



Waiohine River instream values and minimum flow assessment

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Waiohine River instream values and minimum flow assessment

Laura Keenan

Environmental Monitoring and Investigations Department

FOR FURTHER INFORMATION

Greater Wellington
Regional Council
Wellington
PO Box 11646

T 04 384 5708
F 04 385 6960
www.gw.govt.nz

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Executive summary

This report investigates flow requirements for sustaining key 'instream' values of the Waiohine River, in order to review the appropriateness of the current minimum flow for the river specified in Greater Wellington Regional Council's Regional Freshwater Plan.

The Waiohine River is one of the main tributaries of the Ruamahanga River, and has important ecological, cultural and economic values. As well as providing water for the towns of Greytown and Featherston, the Moroa Water Race and other abstractive uses such as irrigation, the Waiohine River is highly-used for recreational activities such as swimming and angling. The river supports a wide range of fish species, provides regionally significant trout habitat, and holds many important values for Maori – particularly relating to mauri, waahi tapu and mahinga kai. Despite the high baseflow nature of the Waiohine River, these values could be threatened at times by low flows that may be exacerbated by water abstraction.

Scientific investigations were carried out to determine a minimum flow for the river that will achieve two instream flow objectives relating to ecological values: maintenance of habitat (in particular, of trout), and maintenance of passage for migratory fish. Instream habitat modelling and hydrological analysis predicts that a flow of 2,765 L/s at Waiohine Gorge is required to protect fish habitat in the Waiohine River as a whole, by ensuring no more than 10% habitat loss compared to the habitat available during mean annual low flow conditions. Predictions of fish passage in the Waiohine River suggest that, at this minimum flow, the passage of fish will not be adversely affected. Furthermore, implementation of this minimum flow should not increase the risk of the minimum flow for the lower Ruamahanga River being compromised.

The current minimum flow for the Waiohine River in the Regional Freshwater Plan is 2,300 L/s at Waiohine Gorge. Increasing the minimum flow to 2,765 L/s will result in restrictions on consented abstractions being required more often than is currently the case. The change to the security of supply of existing abstractors will depend on how 'essential-use' abstractions are assessed in the future, and whether or not the core allocation is increased.

It is recommended that consideration is given to:

- Increasing the minimum flow for the Waiohine River from 2,300 L/s to 2,765 L/s; and
- Reviewing the flow at which consented takes are restricted or prohibited, to ensure that the minimum flow of the Waiohine River is protected.

Additional recommendations are made relating to the core allocation, and reviewing the flow required for supplementary allocation.

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1. Introduction

This report investigates flow requirements for sustaining key 'instream' values of the Waiohine River. Instream values are the values relating to a river or stream's environment, and include ecological, recreational and Maori cultural values.

The Waiohine River is one of the main tributaries of the Ruamahanga River, and has important ecological, cultural and economic values. As well as providing water for the towns of Greytown and Featherston and for the Moroa Water Race, the Waiohine River is highly-used for recreational activities such as swimming and angling. The river also supports a wide range of fish species and is regionally significant for its trout habitat.

The Waiohine River is under pressure from water abstraction, with the core allocation specified in Greater Wellington's Regional Freshwater Plan (RFP) (1999) nearly fully utilised. The RFP also specifies minimum flow policies for the river, which require water abstraction to cease or reduce during times of low flow. The policies relate back to a Waiohine River water resources plan that is nearly 30 years old (Wairarapa Catchment Board 1980).

A review of the RFP is commencing in 2009/10. This will include a review and update of the policies relating to water allocation and minimum flows for many rivers and streams in the Wellington region. Knowledge of the instream values of the Waiohine River, and flow requirements for protecting those values, is important for checking the appropriateness of the existing water allocation and minimum flow policies for the river. The information gathered for this report will therefore be taken into consideration when a new RFP is proposed.

The report contains:

- A background description of the Waiohine River's characteristics;
- Information on consented water abstraction from the river;
- An assessment of the river's instream values;
- An assessment of minimum flow requirements to achieve objectives that relate to the key instream values (known as an 'instream flow assessment'); and
- Recommendations relating to the river's water allocation and minimum flow policies to be considered in the upcoming review of the RFP.

2. Characteristics of the Waiohine River and its catchment

The Waiohine River has a catchment of 378 km² originating at the drainage divide of the Tararua Range, south of Mt Arete. About half of the Waiohine catchment is mountain catchment. The river travels for about 24 km through Tararua Forest Park before emerging onto the Wairarapa plains from the Waiohine Gorge. It flows for a further 20 km to its confluence with the Ruamahanga River, 5 km east of Greytown (Figure 2.1).

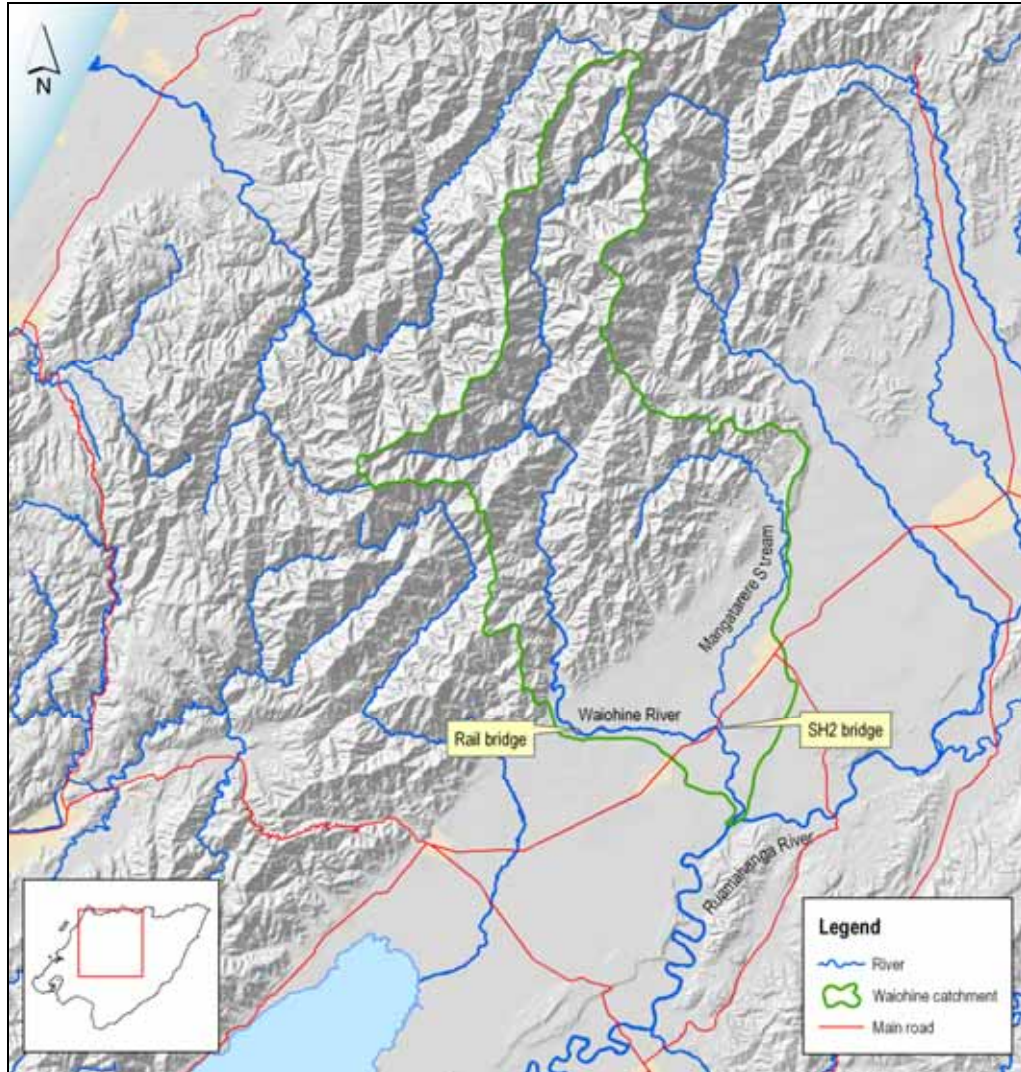


Figure 2.1: The Waiohine River and one of its tributaries, Mangatarere Stream

Upstream of its confluence the Waiohine River is joined by a major tributary, the Mangatarere Stream. The Mangatarere Stream has a catchment of 90 km² (about 24% of the Waiohine catchment area) located in the foothills of the Tararua Range. A second major tributary, Muhunua Stream, joins the Waiohine River a short distance downstream of the Mangatarere Stream confluence. This is a spring-fed stream originating east of Greytown and does not have a significant catchment area.

2.1 Land use and vegetation cover

A large proportion (about 50%) of the Waiohine catchment is within the Tararua Forest Park, and is predominantly covered in indigenous podocarp / broadleaf forest. Low altitude podocarp forests of rimu and red beech occur on river terraces and lower valley slopes, with kamahi as the dominant sub-canopy species. In the steep mid to high altitudes a complex mixture of red beech, silver beech and kamahi grows in association with sub-canopy totara, toro and broadleaf. The treeline is at approximately 1,250 m. At the highest altitudes of the catchment (over 1,400 m), sub-alpine scrub gives way to true sub-alpine tussock grassland (Heslop 1993).

The pre-European vegetation on the plain consisted of fern, sedge and scrublands, broken by clearing and isolated stands of matai, totara, tawa and kahikatea. Maori modified this lowland vegetation through burning (Heslop 1993). Today the vegetation of the Waiohine River plain is generally pasture with only a few remaining stands of native bush. The land use is largely dairy farming with some sheep and beef farming interspersed, and in the foothills there is some cattle grazing and exotic forestry.

2.2 Channel morphology

On leaving the Tararua Range at the gorge, the Waiohine River has a single thread channel form with alternating gravel beaches that are exposed during low flows. The river is confined by high river terraces. The river gradually widens to a semi-braided form. Downstream of the rail bridge (see Figure 2.1) the river terraces are lower or absent, meaning that the river is able to widen considerably (Figure 2.2). However, downstream of State Highway 2 (SH2) the river has a narrower single channel form with pronounced gravel beaches. The unusual and sudden change in channel form is due to a combination of factors, including a reduction in gradient and reduced gravel load (Heslop 1993).

The Waiohine River is disrupted in places due to fault movements. The faults influence the flow losses and gains, as outlined in Section 2.3.

2.3 Climate and hydrology

Rainfall in the Waiohine catchment is strongly influenced by the Tararua Range. Mean annual rainfall varies from about 800 mm around Greytown, to 2,000 mm in the Tararua foothills and up to 8,000 mm in parts of the Tararua Range.

Greater Wellington monitors flow at the site 'Waiohine River at Gorge', a short distance upstream from where the river emerges onto the plains. The flow monitoring site has been rated for low flows since 1975, although the audited data record begins in 1979. Due to having its headwaters deep in the Tararua Range, the Waiohine River is generally not subject to extreme low flows. Its 7-day mean annual low flow (MALF) of 3,570 L/s (Table 2.1) equates to a specific flow of 19.8 L/s/km², which is the highest specific MALF of all monitored rivers in the Wellington region (Harkness 1998). The river falls into

the ‘high baseflow’ category of Beca (2008); i.e., MALF is more than 1/20th of the mean flow and occurs, on average, less than 3% of the time.



Figure 2.2: Waiohine River downstream of the rail bridge (top photo) and downstream of the SH2 bridge (bottom photo)

Table 2.1: Low flow statistics for Waiohine River at Gorge, 1979-2009

	1-day MALF (L/s)	7-day MALF (L/s)
Mean annual low flow	3,050	3,570
5-year return period low flow	2,490	2,940
10-year return period low flow	2,260	2,740

Concurrent flow gaugings have been carried out to assess flow losses and gains along the length of the river. The gaugings indicate that downstream of emerging onto the plains the river loses water to the groundwater system. During times of low flow, the loss appears to be in the order of 15-25% of the flow between the rail bridge and the SH2 bridge. Immediately downstream of SH2 the river gains flow from the Mangatarere Stream (estimated to be about 400 L/s during mean annual low flow conditions) and the spring-fed Muhunoa Stream (estimated to be about 550 L/s during mean annual low flow conditions). Downstream of the Muhunoa Stream confluence the Waiohine River gains more flow from groundwater, although this is probably only a 5-10% increase during times of low flow.

It is difficult to estimate mean annual low flow statistics of various reaches of the Waiohine River due to the lack of gaugings at a range of flows and because some of the flow measurements in Greater Wellington's database have not taken into account the abstractions from the river. However, in an attempt to estimate low flows at other locations in the river, a basic model was set up to account for the flow losses and gains, by assuming the concurrent flow gaugings carried out in February 2006 and 2007 were representative of typical low flow behaviour of the river. The resulting estimates of the naturalised MALF (i.e. with no abstraction from the river) are shown in Table 2.2, for the locations marked in Figure 2.3.

Table 2.2: Estimated mean annual low flows of the Waiohine River

River reach	Location	Estimated 1-day MALF (L/s)	Estimated 7-day MALF (L/s)
Upper	Gorge	3,050	3,570
Middle	Railway Bridge	2,590	3,035
	Matarawa	2,200	2,570
	State Highway 2	1,950	2,275
Lower	Immediately downstream of Mangatarere Stream confluence	2,350	2,675
	Immediately downstream of Muhunoa Stream confluence	2,900	3,225
	Immediately upstream of Ruamahanga River confluence	3,190	3,550



Figure 2.3: Locations on the Waiohine River for which low flow statistics have been estimated in Table 2.2

2.4 Water quality

Information on water quality in the Waiohine River is important for determining the condition and significance of instream values. Greater Wellington monitors water quality as part of the Rivers State of Environment monitoring programme at two locations on the Waiohine River: at the gorge, and at ‘Bicknells’ in the lower reach of the river (a short distance upstream of the Ruamahanga River confluence). Other locations within the catchment – on the Mangatarere Stream and Beef Creek – are also included in the monitoring programme. The sites are sampled on a monthly basis for a variety of physico-chemical and microbiological variables, and biological monitoring (of periphyton and macroinvertebrates) is carried out annually.

A water quality index (WQI) is used to facilitate inter-site comparisons of water quality in the region’s rivers and streams. The WQI, as outlined by Perrie (2007a), is derived by comparing the median results of six variables with guidelines: dissolved oxygen, clarity, *E. coli*, nitrite-nitrate nitrogen, ammoniacal nitrogen, and dissolved reactive phosphorus (DRP). Application of the WQI to the Waiohine River monitoring results, for the period 2003-2006, found that the site Waiohine River at Gorge has a grade of ‘excellent’ water quality, and Waiohine River at Bicknells has ‘good’ water quality (Perrie 2007a). The average Macroinvertebrate Community Index (MCI) results for 2003-2006 were in agreement with the WQI (Table 2.3). The same grades were also assigned to the more recent monitoring results of 2007/08 (Perrie 2008)¹.

¹ However, for 2008/09 the site was assigned a WQI of ‘fair’ due to non-compliance with guidelines for clarity (Perrie 2009, in press)

Table 2.3: Waiohine River water quality index (WQI) grades and Macroinvertebrate Community Index (MCI) classification, 2003-2006

Site	Guideline compliance (median values)						Overall WQI grade	MCI classification
	DO	Clarity	<i>E.coli</i>	NNN	Amm N	DRP		
Waiohine at Gorge	✓	✓	✓	✓	✓	✓	Excellent	Excellent
Waiohine at Bicknells	✓	✓	✓	✓	✓	✗	Good	Good

The excellent water quality in the upper reaches of the Waiohine River – reflected in both the WQI grading and the MCI results – is a result of the largely unmodified upper catchment, with the land cover being predominantly indigenous vegetation. The lower WQI grading of ‘good’ at the site Waiohine River at Bicknells is due to a median DRP concentration above the ANZECC (2000) trigger value for lowland waters (0.01 mg/L). Although monitoring has shown the Waiohine River generally complies with guidelines for maximum periphyton cover, on one occasion in the last five years the cover of filamentous algae at the Bicknells site has exceeded the MfE (2000) guideline for protecting recreational and aesthetic value (Perrie 2007b). The occasional tendency for nuisance periphyton growth in the lower reach of the river could be linked to the ‘elevated’ DRP concentrations.

The slight decrease in water quality over the length of the Waiohine River is a result of the agricultural and, to a less extent, urban land use on the Wairarapa plains. In addition, the inflow from the Mangatarere Stream will influence water quality in the lower reach of the Waiohine River. The Mangatarere Stream at SH2 (near its confluence with the Waiohine River) has a WQI grading of ‘poor’ (Perrie 2007a). The stream’s catchment has a high proportion of agricultural land use (including dairy farming), and water quality has been degraded by the point-source and diffuse discharges² it receives. Greater Wellington is currently investigating sources of contaminants in the Mangatarere Stream catchment (Milne & Tidswell, in press)

Greater Wellington monitoring data suggests that the Waiohine River has considerably better water quality than the Ruamahanga River at the point where the two rivers meet: the monitoring site Ruamahanga River at Gladstone was assigned a WQI of ‘fair’ due to non-compliance with water clarity guidelines and exceedance of nitrite-nitrate nitrogen and ammoniacal nitrogen trigger values (Perrie 2007a). The difference in water quality of the two rivers is due to the Waiohine River having a higher proportion of pristine catchment, and therefore less influence from agricultural and municipal discharges.

² Effluent from the Carterton wastewater treatment plant and from a large piggery is discharged to land in the Mangatarere catchment, with the wastewater effluent discharge directly to the stream for considerable periods of the year.

3. Water abstraction from the Waiohine River

3.1 Water allocation and minimum flow policies

The RFP, which became operative in 1999, specifies the following water allocation and minimum flow policies for the Waiohine River:

- ‘Core allocation’ (the amount of water to be taken below a flow of 4,000 L/s) shall not exceed 740 L/s;
- When river flow drops to 3,040 L/s, abstraction will reduce to 500 L/s;
- The minimum flow is 2,300 L/s.

These policies were based on an earlier water resources management plan for the Waiohine River (Wairarapa Catchment Board 1980). The core allocation of 740 L/s was equal to the estimated take for the Moroa Water Race, as this was the main abstraction from the river³. Since that time, additional resource consents for irrigation and industrial takes have been granted, because the maximum consented take for the Moroa Water Race and public water supply combined is now 630 L/s at flows below 4,000 L/s. The limit above which the core allocation may be exceeded (4,000 L/s) appears to have been set arbitrarily.

The 1980 water resources management plan suggested a minimum flow of 2,300 L/s for protection of aquatic life and recreational values. At that time there were limited low flow data available for the Waiohine River, and so the flow of 2,300 L/s was derived based on a correlation with the Ruamahanga River (Wairarapa Catchment Board 1980).

A restriction level was set at 3,040 L/s (equal to the minimum flow plus the water race allocation), below which the maximum abstraction for the Moroa Water Race had to reduce to 500 L/s. Because this was deemed to be an essential use, there was no absolute minimum flow at which consented takes must cease. These policies were carried over to the RFP, although they are applied so that below 3,040 L/s only ‘essential-use’ takes (for the Moroa Water Race and Greytown and Featherston public water supply) may operate.

Under the RFP, water allocations from the Waiohine River’s main tributary, Mangatarere Stream, are specified separately to those for the Waiohine River. Similarly, the Mangatarere Stream has its own minimum flow policies which are not being assessed as part of this investigation.

3.2 Current water allocation

There are eight resource consents for abstraction of water from the Waiohine River, totalling 780 L/s (Table 3.1). Of this, 730 L/s is considered to be from core allocation (permit WAR010200 includes 50 L/s to be taken as

³ Water supply for Greytown was taken from Bassett’s Creek, a small tributary of the Waiohine River, and was supplemented by flow from the Moroa Water Race during times of low flow. Hence the maximum take for the Moroa Water Race included some take for Greytown public water supply. At that time Featherston’s public water supply came from another source.

‘supplementary allocation’, when river flow exceeds 4,000 L/s). The core allocation in the RFP is 740 L/s and hence there is only 10 L/s remaining.

Table 3.1: Details of resource consents for taking water from the Waiohine River

Consent	Consent holder	Rate (L/s)	Comments
WAR010200	South Wairarapa District Council	500	Moroa water race
WAR990142	South Wairarapa District Council	180	Public water supply
WAR980212	Berthold	2.5	From a small tributary
WAR010164	Bell	24	
WAR010173	Craig	12	
WAR010065	Wairarapa Aggregates Ltd	15	
WAR050045	Engel	46	

About 85% of the water allocated from core allocation is to South Wairarapa District Council, for the Moroa Water Race and public water supply for Greytown and Featherston. The intake for these abstractions is located a short distance downstream of where the river emerges onto the plains. The other abstractions are for irrigation and aggregate plant wash-down, and all except one are located in the lower reach of the Waiohine River, downstream of the SH2 bridge.

In addition to the consented takes listed in Table 3.1, there are likely to be permitted water takes that are allowed under Rule 7 of the RFP (which specifies a maximum rate of take of 2.5 L/s). The combined magnitude of permitted water takes from the Waiohine River is unknown, but is likely to be extremely minor in relation to the consented takes and low flows.

It is possible that water abstraction from groundwater systems connected to the Waiohine River will affect flow in the river, either by inducing flow leakage or reducing recharge to the river. However, the significance of this is unknown. Greater Wellington investigations into the groundwater systems of the Wairarapa valley (as outlined by Jones & Gyopari 2006) should provide more information on the potential effects of groundwater abstraction on the Waiohine River, prior to the review of the RFP.

4. Instream values of the Waiohine River

4.1 Ecological values

The Waiohine River, its tributaries, and associated wetlands provide a wide range of habitat types. This, along with good water quality in the main stem of the river, means that the ecological values of the river are high.

Both the Waiohine River and its tributary Mangatarere Stream are listed in the RFP as water bodies with important trout habitat, and water quality is therefore to be managed for fishery and fish spawning purposes. The Waiohine River is also listed in the proposed Regional Policy Statement as a river providing habitat for threatened native fish species and habitat for more than six indigenous fish species (Greater Wellington 2009).

The New Zealand Freshwater Fish Database (NZFFD) holds records of the following native fish species in the Waiohine River catchment: shortfin eel, longfin eel, lamprey, giant kokopu, dwarf galaxias, brown mudfish, Cran's bully, upland bully, common bully, redbfin bully and torrentfish. Five of these species (longfin eel, lamprey, giant kokopu, dwarf galaxias and brown mudfish) are listed as threatened species. For some of these species it is the smaller tributaries and adjoining wetlands that may provide more significant habitat rather than the main Waiohine River (e.g., brown mudfish typically inhabit wetland environments rather than riverine environments).

In addition to the native species listed above, it is expected that there are inanga and common smelt in the lower and middle reaches of the Waiohine River (both of these species are present in the Ruamahanga River catchment in reasonable numbers as far upstream as Masterton). Koaro are also likely to be present in headwater reaches (Perrie⁴, pers. comm., 2009).

Two introduced sports fish are recorded in the NZFFD records for the Waiohine River: brown trout and perch. Brown trout are likely to be found in relatively large numbers throughout the river, given the high value of the river for angling. There are also likely to be reasonable numbers of rainbow trout in the Waiohine River. As previously mentioned, the Waiohine River is listed in the RFP as a waterbody with important trout habitat.

The majority of the fish species found in the Waiohine River are diadromous (i.e., migrating between freshwater and marine environments to complete part of their lifecycle). Thus maintaining passage is extremely important to sustain the existing fish community. Several of these diadromous species are not notable climbers (e.g., common bully, torrentfish, inanga and common smelt) and their upstream penetration into this catchment could be compromised by velocity barriers or by dry reaches of streams, which can commonly occur in some parts of the Waiohine catchment, such as the Mangatarere Stream and its tributaries.

⁴ Alton Perrie, Environmental Scientist, Greater Wellington

Due to the unstable gravel bed of the Waiohine River – and relatively frequent floods – the river does not provide high value habitat for river birds. However, some banded dotterel can be found (Boffa Miskell 1993).

4.2 Recreation values

The Waiohine River is listed in the RFP as having water quality to be managed for contact recreation purposes, due to its regionally important amenity and recreational values. The river is used for recreational activities such as swimming, fishing, and tubing. The upper reaches of the river, particularly through the Waiohine Gorge, are popular for tubing and rafting. From the gorge to about the SH2 bridge the river is used for swimming, at locations where public access is possible. A highly-used swimming hole is at the SH2 bridge. From the gorge to the confluence the river is also used for rafting, kayaking and canoeing. The Waiohine River has high baseflows and good water quality, hence its popularity for contact recreation.

The Waiohine River has high value for anglers in its upper reaches, for wilderness fishing (brown and rainbow trout). Angling in the middle and lower reaches is fair to good (Fish & Game 2008, O’Hagan & Kloosterman 1993). Several anglers were observed in the lower reach of the river, a short distance upstream of the Ruamahanga River confluence, during the fieldwork component of this study. The Waiohine River ranks as the second most highly used Wairarapa river for angling, after the main stem of the Ruamahanga River (Unwin & Image 2003).

4.3 Maori cultural and traditional values

“Ko Waiohine ko Ruamahanga ěnei

e wairua tipu mai

i Tararua maunga

e oranga e te iwi”

“These are Waiohine and Ruamahanga. They are like mothers milk flowing out of the Tararua mountains for the prosperity of the people” (Hoani Te Whatahoro Jury, 1841-1923, a Ngati Kahungunu scholar)

The Waiohine River, as one of the main tributaries of the Ruamahanga River, is of significant spiritual value to Wairarapa iwi. Some general Maori cultural and traditional values relating to rivers are described below; these were drawn from documentation that has been provided to Greater Wellington by individuals, hapu and iwi as part of consultation on various council documents, regional plans and resource consent applications.

Ki Uta ki Tai (from the mountains to the sea): Water bodies are viewed holistically and cannot be distinguished from the surrounding land and catchments. Water provides cultural and spiritual sustenance, is viewed as the source of life with life giving properties, and is regarded as a taonga. Wairarapa whānau, hapu and iwi whakapapa to the Ruamahanga River.

Mahinga kai: The waterways of the Wairarapa are used for mahinga kai (the gathering and processing of food). The gathering of food such as birds, eels, fish and plants enable tangata whenua to provide manaakitanga (hospitality), a symbol of tribal mana. In particular, it is important that the waterbody sustains a healthy tuna (eel) population.

Mauri: Iwi try to protect the mauri (life force) which flows through all waterways. In particular, water from different catchments should not be mixed.

Kaitiakitanga: Iwi are charged with the responsibility to protect both the spiritual and physical waterways (including streams and rivers) within their rohe.

Waahi Tapu: Along the rivers are many ancestral sites and other sites of special value to tangata whenua.

Recreational use: Rivers are important for recreational use by tangata whenua, and water quality should be sufficient to enable safe swimming.

Recharge of groundwater: The ability of the water body to recharge aquifers.

Pollution: The water has clarity and is free from odour and discolouration, and is protected from all pollution whether chemical, human or animal waste.

In addition, some specific values relating to the Waiohine River are described below; these were obtained from notes taken during consultation with Ngati Kahungunu ki Wairarapa and Rangitane o Wairarapa on the Waiohine River floodplain management plan investigations (Greater Wellington 1993) and an unpublished Waitangi Tribunal report on inland waters of the Wairarapa (McClellan 2002).

Mahinga kai: the Waiohine River and its tributaries were traditionally a rich food source for the tangata whenua. The Mangatarere Stream/Beef Creek confluence and surrounding area is of particular significance because the founding chief, Tawhirimatea Tawhao Ngatuere, settled in the area. At that time eels, freshwater crayfish and whitebait were plentiful. Lamprey and flounder were also available, and freshwater mussels were transported from Lake Wairarapa and established in the area. The fishery value to local tangata whenua has deteriorated over the years.

Waahi tapu: An Urupa (burial ground) is located in the area, north of the Waiohine River and adjacent to SH2, and is subject to occasional damage from floodwaters. The local tangata whenua are of the view that their elders would not have established the Urupa in a flood-prone site, and that the flooding has been caused by changes in land use. As the Waiohine River was an important food gathering area, members of food gathering groups may have died whilst away from the pa and been buried on along the river banks.

In summary, the Waiohine River and its tributaries hold many important values for local Maori, particularly relating to mauri, waahi tapu and mahinga kai.

4.4 Landscape values

The upper reach of the Waiohine River is well-known for its scenic beauty (Figure 4.1). The Regional Policy Statement lists the Waiohine Gorge as regionally significant for its landscape and scenic qualities, and the RFP specifies that the river “upstream from the cableway” (the gorge reach and upstream) is to be managed in its natural state.



Figure 4.1: Waiohine River in the gorge

In the middle reaches of the river, stands of totara trees give strong natural character. However, flood protection works – notably stopbanks and boulder protection – have lowered the scenic values of the river channel (Boffa Miskell 1993). Downstream of the SH2 bridge, the landscape values of the river increase, as the effect of flood protection works becomes less obvious and willows line the banks.

4.5 Effects of low flows on instream values

Low flows – either naturally occurring or exacerbated by water abstraction – in the Waiohine River have the potential to threaten the instream values in the following ways:

- The wetted area of channel is reduced and hydraulic characteristics may change, which may reduce habitat availability and fish passage opportunities;
- Water temperatures may increase, which may threaten aquatic life and have a secondary effect of encouraging periphyton proliferations;
- There is less water available for dilution of contaminants; and
- The water depth in swimming holes may be reduced.

As mentioned in Section 2.3, the Waiohine River falls into the ‘high baseflow’ category and is not prone to extreme low flows like other nearby streams (e.g., Mangaterere Stream). However, due to the high instream values of the Waiohine River, and its importance for providing flow to the lower reach of the Ruamahanga River, it is important that an appropriate minimum flow is in place.

5. Reviewing minimum flow requirements of the Waiohine River

As outlined in Section 3, the minimum flow for the Waiohine River of 2,300 L/s was set prior to any low flow data being available for the river, and has not been tested to ensure it is adequate for protecting the instream values. Hence, prior to the review of the RFP, Greater Wellington has carried out investigations into the Waiohine River's minimum flow requirements. The investigations are described in this section.

The investigations conducted relate to protecting instream values of the middle and lower reaches of the Waiohine River. Under the RFP, the upper reach of the river is identified as having a high degree of natural character and is to be managed in its natural state. In addition, the upper reach is within the Tararua Forest Park. Thus the demand for water abstraction is likely to be very low in this part of the catchment.

5.1 Instream flow objectives

The instream flow objectives outline the specific values to be sustained by a minimum flow. The instream flow objectives do not replace the management objectives set out in the RFP. Rather, the intention is to have more specific objectives to provide technical guidance for reviewing the minimum flow.

Following the assessment of the instream values in Section 4, the instream flow objectives for the middle and lower reaches of the Waiohine River determined for this minimum flow investigation are:

- To maintain habitat for fish; and
- To maintain passage for migratory fish.

The first objective recognises the importance of the river for providing trout habitat and angling opportunities, and for providing habitat for native fish. The second objective recognises the importance of the Waiohine River as a conduit for migratory fish; for example, for trout and lamprey to gain access to spawning areas, including access to the upper Waiohine River and tributaries such as the Mangatarere Stream.

As outlined in Section 4, the river holds important values for tangata whenua. The values linked with flow levels – such as mauri, the maintenance of habitats, and mahinga kai – were considered when deriving the objectives which relate to maintaining fish habitat and passage. The river also has importance for recreation other than angling. However, most of the recreational use occurs upstream of the reaches where water is abstracted.

5.2 Flows for maintaining instream habitat

In order to investigate flow requirements for maintaining instream habitat in the Waiohine River, habitat modelling was carried out using the Instream Flow Incremental Methodology (IFIM) with the computer programme

RHYHABSIM version 5.0 (Jowett 2004). The method uses hydraulic survey data to predict how width, depth and velocity will change with flow, and then this information is combined with fish habitat suitability criteria to predict how habitat availability will change with flow.

Two sections of the Waiohine River, each about 1.1 km long, were selected for instream habitat modelling: a section of the middle reach of the river between the rail bridge and Matarawa, and a section in the lower reach below the Muhunoa Stream (a short distance upstream of the Ruamahanga River confluence). These are referred to as the ‘upper IFIM reach’ and the ‘lower IFIM reach’ respectively (Figure 5.1).



Figure 5.1: Location of the two IFIM study reaches on the Waiohine River

The upper IFIM reach was selected to represent the stretch of the river from the railway bridge down to SH2, which loses flow to groundwater. This reach is relatively steep with cobble substrate. The estimated 1-day MALF (naturalised) is 2,800 L/s. The lower IFIM reach was selected to represent the river from the Mangatarere Stream confluence downstream, which has a lower gradient and finer sediment, and is more meandering. The estimated MALF for this IFIM reach⁵ is 3,385 L/s.

The instream habitat survey was carried out by Greater Wellington staff and a fish biologist from the Cawthron Institute, during January 2009. The subsequent modelling results are contained in a separate instream flow assessment report (Hay 2009). A summary of the results are presented here.

The instream habitat for a range of fish species found in the Waiohine River was modelled. These included longfin eel, several species of bully, lamprey, torrentfish, dwarf galaxias, inanga, smelt, brown trout and rainbow trout. The habitat suitability criteria selected for these species were the latest available, from a range of sources (as listed by Hay 2009).

⁵ Along the length of the two IFIM study reaches there will be some flow loss or gain due to groundwater interactions. However, these are not considered to be significant and so the ‘average’ flow for the reach has been estimated.

The modelling found that, in the two IFIM study reaches, habitat for brown trout (both adult and juvenile) and rainbow trout is predicted to increase with flow, with the optimum amount of habitat being available at flows considerably higher than MALF. In contrast, habitat for native fish species tended to decrease as flow increased above MALF. This implies that brown and rainbow trout are the most flow-demanding fish species in the Ruamahanga River (i.e., they require the higher flows than native fish to provide the optimum amount of habitat).

In order to determine a minimum flow from IFIM results, a habitat retention level must be selected. This is a decision regarding what level of habitat availability should be maintained. In most cases, it is not practical to set a minimum flow to *optimise* habitat for the most flow-demanding fish species (in this case, trout), because that would preclude any abstraction from the river. A commonly-used approach is to set a habitat retention level equal to a certain proportion of the habitat available at MALF. The MALF is deemed to be an 'ecologically relevant' statistic because it is indicative of the average annual minimum 'living space', and trout populations respond to annual limiting events because their cohorts (year classes) are annual (i.e., they reproduce only once per year). Hay (2009) recommends that for a river with high fishery value such as the Waiohine River, an appropriate habitat retention level is 90% of the habitat available at MALF.

Using a retention level of 90% of the habitat available at the 1-day MALF, the modelling found that adult brown trout generally have the highest flow requirements (Table 5.1). This is consistent with other studies in the Wellington region (e.g., Hay 2008; Hudson 2008). The exception is torrentfish, which were found to require slightly higher flows to retain 90% of habitat at MALF in the upper IFIM reach. Despite this, Hay (2009) recommends that the minimum flow for the Waiohine River should be set according to the habitat requirements of brown trout, stating that it is difficult to rationalise such a high level of habitat retention for torrentfish because they are not considered threatened and do not support fisheries.

The recommended flows for each IFIM reach (based on retaining trout habitat) and their equivalent flows at the Waiohine Gorge monitoring site are shown in Table 5.2. The minimum flow at the gorge for meeting instream flow requirements for the upper IFIM reach, which represents the river from where it emerges onto the plains down to SH2, is higher than the minimum flow to achieve instream flow requirements in the lower IFIM reach, which represents from SH2 to the Ruamahanga River confluence. This is because in the upper reach there is considerable flow loss to groundwater; yet in the lower reach there is considerable flow gain from the Mangatarere and Muhunua streams. A minimum flow of 2,765 L/s at the gorge is required to achieve instream habitat requirements (using brown trout as the indicator) of the Waiohine River as a whole.

Table 5.1: Flows predicted to retain 90% of habitat at MALF (or the optimum amount of habitat) for selected fish species found in the Waiohine River (adapted from Hay 2009)

Reach	Estimated 1-day MALF (L/s)	Species	Flow (L/s) that retains 90% of habitat at MALF*
Upper IFIM reach	2,395	Brown trout – adult	2,170
		Brown trout – juvenile	1,940
		Rainbow trout - adult	2,070
		Rainbow trout – juvenile	1,840
		Longfin eel >300 mm	1,620
		Shortfin eel >300 mm	1,050
		Torrentfish	2,220
		Redfin bully	<1,000
		Dwarf galaxias	1,190
		Smelt	1,270
		Lamprey	<1,000
Lower IFIM reach	3,045	Brown trout – adult	2,680
		Brown trout – juvenile	2,460
		Rainbow trout - adult	2,650
		Rainbow trout – juvenile	2,250
		Longfin eel >300 mm	1,920
		Shortfin eel >300 mm	1,350
		Torrentfish	2,620
		Redfin bully	<1,000
		Dwarf galaxias	<1,000
		Smelt	1,650
		Lamprey	<1,000

*Or the optimum amount of habitat, whichever is lowest

Table 5.2: Flows predicted to maintain 90% of adult brown trout habitat at MALF in the upper IFIM and lower IFIM reaches of the Waiohine River, and corresponding estimated flows at Greater Wellington flow monitoring site, Waiohine River at Gorge

Reach	Estimated 1-day MALF	Habitat retention level	Required flow to achieve habitat retention	Estimated equivalent flow at Waiohine Gorge
Upper IFIM reach	2,395 L/s	90% of habitat at MALF	2,170 L/s	2,765 L/s
Lower IFIM reach	3,045 L/s	90% of habitat at MALF	2,680 L/s	2,520 L/s

Wairarapa iwi have expressed a desire to ensure that eel habitat is protected, with the aim of restoring the Wairarapa eel fishery. The modelling indicates that river flows lower than the current minimum flow would be adequate for ensuring there is no more than 10% loss of eel habitat compared to the habitat available at MALF (for both longfin and shortfin eels). The recommended minimum flows, based on habitat modelling carried out by Hay (2009), are slightly higher than the current minimum flow specified in the RFP.

5.3 Flows for maintaining fish passage

As well as providing habitat for fish, the Waiohine River acts as a conduit for fish passage. The second instream flow objective suggested in this report is to maintain passage for migratory fish.

The hydraulic model constructed using RHYHABSIM for the instream habitat modelling can also be used to show how fish passage is affected by changes in flow in the Waiohine River. It does this by predicting the minimum width of channel with suitable depths and velocities for fish passage within the two study (middle and lower) reaches, and modelling how this minimum width changes with incremental changes in flow. Modelling of fish passage was carried out by Hay (2009). A brief summary of the findings is presented here.

The criteria selected for modelling fish passage were a minimum depth of 25 cm and 5 cm for large trout and native fish, respectively. The modelling found that in the upper IFIM reach, passage for large trout may be blocked even at the MALF (i.e., 'natural' low flows conditions). Therefore, very large trout may have to wait for higher flows before they can move freely through this reach, although Hay (2009) notes that the trout passage criteria of 25 cm water depth is conservative.

The predicted passage for native fish was found to not be reduced significantly at the proposed minimum flow in each IFIM reach, compared to fish passage at MALF. Overall, Hay (2009) concluded that the recommended minimum flows (as in Table 5.2) for the two IFIM reaches should not adversely affect fish passage.

5.4 Effect on minimum flows in the lower Ruamahanga River

Another consideration for the minimum flow of the Waiohine River is to ensure that flows are maintained in downstream waterways – i.e., the lower reach of the Ruamahanga River. If the minimum flow for the Waiohine River, and other Ruamahanga River tributaries, are set too low then the flow requirements of the lower Ruamahanga River may not be achieved.

The current minimum flow for the lower Ruamahanga River is 8,500 at Waihenga. A recent review of instream flow requirements of that river reach (Hay 2008) indicated that the current minimum flow for the lower Ruamahanga River is only slightly lower than the flow required to achieve 90% of brown trout habitat at mean annual low flow. The flow of 8,500 L/s for the lower Ruamahanga River equates to about 78% of the estimated naturalised mean annual low flow.

It is difficult to predict how low flows in the Waiohine River may affect flows in the lower Ruamahanga River without carrying out detailed low flow modelling. Such modelling itself would be difficult, due to the lack of naturalised flow records for the rivers. However, the recommended minimum flows for the upper and lower IFIM reaches (2,765 L/s and 2,520 L/s as measured at Waiohine Gorge) equate to 91% and 83% of the Waiohine River's MALF, respectively. Assuming low flows are coincident across the Ruamahanga River catchment, and restrictions are enacted accordingly, this implies that a minimum flow for the Waiohine River set at either level should not have adverse effects on maintenance of minimum flows in the lower Ruamahanga River. In addition, because the recommended Waiohine River minimum flows are higher than the current minimum flow, the occurrence of the minimum flow in the lower Ruamahanga River should not be exacerbated by the implementation of the findings of this study.

Note that essential-use water takes from the Waiohine River, and other upstream reaches of the Ruamahanga River, might continue below the target minimum flows and this will affect flow in the lower Ruamahanga River. However, the aim is for 'non-essential' takes (such as those for irrigation) to cease before any downstream minimum flows are compromised.

5.5 Summary

In summary, the instream habitat modelling work and subsequent hydrological analysis suggests that a flow of **2,765 L/s** at Greater Wellington's Waiohine Gorge flow monitoring site is required to protect fish habitat in the Waiohine River as a whole. This is predicted to ensure no more than 10% habitat loss compared to the habitat available during MALF conditions. Predictions of fish passage in the Waiohine River suggest that, at this minimum flow, fish passage will not be adversely affected. Furthermore, implementation of this minimum flow should not increase the risk of the minimum flow for the lower Ruamahanga River being compromised.

The minimum flow investigations indicated that a slightly higher minimum flow is required at the Waiohine Gorge in order to meet instream habitat

objectives for the middle reach of the river (2,765 L/s) compared to the lower reach of the river (2,520 L/s). This is due to the hydrological characteristics of the Waiohine River system. Given that there is some uncertainty in the hydrological patterns of the river at low flows, in particular in predicting loss to groundwater and inflow from the Mangatarere Stream, it is recommended that the slightly higher minimum flow of 2,765 L/s be adopted.

6. Implications for water allocation policies

In this section the potential implications of this study on water allocation policies for the Waiohine River are discussed. Actual implications will depend on the outcomes of the review of the RFP.

6.1 Minimum flows and security of supply

The minimum flow proposed by this study is 2,765 L/s at the Waiohine Gorge flow monitoring site (located upstream of all consented water abstractions). This flow is 20% higher than the current minimum flow of 2,300 L/s. On average, a flow of 2,765 L/s or less occurs less than two days per year.

The RFP policies are applied so that non-essential water takes are required to cease at a flow of 3,040 L/s, and the combined take for essential use (water race and town supply) must be no more than 500 L/s. If the proposed new minimum flow for the Waiohine River is adopted, then the flows at which restrictions and cessation of non-essential takes occur should be reviewed. The exact level of these flows will depend on how essential-use takes are to be managed. However, assuming that essential use cannot be reduced to less than 500 L/s, the flow at which non-essential takes should cease should be no lower than **3,265 L/s**. This will prevent non-essential abstraction of water from causing the minimum flow to be breached.

A security of supply analysis was carried out to determine how often flow restrictions (including cessation of non-essential takes) might be imposed. In the last 20 years, a flow of 3,265 L/s has occurred for an average of five days per irrigation season (October to April), with the maximum being 15 days in 2001/02. If this flow were adopted as the flow at which non-essential takes must cease, on average it would result in an additional two days per year of take restrictions compared to the current policies of the RFP (Table 6.1).

Table 6.1: Average and maximum number of days per irrigation season when flow in the Waiohine River at Gorge has been below the current and possible future cessation level, during the last 20 years

	Average number of days at or below this flow per irrigation season, 1989-2009	Maximum number of days at or below this flow per irrigation season, 1989-2009
Current flow at which non-essential takes cease – 3,040 L/s	3	7
Possible future flow at which non-essential takes cease – 3,265 L/s	5	15

This analysis is based on the last 20 years of flow data, and security of supply under future climate scenarios has not been assessed. In addition, restrictions may be imposed more or less frequently depending on the core allocation limit and how essential-use takes are managed in the future.

6.2 Other considerations: core and supplementary allocations

The current core allocation for the Waiohine River (740 L/s) equates to about 23% of the estimated 1-day MALF and 21% of the estimated 7-day MALF, at the confluence with the Ruamahanga River. As described in Section 4, the core allocation was set according to the estimated maximum take of the Moroa Water Race (Wairarapa Catchment Board 1980). If the additional 40 L/s 'supplementary allocation' for the Moroa Water Race is taken into account, the allocation is 780 L/s, or 22% of the 7-day MALF. This fits within the 'moderate' degree of alteration for a river with high baseflow, as defined by Beca (2008) who suggest that allocation from a river such as the Waiohine River should not exceed 30% of MALF.

Greater Wellington has not yet determined if there will be a 'rule-of-thumb' for proposing allocation limits in future. However, it is apparent that the current level of allocation is within the limits recommended in the technical guidelines (Beca 2008) for the proposed National Environment Standard on Ecological Flows and Water Levels. If the core allocation were to be increased, the impacts on security of supply for existing users should be further investigated. However, given the uncertainty regarding flow losses and gains along the river, and the likelihood of more severe and prolonged low flows in future (as a potential impact of climate change), it is recommended that the core allocation remain no higher than the existing level.

The current RFP specifies a flow above which the core allocation may be exceeded, also referred to as a 'supplementary allocation flow'. In other words, in addition to the core allocation, water may be taken from the river during non-low flow conditions. The current supplementary allocation flow for the Waiohine River is 4,000 L/s. This flow is exceeded about 90% of the time during the irrigation season, and is less than half the irrigation season median flow.

The aim of a supplementary allocation flow is to allow water to be taken during times of higher flows, while seeking to maintain flow variability, such as flushing or disturbance flows that are essential to maintaining the instream ecosystem and channel structure (MWH 2008). The supplementary allocation flow is often set according to a rule-of-thumb; for example, equal to mean flow (Otago Regional Council, Environment Southland) or median flow (Horizons Regional Council).

At this stage, no work has been done to review supplementary allocation flows for rivers the Wellington region. However, it is likely that the current supplementary allocation flow for the Waiohine River is too low; if a large amount of water were to be allocated above this level it is possible that flow variability and natural flow characteristics might be affected. It is therefore recommended that an appropriate supplementary allocation flow for the Waiohine River be investigated prior to the review of the RFP.

7. Conclusions and recommendations

The Waiohine River has important ecological, cultural and economic values. Due to its good water quality and high baseflows, the river supports a wide range of fish species and has regionally important trout habitat. It is highly used for recreational activities, including angling and swimming, and holds many important values for Maori particularly relating to mauri, waahi tapu and mahinga kai. Despite the high baseflow nature of the river, these values could be threatened at times by low flows that may be exacerbated by abstraction. The core allocation specified for the Waiohine River is nearly fully utilised, with water being taken for irrigation, industry, municipal supply and the Moroa Water Race.

To protect instream values it is vital that an appropriate minimum flow exists for the river. Instream habitat modelling carried out to determine flows for maintaining fish habitat found that, in the Waiohine River, the fish species with the highest flow requirements is brown trout. A minimum flow of 2,765 L/s at Greater Wellington's Waiohine Gorge flow monitoring site is expected to maintain habitat availability in the river as a whole, based on retaining 90% of the brown trout habitat available at MALF. The flows required to protect instream habitat were also found to be adequate for ensuring fish passage is not adversely affected.

The suggested minimum flow from this study (2,765 L/s at Waiohine Gorge) is higher than the current minimum flow specified in Greater Wellington's RFP (2,300 L/s). On average, a flow of 2,765 L/s or less occurs for less than two days per year.

The results of this study should be taken into account when the RFP is reviewed.

7.1 Recommendations

1. The minimum flow for the Waiohine River is increased from 2,300 L/s to 2,765 L/s.
2. The flow at which consented takes are restricted or prohibited is reviewed, to ensure that the minimum flow of the Waiohine River is protected.
3. Core allocation for the Waiohine River is changed to 780 L/s to reflect current actual allocation at low flows (if a higher of core allocation is sought, a thorough analysis of environmental effects and security of supply for existing users should be carried out).
4. The supplementary allocation flow for the Waiohine River is reviewed.

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For more information, contact Greater Wellington:

Wellington office
PO Box 11646
Manners Street
Wellington 6142
T 04 384 5708
F 04 385 6960

Masterton office
PO Box 41
Masterton 5840
T 06 378 2484
F 06 378 2146

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