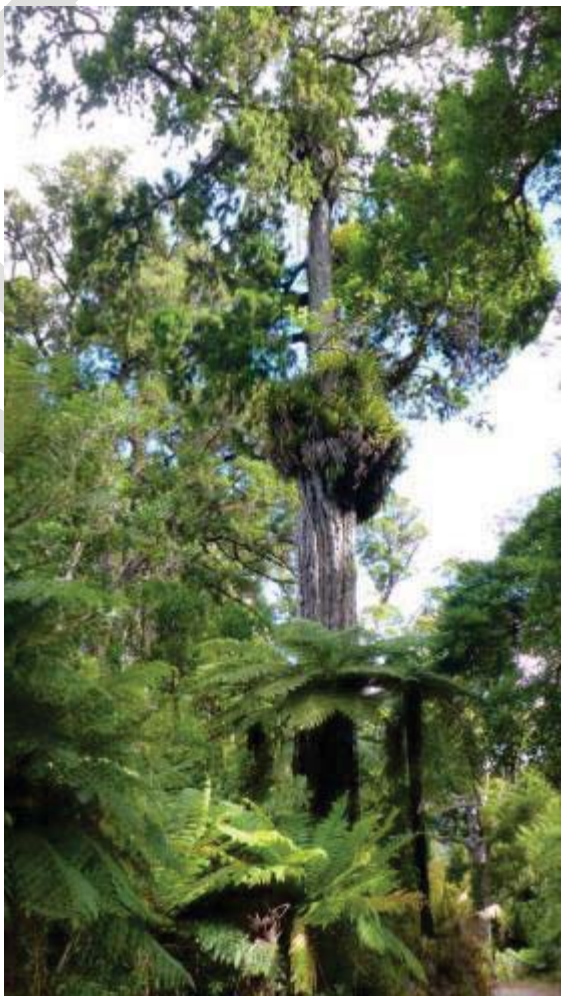
Key challenges in management of the water collection areas are the overarching context of a changing climate and the need to build as much resilience as possible into the manageable aspects of water quality and supply. An opportunity also exists to deliver very high quality raw water that exceeds minimum drinking water quality standards, requires little treatment, and reduces the need for further residential filtering for taste and smell.

Ki uta ki tai – from the mountains to the sea, water is life *(Whhaitua committee theme)*

1. Introduction

The Hutt and Wainuiomata/Orongorongo Water Collection Areas are key sources of drinking water for the populations of Wellington, Lower Hutt, Upper Hutt and Porirua. Approximately 50% of the water supply for the Wellington population comes from the Hutt River Catchment, drawn at the Kaitoke weir, and approximately 15% comes from the Wainuiomata / Orongorongo Catchment area. The remaining 35% of Wellington's water supply is drawn from the Waiwhetu aquifer system below the Hutt Valley. A map on GWRC's website identifies where water supply is being sourced from different parts of the region on a daily basis, raising public awareness of Wellington's water sources.

This plan provides guidance and directions for WWL and GWRC decision making in the form of goals, objectives and policies to direct land management in the two water collection areas (refer to Map 1). It identifies the key threats and management responses to water quality and water supply for the land and ecosystems of the two water collection areas. It does not address water supply and quality issues downstream from the water intake areas which are the subject of other policies, strategies and work programmes.



The Hutt and Wainuiomata/Orongorongo water catchments are forested areas set aside exclusively for harvesting water and contain relatively undisturbed forests with significant biodiversity values. Collecting raw water which is as pure as possible reduces the need for further water treatment. Maintenance of healthy forest cover over water collection land provides natural filtering of impurities and minimises the extent and rates of erosion.

Maximising water quality and minimising the need for artificial water treatment is achieved through a range of management interventions. These include limiting public access to the water collection areas, pest control to maintain vegetation cover and minimise sediment run-off and pest animal contamination of water supply through protozoas (i.e. giardia and cryptosporidium) and measures to minimise the use of potentially harmful agrichemicals and fuel. Other threats to water supply and quality are also actively managed and interventions take place to ensure continuity of water supply.

Both water collection areas represent very high quality ecosystems which have been little modified by human interventions (such as timber harvesting) and are valued for their role in supplying clean source water for the Wellington region. The value of the biodiversity in the water collection area warrants protection for these values alone.

Management and protection of these high biodiversity values helps ensure that water quality objectives are met and maintained in both direct and indirect ways. Scientific evidence identifies that well-vegetated catchments have better water quality, and that control of browsing pest possums and ungulates minimises the loss of vegetation cover as well as the risks of water contamination from animal carcasses. Storm events can also have an immediate impact on both water quality and supply, but maintaining vegetation cover reduces the rate of runoff and extent of sediment in runoff contributing to turbidity and the need for water treatment. The following

diagram illustrates the diverse inputs to water quality and supply.

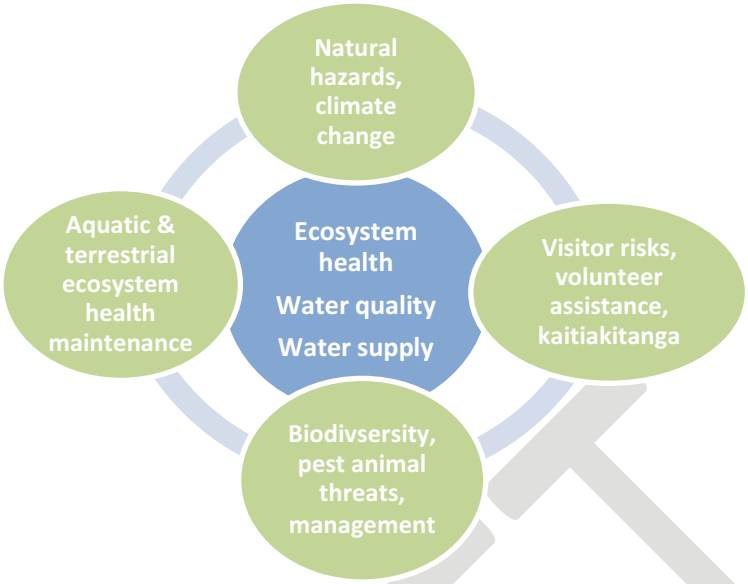
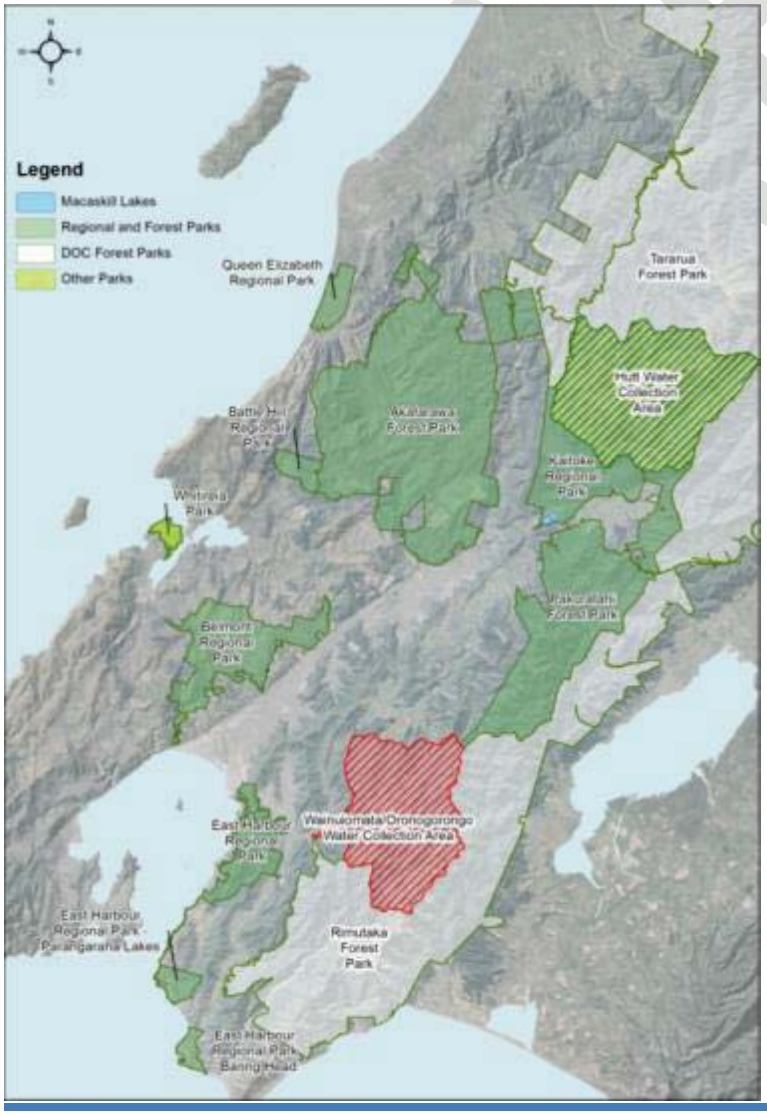


Figure 1. The inputs and influences on water quality, supply and overall terrestrial and aquatic ecosystem heath are interrelated and can be difficult to separate and precisely quantify with many variables to consider.



Map1. Location of the water collection areas and adjoining parks and forest

2. Plan purpose and goals

This section outlines the reason for development of the plan, the purposes of the water collection areas, scope of the plan and goals for management, which are later addressed with objectives and actions (in Section 7).

This plan has been developed to serve a number of purposes:

1. To outline the goals, objectives and policies that will govern the management of the water collection areas and to help ensure that water supply areas are secure and sustainably managed for the optimum public benefit of clean water.
2. To document management responsibilities between agencies in order to reduce risks of unintentional adverse consequences for water quality from catchment management actions (refer Section 7)
3. To be the guiding document to inform operational plans and management procedures such as key native ecosystem plans, service level agreements between agencies and other operational procedures and decision making.

The **primary purposes** of water collection areas management are:

- *Supply water to meet drinking water quality standards to the Wellington metropolitan areas and minimise water treatment*
- *Minimise risks of water supply contamination to be compatible with the objectives of the Water Safety Plans as mandated by the Health Act*
- *Provide a naturally resilient water catchment area through the maintenance of healthy catchment ecosystems to optimise water supply*

Secondary purposes are to:

- *Protect and enhance the regionally significant biodiversity values*
- *Provide for limited recreation activities.*

The long term **Goals** for management of the water collection areas are:

1. *Maximise the **quality** of raw water and minimise the extent of water treatment required*
2. *Manage threats to water **supply** to maintain volumes of raw water*
3. *Maintain and enhance the significant **ecosystem and biodiversity values** of the water collection areas*
4. *Maintain the **cultural heritage** values of the water collection areas, including managed **recreational access***
5. *Maintain **collaborative working relationships** between management agencies and with others to achieve water quality, supply and biodiversity objectives*

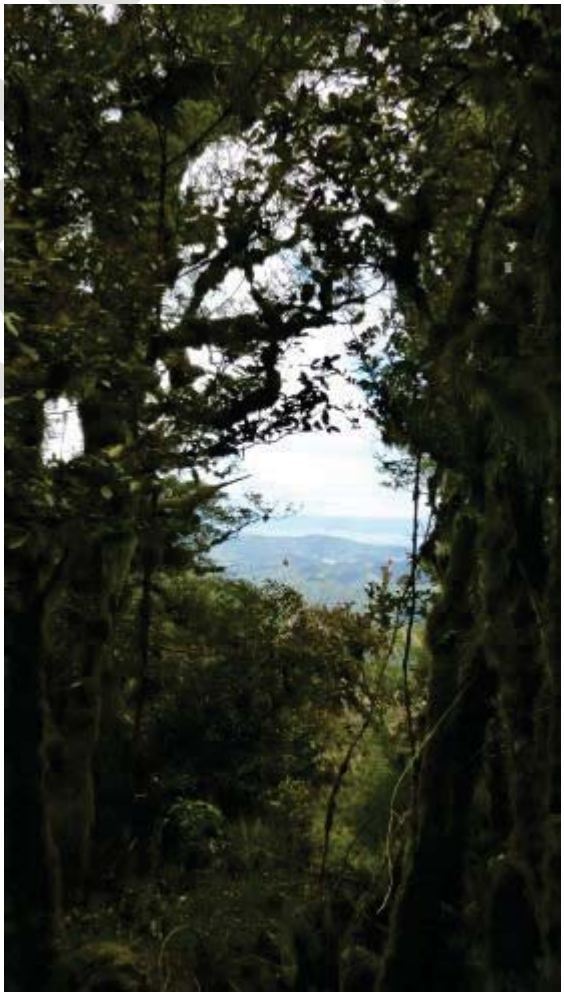
Management Plan Scope

The plan provides management directions for the Hutt and Wainuiomata / Orongorongo Water Collection area forest catchments **upstream of the water intakes (**refer map 1.). Policies are also provided for the Macaskill Lakes, Te Marua which are not included in the provisions of the Parks Network Plan.

The scope of the plan does not include the future water collection areas of the Akatarawa and Pakuratahi Forests, Kaitoke Regional Park or Wainuiomata Recreation Area. Management of these parks and reserves is governed by the Parks Network Plan.

This plan is non-statutory; that is, the Wellington Regional Water Board Act 1972 does not identify the requirement to prepare management plans for the water collection areas. However, GWRC and WWL have identified the need for a management plan for the purposes outlined above and this draft plan will be presented to Council for their formal approval. The plan defines permitted activities (section 7.4) within the water collection areas which can be controlled, if required, through the application of Bylaws. The GWRC Parks, Forests and Reserves Bylaw 2009 made under the Local Government Act 2002 applies to the water collection areas and is the Bylaw used for operational management purposes.

Older bylaws exist for the water collection areas; the Wellington Regional Water Board Bylaws 1976. These bylaws encompass areas beyond the two water collection areas (Karori reservoir) and may be withdrawn in future if deemed fully redundant or updated at a time when changes are made to the Wellington Regional Water Board Act 1972.



Photos: Telecommunications tower and view from the ridge line of Mt Puketaha, Orongorongo catchment (photosFC)

3. Background

This section outlines the legal, statutory and strategic planning framework applicable to management of the water collection areas.

3.1 Management agencies

Wellington Water Limited (WWL) was formed in September 2014 as a result of a merger between Capacity Infrastructure Services and Greater Wellington Regional Council's (GWRC) water supply group. Wellington Water Limited operates as a joint Council Controlled Organisation (CCO). The Hutt, Porirua, Upper Hutt and Wellington city councils and Greater Wellington Regional Council are equal shareholders in the CCO.

Wellington Water Limited's role is to manage the drinking water, wastewater and stormwater services for council owners, and to provide regional water services for the maintenance of healthy communities.

Wellington Water Limited's Statement of Intent identifies three long term outcomes:

1. *Safe drinking water – water delivered to the taps of the region's houses and businesses that satisfies consumers and meets or exceeds our clients' expectations*
2. *Respectful of the environment – we are mindful of the impacts that our activities have on the environment. We work closely with stakeholders to ensure discharges into watercourses and the sea are carefully managed*
3. *Resilient now and in the future – we know how costly and vital the infrastructure is that we work on and how it can be impacted by external influences such as climate change. Our planning, design, consultation and delivery prioritise network and community resilience for day to day use, and in times of emergency, now and in the future.*

GWRC assists WWL in the delivery of service objectives through Service Level Agreements (SLAs) for catchment area management. There are three SLA's in place; Biodiversity Management, Parks Services and Environmental Science. GWRC and WWL have worked together to prepare this management plan. Water quality standards are set by the Ministry of Health: www.health.govt.nz/publication/drinking-water-standards-new-zealand-2005-revised-2008, and National Environmental Standards for Sources of Human Drinking Water 2008 (NES) outline requirements for catchment management for drinking water supplies.

Photo: Orongorongo road is a key asset providing management access into the remote Orongorongo water catchment. Following a ridge line, it is frequently snow covered in winter (Photo FC)

Planning and operational context for the water collection areas

Management of the water collection areas, water quality and supply is undertaken within a hierarchy of statutes, plans and procedures ranging from legislation to day to day operating procedures to manage day to day risks to water quality, supply and biodiversity as identified below. A number plans have both statutory and strategic planning functions. The table below summarises the planning context for management which is then described in more detail in sections 3.2 and 3.3.

Table 1. Summary of the planning context for management of the water collection areas

Legislation		
Local Government Act 2002	Wellington Regional Water Board Act 1972	Health (Drinking Water) Amendment Act 2007
Health Act 1956	Resource Management Act 1991	
Statutory Planning		
WWL Statement of Intent	GWRC Proposed Natural Resources Plan (2016), Regional Management Plans for Freshwater, Soil, Discharges to Land	GWRC Pest Management Strategy
Drinking Water Standards for New Zealand 2005 (Revised 2008) (DWSNZ)	GWRC Parks Network Plan (2011)	GWRC Annual Plan, Long Term Plan
District Plans	WWL Water Safety Plans	National Environmental Standards for Sources of Human Drinking Water 2008
National Environmental Standards for Sources of Human Drinking Water 2008 (NES) and Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007		
Strategic Planning		
GWRC Biodiversity Strategy (2016)	GWRC Climate Change Strategy (2015)	Asset Management Plan Water Supply (2014)
Operational Planning, Standard Operating Procedures, Agreements, MOU's		
Key Native Ecosystem (KNE) plans	Service Level Agreements between WWL & GWRC	Risk management plans, hazard identification plans
Volunteer agreements/MOUs	Permit conditions – hunting, access, research	Health and safety operating procedures
Pest management operational plans	Guidelines for Drinking-water Quality Management in New Zealand, Ministry of Health	Biodiversity protocols for entry to WCAs
	Monitoring and evaluation	
WWL Three Waters Reports	Annual reporting/ reports	Monitoring reports
	Visitor number data collection and reporting	

3.2 Legislation, statutory plans and National Standards

The water collection areas are administered under the **Wellington Regional Water Board Act 1972**, the Local Government Act 2002, and the Wellington Regional Council (Water Board Functions) Act 2005. The Water Board Act 1972 sets out Greater Wellington's legal responsibilities and powers over the lands, enabling Greater Wellington to hold and manage lands for water supply purposes, forestry and recreation. The Act authorises officers and rangers to be empowered by bylaws made under this Act (or the Local Government Act 2002) to control activities in the forests. The 2005 Local Bill allows renewable energy generation (e.g. wind turbines) to take place on land designated for water catchment or forestry purposes (subject to regional and district plan resource consent

requirements).

The **Local Government Act 2002** provides Greater Wellington with the right to establish bylaws and concession policies within parks and reserves which include the water collection areas. The *GWRC Parks and Forests Bylaw 2009* (created under section 149 of the Act) provides for the protection of natural and cultural heritage values, land, buildings and structures from damage or loss through human activity.

The **Resource Management Act 1991** governs water and other resource extraction from the water collection areas and also directs responsibilities for indigenous biodiversity. It also provides the policy context for the development of environmental standards, policies and rules such as district plans and natural resource plans, as well as policy statements such as the National Policy Statement for Freshwater.

Within **district plans**, the Hutt water collection area is zoned Rural Zone in the Upper Hutt City Council District Plan, and the Wainuiomata/ Orongorongo Water Collection areas are within the 'General Rural' zones of the Hutt City Council District Plan. Both plans identify soil and landscape conservation and minimising impacts in river corridors as objectives for these areas.

GWRC's **Proposed Natural Resources Plan** (2015) sets out the objectives, policies and methods for people and organisations that use the Wellington region's resources for a variety of purposes in accordance with the Resource Management Act 1991 (RMA). It informs this plan with a variety of policy directions and will replace the GWRC Regional Freshwater Plan, Regional Plan for Discharges to Land, Regional Soil Plan, Regional Coastal Plan and Regional Air Quality Management Plan. It identifies a number of rules for resource use relevant to the WCA's, for example discharges to land.

The Health Act 1956 was amended by the **Health (Drinking Water) Amendment Act** in 2007 and aims to protect public health by improving the quality of drinking-water provided to communities. The Act requires that drinking water suppliers take all practicable steps to ensure they provide an adequate supply of drinking water that complies with the **New Zealand Drinking Water Standards** and meets required water grading's which are determined by factors including catchment protection, human contamination at source and animal pollution. The Ministry of Health identifies barriers to protect water supplies as; prevent contaminants entering the water, removing particles from the water; killing germs in the water, and preventing recontamination of water after treatment. Maintaining raw water quality at source therefore remains an important factor in drinking water quality and in minimising the extent and cost of treatment of water derived from the water collection areas.

The **Drinking-water Standards for New Zealand** 2005 (Revised 2007), (DWSNZ) 'specify MAVs for the microbial, chemical and radiological determinands of public health significance in drinking-water, and provide compliance criteria and procedures for verifying the water supply is not exceeding these values'. The MAV of a micro-organism is its concentration in drinking-water above which there is a significant risk of contracting a waterborne (enteric) disease. Raw and treated water quality monitoring is undertaken to determine the degree to which drinking water standards are met. Minimum allowable values (MAVs) are specified 'for the representative organisms Escherichia coli (E. coli) for the bacteria and Cryptosporidium plus Giardia (representing the protozoa)'. WWL treats raw water at the treatment plants to ensure these MAVs are met for drinking water.

Health Act 1956 has sections relating to drinking water. In particular section 69U and 69Z are particularly relevant and identify that drinking water suppliers must take reasonable steps to protect sources of drinking water. Water Safety Plans are mandatory and among other things, must identify public health risks and control measures – this includes catchment risks.

National Environmental Standards for Sources of Human Drinking Water 2008 (NES) and Resource Management (National Environmental Standards for Sources of Human Drinking Water)

Regulations 2007 complement the Ministry of Health legislation for improving drinking water supply and delivery and ensures that a comprehensive approach exists to the management of drinking water from source to tap. The standard and regulations apply to source water before it is treated and only sources used to supply human drinking water ie, not stock or other animals. It identifies significant restrictions on regional councils ability to grant abstraction or discharge consents upstream of abstraction points. The NES is a regulation made under sections 43 and 44 of the Resource Management Act 1991 (RMA).

3.3 Strategic planning context

There are a variety of other strategies, plans and policies which have relevance to the directions of this plan. They include:

GWRC's **Annual Plan** identifies focus areas for water supply as meeting future demand and improving resilience of water supply in the event of a major movement of the Wellington fault. Earthquake strengthening of water supply structures is a component of this.

The **Parks Network Plan 2011** provides management directions for most of the remaining GWRC managed park areas including the two areas reserved for future water collection; Akatarawa Forest and Pakuratahi Forest.

The **GWRC Biodiversity Strategy 2016** sets the framework to guide activities to protect and manage indigenous biodiversity in the Wellington region over a ten year planning horizon. The three Strategy goals are all relevant to the water collection areas; areas of high biodiversity value are protected or restored, ecosystem functions are maintained or restored across the landscape, people understand and value biodiversity and ecosystems.
Two objectives are particularly pertinent to the water collection areas:

- *Protect or restore wetlands and significant freshwater habitats*
- *Safeguard aquatic ecosystem health and mauri in fresh water bodies and in the coastal marine area*

The Strategy is implemented via Biodiversity Department Operational Plan 2014-17 and work programmes including Key Native Ecosystems, QEII Covenant Support, Fish Passage Restoration and Wetland Protection Support. At an operational level in the water collection areas key native ecosystem plans direct and deliver the majority of biodiversity work.

Key Native Ecosystem (KNE) plans for the water collection areas identify significant biodiversity values to be protected, guiding management actions, and outline how they are delivered and funded (through Service Level Agreements between GWRC and WWL. A KNE plan has been developed for the Hutt Water Collection Area and the development of a KNE plan is scheduled to be developed for the Wainuiomata / Orongorongo Water Collection Area in 2016/17. .

For the Wainuiomata Mainland Island located within this water collection area, more detailed management directions are provided in the **Wainuiomata Mainland Island Strategic Plan 2006-2016.** The directions of this plan will be incorporated into the directions of the Wainuiomata/ Orongorongo KNE plan.

The Greater Wellington **Pest Management Strategy** provides a strategic and statutory framework for management of selected pest animal and pest plant species in the Wellington region in order to minimise negative effects on environment, economy, biodiversity and the community, and to provide a regionally co-ordinated response.

The GWRC **Climate Change Strategy** (2015) coordinates climate change related actions across GWRC responsibilities and operations. Of particular relevance to this plan are initiatives designed to increase long term resilience to climate change impacts. The strategy identifies the need to consider

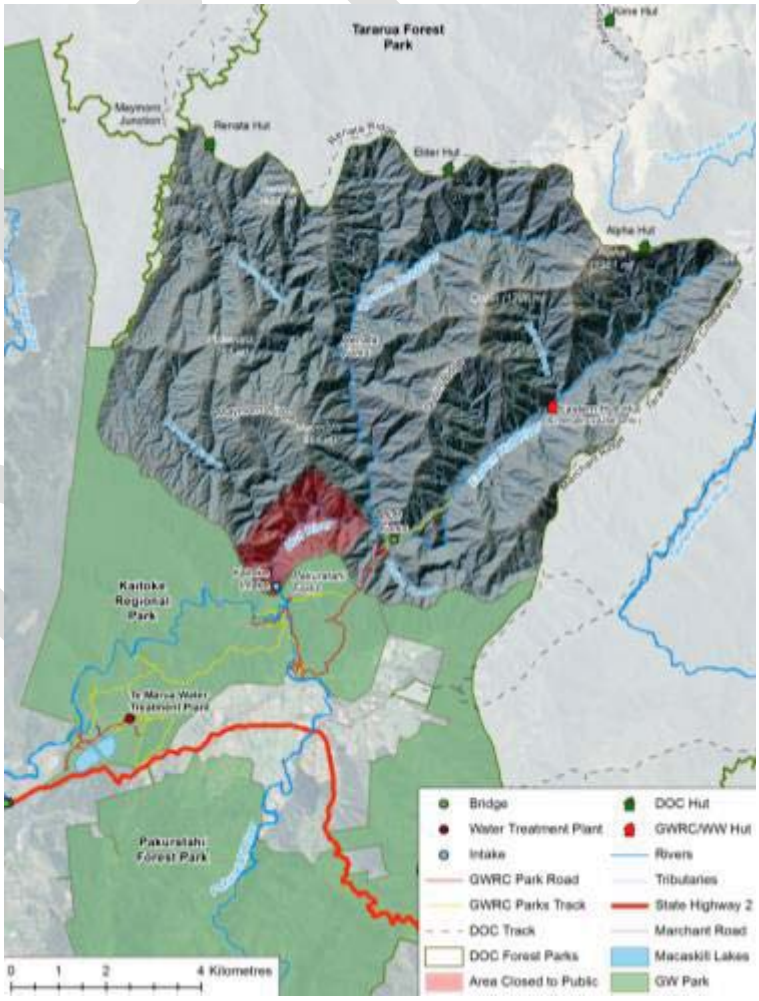
the effects of climate change and integrate adaptive planning into decision-making and routine work delivery programmes. This planned approach will minimise the need for urgent, reactive changes in future.

4. Land and water description

The following two sections are largely descriptive; they identify the landscape and natural and cultural values of importance in the two water collection areas, their unique qualities and the issues they present for management.

4.1 Location

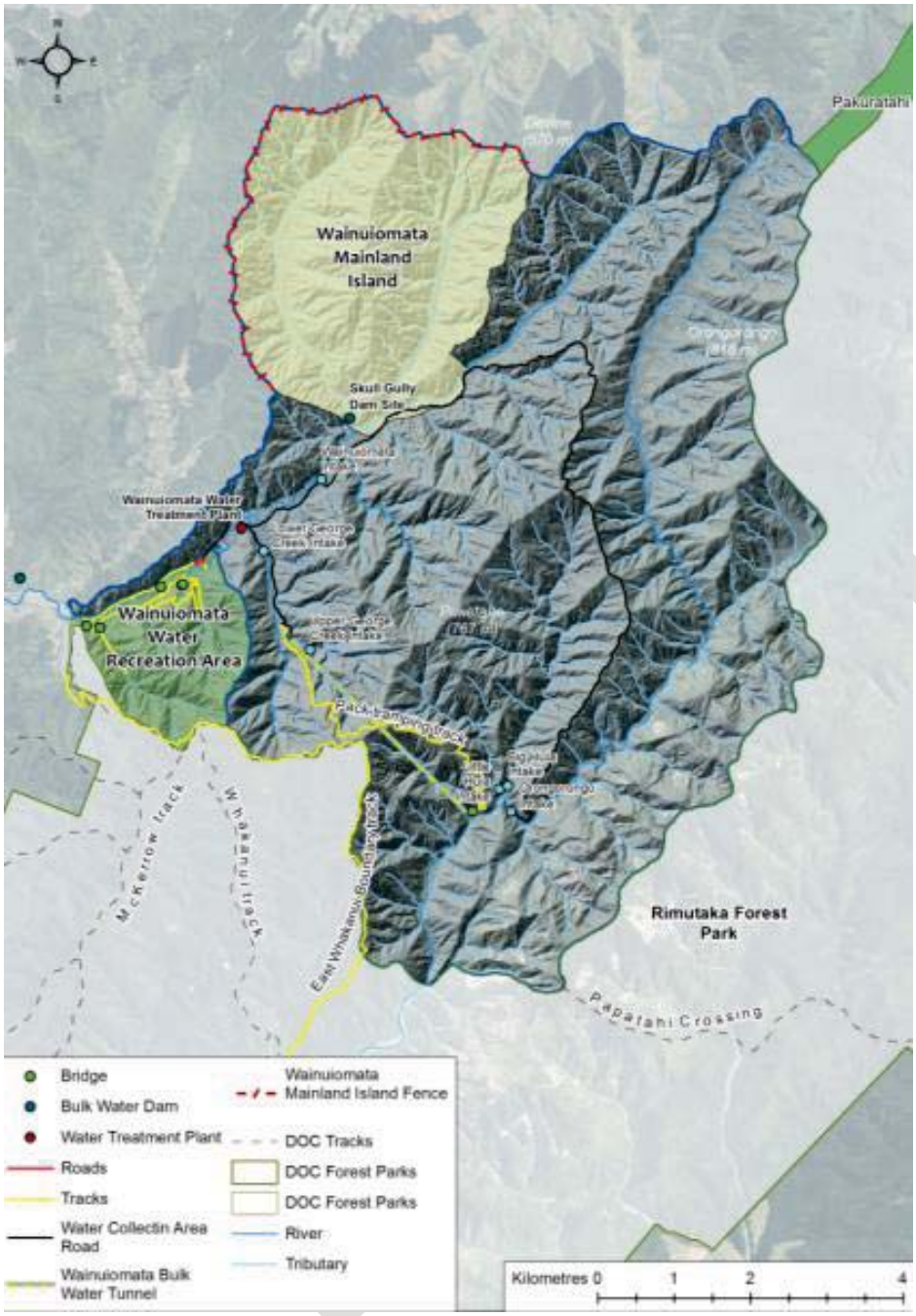
The 8963 hectare **Hutt Water Collection Area** includes the catchments of the Western Hutt River, Eastern Hutt River and Kerekere Stream upstream of the intake weir at Kaitoke. The catchment is located at the headwaters of the Hutt River and part of the southern end of the Tararua Range. The terrain is mountainous and rugged, broken by multiple streams and narrow, steep-sided ridges. The hilltops are extremely exposed to the north-west and the south with a reputation for high winds, fog and sudden weather changes. Rivers and streams can rise very rapidly in heavy rain. Water from this catchment is treated at the Te Marua Water Treatment Plant and then supplied to the upper Hutt valley and the northern and western suburbs of Wellington. The Macaskill Lakes provide water storage for short periods when the Hutt River is unavailable because of poor water quality associated with "fresh" events or because of drought.



Map 2. Location map Hutt Water Collection Area and Macaskill Lakes (version 3)

The 7373 hectare **Wainuiomata/ Orongorongo Water Collection Area** includes the upper catchments of the Wainuiomata and Orongorongo Rivers. The catchment commences at the intake to the Orongorongo tunnel and includes the Big Huia and Little Huia Streams, Wainuiomata River including tributary streams upstream of the fence at the Water Treatment Plant. There are six water intakes; three in the Orongorongo Valley and three in the Wainuiomata Valley. Water from this catchment is treated at the Wainuiomata Water Treatment Plant and supplied to the eastern and

central suburbs of Wellington. There is no untreated water storage facility at Wainuiomata so if river conditions are unsuitable for treatment the plant must temporarily be turned off.



Map 3. Wainuiomata / Orongorongo WCA including Mainland Island and adjoining Wainuiomata Recreation Area (version 3)

4.2 The role of water catchments and water quality

Forest areas act as natural water filters, receiving rain, nourishing plant and animal life, filtering it through soils and rock to aquifers, and releasing it via springs, streams and rivers and to the sea. Water, once on land collects and naturally contains a variety of chemical elements and contamination from dirt, decaying vegetation and animal waste. The aquatic ecosystem and its animals and organisms dilute impurities in water and provide further filtering. Flowing rivers further cleanse water via daylighting and aerating processes. Storing water (for long periods) in reservoirs also allows some natural filtration processes to occur and minimises silt and other suspended solids in the water supply before further straining and purification treatment processes take place.

Maintaining purity of raw water from the catchments minimises downline filtration and treatment requirements. To achieve this, public access to these areas is limited and a range of other management actions are employed, such as pest animal control, to limit contamination from animals and their waste.

Maintaining consistency of raw water quality is also important. Water treatment infrastructure is designed to match particular raw water qualities. Changes in raw water quality can result in short term marginal cost impacts and potentially major infrastructure changes in the longer term.

Caption: Hutt water collection area tributary stream. Maintaining optimum water quality free of human and pest animal introduced contaminants is a key objective for the water collection areas.

(Image: Colourcraft library)

Components of raw water quality

Whilst drinking water sourced from water catchments which are fully or partially closed to visitor access is generally very good, the National Environmental Standard for Sources of Human Drinking Water User's Guide (2009) identifies that disease-causing micro-organisms are present in many water sources, entering water from sources such as animal waste. Escherichia coli (E. coli) bacteria and protozoa are a common in the guts of warm-blooded animals present in the water catchments.

The New Zealand Drinking Water Standard (2008) defines Maximum Allowable Values (MAV) for contaminants of health significance as:

- Microbiological (bacteria represented via e -coli, viruses, and protozoa represented via Cryptosporidium and giardia)
- Chemical
- Radiological

Contaminants which affect the aesthetic properties of water include:

- Turbidity
- Natural organic matter
- Hardness
- Some major ions such as sodium ions

Protozoa are the most significant threat to human health and are defined as 'priority determinands' in the NZDWS. Ongoing monitoring programmes for Cryptosporidium and giardia protozoa in raw

water from the catchments identifies levels well below the NZ Drinking Water Standard MAV of <10 mean oocycsts per 10 litres, 5 log credits (refer section 6.6). Average monitoring results for these protozoa are below in Table 2. Results are absent in periods when rivers were below the abstraction limits and abstracting wasn't occurring. Higher protozoa levels result in greater need (and cost) for water treatment.

Notable in these results is the effect of the beech forest mast event in the Wainuiomata catchment in 2014. During mast events beech trees flowers produce large quantities of seed (masts) which provide prolific food for rats and mice, which in turn provide food for stoats and possums (which prey on native birds, bats and snails). Mast events generally occur naturally every 2 to 6 years, triggered by a summer that is warmer than the previous one, and measured by DOC by counting seeds on beech tree branches www.doc.govt.nz/our-work/battle-for-our-birds/beech-mast/.

Table 2. Average Giardia and Cryptosporidium and e-coli in raw water

	Orongorongo River Intake		Wainuiomata River Intake		Kaitoke Intake	
	Number of Sample	**Average of Results**	**Number of Sample**	**Average Results**	**Number of Sample**	**Average of Results**
Cryptosporidium						
2001	6	0.9	6	0.7	-	-
2002	12	0.5	12	0.9	-	-
2003	12	0.9	12	1.7	2	0.6
2004	11	0.5	12	1.7	-	-
2005	9	1.4	14	1.4	-	-
2006	11	1.2	12	1.5	-	-
2007	12	0.8	11	0.8	5	0.5
2008	12	0.5	12	0.5	12	0.5
2009	12	0.5	12	0.5	11	0.5
2010	4	0.5	4	0.5	4	0.5
2012	2	0.5	2	0.5	-	-
2014 (mast year)	-	-	19	0.5	21	0.5
2015	26	0	26	0.08	26	0
Overall average	**103**	**0.7**	**135**	**1.0**	**63**	**0.5**
Giardia						
2001	6	1.5	6	2.7	-	-
2002	12	0.9	12	1.5	-	-
2003	12	0.5	12	1.3	2	0.25
2004	11	0.6	12	1.6	-	-
2005	4	0.7	5	0.6	-	-
2007	6	0.5	6	0.5	5	0.5
2008	12	0.5	12	0.5	12	0.5
2009	12	0.6	12	0.6	11	0.5
2010	4	0.5	4	0.5	4	0.5
2012	2	<0.5	2	0.5	-	-
2014 (mast year)	-	-	20	2.5	21	0.5
2015	26	0.25	26	0.25	26	0.4
Overall average	**81**	**0.7**	**110**	**1.3**	**63**	**0.5**

River flows

Water can only be extracted when river flows provide sufficient supply and a minimum levels must be retained for ecosystem health. Appendix 4 provides full details of average river flow rates and day's water extraction was possibly from the three rivers between 2005 and 2015. Overall the average number of days a year when water available for abstraction is below the 5 percentile of the range for each catchment is:

- 17 days Orongorongo catchment averages
- 19 days Wainuiomata catchment
- 17 days Kaitoke catchment (Hutt WCA)

During times when there is insufficient water for extraction, water supply for Wellington is dependent on the Waiwhetu aquifer system and Macaskill lakes.

Water quality - Turbidity and UV 254 testing

Water turbidity (water clarity determined by the presence of suspended sediments and organic matter) is monitored continuously at the water treatment plants. The average turbidity figures below relate to the organic load carried in water. Higher turbidity indicates more soil erosion and slips which can be expected during periods of very high rainfall when the normal slow filtering mechanisms of the forest floor are overwhelmed.

UV254 is a water quality test parameter which utilises light at the UV 254nm wavelength to detect organic matter in water. It measures the amount of light absorbed by organic compounds in a water sample. Turbidity monitoring results are detailed in Appendix 5, and summarised below in Table 3 which includes the number of days per year the UV 254 has been in the 95% quartile. This means the number of days that the discharge water quality measure (UV254) does not exceed defined levels for 95% of the time. Turbidity in raw water is a measure of how much sediment needs to be removed with the treatment processes.

These measures relate to the raw water quality entering the treatment plants and the level of treatment required in order to meet drinking water standards before it leaves the plants. Less chemical water treatment generally results in better tasting water for Wellington water customers.

Table 3. Average river turbidity and number of days in 95th percentile of measure

Year	Average Kaitoke River intake Turbidity (what is it a measure of?	Number of Days in the 95th Percentile- Kaitoke Scan UV254	Average Wainui. Intake Turbidity	Number of days in the 95th Percentile- Wainui. Intake UV254	Average Wainuiomata Orongorongo intakes Turbidity	Number of days in the 95th percentile- Orongo. UV254
2011	2.13	345	2.73	70	2.73	140
2012	4.52	345	2.66	250	3.44	344
2013	5.62	346	3.06	288	4.68	291
2014	6.10	346	1.86	344	3.88	331
2015	6.17	356	2.25	210	1.78	277

Ongoing work programmes to maintain low levels of warm blooded pest animals, which carry health threatening protozoa and contribute to vegetation loss and soil erosion, in the catchments is required in order to maintain consistent raw water quality. Maintenance of native vegetation cover is required to minimise erosion and maintain a healthy forest floor for filtering and minimising soil and organic matter erosion which contributes to higher turbidity levels in raw water entering the treatment plants.

5. Natural and cultural heritage values

The topography, geology and geographic locations of the water collection areas was identified in the early days of European settlement of Wellington as ideal sources of water collection of high volumes of water- and remain so today. The catchments receive high rainfall captured by the multitude of tributary streams to the major rivers identified in Maps 2 and 3. These features are described in more detail below, with further detail provided in the Resource Statement for the WCAs (unpublished).

5.1 Landscape features and climate

Landscape features

Greywacke rock interbedded with mudstone forms the bedrock under most of the Wellington region. It is part of the Torlesse Terrane which forms much of the mountainous spine of central New Zealand. Wellington's proximity to the active margins of the Indian/ Australian tectonic plate and the Pacific Plate generates stresses, causing this bedrock to fracture along fault lines. The four main fault lines; Wellington, Wairarapa, Ohariu and Pukerua see both lateral and horizontal movements, with some vertical land movements occurring on the Wellington Fault. Mostly running in a north east to south west direction, the fault lines control Wellington's major water collection and drainage network, with rivers and streams following the lines of the easily eroded crushed rocks in the fault zones (GWRC Wellington Region Water Collection Areas Resource Statement, unpublished).

Climate

The topography of the catchment influences rainfall received, the frequency and amount of snowfall received and wind speeds. GWRC's publication *Air, land and water in the Wellington Harbour sub-region* (2012) identifies that 'annual extremes in minimum summer rainfall and river flows have not changed significantly over the past 30 to 40 years'. It identifies that 'river and stream health is excellent at sites near the ranges' and that 'during times of low flow, up to 40-70% of water in the rivers can potentially be removed', and that 'prolonged low flows are known to contribute to water quality issues, particularly nuisance algae growth'. The El Nino/Southern Oscilliation and La Nina climate phenomenon periodically influence temperatures, rainfall and other aspects of climate, commonly creating either drier or wetter than average summers. Localised heavy rainfall is more likely during La Nina events, but not uncommon in El nino, as occurred in the summer of 2015/16, according to GWRC's Whaitua summaries report 2015/16.

NIWA's 'Climate and Weather of Wellington 2nd Edition' (2014) publication documents some of the weather history and cycles of the region, characterised anticyclones and troughs of low pressure. Most anticyclones have their centres passing to the north of the region which creates 'the lifting of westerly airstreams over the high ground in the north and the north east of the region, as well as the Rimutaka and Tararua Ranges, often results in increased shower activity and also heavier falls during a period of general rain'. The location of the two water catchments areas was well chosen for capturing this heaver rainfall.

Rainfall monitoring occurs within the WCA at three sites maintained by GWRC; Kaitoke Weir, Orongorongo Swamp and the Wainuiomata Waterworks / Lower Dam. The rainfall sites are automatic and record rainfall intensity (the time of every 0.5mm of rainfall is logged) into a data logger which telemeters information to the GWRC database for real time monitoring. This monitoring is part of the 'Hydrology State of the Environment monitoring programme' with annual reports available on the GWRC website.

Hutt water collection area

Hutt water collection area is bounded by the Marchant Ridge to the east, Renata Ridge to the North and catchments of the Renata and Kerekere Streams to the west. The ridges average 860m in height, with the highest point 1376m at Alpha Trig, and frequently receive snow cover in winter. The Eastern

and Western Hutt Rivers join at Hutt Forks to form the Hutt River / Te Awa Kairangi. The river valleys are steep sided with over 60 percent of the area exceeding 35 degrees of slope.

Rainfall, wind and snow

The rainfall averages within the Hutt water catchment vary between 2330mm at the Kaitoke weir water intake to 3161mm per annum on Renata Ridge. The Quoin Ridge lies between the branches of the Hutt River, and shelters either valley from rainfall depending on wind direction, resulting in variations in rainfall between valleys of up to 50%.

Over a thirty year period the average annual rainfall is **2335mm annually at Kaitoke** (NIWA database). Predominant winds are north westerly (50%) and southerly (30%).

The height of the water catchment at the southern end of the Tararua Range results in over 40 days per year of winds over 100km/hour. Snow falls over 800m elevations, encompassing the Marchant, Renata and Quoin ridges, are common in winter. The lower level Kaitoke weather station reports an average of 2.5 days of snowfall per year (NIWA 2014). Of the Wellington regional weather stations, average rain day frequency and highest number of wet days receiving more than 1mm of rain is highest in the Hutt Valley, with an average 188 rain days and 134 wet days per year (NIWA 2014).

Caption: The location of the water collection area at the southern end of the Tararua Range is ideal for capturing high level rainfalls.

Looking from Maymorn Peak, Western Hutt River valley in the foreground and Tararua Southern Crossing on the horizon, Hutt Water Collection Area. (Image: Colourcraft library)

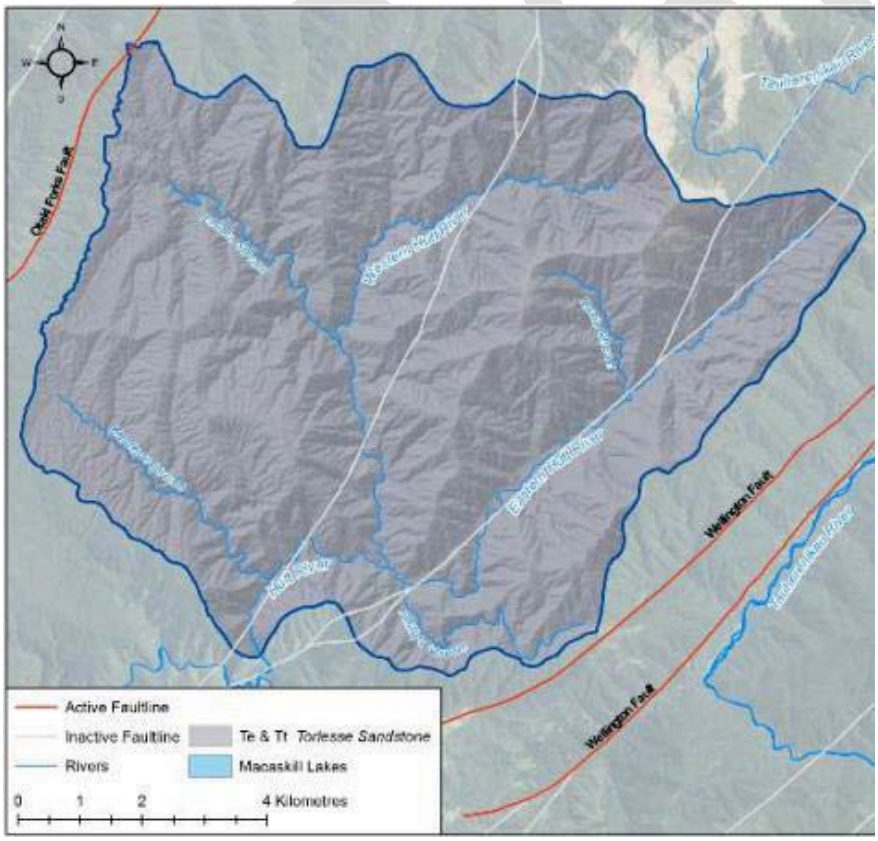
Caption: Hutt River in flood at Kaitoke Weir in 1995 making it almost invisible (refer other photos). The very steep slopes of the Western and Eastern Hutt Rivers create fast water flows and the potential for significant erosion, particularly if overall vegetation health is not maintained. Flood events deliver a much higher sediment load to be filtered for drinking water via the water treatment plants.

(Colourcraft library image)

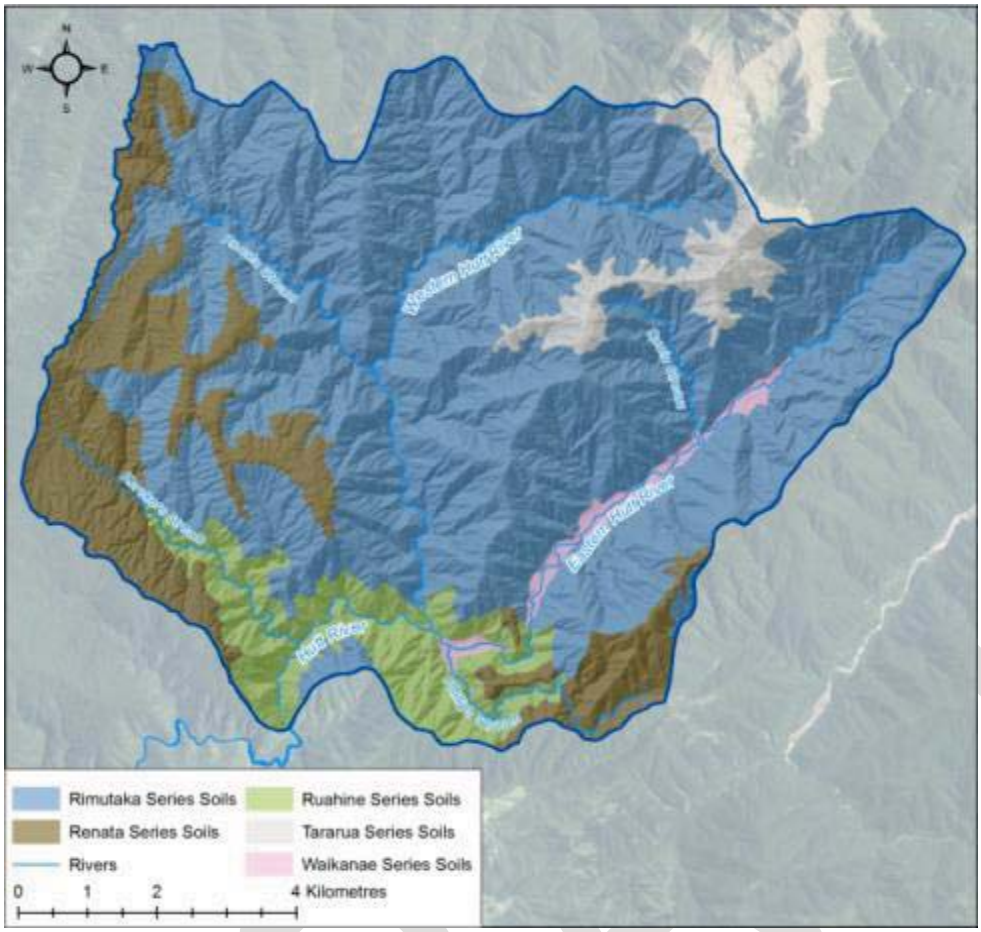
Geology

The water collection area at the southern end of the Tararua Range includes a branch of the main Wellington Fault, known as the Tararua Fault, which branches from the Kaitoke basin area and is responsible for the line of the Eastern Hutt and the mid-Waiohine Rivers. The best known feature of this fault line is the deep saddle known as Hells Gate with red rocks and soils between Omega and Alpha huts which are on the north eastern boundary of the water collection area, within Tararua Forest Park. Other noticeable geological land forms are the smooth-surfaced uplands extending from the southern Tararua range across the Maymorn and Renata Ridges to the Akatarawa hill country (DOC Tararua Park Map, 2006) which can be seen from the Rimutaka Hill summit. These gently rounded summit forms date from the Ice Age period (from 70,000-14,000 years ago) when a vast sheet of gravel was washed out over the foot of the mountains creating the Hutt Valley and Wellington 'peneplain' (large flat areas formed from erosion).

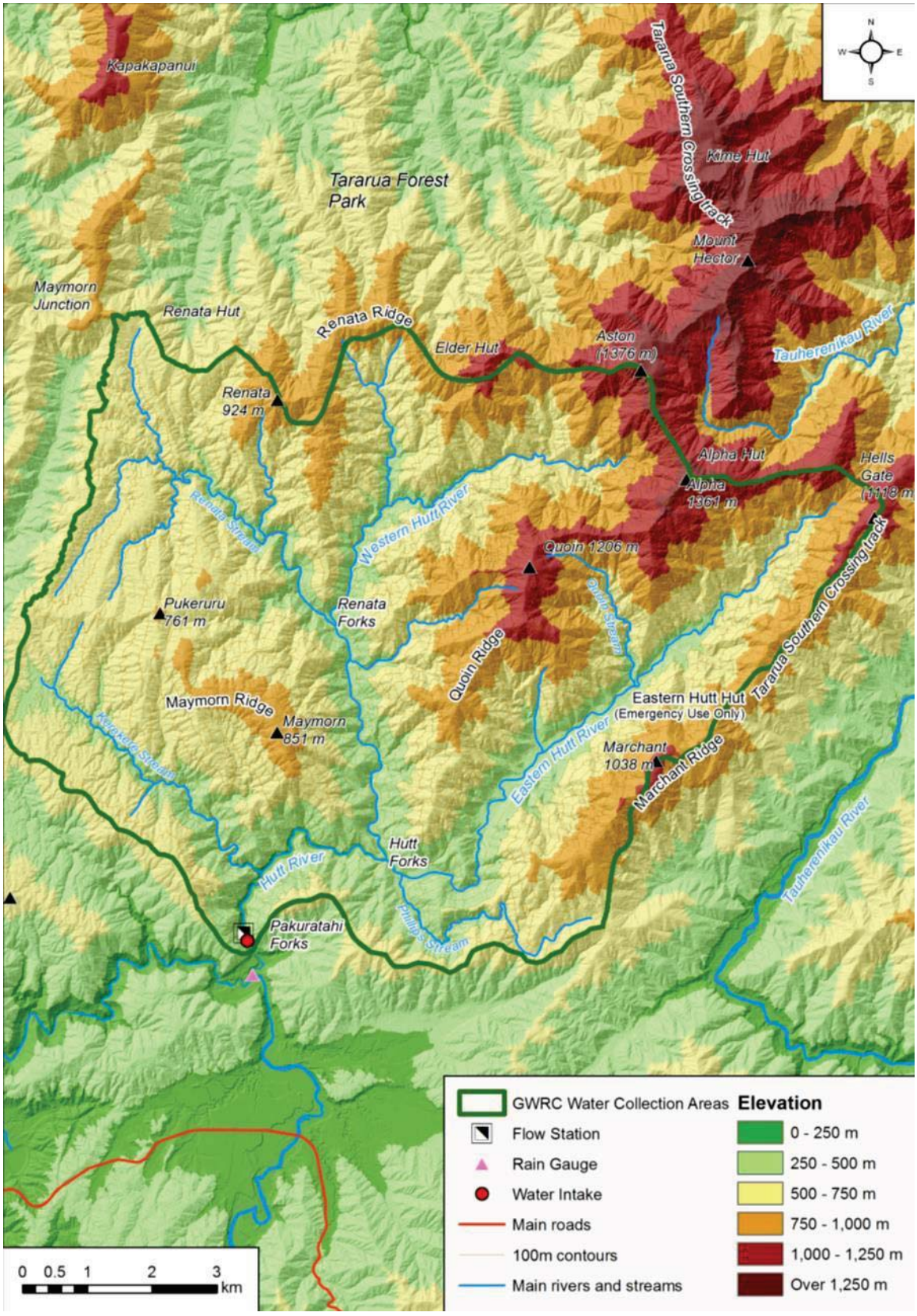
According to the Resource Statement for the water collection areas (GWRC, unpublished), the catchment is a classic fan shape created by tributaries of the Western Hutt and Kerekere Rivers, which are not controlled by fault lines like the Eastern Hutt River. The Moonshine Fault also passes outside the catchment boundary. The soils of the area reflect changes as the land steps up from Kaitoke to the Tararua Range, all dark brown and becoming more strongly leached with less clay content as the elevation increases. Four types of soils are identified; Rimutaka series steep land soils (covering 70% of the catchment), Ruahine soils in lower elevations with a thin stony profile, Tararua series soils are found under tussocks on the highest ridges with high rainfall keeping them wet and frost and snow affecting drainage, and Renata Series soils in weathered loess on the crests of rolling hills and spurs in the west of the catchment. These latter soils are identified as being 'imperfectly drained and liable to erode should vegetation cover be removed (2008:21).



Map 4. Hutt WCA Geology. Three active fault lines traverse the area nearby (version 3)



Map 5. Hutt WCA Soils (version 2)



Map 6. Hutt WCA Topography

Wainuiomata/ Orongorongo water collection area

The Wainuiomata/ Orongorongo water collection areas are accessed from the Moores Valley Road to the east of Wainuiomata and characterised by more streams and less steep hills than the Hutt catchment.

The Orongorongo catchment is bounded by the Rimutaka Range to the east and Puketaha Peak (767m) to the west, and includes the upper Orongorongo River and tributaries, and Big and Little Huia Creeks and Telephone Creek which meet the river not far from the water intake. There are areas of steep and unstable scree slope on the eastern side of the Rimutaka Range close to the Orongorongo River.

The Wainuiomata catchment includes the Wainuiomata River east and west tributary branches, the Skull Gully Stream, Sinclair Creek Stream and George Creek. The highest peak in this catchment is Mt Devine (632m). The U-shaped river valley floors regularly flood moving gravel eventually to the coast. Sixty percent of the land is considered to be moderately steep to steep (21-35°), and 8% is considered to be very steep (over 35°) with little flat or undulating ground (GWRC WCA Resource Statement: unpublished).

Rainfall, wind and snow

According to NIWA (2014) average annual reporting for rainfall measured at Wainuiomata Reservoir is 1800mm per year with the highest monthly averages received in June-July at 224mm per month, and the lowest in January-February at 81 and 89mm per month. However rainfall is variable throughout the Wainuiomata and Orongorongo catchments with parts of the Rimutaka Range average rainfalls of over 2000mm of rainfall per annum. Like the Hutt WCA, snow falls over 800m elevations are common in winter. In this WCA the higher ridges of the Rimutaka Range primarily receive snowfall, but snowfalls at lower elevations also occur for short periods most winters. The Catchment road ridgeline is below 800m elevation but still periodically receives enough snowfall to make access to the weather reporting, telecommunications and other reporting equipment on Spur road, off Orongorongo Road difficult at times.

Caption: Rain gauge recorder at the Lower Dam, Wainuiomata WCA (photo FC collection)

Extreme weather events such as storms are common in the Wellington region with high winds causing land slips, vegetation damage and localised flooding in the catchments. Images in Section Six, threats illustrate examples of storm damage.

Periods of low rainfall, referred to as 'dry spells' by NIWA when less than 1mm of rain falls over 15 days or more, average two periods per year of 19 days, and are most common in summer. The longest dry spell recorded was 33 days in March 2013 (NIWA 2014). During these periods Wellington's drinking water is drawn from the Hutt Valley, Waiwhetu aquifer and water storage facilities such as Macaskill Lakes.

Geology

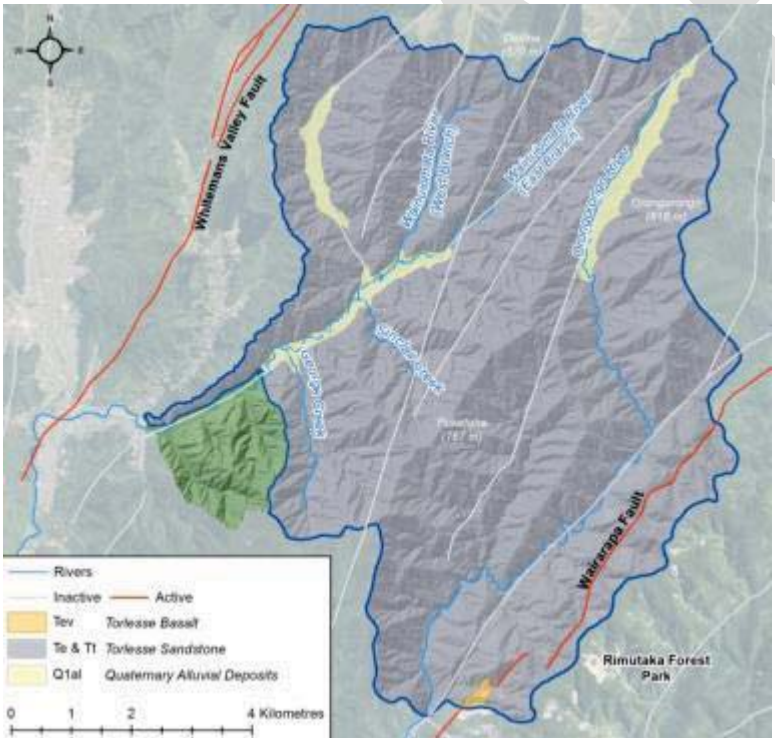
The catchment is geologically associated with the Rimutaka Range, the southernmost range of the north island. With five major uplifts in the past 6500 years it is an actively moving range, rising faster than any other New Zealand mountain region. The Rimutaka range main axis runs along the eastern side of the catchment with the highest peak, Mt Matthews to the south of the WCA boundary. The

1855 Wairarapa Fault earthquake and associated land movements created many landslides still evident in the landscape today. The Wairarapa Fault runs inside the eastern boundary of the WCA, the Wainuiomata and Orongorongo Rivers follow old fault lines, and the Whitemans Valley Fault extends into the Wainuiomata catchment.

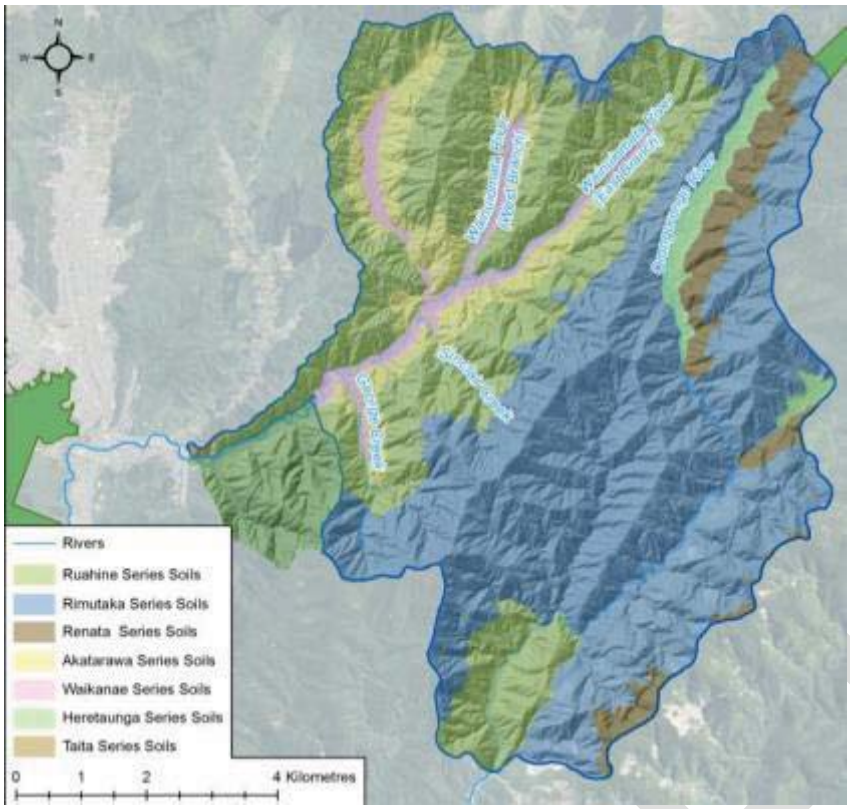
Rocks and soils of the area consist of greywacke (light grey sandstone) and argillite rock (dark grey sandstone), slope debris (colluvium), river deposits (alluvium), wind-blown silt (loess) and sand and peat. They have formed on generally hilly terrain under a climate where temperatures and rainfall vary markedly. These soils have formed during the last 10,000 years, mainly under forest. The rocks have been shattered by millions of years of earth movements along fault lines running alongside and through the range.

The Resource Statement (unpublished) for the WCA's identifies that the rate of uplift in the Rimutaka Range is so great that the rate of erosion cannot keep pace, with the range growing in height a few millimetres each year. The Orongorongo Valleys steeper sides and higher rainfall make it more prone to the forces of erosion than the Wainuiomata Valley, with erosion in the past accelerated by vegetation cover lost from pest animal grazing (now largely controlled).

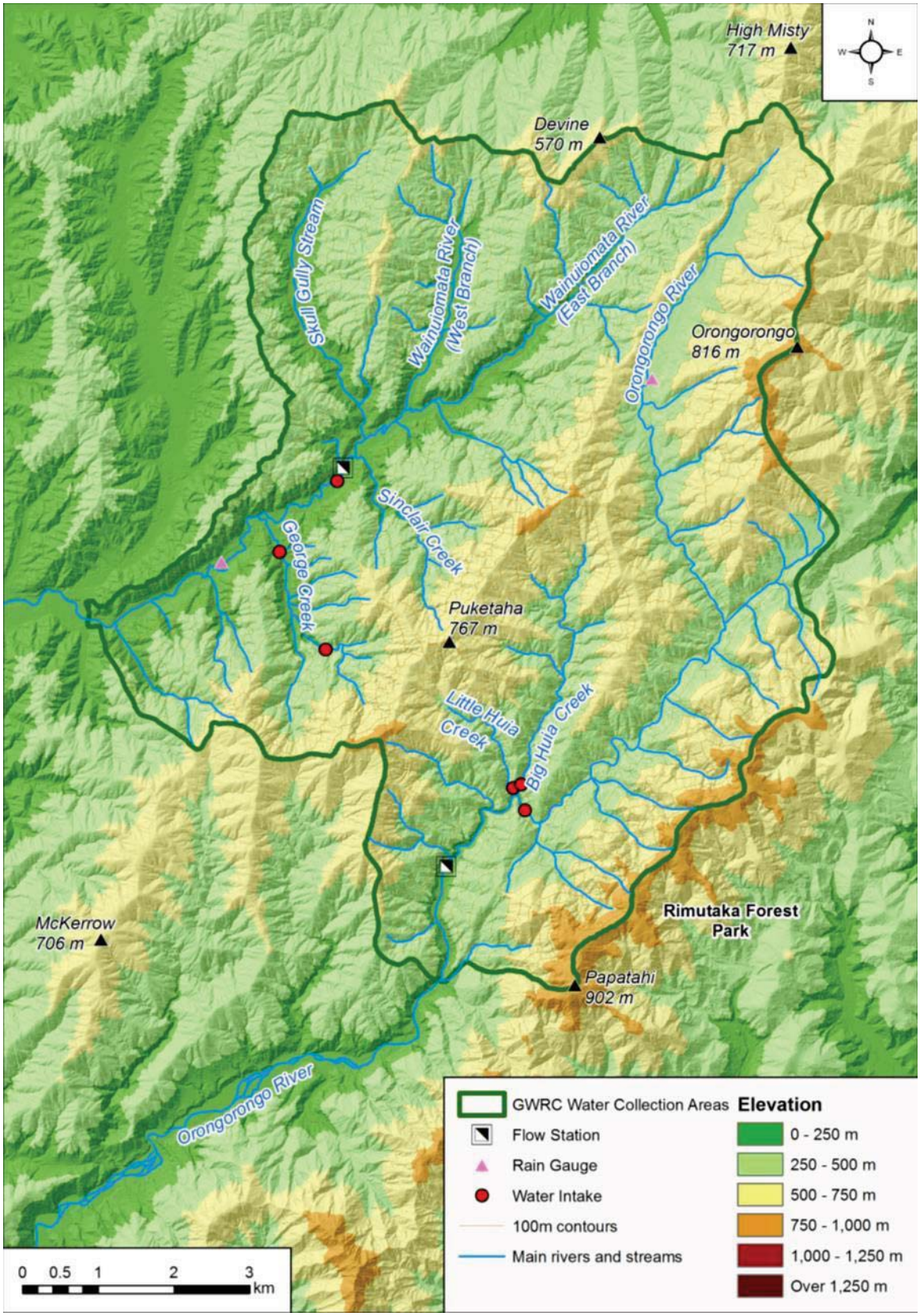
The same four soil types as the Hutt WCA are present, with the brown Rimutaka series soils dominating both catchments. Ruahine soils predominate on lower slopes in the valleys and are identified as shallow soils with a thin dark greyish brown silt loam horizon with yellowish brown stony silt loam subsoil. The Resource Statement also identifies that Waikanae and Heretaunga soils also develop in alluvial silt, sand and gravel on the floors of the river valleys, river terraces and fans.



Map 7. Geology Wainuiomata/ Orongorongo WCA (version 3)



Map 8. Soils Wainuiomata/ Orongorongo WCA (version 3)



Map 9. Wainuiomata/ Orongorongo WCA Topography and waterways

5.2 Biodiversity - flora and fauna

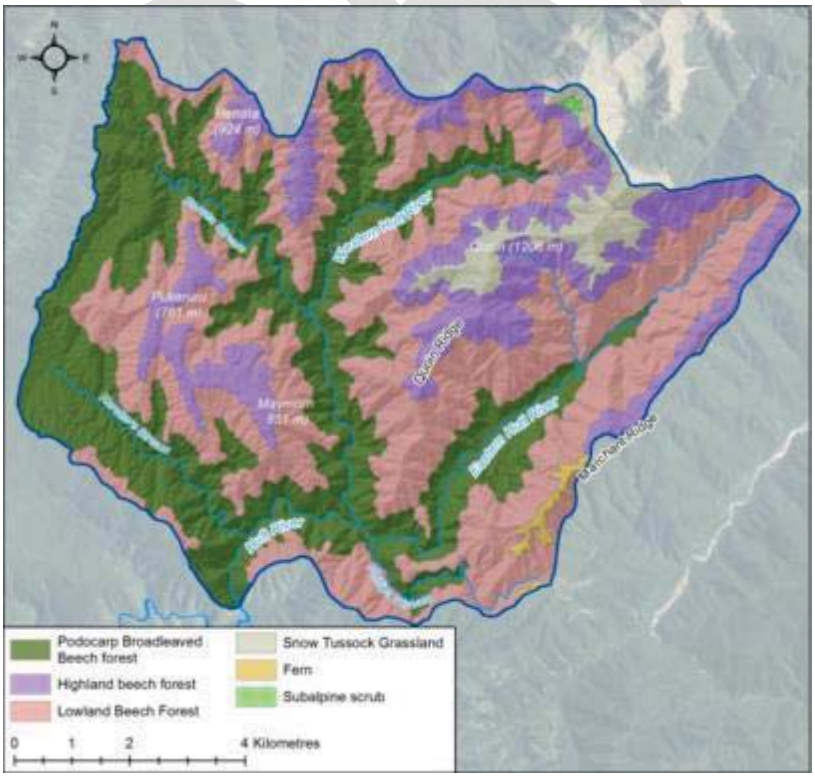
The water collection areas are part of the Tararua Ecological District (as described by the Department of Conservation 1987 Ecological Regions and Districts of New Zealand) cover the Akatarawa, Tararua and Rimutaka Ranges. Containing areas of unmodified forest, the catchments have some of the highest biodiversity values of any reserves managed by GWRC. Rich in native flora and fauna and with an area of Mainland Island within the Wainuiomata catchment, the catchments have some unique features described below. In the Wainuiomata catchment, guided tours interpret these features for visitors, and the area is a popular destination for conservation groups. Pest management volunteering assistance provided by local conservation groups such as the Rimutaka Forest Trust helps to protect flora and fauna from pest plant and animal incursions.

Healthy terrestrial ecosystems support good aquatic ecosystem health. River ecosystems are supported by vegetation providing shade and temperature control, improving soil and water quality, stabilising river beds and banks, and supporting macroinvertebrates; a source of food for fish and frogs. The type of plants within and alongside waterways influences river health with weed seeds easily transported downstream and dispersed by birds.

Hutt Water collection area

The forests of this water collection area include extensive areas of unmodified silver beech, red beech, and valley floor podocarp forest, and areas of alpine tussock lands, alpine wet turf and sub-alpine sphagnum bog. It is one of the few areas in the Wellington region containing southern rata (endangered by possum browsing).

Areas of vegetation that have been identified as being particularly important ecologically include the alpine and subalpine associations, tree fuchsia (*Fuchsia excorticata*) forest located in gully heads around Quoin Ridge, Mt Alpha, on the Eastern slopes between Renata Forks and Hutt Forks, and areas of podocarp forest. The vegetation on the Maymorn ridge and wetlands is unique in the region with a dominance of Gleichenia alpina (Mountain tangle fern). This species is found nowhere else in the Tararua Ranges.



Map 10. Vegetation classes in the Hutt WCA include large areas of podocarp and beech forest and an area of some areas snow tussock at the highest points of the Quoin Range.

There are four areas of wetlands considered to be important within the catchment; Phillips Stream marsh, upper Eastern Hutt fen, Maymorn Ridge marsh and Maymorn Ridge bog (GWRC Regional Water Collection Areas Resource Statement: unpublished). The Maymorn wetlands combined are scheduled outstanding wetlands in the GWRC Proposed Natural Resources Plan (2015).

The GWRC Key Native Ecosystem Plan for Hutt Water Collection Area (2014-2017) draws on the GWRC Regional Water Collection Areas Resource Statement (unpublished). It identifies that ten species of native fish have been recorded in the KNE, but only two have been recorded above the large weir on the Hutt River at Kaitoke; short jaw kōkopu (*Galaxias postvectis*) and kōaro (*G. brevipinnis*). Most native fish are unable to climb the weir to reach the large areas of habitat. Kōaro is classified as a threatened native species. Introduced brown trout (*Salmo trutta*) are also present in the main rivers of the WCAs and prey on native fish and compete for food resources.

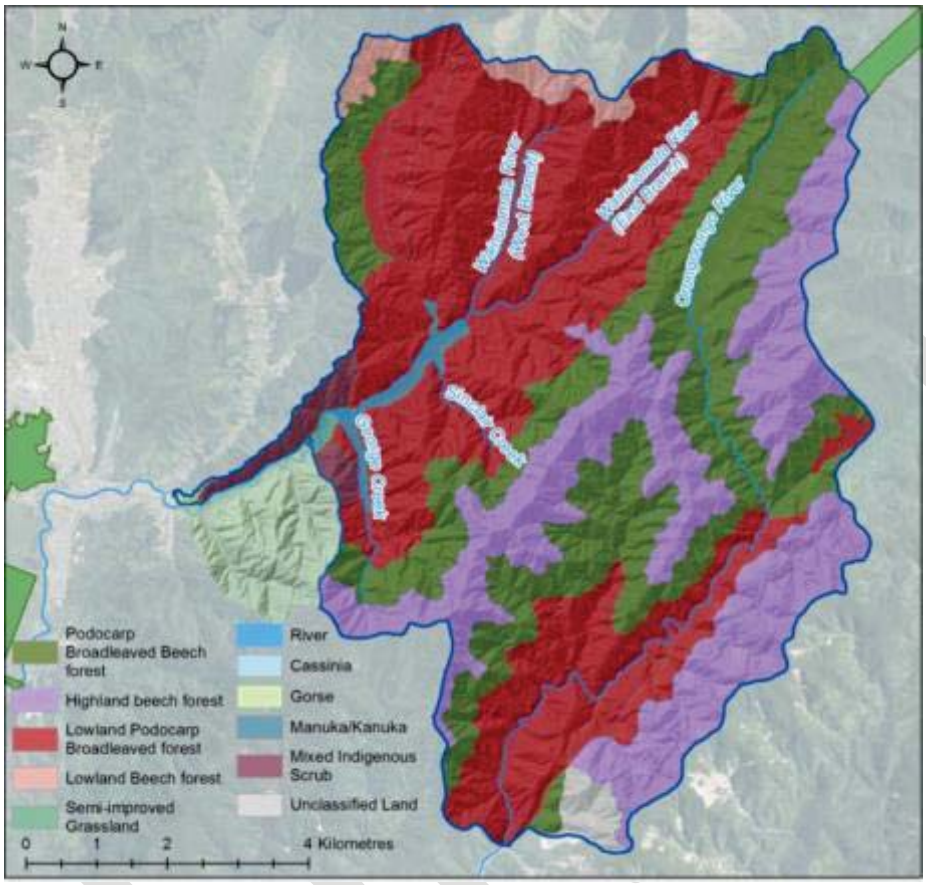
The plan identifies that fifteen native bird species are present in the catchment including threatened species such as rifleman (*Acanthisitta chloris)*, red-crowned parakeet/ kakariki (*Cyanoramphus novaezelandiae*), long-tailed cuckoo (*Urodynamis taitensis*), NZ falcon (*Falco novaeseelandiae*), kaka (*Nestor meridionalis*) and black shag (*Phalacrocorax carbo novaehollandiae*). Species of New Zealand long tailed bat (*Chalinolobus tuberculatus*) and the lesser short tailed bat (*Mystacina tuberculate*) are present in the adjoining Tararua Forest Park and are also likely to be present in the water collection area. Giant molluscs (snails and slugs) are found in the area, the most common snail is the translucent dark-shelled. The Ngahere gecko (*Mokopirirakau 'southern North Island'*) is the only lizard species recorded, but barking geckos (*Naultinus punctatus*), northern grass (*Oligosoma polychroma*) and ornate (*Oligosoma ornatum*) skinks have been recorded nearby.

Two nationally threatened/at risk plant species and several regionally rare plant species have been recorded in the KNE including Kirk's tree daisy (*Brachyglottis kirkii var. kirkii*), greenhood orchid (*Plumatochilus tasmanica*), gully tree fern (*Cyathea cunninghamii*), and raukawa (*Raukaua edgerleyi*) (GWRC: 2014).

Caption: Well camouflaged barking gecko (Naultinus elegans punctatus) and ngahere gecko (Genus B. silvestris) are found in both water collection areas.

Wainuiomata and Orongorongo water collection areas

The Wainuiomata catchment is notable in the region for the lack of beech forest and is a Podocarp Broadleaf forest. Above 500 metres silver beech dominates on the high ridge-tops. Northern rata is the dominant emergent tree species in the eastern Wainuiomata catchment above skull gully. Hinau, kamahi, rewa rewa and tree ferns also form part of the vegetation canopy along with some black beech in drier locations. The forest type in the Orongorongo catchment is largely Podocarp Beech forest.



Map 11. Vegetation classes Wainuiomata / Orongorongo WCA (version 2)

Bird species include North Island brown kiwi which self-introduced into the catchment from the adjacent reintroduction programme run by the Rimutaka Forest Park Trust. Other species include rifleman, tomtit, whitehead, kakariki, kereru, tui and king fisher.

The same species of lizards are found in this WCA as the Hutt WCA, but in addition, the raukawa gecko (*Woodworthia maculata*) uses a wide range of habitats and altitudes but is most likely to be found around forest margins, river terraces, and above the tree line. (Resource Statement: unpublished). GWRC environmental science team members report findings of common grass skink and copper skinks in the Orongorongo valley near the weir.

The Mainland Island Strategic Plan (2007) identifies that nine species of fish have been found to occur in the Wainuiomata catchment, and twelve in the Orongorongo catchment. The Orongorongo catchment is identified as an important area for fish conservation because of is largely unmodified state. Invertebrates include the snail species Wainui urnula urnula in rata-rimu forest and many species of weta, butterflies, dragonflies, moths, cicadas, earthworms and spiders. The Strategy reports primary research identifying over 80 species of invertebrate species in beech forest litter.

Caption: Wainuia urnula urnula is a snail first found in Wainuiomata forest are known to be a carnivorous hunter and move rapidly (for a snail)

5.3 Key Native Ecosystems (KNE)

The KNE programme supports the GWRC Biodiversity Strategy (2016) goal of protecting high value biodiversity areas. Areas with high biodiversity values are prioritised for protection and management via the KNE site management program. Within the identified key native ecosystems, threats to biodiversity values such as ecological weeds and pest animals are prioritised for active management in order to protect and preserve, in this case the forest and freshwater ecosystem values. The plans outline the ecological values and threats specific to the KNE and prescribe operational budget and actions, reviewed on a three yearly basis (GWRC Key Native Ecosystem Plan for the Hutt Water Collection Area 2014-2017). The entirety of both water collection areas have been identified as KNEs.

The KNE management objectives for ecosystem health are consistent with management of forests for optimum water quality. However in some areas, such as the Wainuiomata Mainland Island, the KNE management objectives may aim to deliver a higher level of management intervention for species recovery for example, than is required purely for water quality and supply management objectives. Within this water collection area 1200 hectares is a designated 'mainland island', set aside in 2004 by GWRC for intensive native wildlife restoration. This area contains rare areas of un-logged native forest with large mature rimu and matai trees and a manuka fern wetland. The management directions for this area are outlined in the 'Wainuiomata Mainland Island Strategic Plan 2006-2016'.

The vision for the mainland island is identified as '*Maintain and restore the Wainuiomata Mainland Island Ecosystem to a healthy functioning state and sustain those ecological processes that support its indigenous biodiversity, whilst maintaining a pure, clean water source'.* The focus is different to other mainland islands which aim for high levels of community engagement. The primary goal for the mainland island is identified as '*Control pest animals and plants to low levels to enhance the fauna and flora already present in the mainland island and, as site conditions allow, re-introduce appropriate locally extinct species thereby restoring the wholeness and character of this ancient forest'.* Pest animal control is carried out within the context of the key native ecosystem operational programme.

GWRC KNE plans are developed in collaboration with stakeholders and management partners such as WWL, and delivered via service level agreements and the assistance of contractors.

The Hutt WCA KNE plan identifies that although the general forest types have remained unchanged, their composition has been significantly modified by the impacts of browsing feral goats (Capra

hircus) and deer (Cervus elaphus scoticus), with species palatable to goats and deer now rare in some areas. It notes that the Hutt Water Collection Area has very few and only small infestations of ecological weeds. However, these infestations will spread if left uncontrolled. The plan has the following objectives for management activities to:

1. *Maintain native plant dominance*
2. *Increase native plant regeneration*
3. *Increase abundance of threatened plants*
4. *Increase populations of native birds*
5. *Increase populations of threatened animal species*

Indirectly these objectives relate to overall ecosystem health and achieving water quality and supply objectives. Of the 'Management activities' of pest animal control and ecological weed control identified in the plan, pest animal control can be more directly attributed to achieving water quality objectives. Section 6 below, threat management identifies details. The operational plan component of KNE plans identifies the range of specific actions to be undertaken and targets to be achieved. These are also identified in less detail in the service level agreements between WWL and GWRC Biodiversity.

5.4 Cultural heritage

Early Māori cultural heritage

The GWRC Parks Network Plan (2011) identifies that Māori sites of significance are limited, with few early permanent settlements in either water collection area. However, early Māori often moved through the area's hills and valleys, travelling to the Wairarapa via the Turakirae coast to Te Whanganui a Tara (Wellington Harbour), and the areas were places of food collection, mahinga kai, and used extensively for hunting birds, animals (rongoā) and freshwater fishing, as well as gathering forest weaving materials, taonga raranga.

There are no known Pā or kainga sites and no archaeological sites have been recorded within either the water collection area. Because of the isolation and rugged terrain in these extensive forest areas, there was little reason for early Māori to venture into much of the area apart from food gathering or travel to neighbouring areas. However, the lower catchments of the Wainuiomata and Orongorongo rivers supported the local villages from Mukamuka on the South Wairarapa coast around to Orongorongo Pā and the various Pā from the Wainuiomata River mouth around Fitzroy Bay, including a major Ngai Tara Pā, Parangarehu, and into Wellington Harbour. Trails through these areas were traditional places to gather traditional resources and also served as routes for war parties (Wellington Regional Water Collection Areas Resource Statement, unpublished).

Mana whenua

Today Taranki Whānui (Taranaki Whānui ki Te Upoko o Te Ika)/ Port Nicholson Block Settlement Trust and Ngāti Toa Rangātira share mana whenua over the general area of the Hutt water collection area land, and Taranki Whānui have mana whenua over the Wainuiomata/ Orongorongo water collection area. Both iwi have significant roles in the Whaitua advisory committees for the Wellington Harbour and the Hutt Valley and Te Awarua o Porirua whaitua's.

Caption: Steep terrain and often windswept cloud covered hills of the Wainuiomata/ Orongorongo catchments can be tough territory to traverse which limits the area's appeal for recreation access. (photo FC)

Whaitua committees

The GWRC Proposed Natural Resources Plan (2016) identifies the creation of Whaitua committees which include representation from Te Upoko Taiao – the Natural Resource Committee, iwi and territorial authorities and people from the community who have an interest in land and water management issues. Their role is to create a vision and to prioritise overall objectives for land and water management in the broader whaitua catchment areas, which may include recommendations on regulatory and non-regulatory management water resources. Committee recommendations will be considered by GWRC and Te Upoko Taiao for approval and regulatory provisions incorporated into the Natural Resources Plan for the Wellington region through a plan change process. The Whaitua process is expected to be completed encompassing plan changes by 2023.

5.5 Water supply built heritage

The GWRC publication '*Our water history – on tap'* (2007) outlines a detailed history of water supply in for the region from 1867 to 2006. Providing a safe and reliable drinking water supply is as important today as it was for the early settlement and growth of Wellington. A very brief outline of water supply built heritage is provided here as context for management of water related assets of historic significance.

Wainuiomata/Orongorongo

The lush native forests and clear rivers of the Wainuiomata and Orongorongo catchment areas were recognised early on for their water supply potential. During the late 1800's and early years of European settlement of Wellington water was sourced from local streams. As the population grew alternative, more water was required, and the Wainuiomata Valley was the first area for construction of significant water supply infrastructure.

The Waterworks dam (also known as the Lower dam), a tunnel through the Wainuiomata Hill and pipe line to Wellington city opened in 1884, followed by the Morton Dam at Wainuiomata in 1911, and in 1926 a weir and pipeline were constructed to take water from the Orongorongo River and pipe it 31 kilometres to Karori Reservoir, including a 3.2km tunnel from the river to George Creek and the water treatment plant. The Hutt River was also identified as a water source at this time, but was not utilised until a weir at Kaitoke was built in 1957.

By the late 1980s the original Wainuiomata system had reached the end of its useful working life. Morton Dam was decommissioned and emptied of its water. In 1993 a new treatment plant was built with water taken directly from weirs in both the Wainuiomata and Orongorongo catchments. The new plant produces up to 60 million litres of high quality water a day for Wellington, with typical production 30 million litres of water a day.

Hutt catchment

The Hutt river headwaters were investigated in 1906 for a site for a hydroelectric dam, but it wasn't until the 1930's that land was purchased for future water supply. In the 1940's detailed engineering studies were undertaken and designs developed, but progress on construction of the Hutt water supply scheme was hampered by wartime construction labour and material shortages until the 1950's. Shortage of steel during the Korean War resulted in steel pipes being imported from Britain. The Kaitoke water scheme was completed in 1957, including the weir, holding dams and pipeline from water intakes. Water from the scheme supplies Wellington, the Hutt Valley and Porirua.

Heritage assets within the water supply areas

There are a number of structures considered to be heritage assets within the water collection areas. A key aspect of the management of heritage places is the identification of threats to heritage values and the implementation of appropriate actions to remove or ameliorate any potential or actual damage. Natural processes such as earthquakes, cyclonic storm events, intense periods of rainfall, or land slips all have the potential to have catastrophic effects on the heritage structures, particularly water supply structures such as dams, and damage can occur quickly. Other threats include vegetation growth, fire, erosion and damage from tree roots and invasive weed species which can damage both the surface and sub-surface heritage features.

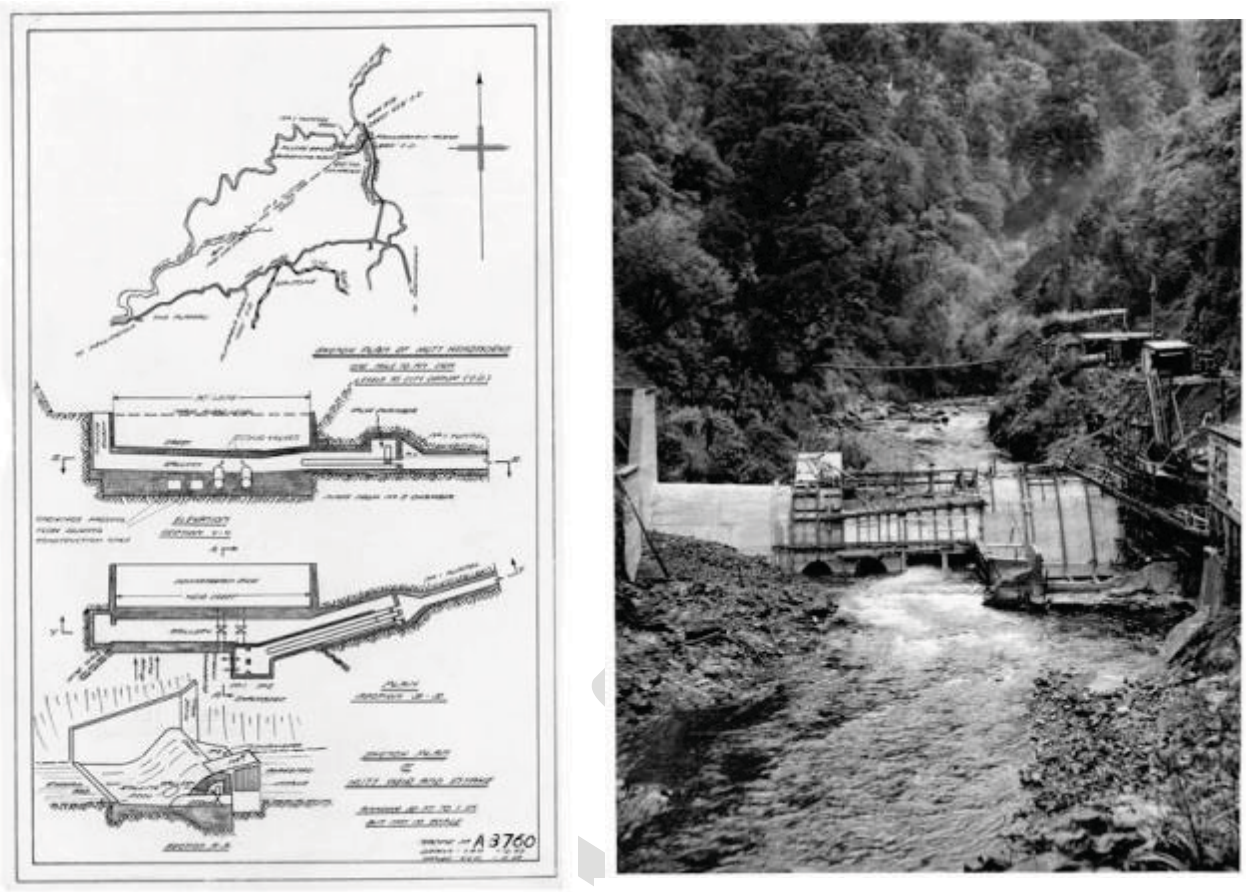
ICOMOS NZ charter principles provide direction for management of heritage assets and conservation management plans, where developed, provide detailed management directions. The structures also provide opportunities for interpretation of Wellington water history. The GWRC Heritage Assets Management Plan (2008) also provides management directions.

Table 4. Heritage Assets

Asset / constructed	Location	HNZ Register/ District Plan/ IPENZ Engineering Heritage NZ Register	Significance
Kaitoke Water Works Weir, 1946-1957	Hutt River, Kaitoke	Upper Hutt City District Plan- Not listed (2016)	Referenced in Freshwater Historic Heritage of the Wellington Region. Identified as 'an important water supply scheme'.
Wainuiomata Water Works Dam, 1884 (Wainuiomata Recreation Area, Parks Network Plan)	Wainuiomata	Hutt City District Plan - Not listed (2016)	Referenced in Freshwater Historic Heritage of the Wellington Region as 'high historic significance'.
Orongorongo Weir and intake, two tunnels, 1921-1926	Orongorongo River	Hutt City District Plan – Not listed (2016)	Referenced in Freshwater Historic Heritage of the Wellington Region. Identified as 'a very significant engineering achievement of the 1920's'
Morton Dam, 1911	Wainuiomata River	Hutt City District Plan – listed IPENZ – listed	Referenced in Freshwater Historic Heritage of the Wellington Region as 'significant for being a rare example of a buttress dam'.

Caption: The Orongorongo water supply complex encomapssing tunnels, weir and intakes is considered to be a historically signficant eningeering achievement of the 1920's which still operating today. A diesel powered jigger is are used to access the Orongorongo tunnel and maintain the water pipleline carrying water from the Orongorongo River. Ranger lead guided walk tours enable visitors to see the tunnel entrance and jigger shed and reveal interesting stories about the work to construct and then maintain the tunnel, including an incident in 1967 where the jigger failed to stop at the end of the tunnel and crashed into the Orongrongo River (Our water history- on tap, 2007).

Caption: Kaitoke Water Works Weir location of the water intake on the Hutt River constructed between 1946 and 1957 and refurbished on a number of occasions since then. There are two tunnels associated with the weir. (Image FC)



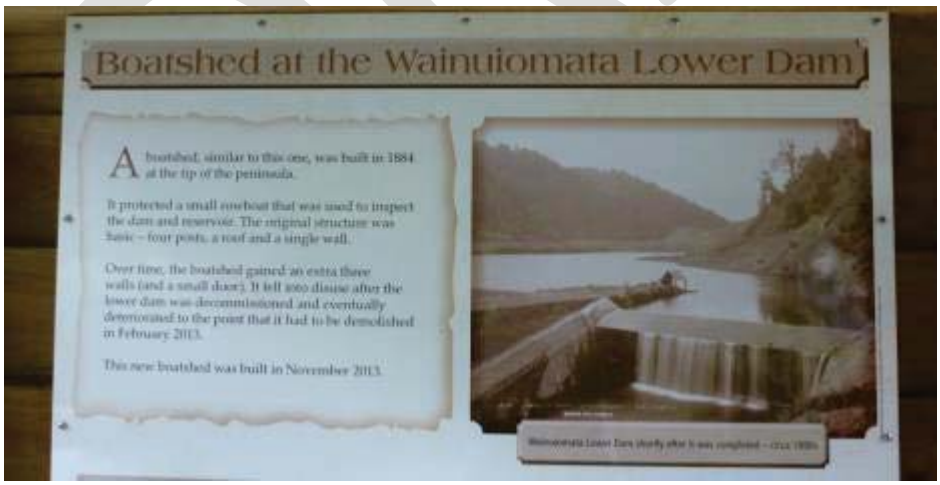
Caption: Left, Kaitoke weir and intake sketch plan 1949 and right, during construction, 1955. (Colourcraft library images)

European settlers logged some of the catchment for timber resources including rimu and totara, with some logging relics remaining in the forests of the catchment areas . The most significant European settlement relics are the early water supply structures detailed above.

Interpreting interesting heritage stories and in particular the stories of people who worked and lived in the water catchments is a key component of guided ranger tours. Some onsite interpretation panels also present stories for visitors, particularly in the Morton Dam area at Wainuiomata WCA.

Caption: Guided walking tour viewing Moreton Dam. Construction of this dam was completed in 1911 and it was decommissioned and superseded by the Te Marua lakes scheme in 1988. The dam is historically significant because of its form of construction which is unusual in New Zealand; reinforced concrete made in sections of slab and buttresses.

Caption for all photos: Construction of the Waterworks Dam, also known as the Lower Dam, was completed in 1884, Wainuiomata WCA. Interpretation panels and a reconstructed boathouse beside the lake reveal interesting aspects of history for visitors. (photos FC)



5.6 Recreation activities

To protect the water catchments and preserve water quality, access for recreation activities within the two water collection areas is limited to walking / tramping, guided tours and hunting.

Hutt Water Collection Area

Due to the relative remoteness and terrain of the Hutt WCA access to the area is less appealing for recreation activities. Recreation activities in the Hutt Water Collection Area are limited to walking/ tramping and hunting by permit (and defined in section 8 of this plan, Rules for use and development). Overnight stays are not permitted. Signs identify water collection assets where no public access is permitted, for example, Kaitoke Weir and water intake, water monitoring stations.

Tramping

Recreation facilities are limited to tramping tracks, marked and unmarked routes. No camping is permitted in the Water Collection Area.

Hutt Forks, the confluence of the Eastern and Western Hutt Rivers, is the most popular walking destination within the Hutt Water Collection Area. It can be accessed from Kaitoke Regional Park via the Norbert Creek Route or the Hutt Water Collection Area access road (2 hours walking one way).

Longer tramping tracks include the Marchant and Renata Ridge Tracks which border the eastern and northern edges of the water collection area and Tararua Forest Park, supported by three DOC managed huts (Alpha, Elder and Renata). These tracks are part of the popular Tararua Range Southern Crossing.

A NEW MORE RECENT PHOTO REQUIRED

Caption: Hutt Water Collection Area's silver beech goblin forest, Renata Ridge Image: Colourcraft library)

There is one backcountry hut, an ex NZ Forest Service style deer cullers hut built in the 1960's. Eastern Hutt hut is located on the Eastern Hutt River and serviced with 6 bunks, a pot belly stove, mattresses and water tank. It is intended for emergency shelter only.

Caption: Eastern Hutt hut, located on the western side of the Eastern Hutt River is managed as an emergency shelter for walkers.

There are sections of marked route (posts and directional arrows) beside the lower Eastern Hutt River. This includes a marked route down to Hutt forks and up Quoin ridge to above the saddle on the Eastern Hutt route. All these tracks were marked to guide people to the swing bridge across the Eastern Hutt River. There are no route markers along the Quoin ridge tops.

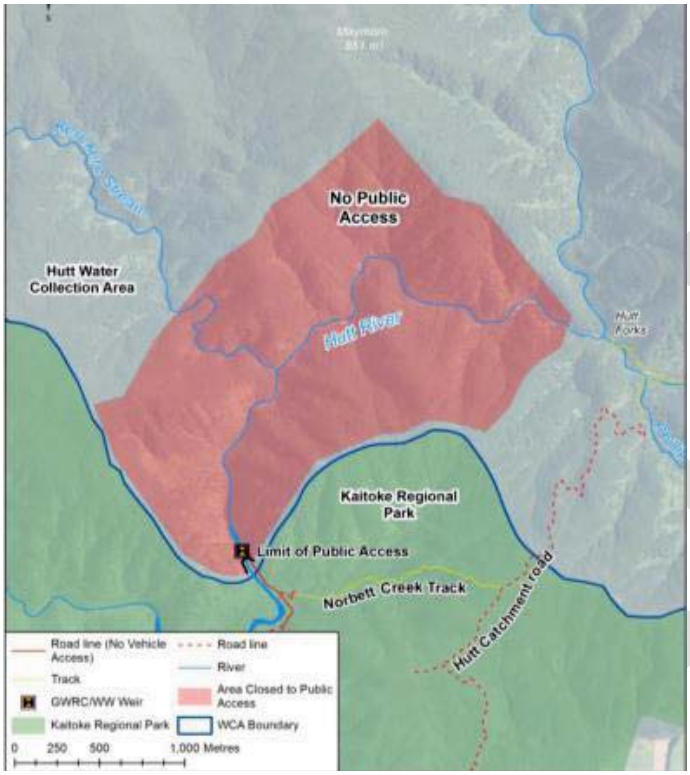
Unmarked tramping routes include Hutt Forks to DOC's Alpha Hut (5 hours) via the Eastern Hutt river valley, a spur on the northern side of Quoin Stream and Quoin Spur, and Hutt Forks to Renata Hut (DOC) via the Western Hutt River (7 hours), or via Maymourn Ridge and Mt Pukeruru (6 hours). All are remote and require backcountry navigation skills and experience.

Caption: A suspension bridge at Hutt Forks minimises risks from water contamination via river crossings and provides access to the Quoin Ridge route. Photo FC

Caption: DOC orientation sign information for trampers commencing the Southern Crossing at Kaitoke. The NZ Environmental Care code provides advice about how visitors can minimise impacts. Photo FC

Hunting

Hunting is a traditional and popular recreation activity in the Tararua ranges, but within the Hutt WCA it is a restricted activity managed via a permit system (free permits, valid for 6 months) and limited to designated daytime activity. Due to access constraints (long walk in times) the number of hunters entering the area is low and not many hunting permits are repeat hunters. Access for hunters, people fishing and other visitors is not permitted between the intake at Kaitoke Weir and Hutt Forks.



Map 12 Area of Hutt Water Collection area closed to public access (from intake weir upstream towards Hutt Forks)

Caption: Signs in the Hutt Water Collection area clearly define the limits of public access and the reasons why access to this area is not permitted. Behavioural research indicates that visitors will generally take more notice of restrictions if they understand the rationale for them. (photos FC)

Wainuiomata and Orongorongo Water Collection Area

Walking and tramping

Access to this WCA is more closely controlled than the Hutt WCA due to its proximity to urban areas. The catchment is closed for public access to protect water quality and supply, other than by management permit for hunting or through guided walking activities. Public guided interpreted walks into the catchment are available year round and are very popular. Walks are advertised on the GWRC website and in other media with numbers limited.

Caption: The rugged ranges of the Wainuiomata water collection area looking south from Catchment Road showing extensive areas of land slipping. (photo FC)

The directions for management of public access in this water catchment have in the past been guided by the *Wainuiomata / Orongorongo Water Collection Area Public Access Plan 2008.* This plan set the total visitor numbers but allowed for discretion for ranger staff to review hunting ballot numbers and the types of visits provided they did not exceed the overall maximum visitor numbers. A Council adopted recommendation of the 2008 Access Plan was for its incorporation into a future

WCA management plan - this plan (Report 08.462, 20 June 2008).

Guided walks are offered into the more accessible Wainuiomata catchment, and guided tramping tours offered into the more difficult terrain of the Orongorongo catchment.

The total number of annual visitors permitted is 1200 plus educational or special interest groups, ballot hunting and research permits.

The number of participants on guided walks steadily increased from a total of 326 in 2006 to 591 in 2008, but only 300 in 2009. In 2011-12 the total number of walking tour participants was 265. The number of more strenuous tramping trip participants has remained constant at less than 50 annually. In 2015 only 172 people booked on guided walks. There were no conference trip visitors and the number of trampers remained at less than 50. A single guided mountain biking tour was held as part of the GWRC summer activity program with approximately 25 participants riding the Catchment Road and along the George Creek Road to the tunnel entrance.

Guided walks and tramps include a briefing about site hazards, biosecurity issues and interpretation of topics relating to water supply infrastructure, flora, fauna and management issues such as protecting water quality and reducing the impacts of pest species. A participant information sheet is provided for catchment walking and tramping tours.

Caption: Ranger lead guided walking tour in Wainuiomata catchment 2016.

Hunting

Hunting by permit during the deer 'roar' season is allowed as a recreation activity annually between April and May. The hunting ballot contribution to pest animal control is considered minimal, but is continued as a traditional recreation activity. For example, between 2000 and 2007 the average total kill rates per roar ballot period for feral deer were 8, goats 7 and pigs 6. Up to 40 hunting permits per roar are allocated over an area of 10 hunting blocks. Rangers report that the full allocation is not

always met with only 32 issued in 2015 with some repeat hunters, but the difficult access and terrain, and low kill rates deter many. Professional hunters reduce animal numbers annually, generally before the public ballot. Biosecurity staff report that this is to ensure the most efficient control and to access difficult terrain such as open mountain top and slip areas, at a time when the weather is most settled.


Caption: Forest floor damage from feral pigs can contribute to erosion and increased sediment runoff. (Require a high resolution image)

6. Threats to water quality and supply

*Protecting source water from contamination is a key component of a **multiple barrier approach** (recommended by the World health Organisation, refer Figure 2) to management of drinking water supplies. Reducing the risks of contamination upstream of water intakes reduces water treatment requirements to meet drinking water standards.*

This section addresses the core threats to water quality and water supply. Some threats apply to both such as landslips which may block water intakes and also create significant turbidity. The threats identified are derived from Water Safety plans for the WCAs.

There are a wide range of threats to water quality, supply and overall ecosystem health in the water collection areas. This includes threats to vegetation cover such as invasion of pest plants and animals and new diseases, natural events such as earthquake, weather, fire from lightning strike, and threats from imported human and other contaminants (protozoa, e-coli, petrochemicals, herbicides, pesticides and algaecides), and aquatic ecosystem threats such as toxic algal blooms and pest species invasion . Threats to water volumes include erosion and land slips, earth movements generated by earthquakes and drought duration and intensity exacerbated by climate change.

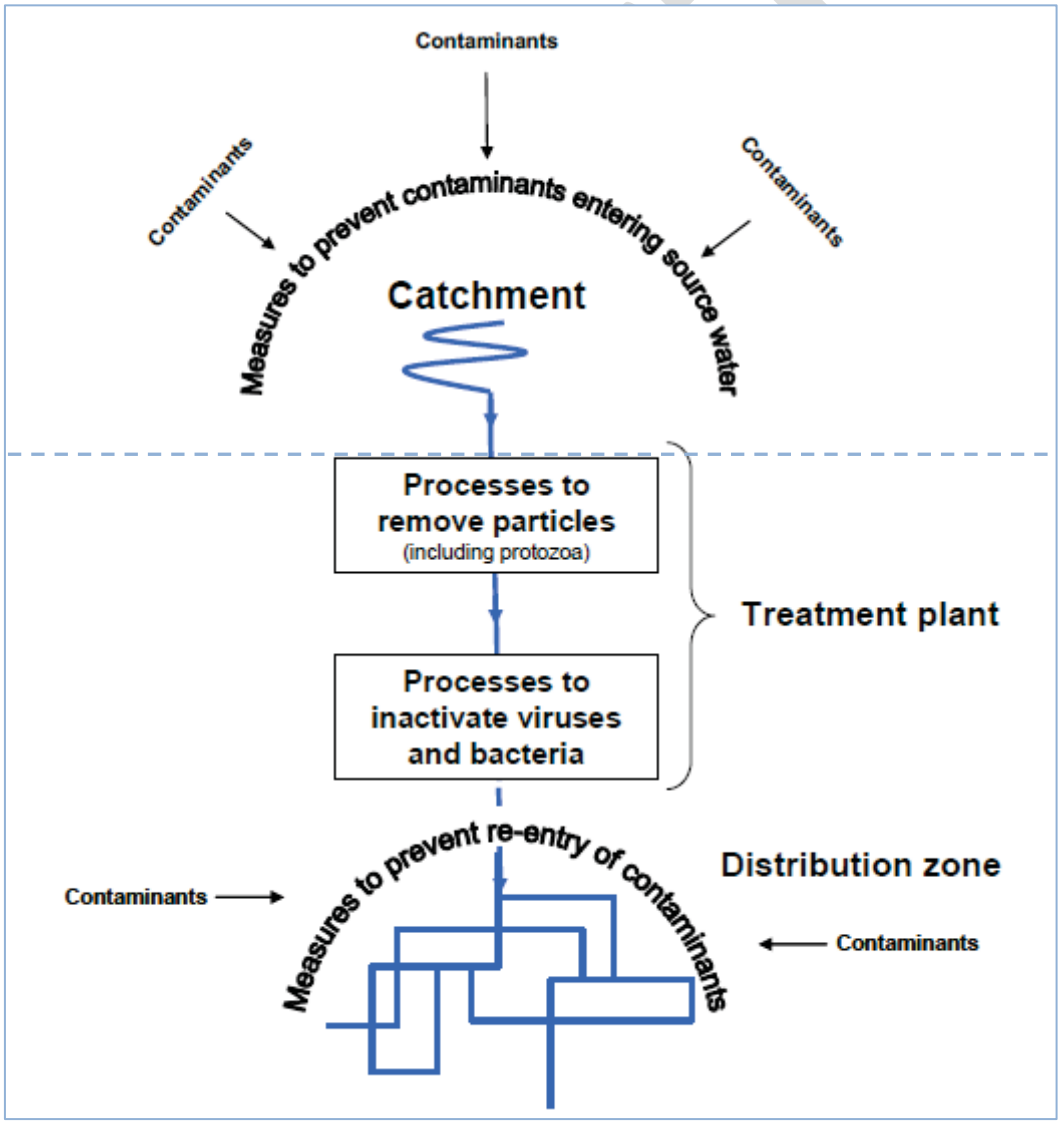
Threats with potentially the most significant consequences for human health are managed more actively; for example water quality threats from protozoa carried by pest animals managed by annual pest animal culling programmes. Threats may change over time and require changes in operational management regimes, for example climate change may introduce more regular periods of drought, an increased fire threat, deliver more frequent storms and more land slips and lightning strikes may occur. Operationally, a more proactive management response to monitoring storms and lightning strikes in the water collection areas may be required in future (as occurs in Victorian and NSW parks and water collection areas in Australia) as a result of climate change.

The multiple barrier approach outlined in the NZDWS and National Environmental Standards for sources of drinking water is illustrated in Figure 2. Closed public access water collection areas such

as Wainuiomata/ Orongorongo generally offer a higher degree of control over the threats which can be actively managed within the catchment, such as visitors and pest animal management.

The Health (drinking water) Amendment Act 2007 requires water supply agencies to develop and maintain water safety plans for water supply management. The GWRC Water Safety Plans for the Te Marua and Wainuiomata water treatment plants (WTP)(2014) outline the risk management assessments for the two water supply plants and include risk assessment relating to raw water before treatment and risk events within the water catchment. The risk assessment methodology is detailed in the plans, with overall risk evaluation a combination of likelihood and consequences for water supply and quality. Where residual risks are considered to be 'high' or 'very high' they are managed with Improvement Plan measures also detailed in the Water Safety Plan. Residual risks considered to be 'medium' have ongoing monitoring and reporting mechanisms in place.

Figure 2. **Elements of the multiple barrier approach** (Draft Users Guide: National Environmental Standard for Sources of Human Drinking Water, 2009)



Summary of threats and minimisation and mitigation measures

The following table summarises the key threats to water quality and supply (derived from Water Safety Plans) which are then addressed individually and in detail following this section. The water safety plans outline a detailed risk likelihood and consequence assessment which are summarised as a general risk evaluation ranging from low to very high risk as indicated in the table below and each threat description section that follows.

Table 5. Summary of threats and minimisation and mitigation measures

Plan section	**Threat to water quality or supply**	**Primary minimisation and mitigation measures**	**Identified risk level** (water safety plans) after minimisation/ mitigation. NA = not assessed in Water Safety Plan	
Threats to water quality			Hutt	Wainuiomata/ Orongorongo
6.1	Pest animal threats and vegetation browsing	Pest animal control	NA but actively managed	
6.2	Water contamination from feral animals or livestock	Pest animal control	Medium	NA
6.3	Contamination by human activity	Managed access only (Wainuiomata/ Orongorongo WCA), areas of restricted access Hutt WCA, visitor information signs	Low	Low
6.4	Fire	No fires policy, maintenance of access roads into catchments, water treatment	NA	NA
6.5	Pest plants, plant disease introduction and spread	Pest plant management via KNE programme delivery ,	NA but actively managed	
Monitoring threats			Hutt	Wainuiomata/ Orongorongo
6.6	Monitoring threats to forest health from pest plants and animals	Environmental science monitoring programme	Monitoring programme in place	
Other threats			Hutt	Wainuiomata/ Orongorongo
6.7	Petrochemical fuel spillage (diesel)	Standard operating procedures, emergency response plans, water treatment	Low	Low
6.8	Contamination by agrichemicals	Standard operating procedures, emergency response plans, (future) chemical register, water treatment	Low	Low
6.9	Sediment run-off	Maintenance of vegetation cover, water sensitive design of built assets such as roads and tracks, water treatment	Medium	Medium
6.10	Source water run-off from sealed surfaces	Water sensitive design of built assets such as roads, filtering treatments	No sealed surfaces up steam of intake	Medium
6.11	Algae (toxic bloom)	Monitoring, water treatment	Medium	Medium
Threats to water supply			Hutt	Wainuiomata/ Orongorongo

Plan section	Threat to water quality or supply	Primary minimisation and mitigation measures	**Identified risk level** (water safety plans) after minimisation/ mitigation. NA = not assessed in Water Safety Plan
6.12	Climate change and severe weather events	Proactive response in policy and operations, integrated management, resilience improvements (assets), emergency response plans	NA GWRC Climate Change Strategy directions
6.13	Slope stability and soil erosion	Maintenance of vegetation cover, pest animal management, slip revegetation works, emergency response plans	NA Biodiversity management via KNE plans
6.14	Earthquakes and resilience of water supply	Proactive response in policy and operations, integrated management, resilience improvements (assets)	NA Asset renewal & upgrade programme

Threats to water quality

There are a variety of threats to water quality. Direct threats are outlined here in order of significance and consequence of the threat (by GWRC Environmental Science). Overall, the loss of vegetative cover from browsing animals, plant disease and fire, and the presence of animals (and humans) that can contaminate the water are the most important aspects of managing the water collection areas for optimum water quality. Biodiversity objectives for maintenance and restoration of, for example, bird species that improve the seeding of forest vegetation indirectly contribute to water quality and directly to maintenance of a more resilient forest.

Contaminants such as microorganisms (protozoa) can pose a significant threat to human health when they enter drinking water supplies. Ongoing management actions are required to prevent contaminants from entering drinking water sources from pest animal sources. This then reduces the need for downstream water treatment.

6.1 Pest animal threats and vegetation browsing

Management of pest animals is undertaken in both water collection areas to minimise the loss of vegetation cover and maintain ecosystem health. Pest animals affect the health of the forest by eating the foliage, fruit, and seedlings in the forest canopy and understorey.

Pest animals can be a significant threat to vegetation cover, sediment movement (through loss of vegetation) and overall ecosystem health for optimum water quality. Brush tailed possums (*Trichosurus vulpecula*), can affect the health of canopy trees through browsing of the foliage and fruit. Some species are more susceptible that others, but canopy dominants, such as northern rata have been severely depleted where possum control is absent (Brockie 1992). Browsing by feral goats (*Capra hircus*) and feral deer (*Cervus elaphus scoticus*) can substantially modify plant species composition in forests over time. For example, in the Hutt WCA species palatable to feral goats and deer have declined and are in some cases rare. This weakens the forest structure over time as the diversity of the forest is decreased. Species heavily impacted include two nationally threatened/at risk plant species and several regionally rare plant species. Plant species palatable to exotic browsers can become locally extinct (Hutt KNE Plan 2016). Pigs (*Sus scrofa*) plough up the soil in search of invertebrates and can create large areas of bare soil in the forest.

Other pest animals present in the water collection areas include mice (*Mus musculus*), rats (*Rattus* spp.), hedgehogs (*Erinaceus europaeus*), mustelids including weasels (*Mustela nivalis*), stoats (*M. erminea*) and ferrets (*M. furo*), and feral cats (*Felis catus*).

The KNE plans (2016) for the WCAs identify the threat and impact on biodiversity that different pest species pose:

Hedgehogs (Erinaceus europaeus) prey on native invertebrates , lizards and the eggs and chicks of ground-nesting birds
House mice (Mus musculus) browse native fruit, seeds and vegetation, and prey on invertebrates. They compete with native fauna for food and can reduce forest regeneration. They also prey on invertebrates, lizards and small eggs and nestlings
Possums (Trichosurus vulpecula) browse palatable canopy vegetation until it can no longer recover. This destroys the forest's structure, diversity and function. Possums may also prey on native birds and invertebrates and can carry tuberculosis
Rats (Rattus spp.) browse native fruit, seeds and vegetation. They compete with native fauna for food and can reduce forest regeneration. They also prey on invertebrates, lizards and native birds.
Mustelids (stoats(Mustela erminea), ferrets , (M. furo) and weasels , (M. nivalis)) prey on native birds, lizards and invertebrates, reducing their breeding success and potentially causing local extinctions
Feral and domestic cats (Felis catus) prey on native birds, lizards and invertebrates , reducing native fauna breeding success and potentially causing local extinctions
Rabbits (Oryctolagus cuniculus) and hares (Lepus europaeus) graze on palatable native vegetation and prevent natural regeneration in some environments. Rabbits are particularly damaging in sand dune environments where they graze native binding plants and restoration plantings. In drier times hares especially, will penetrate into wetland forest areas browsing and reducing regenerating native seedlings
Wasps (Vespula spp.) adversely impact native invertebrates and birds through predation and competition for food resources. They also affect nutrient cycles in beech forests
Feral red deer (Cervus elaphus) and **fallow deer** (Dama dama) browse the forest understory and can significantly change vegetation composition by preferential browsing and preventing regeneration
Feral pigs (Sus scrofa) root up the soil and eat roots, invertebrates, seeds and native plants preventing forest regeneration
Feral goats (Capra hircus) browsing affects the composition and biomass of native vegetation in the understory tiers of forest habitats, preventing regeneration of the most palatable understory species and reducing species diversity .
Brown trout (Salmo trutta) and rainbow trout (Oncorhynchus mykiss) prey on native fish and compete with them for food resources
Eastern rosella (Platycercus eximius) parakeets are known to out-compete native red-crowned parakeets for nest-sites and are a vector of avian diseases. The continued presence of eastern rosella in the KNE site could limit the ability of red crowned parakeets to establish functional populations.

Pest animals that present the greatest threat to loss of vegetation cover and ecosystem health are

possums, feral goats, deer and pigs. For this reason a significant management effort is directed towards control of these animals to target levels which are identified in KNE plans.

Caption: A rare Kirk's tree daisy / Kohurangi (Brachyglottis Kirkii var. Kirkii) protected from possum and ungulate browsing beside Catchment Road in the Orongorongo catchment. (photo FC)

Threat minimisation and mitigation

The *Greater Wellington Water Asset Management Plan Water Collection Areas* 2004 identifies that 'vegetation cover should be sufficiently diverse so that pest attack or disease that targets an individual species or group of species will not adversely affect the quality of water supplied to the treatment plants. Conditions should enable the ongoing regeneration of the species within the areas so that overall 'health' is maintained in the long term'. Managing the WCAs overall forest health helps to improve their resilience when under attack from pest animals and plant disease, and their recovery from destructive weather events.

Pest control measures for possums and rodents is undertaken via poisoning and trapping (in some locations). Control operations using 1080 poison have been undertaken on a residual trap possum basis (numbers below 5%) in the Wainuiomata/ Orongorongo catchment since 1999, and the Hutt catchment since 2003. In 2014 1080 was also dropped in the Wainuiomata Mainland Island to control rat numbers during the mast event. A different poison was applied following that as the 1080 didn't get as higher kill rate as expected. Goats and deer have been culled in the Wainuiomata/Orongorongo catchment since 2001 and in the Hutt catchment since 2009 and possibly earlier. The Wainuiomata/Orongorongo catchment particularly harboured many goats and deer and is vulnerable to continual immigration from surrounding land. Over 1000 goats and 160 deer have been culled by professional hunters in this catchment since 2001. Within the Mainland Island area of the Wainuiomata catchment intensive predator control is carried out using bait stations for rodents, and traps for possums, hedgehogs and mustelids. Pig control is also carried out here with over 500 pigs being culled since 2001.

Caption: Rata (in foreground) can be heavily browsed by possums. Rata foliage cover is measured as an indicator of overall ecosystem health in the water collection areas. (Colourcraft library image)

Caption: Omnivorous Tasmanian possums, introduced to NZ in 1837 to establish a fur trade, are a significant threat to vegetation cover as well as native bird populations; they can disturb nesting birds and eat their eggs and chicks. Possums can also impact native snail populations. Trapping and poisoning programmes are used in the WCAs with some trap lines maintained by volunteers. (Image: GWRC collection)

Caption: Volunteers from the Rimutaka Forest Park Trust monitor and maintain bait stations along the access road and main track of the Mainland Island within the Wainuiomata catchment.

From 2003 to 2005 fences were constructed on the northern and western boundaries of the Wainuiomata catchment to exclude livestock such as cattle and sheep and feral goats, deer and pigs from accessing the catchment from adjacent private land and the Moores and Whiteman's Valleys. This exclusion of larger pest animals is also beneficial to the Mainland Island.

Caption: High fences to exclude goats, deer and pigs from much of the Wainuiomata water collection area have been highly successful in reducing the numbers of these pest animals in the catchment.

Caption: Goats are heavy browsers and highly destructive to native vegetation. (Image GWRC collection)

GWRC uses permanent vegetation plots and photo points as well as animal browse plots to monitor animal numbers in an area. Regular bird monitoring is used to track the recovery of native bird populations. Photo points provide a record of vegetation changes at specific sites, such as vegetation recovery after browsing.

6.2 Water contamination from feral animals or livestock

The National Environmental Standard for Sources of Human Drinking Water 2008 identifies the need for a 'multiple barrier approach' as a cornerstone of managing threats and risks to drinking water quality. Protection of source water from contamination reduces the type and concentration of contaminants that have to be dealt with in water treatment plants. The NES Users Guide (2009) cites examples of the consequences of serious disease outbreaks including illness and deaths directly linked to contaminated water supplies. In 1993 in Milwaukee, Wisonsin Cryptosporidium protozoa parasites created the largest waterbourne disease outbreak in United States history arising from contamination upstream attributed to stock and runoff, with over 400,000 people ill and over 100 deaths.

Protozoa such as Cryptosporidium and Giardia are the most commonly found types of microscopic parasites that can be found in water supplies. Both parasites produce cysts that when ingested, germinate, reproduce, and cause illness. After feeding, the parasites form new cysts, which are then passed in the faeces. The ingestion of only a few cysts can cause illness. They are commonly found in human, cattle stock, deer and dog faeces. Drinking water sources become contaminated when faeces containing the parasites are deposited or flushed into them.

The risk of water contamination from faecal matter from feral animals such as deer, pigs and goats within the water collection areas is assessed in the Te Marua Water Safety Plan (Hutt catchment). For the Hutt water supply the likelihood is assessed as 'almost certain' and the inherent risk 'very high' with 'major' consequences for water quality and public health. Water quality risk from faecal matter from livestock or feral animals is also a significant risk in the Wainuiomata /Orongorongo WCA, but this risk is not assessed in the 2014 Wainuiomata WTP- Water Safety Plan.

With the effective feral animal management programme (described above) and the number of animals entering the catchments from adjoining land remain low, the 'residual risks' with these preventative measures is assessed as being 'medium' (Te Marua WTP- Water Safety Plan 2014).

Livestock are not permitted within the water collection areas but are present on properties near the catchments. Both water collection areas adjoin Department of Conservation managed forest parks which also act as a buffer where cattle and other stock are not permitted. However it has been reported by DOC that cattle stock wandering from farms occasionally occurs, with stock sightings

reported by trampers downstream from the Orongorongo River water intake within Rimutaka Forest Park but outside the water collection area.

Threat minimisation and mitigation

The water treatment plants at Te Marua and Wainuiomata treat all raw water to remove microbiological contamination from drinking water supplies before it reaches the Wellington population, with MAVs for Cryptosporidium and Giardia monitored and treated as required.

The range of risk minimisation and mitigation management measures undertaken is addressed above in the pest plant and animal section.

Reducing risks of contamination and treatment are part of a 'multiple-barrier' approach to achieving optimum drinking water quality.

Caption: Feral goats and deer. Maintaining low feral animal numbers is a critical for minimise the threat they pose to water quality. (Images: Colourcraft library)

6.3 Contamination by human activity

Fences and other exclusion measures and advice (warning signs/ possible fines) are provided in the collection areas where the public is fully excluded and trespass is more prevalent or likely, but where access is largely permitted (Hutt) and controlled (Wainuiomata/Orongorongo) other measures to minimise risks to water quality are required. In the Wainuiomata fencing along the private land boundary reinforcing the boundary of the water collection area and its 'closed' access status.

Human and animal waste can have detrimental effects on water quality. The presence of organisms such as Giardia and Cryptosporidium (both present in the water collection areas) is usually associated with contamination by human and/or animal faecal matter. Whilst water treatment removes both protozoa, their presence represents some risk to water quality. A ranger is stationed at Wainuiomata to actively manage this risk with regular ranger patrols.

For the Wainuiomata and Hutt water supplies, the risk of faecal contamination of water is considered to be of low likelihood, and low inherent and residual risk, but with high consequences for water quality if the event were to occur.

Threat minimisation and mitigation

Controlled visitor access (as per section 7.4) to the Wainuiomata and Orongorongo WCA significantly minimises this threat, with toilet facilities provided for use prior to the commencement of guided walks, and another facility within the catchment for tour group use. Controlled access also includes ranger patrol, fences and gates. Standard operating procedures for visitor access and biosecurity also assist in minimising threats.

In the Hutt WCA, where public access is permitted in most places, but not overnight visits, further site based advice is provided to minimise the risk of faecal contamination of water ways. For example, visitors are advised to bury human waste well away from water ways. Public camping is not permitted in either WCA, but some overnight stays occur periodically for management purposes such as pest animal control or monitoring. Permitted activities are identified in section 7.4 of this plan.

Caption: Signage is an important aspect of visitor management on the boundaries and entry points to the water collection areas. Interpretation panels and ranger talks in the adjoining areas at Kaitoke Regional Park and Wainuiomata Recreation Area inform visitors about *why* protection of water collection areas is important and how they can minimise impacts.

Ongoing interpretation and education activities foster public understanding of the various ways of minimising impacts on drinking water quality. This is achieved through formal education opportunities such as school trips and booked tours for the public and informal face to face or static media interpretation in the parks adjoining the water collection areas.

Fostering minimal impact behaviour by visitors is paramount for minimising threats to water quality from recreation activities in the water collection areas. Information for visitors about appropriate behaviour in the water collection areas is provided via a variety of media including the GW website, printed brochures, on site information and interpretation signs and kiosks at park entrances, and via ranger talks. The following messages are provided:

Care for water supply

- To preserve the forest and protect our water supply from contamination and infectious diseases, please do not enter the catchment if you have had diarrhoea in the past two weeks.
- Keep rivers and streams clean. Bury toilet waste in a shallow hole well away from watercourses
- Light no fires. Take care with portable stoves, matches and cigarettes
- Remove rubbish. Carry out what you carry in
- Foot access only. No motor vehicles, trail bikes or mountain bikes are allowed in the Water Collection Areas
- No camping
- Do not damage or remove plants
- Do not disturb vegetation research plots and markers
- Do not bring animals into the catchments (except registered dogs via hunting permit)
- Hunters must comply with the NZ Fire Arms Code at all times

Specific messages for Hutt WCA include:

- Keep out of the area between Hutt Forks and the Kaitoke weir

- Hunting is by permit only in the Hutt Water Collection Area. Contact GWRC to obtain a 6 month hunting permit
- Dispose of offal and carcasses at least 50 metres away from stream beds
- Complete your trip into or through the catchment in one day

Specific messages for Wainuiomata/ Orongorongo WCA include:

- No casual access
- Hunting is by permit only and allocated via a ballot system
- All visitors including hunters must comply with biosecurity policies
- Vehicles must be kept out of waterways

The threat of animal faecal matter contamination is reduced through pest animal control programmes which must be ongoing with largely unfenced WCAs. Working in collaboration with adjoining and nearby land managers such as DOC and private land holders can also reduce the overall pest animal numbers within the catchments and adjoining areas and their movements into the WCAs.

6.4 Fire

Growth of introduced plant species such as gorse can significantly increase fire risk and overall vegetation cover with significant impacts on water supply and quality. Other exotic plants such as eucalypts and pinus radiata can also contribute to increased fire risk due to high flammability.

Climate change, resulting in lower rainfall, may result in changes in the frequency of bushfires which can have a significant short term impact on water quality. After fire rain washes ash, nutrients and other materials into rivers, causing increased turbidity and changes to stream ecology. Longer term impacts can include reduced catchment yield due to a reduction in vegetation cover. Once regenerating vegetation enters a phase of rapid growth, surface and groundwater levels may be reduced. Fire also offers opportunities for rapid growth of weed recruitment opportunities.

Severe weather events, such as intense rain and snow storms (the frequency and intensity of which are expected to increase with climate change), are likely to cause further disturbance in riparian areas and move weed species through river corridors. When native species become stressed by changes in climate they are more vulnerable to attack or competition (Buckley 2007).

Chris Maclean's book, 'Tararua, the story of a mountain range', documents some of the Tararua fire history, and notes that "*fire has transformed the forest around the headwaters of the Hutt River where, in 1938, a hunter's campfire accidently ignited bush on the Marchant Ridge. Half a century later the expanse of gaunt tree trunks still resembles a battlefield*" (1994:42). The book references another accidental fire started by a local tramping club in 1947 which burnt for two days, as well as earlier fires deliberately lit for land clearing for farming, and much earlier fires lit by local Maori for hunting moa (1994:41).

Little documentation has been found of fires in the Wainuiomata/ Orongorongo WCA, except anecdotal evidence of a fire at Skull Gully in the 1980's.

Threat minimisation and mitigation

Lightning strikes are a common cause of fire in many areas, but are fortunately uncommon in the Wellington region. The relative remoteness of the WCAs also means that fires started by deliberate or unintended human activity are likely to be controlled before they reach these areas. Should a fire reach or start in the WCA the ongoing pest plant control programme, particularly of high flammability species such as gorse, eucalyptus and pines should contribute to reducing the spread and intensity of fire. Whilst aerial fire control offers the least physical impact, use of fire retarding chemicals could have some consequences for water quality and should be avoided. Maintenance of access roads in good condition is a critical measure in facilitating a prompt on-ground response to fire activity. Climate change may in future create the need for use of 'lightning tracker tools' and

other early warning fire detection methods commonly utilised in more fire prone parts of the world.

Caption: Evidence of old fire damage near Hutt River Forks. Fire events were much more common in the past than they are now with rapid aerial response to fire ignitions possible and a no fires policy for visitors to the WCAs.

6.5 Pest plants, plant disease introduction and spread

Pest plants can invade native forest and interfere with forest regeneration and effect forest vitality. Climbing pest plants smoother and displace native vegetation and can cause forest canopy collapse; woody species displace native vegetation altering the vegetation structure; and ground covers inhibit natural forest regeneration threatening forest sustainability.

The KNE plan for the Hutt WCA notes that the catchment has 'very few and only very small infestations of ecological weeds' but that infestations will spread if left uncontrolled (2016:5). Infestations of gorse (*Ulex europaeus*), Himalayan honeysuckle (*Leycesteria formosa*) and lotus (*Nelumbo nucifera*) are restricted to small areas in the lower Eastern Hutt River valley and the Eastern Hutt access road.

In the Wainuiomata/Orongorongo WCA, pest plants presenting the most threat include buddleia (*Buddleja davidii*), wilding pines (*Pinus radiata*), pampas (*Cortaderia* spp.), Japanese honeysuckle (*Lonicera japonica*) and beggars' ticks (Bidens frondosa). Of these the most widespread and densely growing species is buddleia. This species is present along the margins of most of the Orongorongo River and many of its main tributaries. Whilst resources allocated in 2016 don't allow for any control of buddleia to be carried out within the Orongorongo catchment, the buddleia lead weevil, a biocontrol agent, was released in the area in 2012. It has become established and appears to be spreading; the photos below illustrates a buddleia plant before and after leaf weevil presence. The other species identified above within the Wainuiomata catchment are far sparser, as a result of many years of control.

The threat of new plant species and diseases spreading via seeds is ever present with transmission via wind, waterways, birds, animals, park visitors, vehicles and equipment.

The KNE plans for the WCAs identify the threats management and recreational activities can pose:

- Road and track maintenance, the installation of structures, ecological monitoring and other

management activities can all cause the accidental introduction of weed species through the carriage of seeds and plant fragments on machinery, equipment and clothing

- Hunting and tramping can cause the accidental introduction of weed species and plant disease through the carriage of seeds and plant fragments on clothing, equipment and dogs

Naturally present plant disease such as different varieties of phytophthora can also affect particular plants causing die back and eventual death, as can introduced insects or fungi, both with potentially significant impacts on vegetation cover.

Caption: Buddleia (left) and Japanese honeysuckle (right) in bloom. Both are significant pest plants in the Wainuiomata/Orongorongo water collection area.(images Colourcraft library)

Caption: A biocontrol agent, the buddleia lead weevil was released in the Wainuiomata catchment in 2012, has become established and appears to be spreading. The photos above illustrate the before and after effect of the weevil. In 2016 it is the primary control mechanism for this pest plant. Images Ewan Kelsall.

Threat minimisation and mitigation

GWRC monitor the spread of pest plant species and use targeted control measures appropriate to the species. The KNE plans identify measures for particular species, with the aim of containing and controlling all infestations and ultimately their complete elimination in the medium to longer term. This is achieved by controlling targeted ecological weeds annually before they set seed, so that the seed bank will be reduced over time.

Maintenance of a diversity of species within forest helps to minimise the threat of plant disease.

To help protect biodiversity values, visitors to the water catchments are requested to have clean gear and equipment and be aware of seeds and fragments of weeds which can be carried on clothing equipment and dogs. Maintaining clean gear and equipment also helps to minimise the spread of

threats such as didymo algae; a message highly promoted by other government agencies.

To minimise the spread of pest plants and plant and animal disease, vehicles entering the Wainuiomata / Orongorongo Water Collection area are required to have clean chassis and wheels and a facility is provided for this purpose. Staff and visitors must also clean their boots and other equipment prior to entry, and in particular for entry to the Mainland Island.

Caption: Vehicle wheel wash to remove potential contaminants. All vehicles entering the Wainuiomata /Orongorongo WCA must go through this wash before entering. (Image: FC)

Monitoring threats

6.6 Monitoring water quality and threats to forest health

Terrestrial ecosystem health monitoring

GWRC undertakes regular monitoring of the health of vegetation cover for WWL and also looks for changes potentially caused by plant disease and weed plant infestations. The Service Level Agreement (between WWL and GWRC) for Terrestrial and Hydrological Monitoring (2014) identifies that 'monitoring techniques that focus on changes in canopy cover, fruit survival and seedling growth can show if pest control is being effective in minimising the impacts of pests on forest health'. This SLA identifies the additional threat of the WCA being close to a major port, increasing the chances of introduction of new plant and animal diseases entering the forests of the water collection areas.

WWL funds this work to identify longitudinal trends in the state of forest health and to report on water quality to the Ministry of Health. Pest control and other works in the catchments provide the first barrier to unwanted water quality impacts.

The SLA identifies a range of monitoring methods and indicators for ecosystem health as well as target levels and frequency of monitoring. Methods and indicators include:

- Rata health – measured by foliage cover (rata is an ideal indicator species for possum damage)
- Hinau fruit fall plots - measured by the number of possum damaged fruit
- Aerial surveys for pest insects and fungi – identifying new incursions of pest species
- Permanent vegetation plots – provides information about forest health and regeneration
- Phenology* – measures fruiting and flowering
- Ungulate browse plots – measures regeneration of palatable species
- Bird counts – measures abundance of species
- Possum numbers – measures residual trap catch (RTC) or waxtag rate(WTT) (the rate possums bite waxtags)

- Rodent and mustelid numbers – measured via tracking rates

*Phenology is the study of periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions

Targets for other pest species such as deer and goats are identified in KNE plans and the SLA for catchment management and biodiversity. Measures and targets for management of particular ecological weeds are identified, measuring annual reduction in the density and distribution of pest plant infestations.

The Service Level Agreement between WWL and the Biodiversity Department details outcome monitoring and targets for pest plant and animal control in the water collection areas. These are:

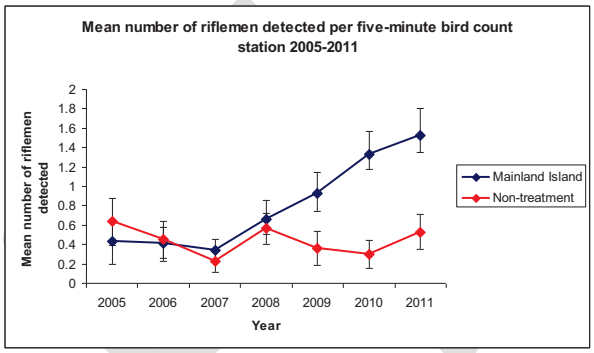
- Possum control, undertaken every 5-6 years <5%Residual Trap Catch
- Goat and deer control, undertaken annually <1 animal/8 hour ground hunting or <5 animals/1hour aerial hunting
- Environmental Weed control, undertaken annually - Annual reduction in the density and distribution of infestations

There are also 'human activity' targets in the KNE. These are:

- Distribution of ecological weed biosecurity information to all permit holders through the existing permit systems, and to tramping groups when opportunities arise.
  Target - Biosecurity precautions disseminated to all permit holders and to trampers when possible.
- Ensure pest plant biosecurity guidelines are adhered to while carrying out all management activities.
  Target - Guidelines are available and adhered to during all management activities.

The Service Level Agreement between WWL and the Environmental Science Department details outcome monitoring that will provide a measure of targets for forest health of the water collection areas. These are:

- Rata health >70% foliage cover,
- Hinau fruit-fall plots <3% fruit damaged by possums,
- Ungulate browse plots <10% ungulate brwose recorded
- Permanent vegetation plots appropriate to forest type No change in basal area and seedling regeneration curve



Caption left to right, top to bottom: Measuring seedlings in a vegetation plot, ungulate browse monitoring in the Wainuiomata / Orongorongo WCA, rodent monitoring tunnel, bird counts.

Aquatic ecosystem health and hydrological monitoring

GWRC undertakes hydrological and water quality monitoring for WWL, including monitoring of surface water flows, dissolved oxygen, and groundwater saltwater-intrusion sentinel wells.

Aquatic ecosystem health monitoring

Hutt WCA

GWRC and NIWA carry out other water quality and aquatic ecological monitoring in the Hutt WCA. NIWA monitors water quality, periphyton cover and aquatic invertebrate diversity in the Hutt WCA at a site upstream of the swing bridge. This site monitors flow and turbidity on a continuous basis and monthly water quality sampling and annual periphyton and macroinvertebrate sampling is also carried out. GWRC also monitors continuous dissolved oxygen and water temperature at the Kaitoke weir. A new rain gauge station is planned here.

Wainuiomata /Orongorongo WCA

GWRC has two telemetered rainfall gauges in the WCA at Orongorongo Swamp and Wainuiomata Reservoir, two telemetered flow recorder sites (Wainuiomata River at Manuka Track and Orongorongo River at Truss Bridge), and one water quality site (Wainuiomata River at Manuka Track) which is sampled monthly. Periphyton and macroinvertebrate sampling is also carried out at the Manuka Track site annually in summer/autumn along with a rapid assessment of stream habitat quality. There is also a decommissioned flow recorder site at the Upper Dam (some historical data exists).

Caption: Telemetered rainfall gauge near Morton Dam, Wainuiomata (photo FC)

Hydrological monitoring

A river water quality monitoring site at Kaitoke includes continuous measurements of turbidity and UV 254 (dissolved organic surgate measurement). The record from this monitoring is useful in assessing changes in 'raw' water quality such as post slips or major storm events, and any deteriorating trends in water quality (including increasing presence of algal blooms) detected can be of interest to maintenance of the *effects of climate change* at the Te Marua water treatment plant.

Resource consent related monitoring also takes place in the WCAs. This includes fish surveys and monitoring of overall aquatic health indicators.

MAV monitoring

Monitoring also takes place for compliance with drinking water standards (NZDSW) including 'maximum allowable values' (MAV) for agrichemicals such as pesticides and herbicides that permitted for use in the WCA (and defined in the NZ Drinking Water Standards), and for protozoa including cryptosporidium and giardia.

The targets identified in the NZ Drinking Water Standard 2008 for cryptosporidium monitored over a 12 month period and repeated at a minimum of five yearly intervals.

The targets for Cryptosporidium and Giardia are:

<10 mean oocycsts per 10 litres, 5 log credits(NZDWS)

WWL monitoring also takes place for maximum acceptable values for organic determinands of health significance (including cyanotoxins and pesticides). Contaminants that affect the aesthetic properties of water including taste, odour and appearance largely have 'guideline values' defined with some MAVs. Aesthetic determinands include aluminium, ammonia, calcium, chlorine, copper, colour, hardness, dichlorobenzene, turbidity, xylene, trichlorobenzene and zinc.

Other threats

6.7 Petrochemical fuel spillage

Spillage or leaking petrol, diesel or oil into or in the vicinity of waterways in the water collection areas is likely to result in contamination. Other possible but unlikely sources of chemical contamination could arise from incidents such as an aircraft crashes within the water collection areas, and addressed through implementation of emergency response plans.

Threat minimisation and mitigation

Strict standard operating procedures (SOPs) relating to minimising and mitigating spills are in place for GWRC and WWL officers, maintenance contractors and visitors permitted who may be permitted

to bring vehicles containing petrochemicals into the water collection areas (eg. contractors, hunters, disabled access, commercial filming). Machinery used or repaired in the water collection areas must be refuelled or repaired well-clear of waterways. Other management minimisation and mitigation measures are detailed in operational standard operating procedures (SOP). No refuelling is permitted in the catchments with the exception of the bunded generator at the Orongo repeater site. For maintenance activity projects where machinery (especially excavators using hydraulic oil, those projects have associated action and hazard plans detailed to minimise the risk to water supply and the environment.

Caption: Maintenance activities at Kaitoke Weir. The threat of contamination from vehicles entering the water collection areas is actively managed via means such as standard operating procedures and works contract conditions. (Image GWRC Gallery collection)

6.8 Contamination by agrichemicals

Vertebrate Toxic Agent (specific animal control poisons) such as 1080 are used periodically within the water collection areas for pest animal control (such as brush tail possums). For the Hutt and Wainuiomata water supplies the inherent risk of water contamination is considered to be 'medium' with 'significant' consequences water quality and public health, but with good understanding of appropriate site application in the 'recharge zone', the residual risk is considered to be 'low' (Te Marua WTP- Water Safety Plan 2014, Wainuiomata WTP- Water Safety Plan 2014).

For the Hutt water supply the risk of other agrichemicals such as pesticides, herbicides, or fertilizer within the water source protection zone is considered to have 'low' inherent and residual risks, but 'significant' consequences if the event was widespread. Whilst there are no stock grazing areas close to the water catchment zone, herbicides are used in pest plant control works and .

For the Wainuiomata water supply the inherent risk of contamination from agrichemicals is considered to be 'medium', but with preventative measures the residual risk is assessed as being 'low'.

Stock grazing of cattle, sheep and deer grazing occurs on adjoining properties to the Wainuiomata water supply area, and the potential cause of contamination from these sources is identified as 'poor understanding of catchment/recharge zone', e.g. catchment boundaries. The Department of Conservation rangers have reported observing cattle close to the WCA boundary beside the Orongorongo River.

Threat minimisation and mitigation

Preventative measures to alleviate the risk of contamination include clear catchment boundary definition and ongoing awareness/ education activities with adjoining land owners and contractors using agrichemicals as well as GWRC and WWL staff.

Changes in the use of agrichemicals for pest plant and animal control in the WCAs can have

downstream effects on water quality. Maximum allowable values (MAV) for agrichemicals permitted for use in the WCA are defined in the national drinking water quality standards and monitored via water quality testing. WWL is responsible for maintaining MAV and GWRC for pest plant and animal control.

Some GWRC operational plans such as the Regional Pest Management Strategy – Operational Plan (2015/16) document a list of chemical controls used, however the need for further documentation has been identified as a risk minimisation measure. **Development and maintenance of a single register of approved chemicals to be used in the water collection areas, as well as regular interagency communication about any changes is required.** This is an action identified in this plan, and will help to reduce the threat of possible agrichemical contamination.

6.9 Sediment run-off

Sediment run-off can affect both water quality and supply, but is a more frequent threat to water quality. There may be source water quality impacts if there is significantly increased sediment run-off from soil erosion of steep terrain through loss of vegetation from slips, storms or fire. Sediment run-off can also result in increased nutrient loads and be a potential contributing factor to toxic algal blooms. Reducing overall sediment run off is a long term catchment management goal. Causes of increased sediment run-off include loss of vegetation resulting in soil erosion from fire, storm events or pest animal browsing, and land movement from slips and earthquakes. There is also a risk of metals exceeding MAV from slips, aluminium, iron and arsenic are examples of naturally occurring metals that can do this. This has occurred in the Hutt catchment with aluminium.

For both water supply areas, the Water Safety Plans (2014) identify the likelihood of sediment run-off from loss of vegetation affecting water quality as 'unlikely' and the inherent and residual risks are both considered to be 'medium' with 'moderate' consequences for public health if the event were to occur.

Threat minimisation and mitigation

Management measures to minimise and mitigate risks from sediment run-off include good water sensitive design of unsealed roads and tracks, replanting of slips (if feasible) and maintaining good native forest canopy and understory vegetation cover (through management of pest animals and plants).

Caption: Huia Intake, Orongorongo River in flood. Significant rain events increase turbidity in rivers and streams increasing filtration requirements in the water treatment plants.

6.10 Source water run-off from unsealed surfaces

The Wainuiomata/Orongorongo WCA has two unsealed 4WD only access roads; the 14km

Wainuiomata/ Orongorongo Catchment Road (of which the first 2km is sealed) and the 17km Moore's Valley Ridge Road. If not properly maintained, roads and tracks can be a significant source of sediment to waterways feeding into creeks and rivers. The roads are used by GWRC and WWL, contractors, volunteers and research groups to access the catchment area and Mainland Island.

The Wainuiomata Water Safety Plan identifies a water quality risk from source water run-off from 'urban or sealed surfaces, including substances in transit' (such as petrochemical spills) as a very high inherent risk likelihood with major possible consequences for water quality, but a medium level residual risk with preventative measures in place. The potential causes and sources of contamination are identified as run-off from management activities within the water source protected area at Wainuiomata, and poor identification of areas where run-off may occur and inadequate treatment or collection and disposal of contamination run-off. Standard operating procedures for spill run-off provide directions for mitigation of risk events should they occur.

Threat minimisation and mitigation

Regular maintenance and capital works on unsealed roads, tracks and associated culverts and drainage swales to defined road and track classification service levels, ensures ongoing access to the catchments as well as minimising sediment runoff and negative impacts on water quality.

Water sensitive design

The principles of water sensitive design can be incorporated into the design of road and track development and maintenance, and in particular run-off. Implementing practical water sensitive design measures will contribute to:

- Protecting streams and rivers from excessive sediment run-off
- Filtering run-off, capturing silt and minimising impacts on water quality
- Slowing run-off in heavy rainfall events (storm water retention) and downstream flooding
- Minimising maintenance regimes (service levels)

Water sensitive design treatments may include grassed or landscaped swales, infiltration trenches and bio-retention systems, gross pollutant traps, wetlands and sediment ponds or porous paved areas.

A 'treatment train' may be implemented, where several treatment types are used in conjunction with one another to maximise downstream outcomes. Many pollutants such as nutrients and fine sediments require a number of measures used in sequence for treatment to be effective.

Drainage systems should be designed to minimise changes to flow characteristics and maintain natural stream morphology. Soft engineered solutions should be chosen (e.g. a variable waterway profile supplemented by rockwork and native vegetation), in preference to hard engineered solutions such as a concrete or hard lined channel.

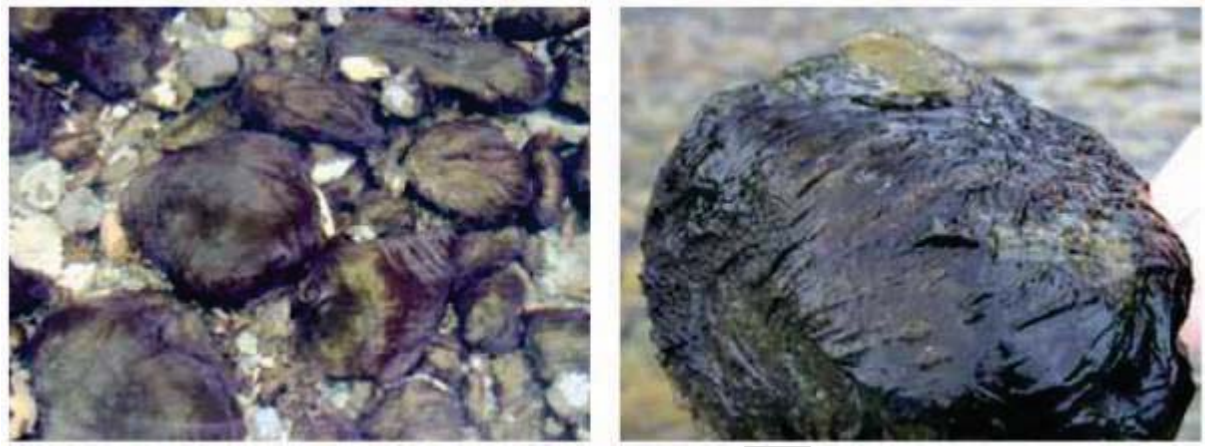
Caption: The design of the Sinclair Creek culvert and ford run off encompass embedded rocks to capture sediment runoff to the creek becoming mossy over time. (Image: GWRC collection)

Caption: Hutt Forks road, Hutt Water Collection Area. Maintaining effective road drainage is importance for minimising sediment runoff from gravel roads in the water collection areas.
(Image: Colourcraft library, left, FC right)

6.11 Algae

Toxic algal blooms occurring in raw water supplies are unwanted and contribute to additional chemical water purification. Toxic algal blooms in water supplies are caused by a combination of conditions suitable for algal growth; elevated nutrient levels, sunshine (light), warmth and relatively still water. The most commonly occurring type of toxic algal bloom is blue–green algae which prefer stable water conditions with low flows, long retention times, light winds and minimal turbulence. Blue–green algae growth is reduced when exposed to long periods of high light intensity but is optimal when intermittently exposed to high light intensities such as partly shaded river areas. Blooms usually develop during the warmer months of the year or when the water temperature is higher and there is increased light. They are not currently common during the winter months in the cool climate of Wellington.

The Water Safety Plans identify that the likelihood of toxic algal blooms for the Te Marua and the Hutt water supply is almost certain and expected to occur at least once over a ten year period, with the inherent risk is considered to be 'very high' with 'major' possible consequences for public health, but the residual risk with existing preventative management measures is considered to be 'medium'. The sheltered location at the end of the Hutt Valley contributes to more favourable conditions for toxic algal bloom – warmer temperatures and less windy weather conditions. When water flows are low in times of reduced rainfall conditions suitable for toxic algal blooms can occur.



Caption: Toxic algal blooms are a threat in the rivers and streams of the water collection areas (photo – GWRC toxic algae in Wellington's rivers brochure)

Algal bloom affecting taste and odour which are not toxic can also occur and result in the need for additional water treatment. The NZDWS identifies a range of determinands and guideline allowable values for aesthetics of water.

The most common water quality side effect from algae is taste and odour. There are three main taste and odour organic compounds produced by algae (Geosmin; 2- Methylisoborneo {2-MiB}; 2,4,6 -Trichloranisole). These require a separate treatment process to remove and are detectable by approximately 5% of the population at very small quantities, typically 4 ng /L, and by the majority of the population at levels above 10 ng/L.

There is a component of the New Zealand Drinking Water Standards that states the water must be palatable, this is primarily based around taste and odour compounds. WWL enable Powdered Activated Carbon (PAC) dosing or turn off a particular source if any of the various taste and odour compounds levels are greater than 4 ng/L. This commonly occurs with the Macaskill lakes but after a prolonged dry period water quality monitoring has observed an increasing trend with taste and odour compounds appearing in the raw water coming in from all catchment intakes sources.

Threat minimisation and mitigation

Risks and results of toxic algal blooms can be minimised with measures such as river riparian zone management to maintain shade over the water and keep water temperatures lower, as well as reducing river bank erosion contributing to increased nutrient load from sediment run-off and catchment management measures to maintain vegetation cover and reduce soil erosion.

Threats to water supply

The threats to water supply tend to be 'bigger' and less actively manageable such as climate change, significant storm events, land slips and earthquakes. However, with adequate resourcing infrastructure can be made more resilient to these events with works such as asset strengthening and upgrading. This section describes the key threats to supply in more detail and outlines possible risk minimisation measures.

6.12 Climate change and severe weather events

The GWRC Climate Change Strategy Objective 2 states that '*Risks from climate change-related impacts are managed and resilience is increased through consistent adaptation planning and actions based on best scientific information'.*

Predicted climate changes and key risks for the Wellington region identified in the GWRC Climate Change Strategy 2015 and MFE Climate Change Effects and Impacts Assessment 2008 which may affect the water catchments and both water quality and supply include:

* More frequent and extreme heavy **rainfall** and **severe wind** events leading to more erosion and landslides. Rainfall changes are predicted to vary within the region, with 'a small increase in rainfall in Kapiti and Wellington city, and less rainfall in the Wairarapa. Very heavy rainfall events are likely to become more frequent, especially in the Tararua Range during north-westerly storms, and in Wellington city and south Wairarapa during southerly storms' (GWRC: 7). Water quality may be affected by storms, flash flooding and increased sediment run off from soil erosion. Water supply may be affected by landslides and significant vegetation windfalls from more frequent or intense than 'usual' storm events. Landslides pose a significant threat to water supply, particularly in the highly seismically active Rimutaka Range where many existing slip and scree slopes from previous events remain un-vegetated. The increased frequency and severity of weather events, such as heavy rainfall, wind and snowfall also has major effects on the health of the forest, as these events can affect canopy trees causing dieback over large areas within the catchments.
* **Drought** frequency and intensity. 'Decreases in rainfall, which are most likely in the north and east of New Zealand, coupled with increased demand, would lead to decreased security of water supply' (MFE 2008:53). More frequent droughts are identified as being likely to lead to water shortages as well as an increased risk of wild fire in summer. To minimise the effects of drought, maintenance of healthy native forest floor understory species and vegetation assists the retention of water and can minimises plant stress.
  Lower stream and river flows in summer months and drier years may increase nutrient loading and lead to increased eutrophication (nutrient enrichment largely with nitrogen and phosphorus) and risk of toxic algal blooms affecting water quality and the need for water purification.
* **Biodiversity** changes which may affect vegetation cover and species distribution. The GWRC Biodiversity Strategy (2012) identifies that there may be 'general uncertainty around how ecosystems will respond- some vulnerable sites may become unviable', with changes in storm and rainfall intensity predicted to increase disturbance to species communities, changes to seed production in plants related to warming, and changes in bird species breeding patterns and distribution (GWRC: 8).
* **Biosecurity** changes over time are predicted such as increases in weed species, shifts in pest migrations or distributions. Warmer average temperatures may result in more flowering or seeding or better breeding and survival of pest species. New pest plant and animal management approaches may be required.
  Extreme weather events can cause considerable costs for Biosecurity related activities, particularly if heavy snow or strong winds result in vegetation falling over access tracks and routes or damage pest control infrastructure. Prolonged periods of unseasonable or unsettled weather can also delay or interfere with aerial pest control activities such as herbicide spraying or aerial application of 1080.
* **Fire** risk from more frequent dry spells, higher temperatures and changing vegetation could result in dryer, more flammable forest which could have a catastrophic effect on water quality if there was a major catchment fire. Rises in temperature of +1 to +2 degrees Celsius are predicted for the Wellington region by NIWA. Climate change reports such as the Royal Society's 'Climate Change implications for New Zealand2016, identifies that '*fire season length will be extended in many already high-risk areas and higher CO2 may enhance fuel loads by increasing vegetation productivity in some regions*', and because native ecosystems have limited exposure and adaptation to fire, '*forest regeneration following wildfires also reduces water yields and reduced vegetation cover increases erosion risk and has implications for water quality*' (2016:41).

Adapting to the threats of climate change

The purpose of the GWRC Climate Change Strategy is to align and coordinate climate change actions across GWRCs responsibilities and operations. The strategy ensures that update scientific information is utilised and that GWRC and WWL collaborate to plan for and implement resilience activities that enable the management of the catchment area to evolve with the challenges posed by a changing climate. Effective planning for water quality and supply in many ways also overlaps with planning for climate change.

Caption: Quoin Ridge from Hutt Forks, Hutt Water Collection Area. Increased frequency and amount of snowfall on the forest canopy can damage vegetation cover and may effect species composition in the longer term. (Image: Colourcraft library)

Caption: Orongorongo River track and pipeline repair works 2005. With severe rain events expected to become more frequent, works to strengthen and reinforce assets such as access tracks and water pipelines are required. (Images: GWRC collection)

6.13 Slope stability and soil erosion

Erosion and unstable slopes can block water supply intakes, damage pipelines, roads and other assets. River and stream bank erosion can change the path of watercourses and increase sediment loads significantly. Major erosion events may also threaten water collection assets such as bridges and weirs. To a lesser degree access roads and tracks can be a source of sediment to waterways feeding into water treatment plants and reservoirs.

Threats such as wildfire and resulting vegetation loss can contribute to erosion events which may last a number of years and contribute to significant sediment movement and downstream soil deposits. Similarly, landslips from earthquakes and major rain events can contribute larger volumes of sediment to streams and rivers, increase turbidity, smother riparian vegetation and ultimately result in reductions in both water quality and volumes.

This threat also applies to water quality, but this threat is addressed above in relation to sediment runoff. According to the Resource Statement for the water collection areas, within the Hutt catchment, 'Just over 50% of the area suffers from erosion (WRC, 1996). As in the past, the sub-alpine belt above the tree line is most susceptible. Erosion has been accelerated throughout the catchment by introduced browsing animals such as deer and pigs. Erosion is an ongoing problem in the fault controlled Eastern Hutt River valley where the sheared and crushed rock is easily eroded by the river. Further erosion occurs in the headwaters of the Western Hutt River under Mt Aston where shingle slides reach up into alpine grasslands' (undated: 22).

Caption: Heavy erosion of an access road and broken water supply pipe and power cable after a storm in the Wainuiomata catchment downstream of the intake in 2005.

Within the Wainuiomata/ Orongorongo WCA, the Rimutaka Range is identified as having 'particularly severe erosion', in the past hastened by goats and possums browsing and removing forest understorey. With higher rainfall and steeper sided valleys, the Orongorongo valley hillsides are more prone to erosion than Wainuiomata.

Threat minimisation and mitigation

Whilst regular high rainfalls create a good water supply for Wellington with minimal need for water storage, they contribute to high levels of sediment movement of already highly erodible soils from steeply sloped and seismically active ranges, in particular the Rimutaka Range. Management of pest animal species which have the most significant impact on vegetation cover is an important aspect of minimising loss of vegetation cover which results in accelerated erosion. Roads and tracks can be designed and maintained to minimise their contribution to sediment loads, and maintenance of riparian vegetation is equally important. Other erosion protection measures can be undertaken for long term benefit such as revegetation of slips through aerial seeding or other methods.

Caption: Scree slope beginning to revegetate through natural seeding processes, Orongorongo Valley, Wainuiomata/Orongorongo Water Collection Area. (image: GWRC)

Caption: Orongorongo River and scree from flood event in 2005. Water flows can be significantly reduced after major rainfall events leading to large scree movements such the one above. (Image: GWRC collection)

Caption: River bank and asset protection measures such as gabion rock baskets are utilised as flood and erosion stabilisation measures. (Image: GWRC collection)

6.14 Earthquakes and resilience of raw water supply

Seismic events such as earthquakes may result in major slips or rock movement which could block or divert rivers and streams, damage water intake and other supply assets, destroy large areas of vegetation, resulting in increased erosion or have other negative effects on water supply and quality.

Caption: The upwardly mobile Rimutaka Range showing many land slips (photo FC)

Major water supply assets within the WCAs potentially vulnerable to earthquake related damage include roads and tracks, bridges, tunnels, water pipes, weirs, water intakes and storage dams.

Weirs and water intakes include:

- A single water intake in the Hutt WCA at Kaitoke Weir (from where the water is piped to the Macaskill storage lakes at Te Marua before treatment)
- Two water intakes in the Wainuiomata catchment, one upstream from the Moreton Dam and on George Creek at small weir
- Three water intakes in the Orongorongo catchment, on the Orongorongo River and Big Hui Creek weir (from where it is piped underground to the Wainuiomata treatment plant) and Little Huia can also be used for supply

Threat minimisation and mitigation

The Wellington Water Committee has adopted a regional approach to the challenge of reinstating downstream water supply to Wellington after a major incident such as an earthquake or storm event. However, preventative upstream management interventions to build resilience into supply are limited.

After a major seismic event which effects supply upstream of the water intakes, emergency responses may be complex and time consuming in the largely inaccessible valleys of the collection areas. Further vegetation loss and damage may also result from works to remove river and stream soil and debris blockages.

Seismic strengthening of water intake and other assets in the water collection areas is possible and in progress, and will also be of benefit to addressing the long term changes brought about by climate change.

Other resilience initiatives include the local government and Welling Region Emergency

Management subsidy of 200L residential emergency supply water tanks available throughout the Wellington region, and the installation by Wellington City Council of fifty 25,000L water tanks in Wellington suburbs for use in the event of emergency loss of water supply.

Caption: Orongorongo Weir and water intake, Orongorongo River. Assets such as weirs are being progressively seismically strengthened via asset renewal programmes.

Caption: The three kilometre long Orongorongo Tunnel provides access for water pipeline inspections and maintenance. It runs from the Big Huia Creek Intake in the Orongorongo Catchment through to the George Creek area of the Wainuiomata catchment. A diesel engine and cart carry gear and equipment. Glow worms live in the tunnel and can be seen approximately 30m from the tunnel entrance. (Image: FC & GWRC collection)

Caption: The two Macaskill water storage lakes in Te Marua, Upper Hutt help ensure continuity of water supply. To protect water quality recreation access to the lakes is not permitted. Image: Colourcraft

Caption: Raw water supply pipeline upstream of the Wainuiomata Water Treatment Plant

Future proofing water supply and reducing the need for water treatment – increasing water storage capacity

There are two significant advantages in increasing water storage capacity:

1. Increasing water storage capacity provides further water supply security in times of drought or events such as land slips or storm damage which may impede or reduce river water supplies. However in Wellington, the effect of drought on supply is lessened with aquifer sourced water available when river supplies are inadequate.
2. Storage reservoirs with sufficient capacity to allow long water storage times can reduce the need for water treatment, resulting in less operating cost and improved taste and smell of water. Long water storage 'resting' time in reservoirs (closed to public access) acts as part of the filtering process with most impurities breaking down over time. This is assisted with water coming from protected catchments generally being high quality. Evidence of this approach is the high quality (taste and smell) of water supplied to much of Melbourne, Victoria; one of only a few cities in the world to harvest water from large protected catchments (90,000+ hectares) and then store it in numerous large capacity reservoirs (www.melbournewater.com.au/whatwedo/supply-water/Water-catchments/Pages/water-catchments.aspx).

In 2014, GWRC purchased a 202 hectare former AgResearch property at Kaitoke for possible future construction of off-river water storage lakes, similar to the Macaskill lakes at Te Marua. Up to 8,000 million litres of raw water could be stored in three lakes of differing sizes (about $2^1/_2$ times of that stored in the Stuart Macaskill Lakes). This land provides several options for the size, cost and location of future bulk water supply source development, even though an additional water supply source will not be needed for a number of years. Water for the lakes would likely come from the existing pipeline to the Te Marua Water Treatment Plant, using water from the Hutt River at the Kaitoke Weir. It is possible that water could also come from the Pakuratahi River. The new lakes would allow GWRC to capture more of the water available when there are higher river levels, but would not affect river levels at low flow.

Investigations have shown that a major water storage dam could be established on the Whakatikei River, (near the end of Bulls Run Road). In 2011, the estimated cost for a dam and associated infrastructure (including a new water treatment plant), was $160 million. Storage dams in Skull Gully (in the Wainuiomata Water Collection Area), and on the Pakuratahi River have also been investigated. A multi-criteria analysis of the three sites showed that the Whakatikei site had considerable advantages over the other two sites.

7. Management framework for the water collection areas

This section of the plan is operationally focused with objectives for achieving goals and specific policies for operations. Management responsibilities are also defined.

Documenting management responsibilities is important in reducing the risk of unintended consequences of management actions – which may be more likely where more than one agency shares the management role.

It is essential that all operational plans and procedures are developed in a consultative and collaborative manner between GWRC and WWL. Operational plans and procedures should reference the outcomes, goals and objectives of this plan and reflect the overall purpose of management of these catchments primary for water collection purposes.

The **primary purposes** of water collection areas management are:

- *Supply water to meet drinking water quality standards to the Wellington metropolitan areas and minimise water treatment*
- *Minimise risks of water supply contamination to be compatible with the objectives of the Water Safety Plans as mandated by the Health Act*
- *Provide a naturally resilient water catchment area through the maintenance of healthy catchment ecosystems to optimise water supply*

Secondary purposes are to:

- *Protect and enhance the regionally significant biodiversity values*
- *Provide for limited recreation activities.*

Goals for the water catchment areas:

1. *Maximise the **quality** of raw water and minimise the extent of water treatment required*
2. *Manage threats to water **supply** to maintain volumes of raw water*
3. *Maintain and enhance the significant **ecosystem and biodiversity values** of the water collection areas*
4. *Maintain the **cultural heritage** values of the water collection areas, including managed **recreational access***
5. *Maintain **collaborative working relationships** within and between agencies and with others to achieve water quality, supply and biodiversity objectives*

7.1 Outcomes, Goals, Objectives and Implementation Activities

The following management framework outlines outcomes sought with goals, objectives and actions for achieving them via delivery of a range of catchment management and some recreation services and facilities.

Maintaining optimum water quality

Outcomes:

- Healthy water collection area ecosystems and the biodiversity within them are maintained
- Threats to water quality are minimised (pest animals and plants, plant disease, human behaviour, natural events/ weather)
- Consistent raw water quality is maintained through whole of ecosystem management
- Overall ecosystem health is monitored via long term programmes to identify changes
- Effective and efficient collaboration is maintained between GWRC and WWL in managing the water collection areas to achieve above outcomes.

Goal 1. Maximise the quality of raw water and minimise the extent of water treatment required		
Objectives and Actions	Implementation activity	
	GWRC	WWL
1.1 Water contamination from public visits to the water collection areas is minimised by: a) Limiting and controlling recreation activities and visitor numbers. Maintain upper limit to visitor numbers in Wainuiomata/ Orongorongo WCA b) Informing and encouraging visitors to undertake minimal impact behaviour c) Prohibiting recreational or commercial activity use of the Macaskill Lakes d) Responding to incidents e) Patrolling of catchments and boundary areas for unauthorised access f) Maintenance of fences and gates g) Visitor facilities such as public toilets in appropriate locations h) Standard operating procedures , personal hygiene, catchment entry requirements i) Application and management of activity rules and new activities as identified in this plan j) Adherence to National Environmental Standard for Sources of Human Drinking Water 2009 and regulations 2007.	SLA – Parks (ranger patrol) Access controls (fencing, signs etc) Signage, information, interpretation, ranger presence	Water quality promotion activities Incident response procedures

Goal 1. Maximise the quality of raw water and minimise the extent of water treatment required		
Objectives and Actions	Implementation activity	
	GWRC	WWL
1.2 Threats to the maintenance of a diversified and self-sustained native vegetation cover are reduced by: a) Maintaining pest animal control programmes for possums, goats, and deer b) Controlling rats during mast years c) Monitoring pest animal numbers d) Controlling invasive pest plants e) Minimising incursion of invasive pest plants f) Monitoring damage to vegetation cover and seeding as an indicator of pest animal presence g) Maintaining fire breaks for management access during fire events h) Reducing areas of flammable pest plants i) Prohibiting open fires j) Monitoring incursion of and damage to forest canopy from invasive insects and fungi k) Monitoring the health of the forest cover and regeneration processes l) Maintain up to date climate change projections and adapt management plans accordingly	SLA – Biodiversity SLA- Environmental Science SLA – Parks KNE plans	
1.3 Aquatic and terrestrial ecosystem health threats from pest animal species are minimised by: a) Maintaining pest animal control programmes for possums, goats and deer b) Monitoring pest animal numbers c) Ongoing water quality monitoring for threats such as cryptosporidium and giardia in accordance with NZ Drinking Water Standards	SLA – Biodiversity SLA- Environmental Science KNE plans SLA – Parks	WWL managers, service programmes
1.4 Develop and maintain a single register for agrichemicals used by GWRC and WWL and contractors in the WCAs. Incorporate into SLAs, and operational documents	GWRC- Biodiversity, Environmental Science, Parks managers	WWL managers

Goal 1. Maximise the quality of raw water and minimise the extent of water treatment required		
Objectives and Actions	Implementation activity	
	GWRC	WWL
1.5 Sediment discharge to waterways is minimised by: a) Designing and maintaining infrastructure (such as tracks and roads) to minimise sediment run-off to water ways b) Implementing water sensitive design best practice for run-off filtering/ cleansing from roads and tracks where threats are greatest c) Minimising the use of ground disturbing machinery during fire suppression or other management activities such as water infrastructure renewal d) Maintaining healthy and diversified canopy and forest floor vegetation cover	SLA – Biodiversity SLA- Environmental Science KNE plans	Asset Management Plans, asset renewal programme New asset design development Emergency Response Plans Asset maintenance.
1.6 Contamination by chemical discharges and spillages from visitor and management vehicles within the water collection areas is minimised by: a) Ensuring staff, contractors and visitors entering WCA's are briefed and aware of relevant standard operating procedures such as biosecurity entry requirements b) Maintaining risk mitigation and incident response procedures c) Ensuring visitors are briefed and aware of procedures	Standard Operating Procedures / training SLA – Parks, Biodiversity, Environmental Science	Emergency Response Plans Other standard Operating Procedures / training
1.7 Maintain cost effective water treatment (and reduce the need for major replacement of downstream water treatment infrastructure) a) The consistency of raw water quality is maintained through ongoing threat management programmes, and water quality is monitored b) Drinking water safety plans are maintained c) Additional water quality monitoring may be required and undertaken for any activities which have the potential to introduce changes to water quality or risk contamination.	SLA- Environmental Science (water quality monitoring)	Other agency monitoring – NIWA NZ Drinking Water Standards & Water Safety Plans WWL monitoring – new activities

Maintaining raw water supply

Outcomes:

- Threats to water supply are actively managed where this can be achieved practically or economically
- Threat / risk management plans and operational procedures are maintained
- Water supply assets are managed to enhance their resilience in natural events (eg storm, seismic, fire)
- New water supply infrastructure is planned to accommodate predicted population growth
- The projected effects of climate change are planned for.

Goal 2. Manage threats to water supply to maintain volumes of raw water		
Objectives:	Implementation activity	
	GWRC	WWL
2.1 Native vegetation cover and ground disturbance threats from pest animals is managed to levels required to maximise water supply by: a) Managing pest species which most affect vegetation cover and create significant ground disturbance as a priority over other pest species (possums, goats, deer) b) Monitoring and managing the outcomes of possum and ungulate control	SLA Biodiversity KNE plan implementation SLA Environmental Science	
2.2 A range of management actions in periods of drought are implemented when water supplies from the WCAs are reduced such as: a) Maintaining current water extraction resource consents at approved levels b) Raising awareness of water supply issues and promote reduced public water consumption c) Increasing water storage capacity in other locations (outside scope of this plan) d) Ensure a healthy forest floor to retain as much moisture as possible.	SLA Environmental Science	Water consents maintained Infrastructure planning Media and public relations
2.3 The effects of climate change are considered as an integral part of planning and operational decision-making including. a) Monitoring and managing pest outbreaks triggered by weather events b) Planning infrastructure to accommodate increasingly frequent high rainfall events (leading to high levels of turbidity and organic matter in water entering treatment plants) c) Increasing the resilience of water supply infrastructure d) Planning for projected water supply demand through asset management plans e) Updating localised climate change projections and assessments of potential impacts	Biosecurity monitoring KNE plans SLA Environmental Science	Asset Management Plans New asset design development
2.4 Road and track assets which provide access to water supply assets are managed according to service level agreements and asset management plans.	SLA - Parks & Biodiversity	Asset Management Plans

Goal 2. Manage threats to water supply to maintain volumes of raw water		
Objectives:	Implementation activity	
	GWRC	WWL
2.5 Water supply and other water supply assets are sustainably maintained and renewed: a) Via current asset management plans for minor works and renewal projects b) With environmental impact assessments undertaken for new asset construction projects c) The resilience of assets is improved d) The projected effects of climate change are considered		Asset management plans & new contracts MFE/ NIWA climate change research and projections

Preserving and enhancing terrestrial and aquatic ecosystem heath and biodiversity

Outcomes:

- Overall ecosystem health is enhanced and restored over time
- Biodiversity is restored where significant change has occurred through the effects of humans, pest plants and animals and plant disease
- Pest plants, pest animals and plant disease threats are reduced
- Threats to rare and endangered native species are reduced
- A collaborative approach is maintained with partner agencies and volunteers
- Longitudinal aquatic and terrestrial ecosystem health monitoring programmes are maintained to identify changes

Goal 3. Maintain and enhance the significant ecosystem and biodiversity values of the water collection areas		
Objectives:	Implementation activity	
	GWRC	WWL
3.1 The biodiversity values in the Wainuiomata /Orongorongo Water Collection areas are managed to achieve identified targets in the Wainuiomata /Orongorongo Water Collection Area Key Native Ecosystem plan. Implement biodiversity actions including: a) Undertaking control of pest plants and animals according to plan target and priorities b) Minimising incursions for new pest plants c) Differentiating pest plant and animal control service levels for the Wainuiomata Mainland Island and Wainuiomata Recreation Area d) Promoting biodiversity gains to foster conservation awareness and engagement e) The outcomes of biodiversity management activities are monitored	Wainuiomata/Orongorongo WCA KNE Plan SLA – Parks, Biodiversity & Environmental Science	

Goal 3. Maintain and enhance the significant ecosystem and biodiversity values of the water collection areas		
Objectives:	Implementation activity	
	GWRC	WWL
3.2 Biodiversity in the Hutt WCA area is managed to achieve objectives identified in the Hutt WCA Key Native Ecosystem plan. Implement biodiversity actions including: a) Undertaking controls of new pest species according to plan target and priorities a) Promoting biodiversity gains to foster conservation awareness and engagement b) The outcomes of biodiversity management activities are monitored c) Promote monitoring of public hunting activities in the area	Hutt WCA KNE plan SLA - Biodiversity, Parks & Environmental Science	
3.3 Strategic and collaborative partnerships are developed and maintained with other organisations and/ or volunteers to support overall objectives for ecosystem health, such as the Rimutaka Forest Park Trust for trapping in the Wainuiomata Orongorongo WCA and local iwi	Partnerships, MOU's, collaboration in research. Shared operational services	
3.4 Issues associated with native fish passage are addressed at the Hutt River weir (which prevents or restricts the access of some native fish species to the entire habitat that would otherwise be available to them).	Biodiversity	Asset management
3.5 Finalise and publish the unpublished GWRC Wellington Regional Water Collection Areas Resource Statement (unpublished)	Environmental Science	WWL review

Preserving cultural heritage and providing for recreation activities

Outcomes:

- Cultural heritage values, assets and features are respected and appropriately protected and preserved
- Recreation access is managed to protect water quality, supply and management operations
- Visitors to the WCAs are informed about ways to minimise impacts on water quality

Goal 4. *Maintain the cultural heritage values of the water collection areas including managed recreational access.*		
Objectives	Implementation activity	
	GWRC	WWL

Goal 4. *Maintain the cultural heritage values of the water collection areas including managed recreational access.*		
Objectives	Implementation activity	
	GWRC	WWL
4.1 Kaitiakitanga and other Māori cultural values are recognised and activities which may cause impacts are minimised by: a) Consulting with iwi stakeholders prior to application for resource consents and during planning for future sources and major assets b) Activities and/ or communication to raise awareness of these values	Ongoing liaison with mana whenua	Ongoing liaison with mana whenua
4.2 Support the directions of the future Wellington Harbour Hutt Valley Whaitua (catchment) and the Whaitua Implementation Programme (WIP) related to the WCAs.	Whaitua Implementation Programme	
4.3 Built heritage assets or features identified as significant are managed according to best practice: a) Follow ICOMOS Charter principles for heritage asset management (where preservation does not compromise water quality, supply, and safety or have downstream negative effects) b) Develop conservation management plans for particular heritage assets, where required, to guide management activities.		Asset management plans Conservation Management Plans for heritage assets.
4.4 Recreation access to Wainuiomata Orongorongo WCA is controlled with defined maximum visitor numbers (identified in this plan): a) Access conditions are addressed in access permits, within SLAs, and standard operating procedures. b) Periodically review maximum visitor numbers and conditions of access c) Develop and maintain systems for accurately reporting annual visitor numbers, trip types and hunting permits	SLA- Parks, Biodiversity, Environmental Science	SLA input/ agreement
4.5 Recreation facilities for visitors are minimised except in the interests of public safety, environmental protection and information and interpretation of WCA values or issues.	SLA – Parks, Biodiversity	Liaison during SLA implementation

Goal 4. *Maintain the cultural heritage values of the water collection areas including managed recreational access.*		
Objectives	Implementation activity	
	GWRC	WWL
4.5 Public access in both WCA is managed: a) By a range of measures such as fences, signs, ranger patrols, access permits, concessions, biosecurity controls, maps, electronic and printed information b) Via permanent and temporary closures to restrict public access to water supply infrastructure, as necessary for its safe and efficient operation c) Research and natural use is managed via a permit system d) In liaison with neighbouring land owners via signs, fencing, information and other measures e) Via visitor number monitoring mechanisms such as pedestrian or vehicle counters in the Hutt WCA (if appropriate) f) As remote areas with minimal recreation facility provision (except for threat/ risk minimisation) g) With application of GWRC Parks, Forests and Reserves Bylaws where appropriate h) Systems for accurately reporting annual visitor numbers, trip types and hunting permits are developed and maintained to inform management decisions and planning. i) New activities are assessed on a case by case (between GWRC & WWL) and following requirements outlined in section 7.5.	SLA – Parks, Environmental Science, Biodiversity	Asset management – fences, signs other management measures Liaison with DOC and other adjoining land owners and managers Permit approvals & conditions Catchment Entry Procedure
4.6 Visitors to the WCA's are informed about water conservation and biodiversity values via a range of media and methods such as: a) Educational talks and tours b) Informal interpretation such as signs/ panels, social media, website information and via other media c) Pre-visit website and other information	SLA - Parks Parks Network Plan – in adjoining Kaitoke Regional Park and Wainuiomata Recreation Area.	Catchment Entry Procedure

Maintaining collaborative working relationships with mana whenua and between and within agencies

Outcomes:

- Operational agreements are maintained as current with responsibilities clearly defined
- Land management agencies cooperate to maintain a whole of catchment approach
- Decisions and issues are resolved efficiently and effectively between agencies and within agency departments
- Regular communication about operational issues and changes is maintained between and within agencies (to minimise possible negative impact of changes)

Goal 5. Maintain collaborative working relationships within and between agencies and with others to achieve water quality, supply and biodiversity objectives		
Objectives:	Implementation activity	
	GWRC	WWL
5.1 Important mana whenua relationships are maintained and enhanced by: a) Working with iwi to provide for cultural harvest and collection as required b) Providing opportunities for iwi involvement in conservation and restoration projects c) Interpreting cultural heritage stories where appropriate d) Other activities identified by mana whenua	Ongoing liaison	Ongoing liaison
5.2 Operational service level agreements are maintained and updated every three years or as required if significant issues/ changes occur. a) GWRC and WWL managers maintain the currency of SLAs	SLA's- Biodiversity, Parks, Environmental Science	SLA input and approval
5.3 A collaborative approach is maintained between GWRC and WWL (and where relevant, adjoining land management agencies and owners such as DOC) for actions including: a) Maintain and periodically review service level agreements for management operations b) Undertake an audit, review the relevance and currency, and develop a single register of standard operating procedures, hazard management plans and other protocols relevant to operations in the WCAs c) Develop and maintain operational plans such as Key Native Ecosystem plans for both WCA d) Any changes to this management plan for the water collection areas e) Emergency response to significant events that threaten water quality or supply (Water Supply Incident Management System (IMS) a) Planning, design and installation or removal of water supply infrastructure or significant maintenance activities, b) Development / implementation of asset management plans f) Managing volunteer works within the WCA g) Processing applications for managed and restricted activities within the WCA h) A whole of region approach to aquatic and terrestrial ecosystem threat management and climate change response i) Other whole of regional projects / programmes	Collaboration between agencies Manager meetings	Collaboration between agencies Manager meetings

Goal 5. Maintain collaborative working relationships within and between agencies and with others to achieve water quality, supply and biodiversity objectives		
Objectives:	Implementation activity	
	GWRC	WWL
5.4 Maintain regular schedule of operational meetings and communication between GWRC and WWL for management purposes: **a) Manage the implementation of actions of this plan, as a priority the actions of section 5.3** b) Ensure relevant WCA standard operating procedures and protocols are maintained, current and implemented c) Ensure operational plans address key threats to water quality and supply as part of the 'multiple barrier' approach to minimising the risks	Manager Parks Principal Ranger Eastern Sector Team Leader Terrestrial Ecosystems and Quality Team Leader Hydrology	Chief Advisor Treatment Optimisation, Manager Operations, Manager Treatment Plants, Team Leader Operations
5.5 Maintain a collaborative working relationship with adjoining land owners and managers including the Department of Conservation for activities such as: c) Public information about access and closed areas d) Messages about minimal impact activity practice in the WCA in Renata, Elder and Alpha huts and the Marchant Ridge Track entrance at Marchant Road. e) Environmental science research projects and programmes, collaborative research f) Pest plant and animal management g) Rimutaka Forest Park Trust Kiwi Project activities such as predator trapping h) Education programmes/ resource kits i) Landscape scale projects across agency boundaries j) Integrated planning for climate change	Ongoing project collaboration	Ongoing collaboration

7.2 Decision making responsibilities and agreements

Natural and introduced threats and risks identified in this plan and management activities carried out in the catchments all have the potential to affect water quality and also potentially public health.

The purpose of this section is to clearly identify and document the two management agency roles and responsibilities and document the existing implementation mechanisms. The table below also cross-checks actions with the objectives and actions outlined in this plan.

GWRC provides catchment management services to WWL to ensure that water quality, supply and public access objectives are met. This includes carrying out biodiversity management, aquatic and terrestrial ecosystem health monitoring, and managing public access visits.

Management of water supply assets such as water intakes, weirs, roads and tracks, and planning for new water supply assets are WWL's responsibility.

Management arrangements are facilitated via Service Level Agreements (SLA) and operational work programmes for biodiversity and asset management are delivered via Key Native Ecosystem (KNE) plans and Asset Management Plans (AMP).

It is important that GWRC and WWL collaborate in developing these plans and setting targets within them to ensure that both agencies are in agreement with works carried out in the WCAs which may affect water quality.

Operational management issues and decisions within the scope of works defined by the agreements are made by GWRC officers.

Within GWRC memorandums of understanding also exist between departments such as Parks and Biodiversity to outline the way departments 'work together to achieve good outcomes for indigenous biodiversity'.

The following table identifies key management agency responsibilities and actions, and agency lead and support roles. It is intended to provide clear directions for management, to minimise possible future disagreements between partner agencies, and to reduce the risk of lack of management role clarity contributing to water quality or supply issues. Corresponding plan objectives and actions are identified as a cross-reference.

Table 6. Management responsibilities

Management agency action / responsibility	Reason activity is undertaken	Agency implementation responsibility LEAD/ SUPPORT	Funded by	Implementation mechanism / agreement	WCA Plan objective number
Threat and biodiversity management					
Pest plants and animals are managed to targets set in KNE plans and SLA's: - Pest plant and animal control through use of vertebrate pesticides and herbicides - Minimisation of pest plant incursions - Pest plant and animal monitoring and reporting - Ecosystem health monitoring and reporting - Plan targets are set in liaison with WWL	To achieve optimum water quality and ecosystem health objectives Operational plans are developed collaboratively to ensure management agreement	GWRC Biodiversity, Biosecurity & Environmental Science	WWL GWRC (some pest animal control and monitoring in Wainuiomata Mainland Island)	- KNE Plan development and implementation - Pest Management Strategy operational plan - Biodiversity Service Level Agreement - Environmental Science Service Level Agreement Pest plant and animal contractors - WWL agrichemical register and SOP	1.2, 1.3, 1.4, 2.1, 2.3, 3.1
Water contamination threats from human activity in the WCA's are managed: - Management of visitors to WCAs including volunteers and event or activity permissions - Limiting total visitor numbers (Wainuiomata Orongorongo WCA) - Additional monitoring occurs (if appropriate) when new activities are permitted	Minimise threats to water quality whilst permitting some access	GWRC Parks	WWL	- SLA – Parks - WCA Management Plan - WWL - Fences, signs, public information - Health and safety operating procedures	1.1, 1.2, 1.5, 2.4, 3.1, 4.4, 4.5, 4.6, 5.1. 5.3

Management agency action / responsibility	Reason activity is undertaken	Agency implementation responsibility LEAD/ SUPPORT	Funded by	Implementation mechanism / agreement	WCA Plan objective number
Failure of water supply infrastructure due to natural hazards (seismic event, weather related damage, manmade hazards / vandalism). Response to land slips.	Minimise threats to water supply	WWL	WWL	- Water Supply Incident Management Plan - Water Supply operating procedures - Asset management plan	1.4, 2.3, 2.4, 2.5, 5.2
Management of visitors to WCAs including volunteers for conservation activities, and event or activity permissions Management of research and natural use/ material collection permits	To minimise threats to water quality during management operations	WWL & GWRC Parks, Environmental Science & Biosecurity (equal responsibility)	WWL	- Staff & contractor awareness training/ briefing - Health and safety operating procedures and management system - Permit system for natural use and research permits	1.1, 1.2, 1.5, 2.4, 3.1, 4.4, 4.5, 4.6, 5.1
Asset management					
Water supply asset ownership including roads, bridges, tracks, reservoirs, intakes, signs.	Operational management	WWL (some GWRC eg in Mainland Island tracks)	WWL	Asset Management Plan Water Supply 2014 SLA- Parks	1.4, 2.3, 2.4, 2.5, 5.2
Water supply assets maintenance and renewal upstream of and downstream of intakes eg rain gauges, monitoring equipment	Operational management	WWL	WWL	Asset Management Plan Water Supply	1.4, 2.3, 2.4, 2.5, 5.2
Tracks and marker access and signage infrastructure in the Mainland Island of Wainuiomata used primarily for biodiversity management purposes Markers at monitoring sites used by Environmental Science.	Operational management	GWRC- Biodiversity	WWL (for monitoring sites) GWRC for Mainland Island	SLA – Biodiversity & Environmental Science Asset Management Plans	1.4, 2.3, 2.4, 2.5, 5.2
Heritage assets maintained according to asset management plan, conservation management plans and ICOMOC NZ Charter principles	To maintain and preserve identified heritage assets	WWL	WWL	Asset Management Plans Conservation Management Plans for particular assets	4.3
Liaison with neighbouring land owners re information about public access and minimal impact activity practice	To minimise threats from human activity and access to closed catchment areas	GWRC- Parks, Biodiversity	WWL	Signs, website information, maps SLA Parks and Biodiversity	5.2
The projected impacts of climate change are understood and planned for.	To build resilience into water supply assets and management actions	WWL/ GWRC	WWL	Asset management plans SLA – Biodiversity, Environmental Science	5.3, 5.5
Operations management					
Health and safety of staff, contractors visitors	Compliance with health and safety legislation and standards	WWL & GWRC (equal responsibility)		Risk Management Plans, Service Level Agreements, Standard operating procedures	5.2, 5.3

Management agency action / responsibility	Reason activity is undertaken	Agency implementation responsibility LEAD/ SUPPORT	Funded by	Implementation mechanism / agreement	WCA Plan objective number
Management of visitor access to Wainuiomata/ Orongorongo WCA	To minimise threat to water quality	GWRC & WWL		WCA Management Plan SLAs Standard operating procedures Access and research permit conditions	1.1, 4.4, 4.5
Monitor raw water quality – in particular for e-coli and cryptosporidium and giardia Maintain water safety plans (as required by NZDWS	Compliance with Drinking Water Standards for NZ 2005 (revised 2008) (Part 4 bacterial compliance)	WWL	WWL	Monitoring mechanisms	1.3, 1.7
Continue to update and improve SLA's for operational role clarity and risk management purposes	To clarify 'grey' areas, ensure delivery role clarity and ensure efficient and effective operational management	GWRC/ WWL (equal responsibility)		Interagency negotiation and cooperation to maintain SLA's for Parks, Biodiversity and Environmental Science	5.2
Monitor water levels at intakes Monitor rainfall in catchments	Water supply objectives Data for research and monitoring	GWRC (ESci)		NIWA	5.3
Maintain a single register for agrichemicals used by GWRC and WWL and contractors in the WCA	To minimise threats to water quality	WWL	WWL	Agrichemical register (and Standard Operating Procedure for changes if required)	5.3
Develop innovative work practice utilising new technology – eg monitoring or inspection after natural events with use of drones or UAVs. Publish relevant research and material	To develop more efficient and/or effective business practice	WWL/ GWRC (equal responsibility)		Ongoing operations	3.5, 5.3
The projected impacts of climate change are planned for.	To ensure integrated planning and management	WWL/ GWRC	WWL	Asset management plans SLA – Biodiversity, Environmental Science, Parks (communication)	5.3, 5.5
Planning and policy development					
Development and maintenance of current operational plans for biodiversity management	KNE plans define targets and operational works to be undertaken	GWRC		KNE plans	3.1, 3.3, 5.2
Develop and maintain asset management plans for water supply assets (including roads & tracks)	AMPs define standards and service levels	WWL	WWL	Asset Management Plans	2.4, 2.5, 5.3

Management agency action / responsibility	Reason activity is undertaken	Agency implementation responsibility LEAD/ SUPPORT	Funded by	Implementation mechanism / agreement	WCA Plan objective number
Periodically review and update management and operational plans. Respond to significant changes which effect policy or operational directions	To maintain currency and relevance for operations	GWRC/ WWL (in collaboration)	WWL/GWRC	WCA Management plan Strategic plans for biodiversity and biosecurity GWRC WCA access plans Other operational plans and SOPs	5.3.
Communication / interagency and within agency liaison re water quality, supply & biodiversity					
Community / visitor communication: - Interpretive guided talks/tours - WCA public access details and information/ signage / minimal impact guidance (onsite, website, other media)	To inform visitors about ways to minimise their impacts on water quality	GWRC/ WWL	WWL	- SLA- Parks - Parks ongoing guided walks programme - Parks Summer Events programme - Interpretation and information signs (developed in liaison with GWRC biodiversity)	1.1, 4.5, 4.6, 5.4
Community engagement activities to promote water purity / quality objectives	Water quality objectives	WWL	WWL		4.6, 5.4
Stakeholder liaison: - Adjoining land owners - Territorial Authorities - Stakeholder groups/ volunteers for conservation, recreation - Whaitua committee (when formed)	Collaboration to achieve shared goals	GWRC/ WWL	WWL	SLA's – Parks, Biodiversity & Environmental Science GWRC Environmental Policy – Whaitua process	5.2, 5.4
Advocacy groups for downstream water quality issues	Water quality objectives	WWL / GWRC Flood Management	WWL	Communication between agencies	5.2, 5.4
Collaboration with other agencies to achieve water quality and biodiversity objectives: DOC – visitor management of Southern Crossing (huts, track, MI behaviour messages for water quality), pest animal control operations - To achieve consistency with neighbouring DOC Ecological Management Unit objectives (EMU) - Project Kaka – a major research project in the Hutt Water Collection Area (outcomes of pest animal control using 1080) Ministry of Health – ongoing reporting (WWL)	Water quality objectives Coordination of pest control operations	GWRC WWL	WWL	SLA's – Parks, Environmental Science & Biodiversity Communication between agencies GWRC Environmental Science/DOC collaborative project (Project Kaka)	5.2, 5.4

7.3 Funding water collection area management

Funding the provision of overall drinking water supply services (from the catchment) comes from the water levy paid by ratepayers of Wellington, Lower Hutt, Porirua and Upper Hutt cities to GWRC. GWRC then allocates an annual budget to Wellington Water Limited, a Council Controlled Organisation (CCO). Funding for water supply reticulation to the population comes from individual TA rates which are paid to WWL for these supply services. Overall WWL operations take place from these two budgets.

However, whilst WWL manages many of its operations internally, others are funded by WWL but undertaken by contractors and GWRC departments via formal Service Level Agreements.

Assets and services within the WCAs that have recreation functions (and not purely water supply or water quality management) may be part funded by GWRC Parks and Wellington Water.

Biodiversity management actions that are beyond the levels required for water supply and quality, such as Wainuiomata Mainland island pest animal control are funded by GWRC.

Water supply assets are owned and managed by WWL. The table below provides further information about management activities and responsibilities (which may be subject to change during the term of this plan).

Table 7. WWL/GWRC funding arrangements 2016

Activities funded by WWL	Activities funded by GWRC
Water supply assets	Management and maintenance of Wainuiomata Mainland Island assets and services
Activities identified in the GWRC Parks SLA such as: - minor works on access road maintenance, access and contractor management - catchment road and boundary patrols to secure the Wainuiomata/ Orongorongo WCA - management of visitor access to the WCAs	Management of assets primarily used for recreation purposes
Activities identified in the GWRC Biodiversity Management SLA such as: - pest plant management - pest animal management operations	Intensive pest animal control in the Wainuiomata Mainland Island
Activities identified in the GWRC Environmental Science SLA such as: - ecosystem health monitoring - pest plant and animal monitoring - hydrology monitoring	Monitoring of the outcomes of biodiversity management activities in Wainuiomata Mainland Island
Activities related to monitoring and research completed by the Environmental Science Department	Monitoring and research activities associated with Project Kaka

7.4 Sustainable service provision

GWRC and WWL are committed to the use of renewable energy and reducing carbon emissions wherever possible.In the Wainuiomata WCA power for the water treatment plant is generated from a hydro-electric power plant. This generator saves up to 400 tonnes of carbon emissions a year which would be generated if the power was produced using diesel or electricity form the grid. Surplus power not used in the treatment plant is sent to the local network, with all the power sent to the network when the plant is not operating. Significant other carbon emission savings are made downstream of the water intakes such as improved efficiency of pumps and electric motors.

Caption: hydro power plant which sustainably powers the water treatment plant at Wainuiomata. Interpretation panels provide information for guided tour participants. Photo FC

7.5 Rules for use and development in the water collection areas

The following table identifies activities which are allowed, managed, restricted or prohibited based on potential impacts on core values of water quality, supply and ecosystem health identified in this plan and the permitted activity rules of the Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007.

The rules outlined below address access for recreation, education, research, commercial and other purposes. **The rules exclude management** GWRC and WWL **access and activities or authorised other agency access and activities*.** Activities not specifically identified are considered to be 'managed' and assessed on a case by case basis.

The activity rules also apply to the Macaskill Lakes raw water storage reservoir, downstream of the Hutt WCA because activities for this water supply facility are not defined in the Parks Network Plan for Kaitoke Regional Park. Enforcement of activity rules is supported by the GWRC Parks, Forests and Reserves Bylaw 2009, made under the Local Government Act 2002.

*Management activities include activities such as the use of kiwi aversion trained dogs, overnight stays and use of gas stoves, other agency access to communication or monitoring equipment.

Consenting and management approval process for 'Managed' and 'Restricted' activities

Managed and Restricted activities requiring written permission will be considered on a case by case basis based on any potential adverse impacts on operations, water quality and supply. All applications will be assessed by the GWRC Parks Department in liaison with WWL managers.

Activities must meet the requirements of the Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007 to be considered. Water quality monitoring may be required and undertaken for any activities which have the potential to introduce changes to current water quality or pose a threat of contamination.

The Parks Network Plan 2011 'decision making guidelines' also outline key considerations for decision making. Applications must outline an impact and risk assessment based approach. Information about concessions and permits is provided on the GWRC website: www.gw.govt.nz/concessions-and-permits/

A GWRC permit system is place for anyone who wishes to collect any material and/or carry out research within the water collection areas. Permit applications are assessed in liaison with WWL. There are two types of permit, High and Low Impact. Information about permits is provided on the GWRC website: www.gw.govt.nz/collection-of-natural-materials/

7.5.1 Rules for activities in the Hutt and Wainuiomata/Orongorongo WCAs

Terms:

✔ **Allowed activities** are activities that are generally permitted in the WCAs, but may be subject to restrictions in order to support water quality and supply objectives.

⭘ **Managed activities** are 'permitted' but generally limited by way of a permit, tour booking (with conditions of access), or code of practice or other requirements issued by a GWRC or WWL authorised officer.

➔ **Restricted activities** are those that are not specifically 'permitted' or 'managed' through a permit system, but are not 'prohibited' in this management plan and require a case-by case assessment.

✖ **Prohibited activities** are activities considered to be inappropriate because of their incompatibility with water quality and supply objectives.

Activities not identified here should be considered as restricted and considered on a case by case basis in liaison between WWL and GWRC, with assessments based on risk and impact to water

quality, supply and day to day operations.

Concession applications should include an impact assessment, the scale and nature of which is commensurate with the scale and nature of the proposal or activity, and **must consider the National Environmental Standard for Sources of Human Drinking Water 2009, and Regulations 2007.**

Table 8. Activity rules

Activity category	Hutt WCA	Wainuiomata Orongorongo WCA	Notes
✔ Allowed ⭘ Managed ➔ Restricted ✖ Prohibited			
Access – general public access to WCA	✔*	⭘	Refer 7.5.1 for public access limits for Wainuiomata/ Orongorongo WCA *Except in closed access areas identified on Map 11
Access by vehicle (hunting/ disabled access or other purposes)	⭘	⭘	Permit required
Access to water supply assets including weirs, intakes, treatment or monitoring equipment or water supply operational areas	➔	➔	
Activities that may impact access to, or operations of water supply infrastructure and services	➔	➔	
Activities that may adversely impact natural or cultural values or the recreation enjoyment or safety of other visitors	➔	➔	
Aircraft take-off and landing	✖	✖	Excludes drones/ UAVs. Refer NZ Civil Aviation Authority Rules.
Animals – domestic, including farming and stock grazing (except dogs associated with hunting)	✖	✖	
Camping, wilderness camping, overnight stays	✖	✖	Except Police Search and Rescue operations
Collecting natural materials or animals, collecting for research or cultural purposes, conducting research	⭘	⭘	Permits required
Commercial / educational filming	⭘	⭘	Permits required
Commercial and non-commercial recreation event activities & temporary toilet facilities for events	⭘	⭘	Permits required
Depositing human or animal ashes or body parts	✖	✖	
Depositing rubbish	✖	✖	
Discharges to land	➔	➔	Refer Proposed Natural Resources Plan Rule R92
Dog walking (except dogs associated with hunting- see hunting below)	✔*	✖	On lead at all times *Not permitted in closed access areas.
Erection of dwellings/ structures	✖	✖	
Events	⭘	⭘	Organised events. Permits required
Fires, fireworks	✖	✖	
Fire arms / crossbows (unless associated with hunting permit)	⭘	⭘	
Fishing - declared 'sports fish' species only	✔*	✖	*Except in prohibited access areas. Subject to Conservation Act 1987, Freshwater Fisheries Regulations 1983.
Flying UAVs/ drones for commercial or recreation purposes	✔*	⭘	Refer CAA Rules.* Permit required for commercial activities
Geocaches	✔*	➔	*Except inn closed access areas
Guided tours	⭘	⭘	

Activity category	Hutt WCA	Wainuiomata Orongorongo WCA	Notes
✔ Allowed ⭘ Managed ➔ Restricted ✖ Prohibited			
Guided / managed volunteer activities	⭘	⭘	
Horse riding	✖	✖	
Hunting, hunting dogs (by permit)	⭘	⭘*	Hunting dogs must be registered, maximum 3 dogs per permit holder. *must be kiwi aversion trained
Lease/ licence	➔	➔	
Mining /forestry activities	✖	✖	
Mountain biking/cycling	✔*	⭘	*Only on gravel access road to Hutt Forks.
Motorised or non-motorised water activities including Waka Ama and remotely controlled vehicles on the Macaskill Lakes, Te Marua	✖	✖	
Motorised recreation vehicle activities	⭘	⭘*	*includes Ballot Hunting
Motorised recreation vehicle tours	✖	✖	Vehicles as defined by the Land Transport Act 2008.
Paragliding/ hang gliding take-off and landing	✖	✖	
Picnicking	✔*	⭘	*Except in closed access areas
Police search and rescue	✔	⭘	Refer section 7.5.2 for S&R practice
Scientific/ educational research	⭘	⭘	
Swimming (including Macaskill Lakes)	✖	✖	
Walking, tramping, running, orienteering	✔*	⭘	*except in exclusion areas identified by onsite signs and maps

7.5.2 Managed public access for Wainuiomata/ Orongorongo WCA

Until this plan was developed public access policies and numbers for the Wainuiomata/ Orongorongo WCA were defined in the Wainuiomata/ Orongorongo Water Collection Area Access Plan (2008). However the (approved) Council report associated with the access plan (Report 08.462) included a recommendation for incorporation of access provisions into a future WCA management plan (this plan).

The previously approved (2008) access limits and visitor to guide ratios are considered to remain appropriate for the foreseeable future, but should be reviewed and revised if significant additional demand exists or other circumstances change.

In 2016 the total public visitor number of 1200 people is still considered to be adequate with maximum group size numbers rarely reached. In 2015-16 the average walking group size was 15-20 people, occurring once a month between November and May, and tramping group size 10-15 people (occurring 4-5 times per year). Only two school group trips took place and one mountain bike tours. Total guided walk numbers in 2015 were 172, significantly less than the peak annual number of 591 in 2008 when the access plan was adopted by Council. The decline is attributed to many local visitors having already visited the WCA.

Operational access provisions such as health and safety, site induction and biosecurity obligations for people entering the WCA which were defined in the 2008 Access Plan are now incorporated into access permit conditions, and can be included in future revisions of Service Level Agreements

between GWRC Parks, Biodiversity and Environmental Science and WWL which address operational matters.

Detailed access requirements for visitors outlined in the Access Plan 2008 will be incorporated into standard operating procedure (SOP) and access permit conditions for visitors as they are updated. The service level agreement for GWRC Parks identifies responsibilities for management of overall

visitor numbers. Provisions outlined in the access plan such as allowing rangers to determine dates, numbers and routes for all public tours remain, as well as reviewing the hunting ballot system based on presence of animal pests.

To protect water quality and public health, all visitors must continue to adhere to the same entry criteria into the catchment, including the requirement to undertake a site induction, be informed of catchment values and safety issues, and be made aware of and adhere to the biosecurity policies of the water collection area.

Requests may be made from time to time for access variations to the provisions outlined in the table below, and will be assessed on a case by case basis by GWRC or WWL with special conditions applied as required.

Table 9. Wainuiomata/ Orongorongo WCA Access

Access type	**Maximum number per year / guiding* ratio.**	**Access conditions / notes** *Guides may be GWRC rangers or inducted volunteers.
Total public visitors per year	1200 people	All vehicles entering the WCA to have clean chassis and wheels.
Walking tours - Wainuiomata catchment only	Maximum group size 60 Guide to participant ratio 1:15	Visitors must adhere to permit conditions and be informed of catchment values, safety issues and made aware of and adhere to biosecurity policies and standard operating procedures.
Tramping tours – Wainuiomata catchment (and Mainland Island)	Maximum group size 30 Guide to participant ratio 1:15	Participants must be a member of a walking or tramping club. Access conditions as above.
Tramping tours – Orongorongo catchment (remote area, limited phone coverage).	Maximum group size 30 Guide to participant ratio 1:5	Participants must be a member of a walking or tramping club. Access conditions as above.
Bicycle tours	Maximum group size 60 Guide to participant ratio 1:15	Only bicycles and mobility scooters as defined by the Land Transport Act 2008. Access conditions as per walking tours above.
Conference field trips	Maximum group size 100 Guiding ratio 1:15 Any number per year within maximum limit above.	Access permitted only between the treatment plant and water intakes (not above the intakes). Access conditions as per walking tours above.
Education and special interest groups – *Wainuiomata catchment* (and Mainland Island)	Maximum total group size 100 Guiding ratio of 1:15 (adult/ students up to age of 15). Any number of tours per year within maximum limit above.	Access permitted only between the treatment plant and water intakes (not above the intakes). Access conditions as per walking tours above.

Education and special interest groups – *Orongorongo catchmen*t (remote area, limited phone coverage).	Maximum total group size 30 Guiding ratio of 1:5 (adult/ students up to age of 15) Any number of tours per year within maximum limit above.	Access conditions as per walking and tramping tours above.
Access dates, times, numbers, routes and meeting arrangements for all tours and permit conditions	Determined by Parks Ranger (within maximum limits above)	Also subject to permit conditions which incorporate the provisions of the Access Plan 2008.
Police Search and Rescue Exercises	Up to three exercises per year	Subject to permit conditions including overnight visit provisions.
Hunting ballot permits	Maximum 2 in each of the 10 hunting blocks at any time. Not included in the overall maximum visitor number.	Hunting permits and season reviewed annually by GWRC Parks & Biodiversity based on the presence of pest animals in the WCA. Hunting permit conditions apply.
Conservation volunteers accessing Wainuiomata Mainland Island	Not included in overall maximum visitor number.	Access conditions defined by GWRC Parks or Biodiversity. Subject to access conditions.
Research and collection of natural material permit holders	Not included in overall maximum visitor number.	Access and research work conditions defined in permit conditions. Research permits are restricted to *bona fide* organisations and made on a case by case basis considering a range of criteria by GWRC & WWL.
Concessions	Not included in overall maximum visitor number.	Subject to general GWRC parks and reserves concession processes.

Caption: Visitors enjoying the old growth forest on a guided walking tour in Wainuiomata catchment 2016

7.5.3 Public access to the Hutt WCA

Public access, with some restrictions, is permitted in all areas except the area outlined on Map 13 and WWL water supply assets.

An access plan for the Hutt WCA was published in 1997. The Hutt Water Collection Access Operational Plan 1997 was developed when the decision was made to open general public access to the WCA (after being closed since the 1950's), as a result focuses on management of risks and a range of detailed actions required to 'open' the catchment. The plan foresaw 'strong interest in hunting' (1997:17) but this has not occurred.

The access plan defined an area where public access is not permitted which is identified in this plan on Map 13; from the water intake at Kaitoke weir, upstream through the gorge almost as far as Kaitoke Forks. This area remains closed to public access to protect water quality immediately upstream of the water intake. Other policies which remain current have been carried forward into this plan, in particular in actions of the Management Framework and the Rules for Activities.

Caption: Hutt Water Collection Area access road via Kaitoke Regional Park (photo FC)

8. Plan implementation and review

This plan provides policy directions for the water collection areas for WWL and GWRC. It should be reviewed periodically to ensure it meets changing circumstances and remains responsive to GWRC and WWL needs, and done so in a collaborative manner with agreement between agencies, and with input from relevant stakeholders.

The threats to water quality and supply identified in section 6 are largely based on those identified in the Water Safety Plans (WSP) required by the Drinking Water Standard New Zealand 2005 (revised 2008). Water Safety Plans are reviewed periodically (identified in the WSPs as being every five years) or if significant changes occur. This plan should be updated if the identified threats to water quality and supply related to the water catchments change significantly.

Whilst this plan is intended to function primarily as a strategic policy document, section 7.5 'Rules for use and development in the water collection areas' provides guidance for day to day decision making about permitted activities. Operational plans such as Key Native Ecosystem plans, service level agreements, standard operating procedures and other protocols guide annual and periodic work deliver programmes are reviewed and updated on a regular basis. Significant changes to these plans may result in the need to update policy directions identified in this plan, such as changes to target measures.

APPENDICES

Appendix 1. Legal description of land

Hutt Water Collection Area property parcels

Lot DP 1820

Lots 2 and 3 DP 26031

Section 24 Pakuratahi Dist BLK XVI ASD

Section 953 HSD, Sections 4 and 5 Blk XI, Sections 8 and 9 BLK VII, Lot 2 DP 1820. Lot 2 DP 615

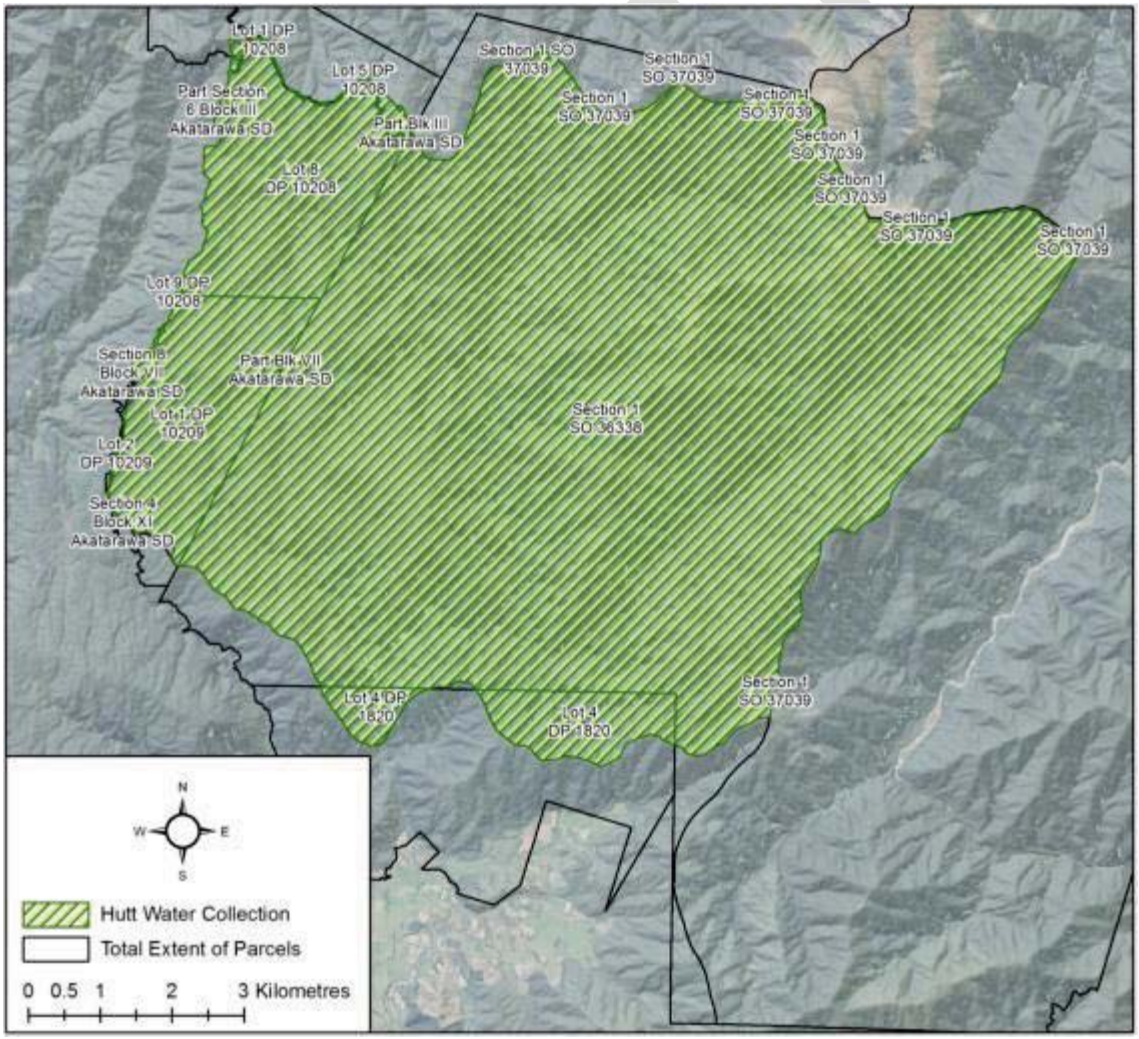
Pt Sections 3, 6 and 12 Blk iii ASD, Pt sections 2,3 and 4 Blk vii ASD, Lots 1-6, 8 and 9 DP 10209

Pt Section 1 Blk ll ASD, Pt sections 5, 6 and 7 Blk vii ASD, Lots 1 and 2 DP 10208

Section 4 DP 1820, Blks xii and XVI ASD, and pt old riverbed

Sections 1 and 2 SO 36338

Section 1 SO 36768



Wainuiomata/Orongorongo WCA property parcels

Part Sections 26,34 and 67, and part Sections 68 and 69 Block XVII Belmont Survey District, and Part Section 94 Wainuiomata District

Sections 36, 37, 38, 72 and 73, and pt Section 35 Wainuiomata Survey District Blocks XV AND xvii Belmont Survey District

Section 5 Block XV Belmont Survey District & Block VIII Rimutaka Survey District

Part section 93 Wainuiomata Survey District

Part Section 4 Block XV Belmont Survey District

Part section 104 Wainuiomata Survey District

Part Section 7 Block VIII Rimutaka Survey District, and Section and Block XV Belmont Survey District, DP 983

Lot 1 DP 3864, block VIII Rimutaka Survey District

Lot 4 DP 3864, block V Rimutaka Survey District

Part Sections 34, 35 & 67 Wainuiomata Survey District

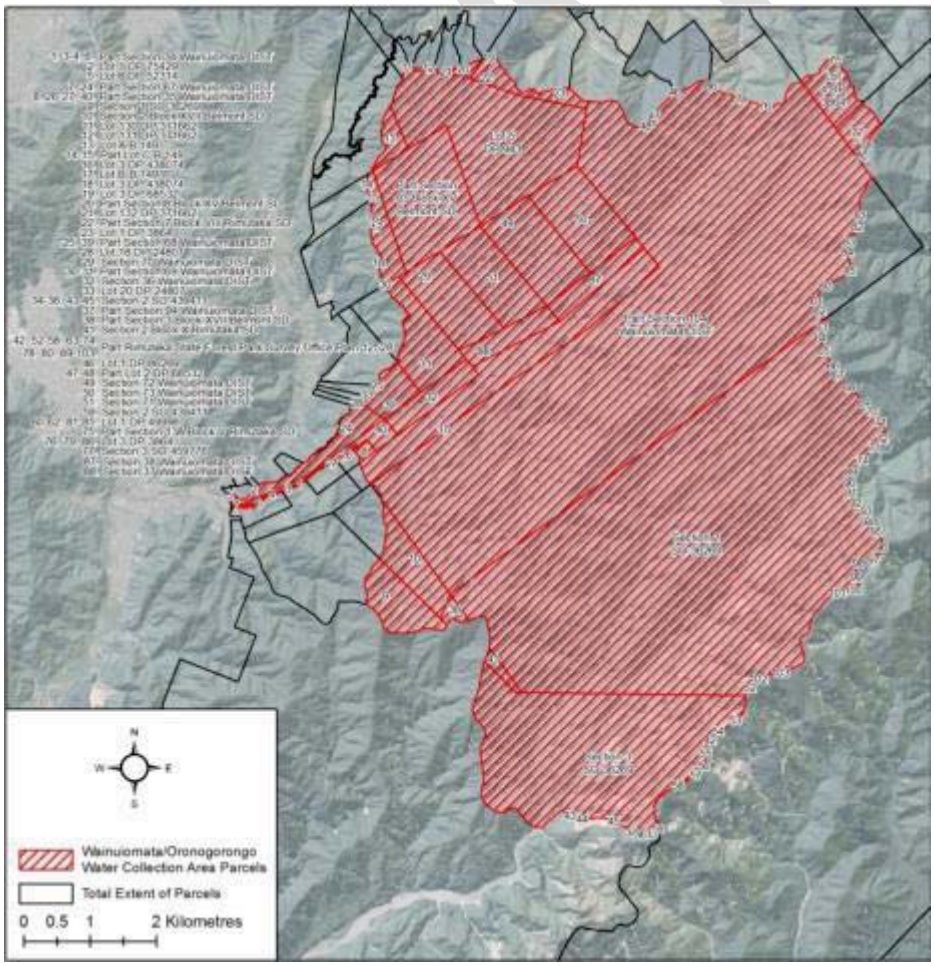
Part 70 & 71 & Part Section 93 Wainuiomata District
Section 1 SO 36269

Section 3 SO 36269

Section 2 SO 36269

Part Section 94 Blocks XV and XVII Belmont Survey District

Sections 2 and 3 Blocks XVII Belmont Survey District and Section 2 Block X Rimutaka Survey District
Part Section 74 and Parts Section 34 Wainuiomata District



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Appendix 3. Definitions

Aesthetic determinand – A constituent or property of the water that can adversely affect the water's taste, odour, colour, clarity or general appearance, including substances such as manganese and iron compounds that can stain washing and utensils. (NZDWS 2008)

Algaecides/ algicides - any chemical added to water which is toxic to and kills algae and/or cyanobacteria (blue–green algae).

Agrichemical - any substance, whether inorganic or organic, human-made or naturally occurring, modified or in its original state, that is used in agriculture, horticulture or related activity to eradicate, modify or control flora and fauna. It excludes fertilisers, vertebrate pest control products, ethylene dibromide, ethylene oxide, methyl bromide, hydrogen cyanide, phosphine or chloropicrin and oral nutrition compounds.

Artificial destratification – Artificial destratification involves increasing the circulation of water that circulates between the shallower and deeper layers of the reservoir. This can be achieved by introducing a plume of bubbles near the bottom of the reservoir or installing a propeller or impeller in or near the dam wall. A circulation pattern is set up that reduces the differences in temperature, oxygen and nutrients between the top and the bottom waters. www.water.nsw.gov.au/water-management/water-quality/algal-information/prevention-and-control

Aquatic ecosystem health - the degree to which an aquatic ecosystem is able to sustain its ecological structure, processes, functions, and resilience within its range of natural variability

Biodiversity- the variety of all living things on land, in water and the sea. Biodiversity is crucial for the functioning of ecosystems that provide us with products and services that we could not live without.

Eutrophication - The process of nutrient enrichment in a waterway. The main nutrients contributing to eutrophication are phosphorus and nitrogen.

Protected catchment – controlled access which may include full or partial public access exclusions

***Cryptosporidium* -** A member of the protozoa family. During its complex life cycle, thick- walled oocysts are formed that are 4–6 µm in diameter. The oocysts are excreted in faeces and are the infectious form of the organism. C. parvum is the species responsible for most human infection. Cryptosporidium generally causes self-limiting diarrhoea, which may include nausea, vomiting and fever. In immunocompromised people, infection can be life-threatening. NZ Drinking Water Standard 2008.

Controlled water collection area - public access permitted but limited by activity and/ or conditions

Closed water collection area - areas where no public access is permitted

***Giardia* -** A flagelated member of the **protozoa** family. *Giardia* infects the gastrointestinal tract of humans and certain animals. **Cysts** are the infectious form of the organism excreted by the host; they are ovoid in shape, 8–12 µm. *G. intestinalis (lamblia)* is the species usually responsible for human infection. *Giardia* causes abdominal cramps and diarrhoea, which is self-limiting in most cases. NZ Drinking Water Standard 2008.

Non-local native species – native to New Zealand but not the (Wellington) Ecological District

MAVs - Water quality standards define the maximum concentrations of contaminants acceptable in safe drinking water. This is done in the form of maximum acceptable values (MAVs), which apply to treated water only. A MAV is the maximum concentration of a contaminant (microbes or chemicals) in drinking water that will not make consumers ill. MAVs provide a yardstick by which the safety of drinking water can be judged. Water is safe to drink if none of the contaminants it contains exceed their MAVs. (NZDWS 2007)

Oocyst - A thick-walled structure within which *Cryptosporidium* zygotes develop and that serves to transfer the organism to new hosts. NZ Drinking Water Standard 2008.

Protozoa - Free-living, aquatic, unicellular animals, larger and more complex than bacteria, and can be differentiated into 4 general types: ciliates, flagellates, sporozoans and amoebae. The Priority 1 protozoa are *Giardia* and *Cryptosporidium*, NZ Drinking Water Standard 2008.

Raw water – water intended for drinking that is after the abstraction point but has not yet received treatment to make it suitable for drinking (NZ Drinking Water Standards definition).

Turbidity - muddiness of water, caused by the presence of suspended sediments and organic matter in the water column that causes loss of clarity by scattering light. For the Drinking-water Standards for New Zealand (DWSNZ), turbidity is measured by nephelometry (measure of water clarity).

Waka ama - outrigger canoe.

Water quality – a water body with healthy physical, chemical and biological characteristics

Water Operational Area – water intakes and treatment plant areas

Water sensitive urban design - the integration of planning, engineering design and water management to mimic or restore or manage natural hydrological processes Water sensitive urban design manages stormwater at its source to control runoff and water quality. The terms low impact design, low impact urban design and water sensitive design are often used synonymously with water sensitive urban design.

Water stratification - A water body becomes thermally stratified when two distinct temperature layers form. During spring the sun will warm the surface layers of water. They become less dense, but will be mixed with cooler 'bottom' water by wave action. As heating continues, the wave action will become less able to drive the mixing. When mixing ceases, the warmer surface water will lie over cooler, dense bottom waters. During autumn this process is reversed, and the water body will 'turn over'. www.water.nsw.gov.au/water-management/water-quality/algal-information/prevention-and-control

Whaitua - a traditional term for a designated area or space which may be a catchment or sub-catchment managed as an integrated system.

Appendix 4. River flow rates and extraction availability between 2005 and 2015

Year	Total days of river extraction available - Orongorongo	Average available flow rate-Orongo.	Minimum of available flow rate-Orongo.	Number of days the available abstraction below the 5th percentile-Orongo
2005	303	51.1	1.9	16
2006	156	59.1	2.2	8
2007	356	56.5	2.2	18
2008	364	97.0	1.2	19
2009	365	87.6	1.9	19
2010	365	87.9	1.0	19
2011	365	60.0	0.2	14
2012	366	50.2	0.2	18
2013	363	70.0	0.2	19
2014	364	56.2	0.7	19
2015	291	66.2	-2.8	15
	Total days of River extraction avail-Wainuiomata	**Average available flow rate-Wainui.**	**Minimum of available flow rate-Wainui.**	**Number of Days the available abstraction below the 5th percentile-Wainui.**
2005	364	30.4	1.0	19
2006	362	70.7	1.1	19
2007	365	27.1	2.1	18
2008	366	56.2	0.8	19
2009	365	55.2	1.8	19
2010	364	65.3	1.2	19
2011	365	29.9	0.2	19
2012	366	35.2	0.1	19
2013	365	52.0	-0.5	19
2014	365	27.7	-4.3	19
2015	291	31.0	0.1	15
	Total of days the river had been available - Kaitoke Catchment	**Average of available flow rate-Kaitoke Catchment**	**Minimum of available flow rate-Kaitoke Catchment**	**Number of days the available abstraction below the 5th percentile-Kaitoke Catchment**
2005	364	181.8	-0.8	18
2006	356	362.6	0.2	18
2007	365	175.9	0.5	6
2008	366	299.1	-7.8	15
2009	351	201.6	-0.8	20
2010	358	338.4	-25.8	11
2011	365	261.9	-20.4	19
2012	362	242.2	-3.5	20
2013	365	388.5	-17.9	19
2014	365	430.2	1.3	19
2015	365	569.5	2.8	19

Appendix 5 River turbidity and UV254 rates

Year	Average Kaitoke Scan UV254	Number of available days-Kaitoke Scan UV254	Number of Days in the 95th Percentile-Kaitoke Scan UV254
2011	6.36	364	345
2012	7.02	365	345
2013	5.25	365	346
2014	5.53	365	346
2015	4.97	365	346
	Average of Orongo UV254	**Number of available days-Orongo UV254**	**Number of days in the 95th percentile-Orongo UV254**
2011	12.14	148	140
2012	12.32	363	344
2013	9.00	307	291
2014	9.26	349	331
2015	7.19	292	277
	Average of Wainui Intake UV255	**Number of available days-Wainui Intake UV254**	**Number of days in the 95th Percentile-Wainui Intake UV254**
2011	6.10	74	70
2012	7.01	264	250
2013	6.51	304	288
2014	6.20	363	344
2015	5.88	222	210
Average days per year turbidity is at full scale			
	Kaitoke River	**Wainuiomata Intake**	**Wainuiomata/ Orongorongo**
2011	2.13	2.73	2.73
2012	4.52	2.66	3.44
2013	5.62	3.06	4.68
2014	6.10	1.86	3.88
2015	6.17	2.25	1.78