Lower Ruamahanga River instream flow assessment

Stage 1: Instream flow issues report

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Executive summary

This report presents the first stage of an instream flow assessment for the Lower Ruamahanga River. The overall objective of the instream flow assessment is to determine the instream flow requirements of the river, to assist with Greater Wellington's review of water allocation policies for the Ruamahanga River downstream of the Waiohine River confluence. The *Instream flow issues report*:

- Analyses the existing hydrological and water quality data for the river;
- Identifies instream values of the river and threats to those values;
- Proposes instream flow objectives; and
- Identifies knowledge gaps and proposes scientific investigations and next steps for the instream flow assessment of the Lower Ruamahanga River.

Hydrology and water quality

Analysis of hydrological data from Ruamahanga River at Waihenga (1976 – 2006) found that the existing minimum flow in the Regional Freshwater Plan (8.5 m^3/s) is approximately equal to a 4-year return period 7 day low flow. However, the flow record for Waihenga is affected by upstream abstraction and has not been naturalised. The Lower Ruamahanga River can experience relatively long periods of stable low flows, particularly during February to April, due to attenuation of upstream 'freshes'. There is likely to be a strong connection between the first reach of the Lower Ruamahanga River (down to Waihenga) and the shallow gravel aquifer, and therefore pumping of groundwater may have an impact on river flows.

There is a general decline in water quality with distance downstream in the Ruamahanga River. This decrease in water quality is attributed to changes in land cover and land use practices, and the influence of point source municipal wastewater discharges. Monitoring at Pukio shows that water quality, based on Greater Wellington's water quality index, is classed as 'poor' relative to other monitored sites in the region. Guideline values for clarity and dissolved nutrients were generally exceeded on more than half of the sampling occasions since monitoring began in 2003. Tidal movement of saltwater up the Ruamahanga River is likely to be the major change in water quality downstream of Pukio.

All three recreational water quality monitoring sites on the Lower Ruamahanga River have been assigned 'very poor' suitability for recreation grades. However, in this case the grading system better reflects the condition of the bathing sites during wet weather, rather than in dry weather when recreational activity is greatest.

Instream values and threats

Ecological values of the Lower Ruamahanga River, particularly in its bottom reach, have been significantly affected by poor water quality and channel modification. Low flows have had an indirect effect on ecological values due to further impaired water quality during times of low flow. However, the river retains an important function of providing a 'corridor' for diadromous fish to travel between upstream reaches and the sea. The river also potentially provides habitat for non-migratory fish, and relatively good habitat diversity is retained downstream to about Bentley's Beach.

The Lower Ruamahanga River has extremely high recreational values, with swimming, angling, canoeing and power boating all popular activities. At times of low flow certain types of recreational use may be adversely affected due to low water depth over riffles. During low flows, particularly in the absence of 'flushing' flows, periphyton cover is encouraged which may also reduce the recreational values of the river.

Landscape values associated with the Ruamahanga River are high, although the aesthetic value of the river in its lower reaches has been reduced due to channel modification. Poor water clarity also threatens the aesthetic value of the river.

Maori customary and traditional values associated with the Lower Ruamahanga River have not yet been assessed. These values are likely to be significant, although poor water quality has potentially degraded the mauri of the river.

Proposed instream flow objectives and scientific investigations

The proposed instream flow objectives for the Lower Ruamahanga River are:

1. There is adequate water depth for migratory fish passage and recreational boating.

2. Sufficient habitat is maintained for fish, in particular brown trout.

3. During times of low flow, water quality is suitable for contact recreation and aquatic ecosystem purposes.

To determine the instream flow requirements to achieve these objectives, and to fill other knowledge gaps for reviewing the minimum flow policies for the Lower Ruamahanga River, the following investigations are proposed:

- Modelling of the effect of changes in flow on water depth, particularly over riffles;

- Estimation of an unimpacted (naturalised) mean annual low flow;

- Modelling of the amount of habitat available at different flows and at the current minimum flow. It is proposed that a physical habitat simulation model (RHYHABSIM; Jowett 1989; Clausen et al. 2004) is used for this investigation;

- Collection of continuous water quality (temperature and dissolved oxygen) data to aid in identifying any links between flow and water quality; and

- An assessment of the risk factors leading to periphyton proliferations in the Lower Ruamahanga River, and determination if the risk can be reduced by water management policies.

Contents

1. Introduction

1.1 Context for an Issues Report

The values relating to a stream's environment (including the channel, stream bed and water) are called instream values, and these include ecological, recreational, aesthetic and Maori cultural values. Instream values can be adversely impacted by activities such as damming, abstraction of water, and the discharge of contaminants.

Knowledge of the relationship between the flow regime and instream values is important when developing water allocation policies, so that the flow requirements for instream values can be considered objectively alongside out-of-stream uses (Ministry for the Environment 1998). This report is a preliminary step in an instream flow assessment for the Lower Ruamahanga River. The information gained in this assessment will be used by Greater Wellington Regional Council (Greater Wellington) when reviewing water allocation policies for the Ruamahanga River downstream of the Waiohine River confluence.

The steps in an instream flow assessment, under Greater Wellington's *Framework for instream flow assessment in the Wellington region* are:

1. Collate and review all existing hydrological, ecological, and water quality data for the stream or river.

2. Carry out a field assessment to identify instream values and gain an impression of flow-related issues in the catchment.

3. Propose instream flow objective(s)[1], outlining the key value(s) to be protected by the proposed instream flow regime.

4. Plan scientific investigations, to determine the flows required to achieve the instream flow objective(s).

5. Prepare an **Instream Flow Issues Report** (this report; which constitutes Stage 1 of the instream flow assessment), and send this report to key stakeholders for consultation.

6. Review the planned investigations in light of stakeholder feedback and carry out scientific investigations.

7. Report on the findings on the scientific investigations through an Instream Flow Technical Report (Stage 2 of the instream flow assessment); this will recommend a flow regime to achieve the instream flow objective(s).

[1] In the Framework for Instream Flow Assessment in the Wellington region, this is referred to as an "Instream Management Objective". Given that the objective is only set to aid in focusing scientific investigations and may not carry through to management documents such as Water Allocation Plans or the Regional Freshwater Plan, the terminology "Instream Flow Objective" is now deemed more appropriate.

1.2 Why is an Instream Flow Assessment needed?

The Regional Freshwater Plan (Wellington Regional Council 1999) sets out water allocation and minimum flow policies for the Lower Ruamahanga River. The aim of the instream flow assessment is, ultimately, to provide information necessary to review those policies.

Periodic review of the Regional Freshwater Plan water allocation and minimum flow policies is important, to ensure that the life-supporting capacity of the river is being protected and management objectives are being achieved. In addition, the Lower Ruamahanga River is fully-allocated under the current Regional Freshwater Plan water allocation policies, and therefore Greater Wellington needs to have sound information on instream values and flow requirements to aid in decision-making on future resource consent applications to take water.

1.3 Policy framework

Under the Resource Management Act 1991 (RMA), Greater Wellington has a responsibility to manage the region's water resources in a sustainable manner. The Regional Policy Statement (Wellington Regional Council 1995) and the Regional Freshwater Plan set out policies to help Greater Wellington meet this responsibility. The parts of the Regional Freshwater Plan that are pertinent to the management of the Lower Ruamahanga River are contained in Appendix 1 of this report.

1.4 Spatial extent of the assessment

The Lower Ruamahanga River, as referred to in this report, covers the Ruamahanga River from the confluence with the Waiohine River to its mouth at Lake Onoke. The reach-based assessment of the Ruamahanga River follows the direction set in the Regional Freshwater Plan. Water allocation policies for the Upper Ruamahanga River were added to the Regional Freshwater Plan in 2002.

The instream flow assessment is for the Ruamahanga River itself, not its major tributaries. However, historically water abstraction from minor tributaries (such as the seepage drains of the lower valley) has been included as part of the total allocation for the Lower Ruamahanga River.

1.5 Report scope

The overall objective of this project is to determine the instream flow requirements of the Lower Ruamahanga River. More specifically, this Issues Report (Stage 1 of the instream flow assessment):

- Describes the river characteristics (Sections 2 and 3) and analyses the existing data relating to the hydrology (Section 4) and water quality (Section 5) of the Lower Ruamahanga River;
- Identifies instream values of the river and threats to those values (Section 6);

- Recommends instream flow objectives for the river (Section 7); and
- Identifies knowledge gaps (Section 8) and proposes scientific investigations and next steps for the instream flow assessment of the Lower Ruamahanga River (Section 9).

2. Catchment characteristics

The Ruamahanga River originates in the north eastern Tararua Range near Mt Dundas (1500 metres above mean sea level) and flows through the Wairarapa valley to Lake Onoke, which discharges to the sea. The river is about 162 kilometres long with a catchment area of approximately 3430 square kilometres[2]. It has major tributaries rising from the Tararua Range (including the Waipoua, Waingawa and Waiohine rivers) and also from the eastern Wairarapa hills (Kopuaranga, Whangaehu, Tauweru and Huangarua rivers).

The Lower Ruamahanga River – defined in this study as the reach from the confluence with the Waiohine River to Lake Onoke – is about 72 kilometres long. Other than the Waiohine River, the major tributaries to the Lower Ruamahanga River are the Huangarua River and the outflow from Lake Wairarapa, which includes the discharge from the Tauherenikau River (Figure 1).

Figure 1: Ruamahanga River (bold) and major tributaries. Lower Ruamahanga River is from the Waiohine River confluence to Lake Onoke.

2.1 Climate

The climate of the Wairarapa valley (and therefore the Ruamahanga catchment) is controlled to a large extent by the Rimutaka and Tararua ranges. In westerly wind conditions the ranges produce a foehn effect on their lee side, causing high temperatures and dry weather in the lowland areas. In southerly and easterly situations, rainfall is enhanced as the airmasses are forced to ascend over the ranges. In extreme conditions heavy rainfall can lead to serious flooding on the Wairarapa plains (Thompson 1982).

[2] Including the surface area of Lake Wairarapa, and the lake's catchment

Annual rainfall in the catchment varies from about 800 mm in parts of central Wairarapa, to over 6400 mm in the tops of the Tararua Range (Figure 2). In the catchment of the Lower Ruamahanga River rainfall varies from around 700 mm, at Martinborough, to around 2400 mm, in the Aorangi Range. Much of the catchment experiences an annual water deficit (up to 240 mm on the Wairarapa plains), meaning that irrigation is necessary for some types of agriculture on the plains.

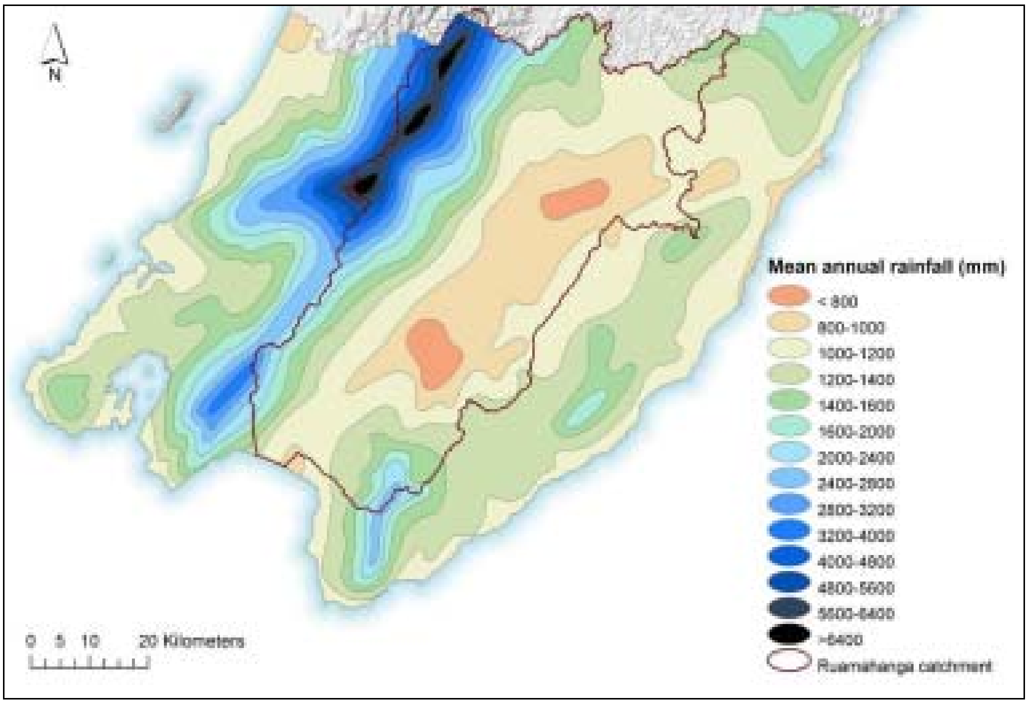

Figure 2: Mean annual rainfall in the Wellington region with Ruamahanga catchment shown

(Source: MetService, based on 1950-1980 rainfall data)

2.2 Geology and geomorphology

The Ruamahanga catchment encompasses three distinct morphological units: the Tararua Range, Wairarapa valley, and the eastern Wairarapa hills. The lower part of the catchment mainly encompasses the latter two morphological units.

The Tararua Range has been shaped by tectonic uplift, derived from local faults, and climatic influences. The range is made up of greywacke (alternating argillite and sandstone) (Baker et al. 1994). On a regional scale, the greywacke is regarded to be impermeable (Begg et al. 2005).

Rivers flowing out of the Tararua Range are sediment-charged, and as they emerge into the Wairarapa Valley a sudden reduction in stream gradient causes deposition of load, forming large coalescing alluvial fans. The plain is up to 300 metres thick in some places (Baker et al. 2004).

The eastern hills comprise geological groups that consist of marine sandstones, siltstones, mudstones and limestone. The dominant soil forming materials of the eastern hills are the soft easily eroded mudstones.

2.3 Land use

The major land use in the Ruamahanga catchment is arable farming including sheep, beef, and dairying (Figure 3). On the lower Wairarapa plains dairying has become the predominant land use in recent years, while the remainder is used for sheep and cattle grazing. Within the eastern hill country sheep and cattle grazing is the dominant land use.

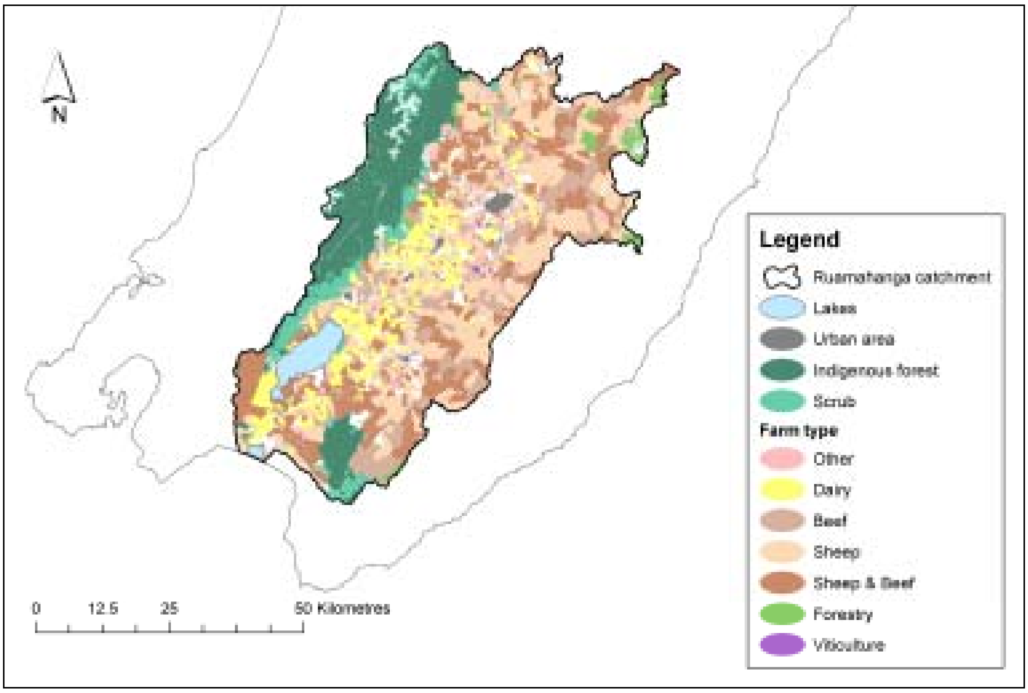

Figure 3: Land use in the Ruamahanga catchment

(Source: AgriQuality NZ 2001, Terralink 1998)

Although the western Ruamahanga River tributaries have a significant proportion of their catchment area under indigenous forest (in the Tararua Range), the pastoral land use of the plains is likely to have a significant impact on the water quality of these rivers (and the Lower Ruamahanga River).

2.4 Lower Wairarapa Valley Development Scheme

A flood prevention scheme for the lower Wairarapa valley was developed between 1963 and 1983, which resulted in significant changes to the Lower Ruamahanga River. The major aspects of the scheme which have affected the river are:

- Extensive stopbanking, downstream of Moiki area;
- Construction of the Barrage Gates, to control outflow from Lake Wairarapa;
- Diversion of the Ruamahanga River across the Kumenga Peninsula (through the 'Ruamahanga Diversion'), so that its natural course is cut off and the river bypasses Lake Wairarapa;

- Development of floodways, which divert high flows out of the Ruamahanga River and overland into Lake Wairarapa (Figure 4); and
- Construction of pump drainage schemes in the lower valley, which discharge into the lower river.

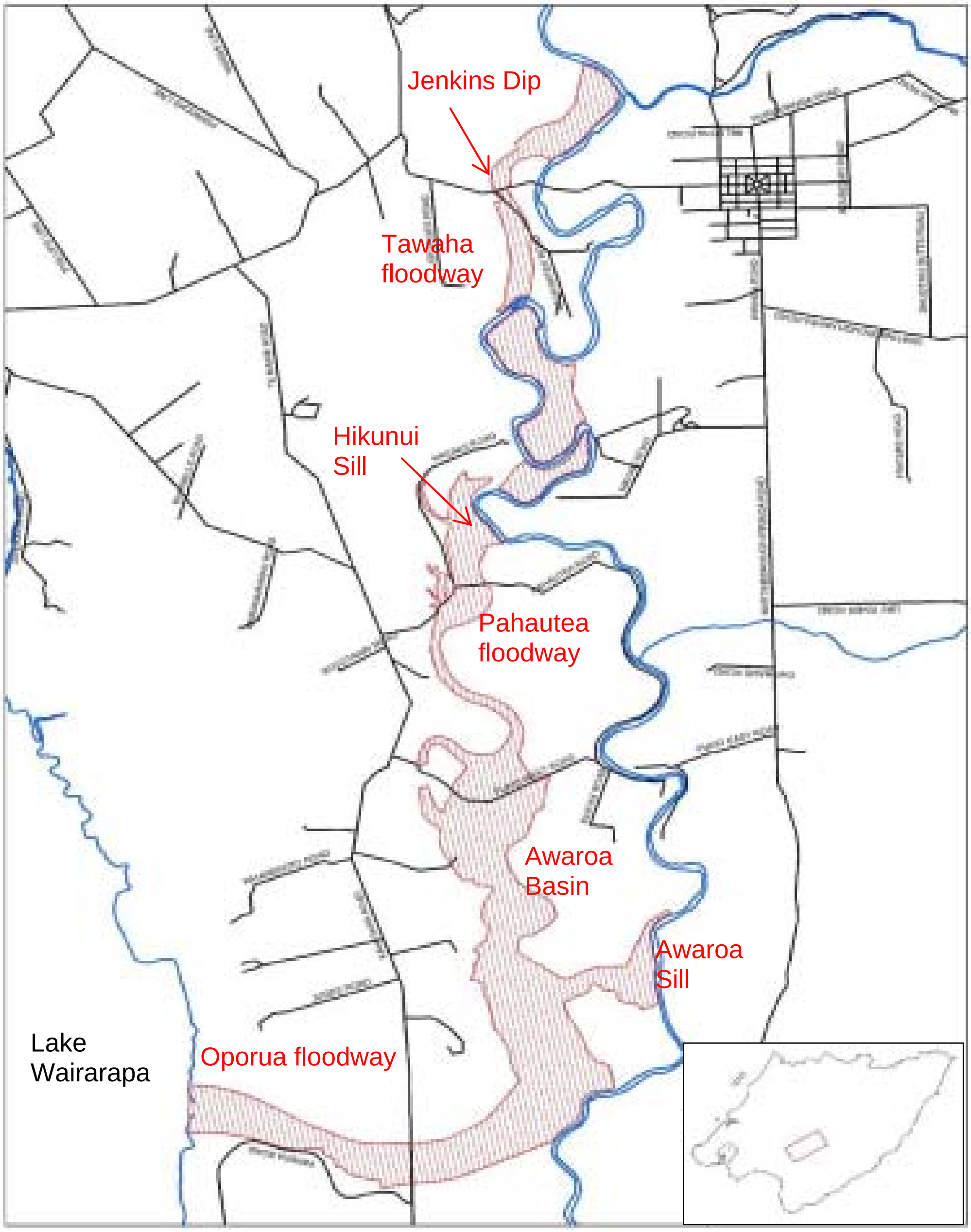

Figure 4: Schematic diagram of the Lower Wairarapa Valley Development Scheme (shaded areas indicate floodways)

2.5 Water resource use and current policies

There are currently 21 consents which allow the taking of water from the Lower Ruamahanga River (Figure 5, Table 1), with a total allocation of 1745 L/s (1.745 m^3/s). Of this, 120 L/s is 'supplementary' allocation, only able to be taken once flow in the river is greater than 11,000 L/s (11 m^3/s) at Waihenga Bridge.

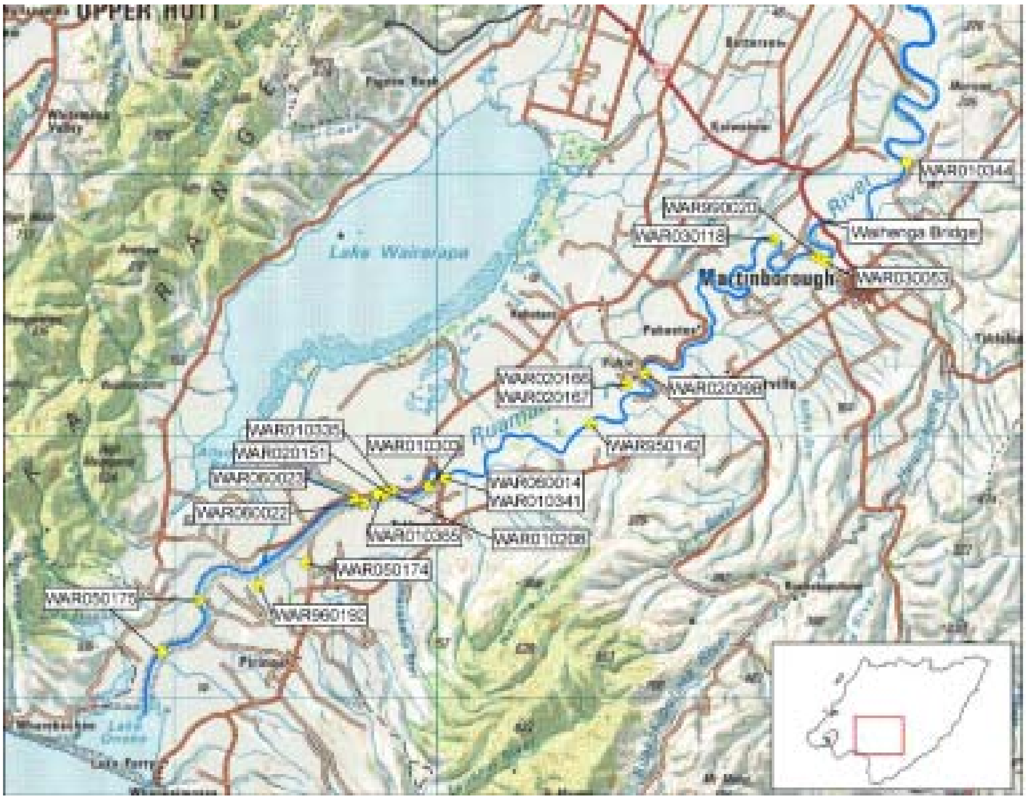

Figure 5: Location of consented abstractions from the Lower Ruamahanga River

The remaining allocation of 1625 L/s exceeds the core allocation of 1500 L/s for the Lower Ruamahanga River, specified in Policy 6.2.1 of the Regional Freshwater Plan. However, in reality, consent WAR 030053 (292 L/s) only operates occasionally, for frost protection purposes. To ensure that the actual abstraction does not exceed 1500 L/s at any one time, consents WAR 060014 and WAR 060023 are not allowed to operate during times of frost. The core allocation specified in the Regional Freshwater Plan is therefore considered to be fully utilised, and it is likely that no further abstraction will be granted under the current policies (except as allowed for under supplementary flow conditions).

All abstractions are required to comply with restrictions during periods of low flow in the Ruamahanga River, although the details of the restrictions vary between consents. The minimum flow (which is the minimum flow Greater Wellington aims to achieve in the Lower Ruamahanga River) is 8.5 m^3/s at Waihenga Bridge (see Appendix 1 of this report). It is unclear how the current minimum flow was derived. It was likely to have been based on historic flow analysis, which gives further justification for a thorough investigation into actual instream flow requirements.

In addition to consented takes from the Lower Ruamahanga River, there are an unknown number of small abstractions, which are a permitted activity under the plan. The Regional Freshwater Plan allows up to 20,000 litres per day to be abstracted (at a maximum rate of 2.5 L/s) without resource consent. It is not known how much water is taken from the Lower Ruamahanga River under the permitted activity rule.

Table 1: Resource consents to abstract water from the Lower Ruamahanga River

Consent	Consent holder	Expiry date	Rate of take (L/s)	Reach (see Section 3)	Purpose	Comments
WAR010344	Station Bush Partnership	2010	50	1	Irrigation	
WAR030053	Palliser Estate Wines	2010	292	1	Frost protection	Only able to operate for 12 days per year
WAR990020	Osborne L	2010	20	1	Irrigation	
WAR030118	George	2010	14	1	Irrigation	
WAR020098	Herrick Land Company Ltd	2010	40	2	Irrigation	
WAR020166	Runnymede Farm	2007	200	2	Irrigation (border dyke)	
WAR020167	Runnymede Farm	2010	26	2	Irrigation	
WAR950142	Martin	Expired in 2005	227	2	Irrigation (border dyke)	Replacement application on hold under S92 of RMA
WAR060014	Rotopai Trust	2016	60	2	Irrigation	Not able to operate during frost
WAR010341	Rotopai Trust	2010	65	2	Irrigation	
WAR010303	Drylands Trust	2010	33	3	Irrigation	
WAR010335	Handyside & de Latour	2010	34	3	Irrigation	
WAR010208	Maori Education Trust	2010	72	3	Irrigation	
WAR010365	Wood	2010	60	3	Irrigation	
WAR020151	Handyside & de Latour	2037	10	3	Wetland level maintenance	Supplementary allocation (high flow diversion)
WAR060022	Handyside	2016	87	3	Irrigation	
WAR050175	MacLand Farms	2016	110	3	Irrigation	
WAR050175	MacLand Farms	2016	110	3	Irrigation	Supplementary allocation (high flow take)
WAR060023	McCreary	2016	65	n/a	Irrigation	Not able to operate during frost
WAR050174	Sutherland	2010	90	n/a	Irrigation	Abstraction from Eastern Cut-off Drain
WAR960192	Turanganui Developments Ltd	2007	80	n/a	Irrigation	Abstraction from Tauanui Seepage Drain

3. Reach delineation

The Lower Ruamahanga River has been divided into three reaches for this study (Figure 6). The reaches are:

- Waiohine confluence to Bentley’s Beach (approximately 38 kilometres);
- Bentley’s Beach to Tuhitarata Bridge (approximately 17 kilometres); and
- Tuhitarata Bridge to Lake Onoke (approximately 17 kilometres).

The reaches were determined based on river morphology (such as degree of channel confinement and hydraulic character) and the influence of channel modification, which will in turn affect habitat characteristics.

Figure 6: Lower Ruamahanga River with reach boundaries shown

3.1 Ruamahanga River from Waiohine to Bentley’s Beach

The Waiohine River contributes a significant amount of flow to the Ruamahanga River, and downstream of the confluence the Ruamahanga River meanders between the foot of the eastern hills and the high terrace to the west. There is localised river control work, which consists mostly of willow planting (Boffa Miskell 1993). In this reach extensive gravel beaches have formed in the river meanders (Figure 7 and Figure 8), and distinct pool/riffle/run sequences exist (although run habitat dominates).

Figure 7: Aerial photo of a section of Lower Ruamahanga River reach 1, showing meandering and frequent gravel beaches

Figure 8: Lower Ruamahanga River at Morison's Bush

The floodway system in this section, which comprises a series of overflow floodways, starts just upstream of Waihenga Bridge. Downstream of this point the river banks are stopbanked along with willow planting. In places there are groynes and other deflecting structures (Boffa Miskell 1993).

Papawai Stream and Huangarua River enter the Lower Ruamahanga River in this reach, a short distance upstream from Greater Wellington's flow recording site at Waihenga Bridge. Comments on the flow data and tributary contributions are made in Section 4.

3.2 Ruamahanga River from Bentley's Beach to Tuhitarata Bridge

Downstream of about Bentley's Beach the effects of flood control works become more pronounced. Stopbanks confine the river to a single channel (Boffa Miskell 1993). Shingle beaches do occur in places, but are less frequent than in the upstream reach, and the substrate is generally finer than in reach 1. Isolated oxbows, wetlands and ponds indicate how the river formerly meandered. There is not as much hydraulic diversity as in the upper reach, with long deep 'runs' and infrequent riffles (Figure 9 and Figure 10).

Figure 9: Long deep run habitat in Lower Ruamahanga River reach 2. Note how the river is confined between stopbanks.

There is some tidal influence on water levels (but not salinity) in the reach. Limited investigations undertaken by Greater Wellington have found that the influence is greatest during times of low flow, and the effect can extend upstream to about Awaroa (Figure 11). Similarly, during times when Lake Onoke's outlet to the sea is blocked, 'backing up' of water to about Awaroa can occur.

There are no major tributary inputs in this reach. During times of low flow Dry River, which enters the river a short distance downstream of Bentley's Beach, will cease flowing.

Figure 10: Aerial photo of a section of Lower Ruamahanga River reach 2. Note less pronounced meanders and fewer gravel beaches than in reach 1.

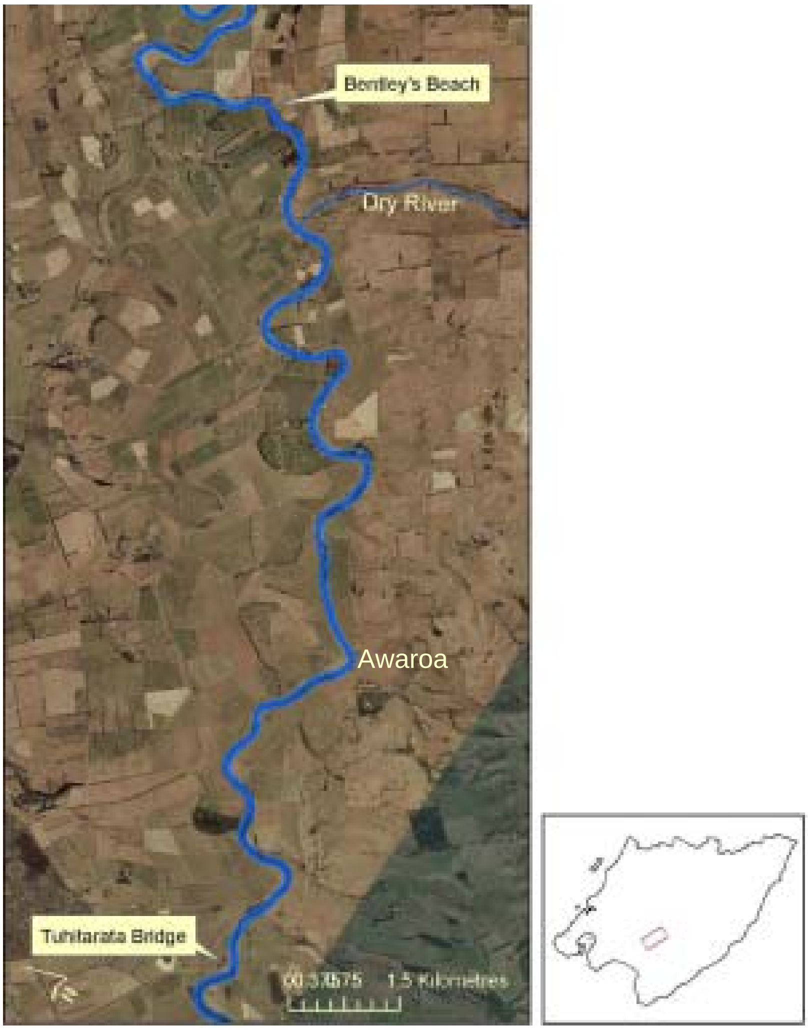

Figure 11: Lower Ruamahanga River reach 2 (Moiki to Tuhitarata Bridge)

3.3 Ruamahanga River from Tuhitarata Bridge to Lake Onoke

The Lower Ruamahanga River changes markedly downstream of Tuhitarata Bridge; high stop banks confine the river and meanders have been cut off. Shingle beaches are largely absent and the banks are generally fine gravels and mud (Boffa Miskell 1993) (Figure 12).

Figure 12: Aerial photo showing a section of the Lower Ruamahanga River reach 3. Note how the channel has been straightened and gravel beaches are largely absent.

About 3.5 kilometres downstream of Tuhitarata Bridge the old Ruamahanga River channel to Lake Wairarapa has been cut off. Thus the current river channel between this point and the Lake Wairarapa outflow confluence (known as the Ruamahanga Diversion) is a completely man-made and straight channel (Figure 13).

There is a tidal influence on water levels in this reach. Saline water extends upstream to around the confluence with the outflow from Lake Wairarapa (the 'Barrage' area).

The Tauanui and Turanganui rivers enter the Lower Ruamahanga River in this reach, although during low flow periods the flow contribution from these rivers is minor. Seepage drains form a network across what was the floodplain (prior to the completion of the Lower Wairarapa Valley Development Scheme) and enter the reach at various points. The main flow contribution to the Lower Ruamahanga River is the outflow from Lake Wairarapa, through the Barrage Gates.

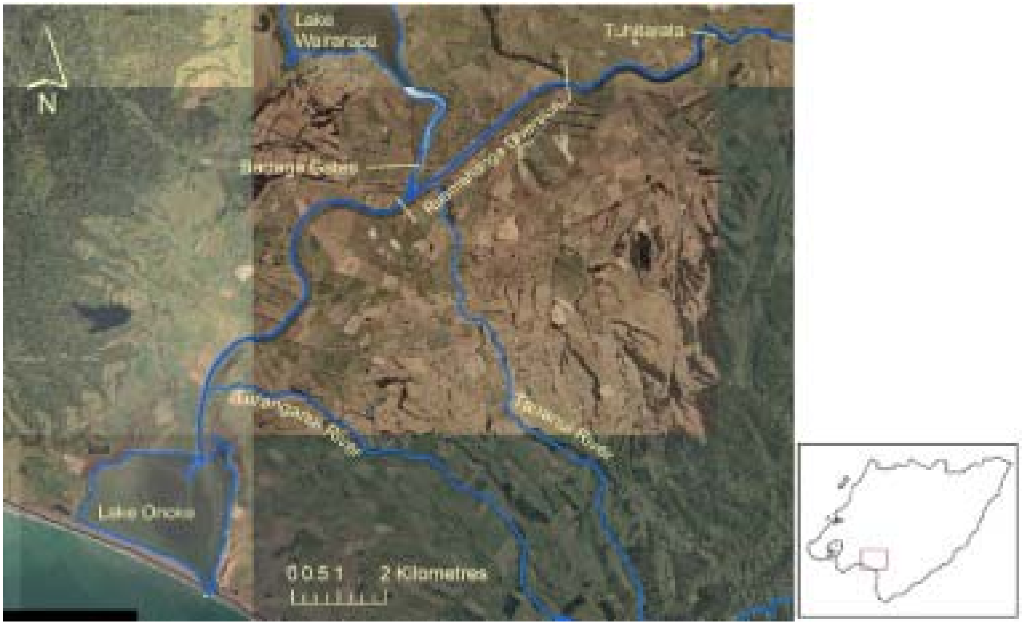

Figure 13: Lower Ruamahanga River reach 3 (Tuhitarata Bridge to Lake Onoke)

4. Hydrology

An important aspect of the Issues Report is an assessment of available hydrological data, as this information is vital when determining flows required to sustain instream values. The hydrological characteristics of primary interest when considering the instream values and flow-dependent issues are:

- River flow seasonality and flow variability;
- Magnitude and frequency of large floods;
- Magnitude and frequency of low flows;
- Frequency and timing of low flow freshes; and
- Groundwater – surface water interactions.

Greater Wellington monitors flow in the Lower Ruamahanga River at Waihenga (site 29202), about 1.8 kilometres downstream of the confluence with the Huangarua River. The site was installed in 1956 and is one of the earliest rated river level recorder sites in the Wellington region. Waihenga is the main flood warning and monitoring site for the Lower Wairarapa Valley Development Scheme, but it is also important for low flow monitoring. The Regional Freshwater Plan specifies a minimum flow at Waihenga, therefore monitoring of flow at this location is important for ensuring water abstraction restrictions are implemented to comply with the Regional Freshwater Plan.

Although Waihenga is located about 46 kilometres upstream of the river mouth at Lake Onoke, the site is representative of flow conditions along most of the Lower Ruamahanga River upstream of the outflow from Lake Wairarapa. There are no major tributaries entering the river between Waihenga and the Lake Wairarapa outflow, particularly during times of low flow. The streams and rivers flowing off the Haurangi Range (e.g., Dry River and Tauanui River) frequently cease flowing during the summer months.

The flow record for Ruamahanga River at Waihenga has been audited from 1976 (when the Ministry of Works and Wairarapa Catchment Board jointly ran the site) and the flow statistics presented in this report are for the period 1976 – 2006. Note that the flow record has not been naturalised, hence all flow statistics include the effects of upstream abstraction. There is a considerable amount of upstream abstraction from the Ruamahanga River and its tributaries for water supply, water race, and irrigation purposes. Because there are no long-term abstraction data available, it would be difficult to naturalise the low flow record for the Lower Ruamahanga River. In addition, the effect of groundwater abstraction on flow in the river is unknown.

4.1 Flow regime and seasonality

The flow distribution curve for Ruamahanga River at Waihenga indicates that the flow has varied between about 5.2 m^3/s and 1900 m^3/s (Figure 14). The median flow for the period 1976-2006 was 51.4 m^3/s. Most (75%) of the time, flow is within the range 15 – 150 m^3/s, and during the recording period flow was below the minimum flow of 8.5 m^3/s (8500 L/s) in the Regional Freshwater Plan less than 2% of the time.

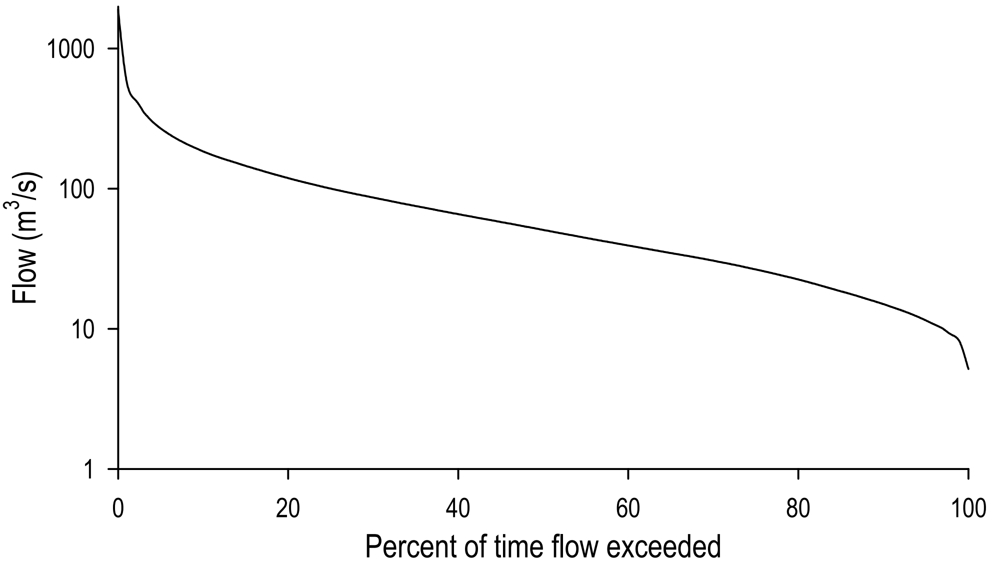

Figure 14: Flow duration curve for Ruamahanga River at Waihenga, 1976 – 2006

Although the flow duration curve gives a picture of the flow variability, it does not show flow seasonality. The average flows for each month (Figure 15) indicate the seasonal variation in flows in the Lower Ruamahanga River. Although large floods can occur at any time of the year, the highest average flows tend to occur between June and October. The high baseflows in winter (June to August) are a result of winter rainfall; a reflection of the increased frequency of depressions that cross the region during that period (Goulter 1984). Continued relatively high baseflows in September and October are due to high rainfall in the Tararua Range and its foothills, a result of westerly flows that prevail over New Zealand during spring. The lowest monthly average flows in the Lower Ruamahanga River occur in January to March.

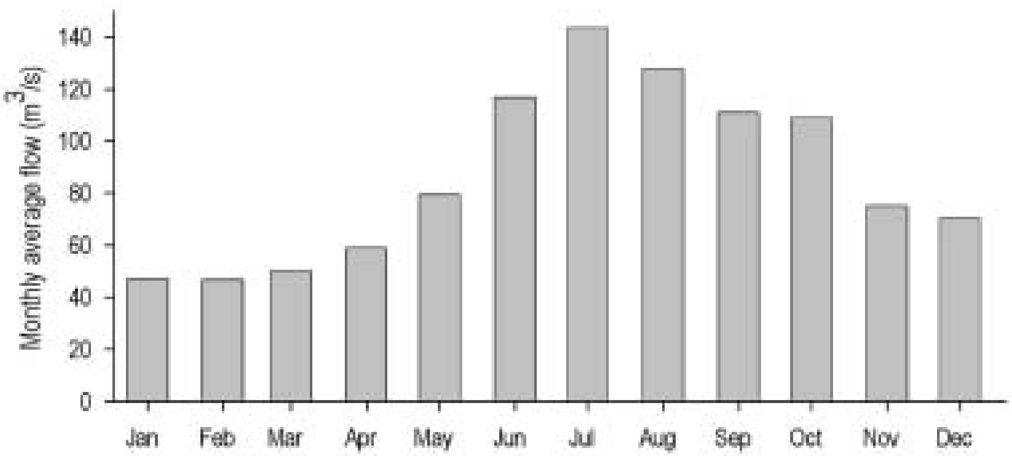

Figure 15: Mean river flow for each month, Ruamahanga River at Waihenga (1976-2006 data)

The pattern of flow seasonality in the Lower Ruamahanga River is slightly different to that of the upper reaches of the Ruamahanga River (Figure 16). The upper reaches of the river show a maximum monthly mean flow in October, because October tends to be the wettest month in the Tararua Range and its foothills. With distance downstream the influence of eastern tributaries, which tend to show maximum monthly mean flows in winter due to southerly rainfall in the eastern hills, becomes greater.

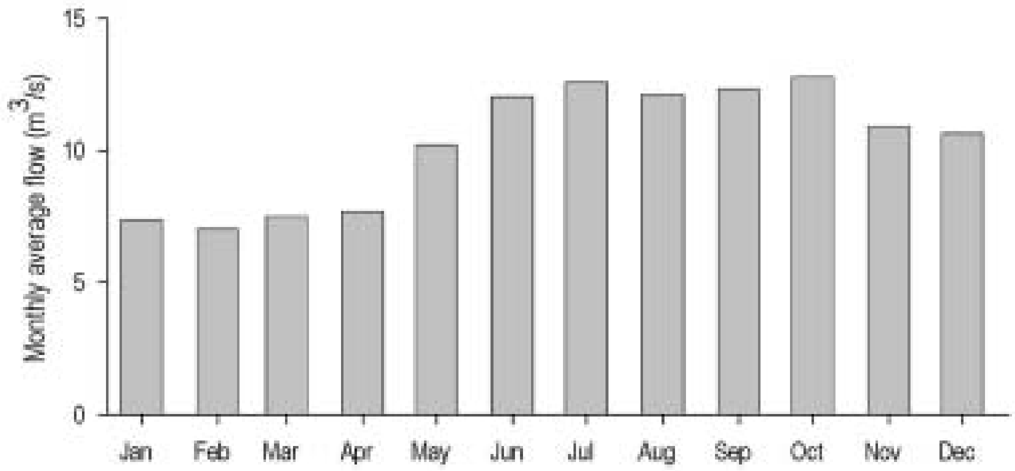

Figure 16: Mean flow for each month, Ruamahanga River at Mt Bruce (1975-2006 data)

4.2 Floods

Waihenga is an important site for floodwarning purposes, although during large floods the Jenkins Dip floodway will operate causing some of the flow to bypass Waihenga. The mean annual flood for the Ruamahanga River at Waihenga is 1064 m^3/s (Table 2), and the maximum recorded flood of 1903 m^3/s occurred on 15-16 February 2004.

Table 2: Flood frequency for Ruamahanga River at Waihenga

Return period	Annual exceedance probability (%)	Flow (m^3/s)
2.33 years	Mean annual flood	1064
5 years	20%	1319
10 years	10%	1527
20 years	5%	1726
50 years	2%	1984
100 years	1%	2177

The Lower Ruamahanga River ultimately receives flood flows from both Tararua Range-fed rivers (e.g., Waingawa River, Waiohine River, Upper Ruamahanga River) and eastern rivers (e.g., Tauweru River, Huangarua River). Therefore large floods can occur at Waihenga from both westerly and easterly-type storms. The flood peak at Waihenga can be of long duration, depending on the timing of flood peaks from the tributary rivers.

4.3 Low flows

Although Waihenga provides a good indication of actual low flows in the river (and therefore the cumulative impact of upstream activities), the flow record has not been naturalised (see Section 4). The (unnaturalised) low flow frequency estimates for Waihenga are shown in Table 3. The current minimum flow of 8.5 m^3/s in the Regional Freshwater Plan is approximately a 4-year return period 7-day low flow. The 7-day mean annual low flow of 10.8 m^3/s is representative of low flow conditions from the Huangarua River confluence to the outflow from Lake Wairarapa. An estimate of the 7-day mean annual low flow of the Huangarua River is 0.3 m^3/s; therefore the 7-day mean annual low flow for the upper reach of the Lower Ruamahanga River (Waiohine River to Huangarua River confluence) is approximately 10.5 m^3/s.

Table 3: Low flow frequency estimates (m^3/s) for Ruamahanga River at Waihenga, 1976 – 2006

Return period	1 day	7 day	14 day	28 day
Mean annual low flow	9.11	10.78	13.50	18.98
5 years	6.96	7.88	9.29	12.45
10 years	6.24	7.09	8.06	10.22
20 years	5.70	6.51	7.16	8.58
100 years	4.83	5.55	5.68	5.91

The lowest flows in the Ruamahanga River at Waihenga during the recording period occurred in autumn 1985 (Table 4). At the same time, significant low flows were recorded in the upper reaches of the Ruamahanga River and in the Waiohine and Waingawa rivers, following below-average rainfall in the Tararua Range (throughout spring 1984 and summer 1984-85). The severity of low flows in the Lower Ruamahanga River is strongly linked to rainfall in the Tararua Range and flows in the western tributary rivers.

Table 4: Lowest flows recorded at Ruamahanga River at Waihenga, 1976 – 2006

Low flow duration	Start date of low flow	Mean flow (m^3/s)
1 day	13 April 1985	5.26
7 days	8 April 1985	5.77
14 days	6 April 1985	6.31
28 days	23 March 1985	7.27

Year-to-year variability in low flows recorded at Waihenga is considerable (Table 5). There are a range of factors affecting the interannual variation in low flows, including the amount of rainfall in the catchment, timing and spatial distribution of rainfall, and the amount of upstream abstraction. The lowest flows in recent years occurred in late March 2001 following an extended phase of low rainfall in the eastern Wairarapa hills, Wairarapa plains, and Tararua foothills. The autumn 2001 low flows coincide with a La Nina event. Both El

Nino and La Nina can lead to low rainfall in the Wairarapa and hence low flows in the Ruamahanga River (Watts 2005, Harkness 2000).

Table 5: Annual low flows (m^3/s) recorded at Ruamahanga River at Waihenga over the last 10 years

	Lowest 1-day flow	Lowest 7-day flow
1997/98	7.92	9.03
1998/99	6.90	7.64
1999/2000	7.21	7.99
2000/01	5.87	6.71
2001/02	11.85	13.38
2002/03	6.65	7.11
2003/04	11.97	15.40
2004/05	6.91	8.02
2005/06	8.59	10.81
2006/07*	6.50	7.48

*Provisional – data for the 2006/07 low flows were not quality checked at the time of publishing this report

4.4 Low flow freshes

The frequency of low flow freshes (‘flushing flows’ that occur during the low flow season) in a stream can have implications for periphyton accumulation and biotic community composition. The frequency of flushing flows equal to or greater than three times the median flow, referred to as FRE_3, has been promoted as a useful statistic for classifying the relative flow stability of instream habitats (Clausen & Biggs 1997).

The record from Waihenga indicates that the Lower Ruamahanga River generally experiences one to two low flow freshes (greater than three times the median flow – about 150 m^3/s) per month during the low flow season (Figure 17). However, the record also shows that low flows can remain relatively stable and there can be extended periods without a significant ‘fresh’. On average, the annual maximum duration without a low flow fresh is 50 days and the most stable low flows occur between February and April. The longest duration of stable low flows on record is 111 days, which occurred during summer / autumn 1985. The Lower Ruamahanga River experiences longer periods of stable low flows than its western tributaries due to peak flow attenuation through the river system.

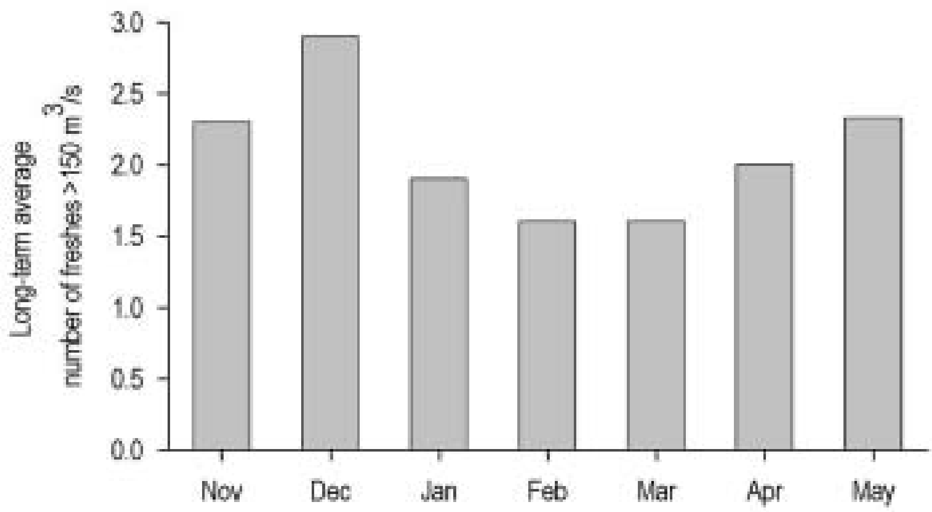

Figure 17: Average number of low flow freshes (greater than 150 m^3/s) in the Ruamahanga River at Waihenga 1976 – 2006

The magnitude of low flow freshes is unlikely to be significantly affected by water abstraction from the river, under the current abstraction status. The total consented abstraction (about 1.5 m^3/s) is small relative to the discharge during a fresh (150 m^3/s for a fresh three times the median flow, i.e., abstraction is less than 1% of discharge during a fresh). There are no major dams that would significantly affect the magnitude of freshes in the Lower Ruamahanga River[3].

4.5 Groundwater – surface water interactions

Significant interactions occur between groundwater and surface water in the Wairarapa valley. Natural outflows from the Wairarapa aquifers occur as spring flow, river baseflow, and seepage into lakes and wetlands. Conversely, the upper reaches of many of the Wairarapa rivers are groundwater recharge sources – they are observed to lose a significant proportion of their flow to groundwater (Jones & Gyopari 2006).

Little work has been carried out to specifically identify the interaction between aquifers and rivers in the Wairarapa (including the Lower Ruamahanga River), although investigations are currently underway to improve our knowledge in this area (Jones & Gyopari 2006). Concurrent gauging of the Lower Ruamahanga River indicates that the river gains a significant amount of water from groundwater immediately downstream of the confluence with the Waiohine River. The increase represents discharge from the Greytown springs and associated shallow groundwater flow (Jones & Gyopari 2006).

Below Morison’s Bush, flow in the Lower Ruamahanga River remains relatively steady; however, the relatively high flow in the river and error associated with manual flow gauging (+/- 7%) means that groundwater-surface water interaction may be undetected. Conceptually, it is expected that there would be a high degree of connection between the river and the shallow water-

[3] The Kourarau Dam affects river flows in the lower Tauweru River, but will not have a significant impact on the Lower Ruamahanga River

bearing gravels along river (Jones & Gyopari 2006), downstream to about Waihenga Bridge.

Due to the likely strong connection between reach 1 of the Lower Ruamahanga River and the shallow gravel aquifer, pumping groundwater in this reach may have a depletion effect on river flows. There are currently nine consented abstractions from the shallow aquifer, between the Waiohine confluence and Waihenga Bridge, which total 236.5 L/s (Figure 18). It is unknown what impact these abstractions have on inducing depletion from the Ruamahanga River. Policy 6.2.8 of the Regional Freshwater Plan stipulates that significant adverse effects on surface water bodies by consented groundwater abstractions are avoided.

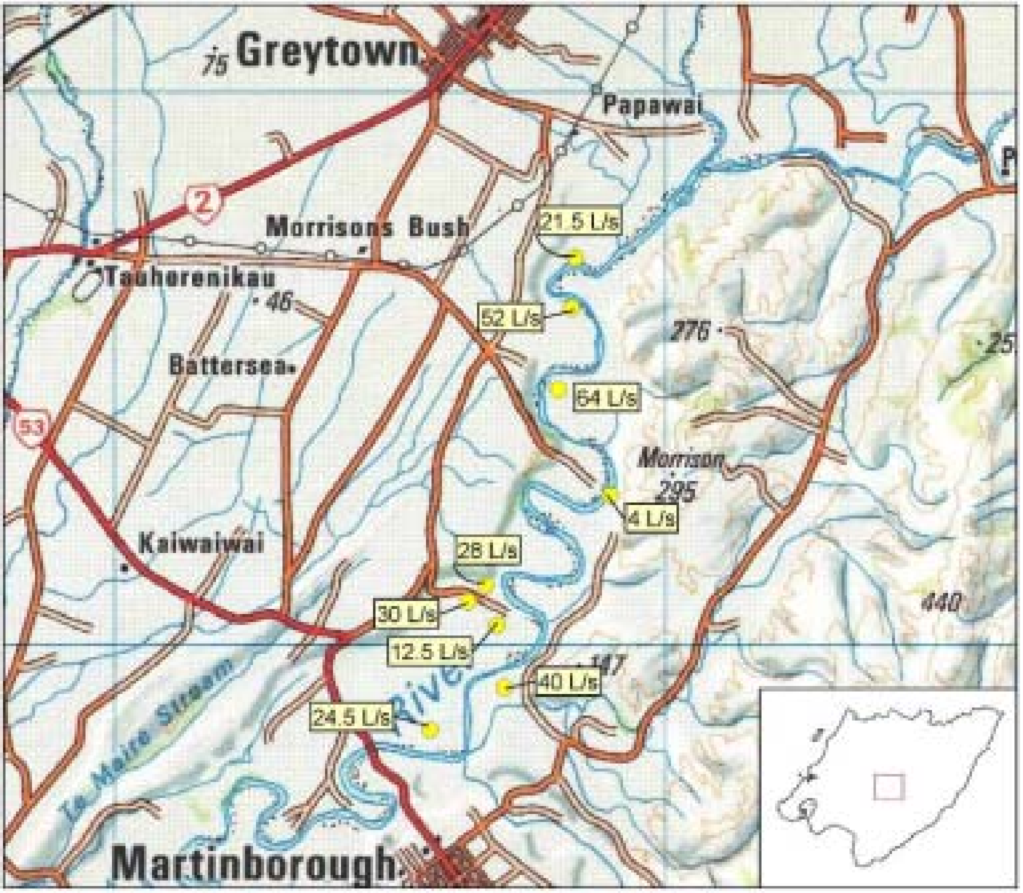

Figure 18: Consented groundwater takes from the shallow gravel aquifer system alongside Lower Ruamahanga River, Waiohine confluence to Waihenga Bridge

5. Water quality

Information on water quality in the Lower Ruamahanga River is important for determining the condition and significance of instream values and for formulating instream flow objectives. Assessing the water quality data will also help identify knowledge gaps that may need to be filled as part of the instream flow assessment.

5.1 Outline of monitoring programmes

There are essentially three types of water quality monitoring conducted on the Lower Ruamahanga River:

- Long-term state of environment water quality monitoring;
- Recreational water quality monitoring; and
- Resource consent (i.e., receiving water) monitoring.

In this report, a summary of the water quality results from the first two monitoring programmes is presented. Although this report focuses on the Lower Ruamahanga River, the water quality results for the entire Ruamahanga River are included to show variations in water quality along the length of the river.

5.1.1 State of environment water quality monitoring

Greater Wellington has monitored water quality of the Ruamahanga River since 1991. Since that time, the monitoring programmes have been reviewed and altered to improve their information value, resulting in a number of changes to monitoring site location, the range of water quality variables monitored, and the methods of analysis (Milne & Perrie 2005). The most significant changes occurred in August 2003 when the Rivers State of the Environment (RSoE) monitoring programme was reviewed. The aims of the RSoE programme are to:

1. Assist in the detection of spatial and temporal changes in fresh waters.

2. Contribute to our understanding of freshwater biodiversity in the region.

3. Determine the suitability of fresh waters for designated uses.

4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality is desired.

5. Provide a mechanism to determine the effectiveness of policies and plans (Milne & Perrie 2005).

There are currently four RSoE monitoring sites located along the length of the Ruamahanga River; McLays, Te Ore Ore, Gladstone and Pukio[4]. Only the most downstream site, Pukio, is located in the Lower Ruamahanga River. All sites have been monitored on a monthly basis for a variety of physico-chemical and microbiological variables since at least September 2003 (although monitoring at Te Ore Ore and Gladstone began in 1997). Biological monitoring of macroinvertebrates and periphyton has also occurred annually during the summer months at each site.

Figure 19: Location of water quality monitoring sites on the Ruamahanga River (Lower Ruamahanga River marked in bold)

5.1.2 Recreational water quality monitoring

In addition to the RSoE monitoring programme, Greater Wellington monitors recreational sites on the Ruamahanga River as part of a region-wide recreational water quality monitoring programme. Monitoring is limited to the official bathing season (1 November to 31 March) and aims to identify any risk to public health from disease-causing organisms, by assessing compliance with Ministry for the Environment (MfE) and Ministry of Health (MoH) microbiological water quality guidelines (2003). Three recreational sites on the Lower Ruamahanga River – Morison’s Bush, Waihenga, and Bentley’s Beach – are included in the monitoring programme (Figure 19).

[4] Three further sites – Mt Bruce, Double Bridges and Waihenga – were removed from the RSoE monitoring programme following recommendations of the review (Warr 2002)

5.1.3 Resource consent monitoring

The Ruamahanga River receives consented point-source contaminant discharges. The major contaminant discharges are stormwater from the main Wairarapa townships, and treated sewage from Rathkeale College, Masterton (via Makoura Stream), Carterton (via Mangatarere River[5]), Greytown (via Papawai Stream), Featherston (via Donalds Creek and Lake Wairarapa) and Martinborough. Other discharges to the Ruamahanga system are from stock water races and activities such as aggregate processing.

There is one direct discharge of treated municipal sewage to the Lower Ruamahanga River, from the Martinborough oxidation ponds, and indirect discharges from the Greytown oxidation ponds (via Papawai Stream) and Featherston (via Lake Wairarapa). Other discharges of treated sewage occur upstream, and therefore may also affect water quality in the Lower Ruamahanga River. Monitoring of the treated sewage discharges and effects on the receiving environments is undertaken by resource consent holders, although until 2003 the monitoring was carried out by Greater Wellington.

A summary of the estimated contaminant loadings from each of the treated municipal sewage discharges and the effects of each discharge on its receiving waters was previously reported by Greater Wellington (Watts 2001), and is not repeated in this report. However, reference to the water quality results collected downstream of the Martinborough treated sewage discharge are included where appropriate.

5.2 Physico-chemical water quality monitoring results

5.2.1 Spatial patterns and guideline compliance

The key physico-chemical and microbiological water quality variables included in the RSoE monitoring programme and relevant guidelines are outlined in Table 6. Most of the guidelines used in this report are the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (herewith denoted as ANZECC 2000) “default trigger values” for aquatic ecosystems. These trigger values are intended to be compared with the *median* value from independent samples at a site. They are not legal standards and exceedances do not necessarily mean an adverse environmental effect would result. Rather an exceedance is an ‘early warning’ mechanism to alert resource managers of a potential problem or emerging change that may warrant site-specific investigation or remedial action (ANZECC 2000).

[5] Discharge to the river system does not occur during January, February and March

Table 6: Physico-chemical and microbiological variables and guideline values used in this report

Variable	Guideline Value	Reference
Water Temperature (ºC)	< 20	-
Dissolved Oxygen (% saturation)	≥ 80	RMA 1991 Third Schedule
pH	6.5-9.0	ANZECC (1992)
Conductivity (uS/cm)	-	-
Clarity (m)	≥ 1.6	MfE (1994)
Turbidity (NTU)	≤ 5.6	ANZECC (2000)
Total Organic Carbon (mg/L)	-	-
Nitrite-Nitrate Nitrogen (mg/L)	≤ 0.444	ANZECC (2000)
Ammoniacal Nitrogen (mg/L)	≤ 0.021	ANZECC (2000)
Total Nitrogen (mg/L)	≤ 0.614	ANZECC (2000)
Dissolved Reactive Phosphorus (mg/L)	≤ 0.010	ANZECC (2000)
Total Phosphorus (mg/L)	≤ 0.033	ANZECC (2000)
E. coli (cfu/100 mL)[6]	≤ 100	ANZECC (2000)

Table 7 summarises selected water quality variables for the period September 2003 to August 2006 inclusive. Water quality generally declines with distance downstream from the McLays site, with increasing nutrient concentrations and decreasing water clarity. Deteriorating water quality with distance downstream can be illustrated by the increased probability of water quality guidelines being exceeded. For example, the percentage of sampling occasions for which the visual clarity guideline was exceeded were 31%, 58%, 64% and 83% for the McLays, Te Ore Ore, Gladstone Bridge and Pukio sites respectively.

[6] Recreational water quality guidelines also exist for *E. coli*, and differ to the guideline value shown here. Discussion of the recreational water quality monitoring programme and analysis of *E. coli* data collected as part of that programme occurs in Section 5.5.

Table 7: Summary of selected water quality data and compliance with guideline values for the RSoE sites on the Ruamahanga River (Sept 2003 – Aug 2006). Number of samples = 36*

Variable		McLays	Te Ore Ore	Gladstone Br	Pukio
Temperature (ºC)	Median	9.4	13.8	14.1	15.2
	Min	4.4	8.3	8.8	8.0
	Max	18.5	26.0	24.6	25.5
	% Results > 20ºC	0	8.3	13.9	13.9
Dissolved Oxygen (% saturation)	Median	100.0	102.5	99.4	98.5
	Min	88.9	93.6	90.3	83.3
	Max	124.8	121.9	149.9	133.1
	% Results <80%	0	0	0	2.9
pH	Median	7.4	7.7	7.5	7.6
	Min	7.1	6.9	7.0	7.0
	Max	7.8	8.7	9.6	9.0
	% Results <6.5 or >9	0	0	8.3	0
Visual Clarity (m)	Median	2.65	1.10	1.09	0.75
	Min	0.20	0.04	0.04	0.02
	Max	8.35	3.64	3.40	2.95
	% Results <1.6 m	30.6	58.3	63.9	83.3
Turbidity (NTU)	Median	1.0	3.2	4.0	7.6
	Min	0.2	0.3	0.5	0.4
	Max	23.6	350	223	358
	% Results >5.6 NTU	16.7	36.1	38.9	52.8
Conductivity (µS/cm)	Median	47	129	112	138
	Min	27	56	52	63
	Max	65	193	147	204
Total Organic Carbon (mg/L)	Median	1.2	2.1	2.1	2.5
	Min	0.7	1.3	1.2	1.2
	Max	3.2	11.4	8.3	12.4
Nitrate-Nitrite Nitrogen (mg/L)	Median	0.025	0.449	0.537	0.505
	Min	<0.01	<0.01	0.026	<0.01
	Max	0.304	1.390	1.590	1.520
	% Results >0.444	0	55.6	63.9	58.3
Ammoniacal Nitrogen (mg/L)	Median	0.005	0.005	0.020	0.011
	Min	<0.01	<0.01	<0.01	<0.01
	Max	0.100	0.060	0.090	0.070
	% Results >0.021	11.1	8.3	47.2	22.2
Total Nitrogen (mg/L)	Median	0.055	0.551	0.709	0.640
	Min	0.025	0.230	0.240	0.051
	Max	0.420	1.850	2.000	2.100
	% Results >0.614	0	41.7	61.1	55.6
Dissolved Reactive Phosphorus (mg/L)	Median	0.005	0.010	0.025	0.019
	Min	<0.005	<0.005	0.010	<0.005
	Max	0.019	0.182	0.047	0.061
	% Results >0.010	2.8	44.4	97.2	80.6
Total Phosphorus (mg/L)	Median	0.008	0.020	0.043	0.040
	Min	<0.005	<0.005	0.015	<0.005
	Max	0.047	0.198	0.999	0.352
	% Results >0.033	5.6	25	75	66.7
E. coli (cfu/100 mL)	Median	4	100	39	110
	Min	<1	15	4	12
	Max	700	4500	3600	3800
	% Results >100	8.3	47.2	22.2	50

* N = 35 for dissolved oxygen at Te Ore Ore, Gladstone Bridge and Pukio

The results from Pukio give an indication of water quality in the Lower Ruamahanga River. At that site, guideline values (as in Table 6) for turbidity, clarity, nitrogen (nitrite-nitrate and total), phosphorus (dissolved reactive and total) and *E. coli* were exceeded on at least 50% of sampling occasions (Table 7).

A closer look at selected water quality variables – visual clarity (black disc), *E. coli*, dissolved reactive phosphorus and nitrite-nitrate nitrogen – indicates that the decline in water quality along the Ruamahanga River largely occurs between the McLays and the Te Ore Ore site north of Masterton (Figure 20). With the exception of dissolved reactive phosphorus, downstream of Te Ore Ore further degradation is less pronounced. As discussed further in Section 5.6, the water quality degradation most probably reflects a significant change in land use (from predominantly indigenous vegetation cover to pastoral) downstream of McLays.

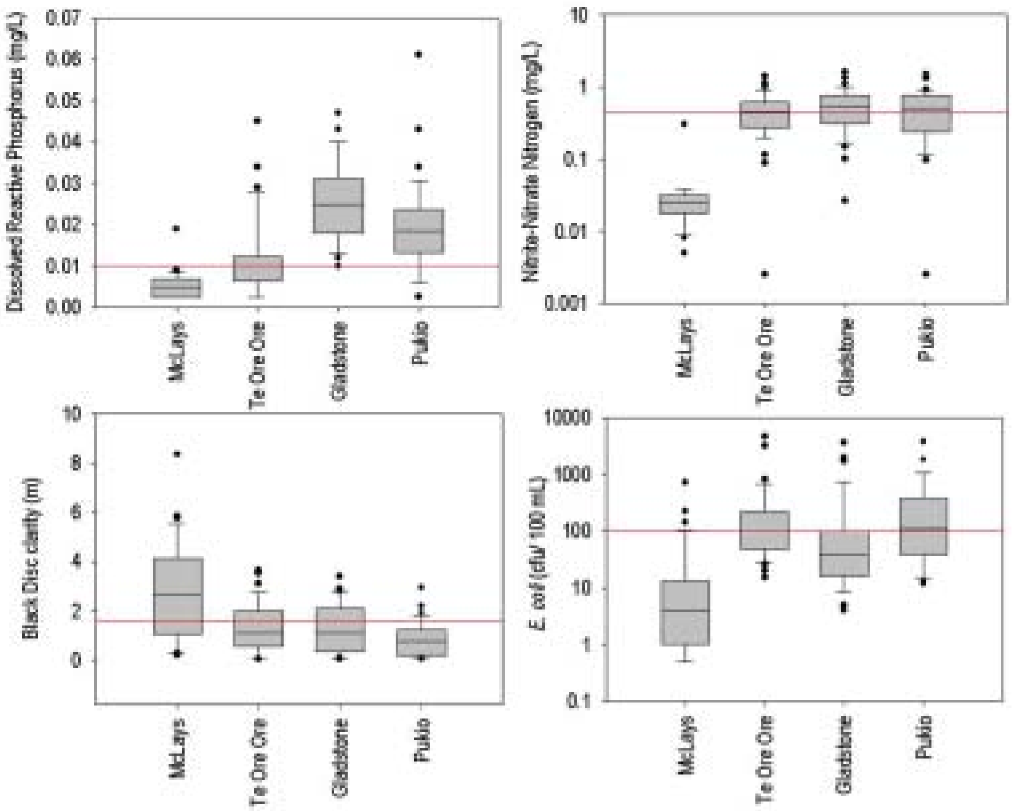

Figure 20: Dissolved reactive phosphorus, nitrite-nitrate nitrogen, visual clarity (black disc), and ***E. coli*** results from routine monthly monitoring of the Ruamahanga River (September 2003 – August 2006). Guidelines shown in red (from Table 6).

The use of a regional water quality 'index' which incorporates six key physico-chemical and microbiological variables (detailed in Milne & Perrie 2005) also serves to demonstrate the decline in water quality with distance downstream on the Ruamahanga River (Table 8). At McLays, water quality complied with guideline and trigger values for all six key variables and is assigned a water quality grade of 'very good'. The Te Ore Ore and Gladstone sites failed guidelines for two and three of the six key water quality variables respectively and are therefore classed as having ‘fair’ water quality.

Table 8: Water quality index ratings for RSoE monitoring sites on the Ruamahanga River, based on compliance of monthly monitoring data with guideline values, 2003 – 2006

Site	Nitrite-Nitrate Nitrogen	Ammoniacal Nitrogen	Dissolved Oxygen	Dissolved Reactive Phosphorus	***E. coli***	Clarity	Water Quality Rating
McLays	✓	✓	✓	✓	✓	✓	Very Good
Te Ore Ore	X	✓	✓	✓	✓	X	Fair
Gladstone Bridge	X	✓	✓	X	✓	X	Fair
Pukio	X	✓	✓	X	X	X	Poor

The Pukio site on the Lower Ruamahanga River exceeded guidelines for four of the six variables and is classed as having ‘poor’ water quality. Note that this index is for comparative purposes rather than an absolute measure of water quality; the index was developed to facilitate inter-site comparisons across the Wellington region (Milne & Perrie 2005). The ‘poor’ class assigned to Pukio indicates that the site is degraded relative to many of the other RSoE sites in the Wellington region.

5.3 Macroinvertebrate monitoring results

Macroinvertebrates are organisms that lack a backbone and are larger than 250 microns. Stream macroinvertebrate community structure is a product of both the physical environment and water quality over time (Milne & Perrie 2005). Various biotic indices have been developed to provide an indication of the water quality based on the number, type and abundance of macroinvertebrate taxa present at a monitoring site. The Macroinvertebrate Community Index (MCI) was developed by Stark (1985, 1993, 1998) for assessing organic enrichment of stony or hard-bottomed streams based on sampling macroinvertebrates from riffle or run habitats. The %EPT taxa scores[7] indicate the presence of pollution-sensitive taxa.

Analysis of the annual macroinvertebrate sampling results for 2004, 2005 and 2006 show that mean MCI scores generally decrease with distance downstream on the Ruamahanga River (Table 9). The McLays site has some of the highest MCI scores observed across the Wellington region, indicating the pristine water quality and high habitat quality available for macroinvertebrates in the upper reaches of the Ruamahanga River. The most significant downstream change in macroinvertebrate community occurs between the upstream site, McLays, and Te Ore Ore (north of Masterton).

[7] The %EPT taxa score is the number of pollution–sensitive Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa present, expressed as a percentage of total taxa richness.

Table 9: Mean MCI and %EPT (taxa) scores for RSoE sites on the Ruamahanga River, based on three replicate samples

Macroinvertebrate Community Index (MCI)								
	2004		2005		2006		Overall mean	Overall SD
	mean	SD*	mean	SD	mean	SD		
McLays	145.9	4.1	146.5	1.5	153.6	9.5	148.7	6.4
Te Ore Ore	113.0	11.9	100.9	5.9	114.8	2.5	109.6	9.4
Gladstone Bridge	121.5	15.6	118.3	13.6	110.4	14.9	116.7	13.7
Pukio	97.7	10.7	110.7	6.1	110.4	4.6	106.3	9.2
%EPT taxa								
	2004		2005		2006		Overall mean	Overall SD
	mean	SD	mean	SD	mean	SD		
McLays	62.0	1.9	72.4	6.9	67.6	2.9	67.3	5.9
Te Ore Ore	41.7	8.3	34.3	1.7	43.2	7.2	39.7	6.9
Gladstone Bridge	50.9	7.0	45.8	15.0	46.3	14.2	47.7	11.2
Pukio	40.6	6.7	37.9	4.8	44.4	11.1	41.0	7.5

*Standard deviation

The three lower sites (Te Ore Ore, Gladstone and Pukio) share similar scores for MCI and %EPT taxa. This is surprising because the habitat quality at the most downstream site (Pukio) is considered to be much poorer than at the two upstream sites, with relatively fine substrate and the absence of a 'true' riffle to sample (Figure 21). Both water quality and habitat quality influence invertebrate communities.

Figure 21: Ruamahanga River at Pukio sampling site, showing absence of a 'true riffle' in which to collect macroinvertebrate samples

Macroinvertebrate data are available for other sites on the Lower Ruamahanga River: Waihenga Bridge (dropped from the monitoring programme in 2003) and Martinborough (downstream of the Martinborough oxidation pond discharge, monitored historically as part of resource consent conditions). The results show that monitored sites have MCI scores that generally fall into the 'possible mild pollution' category of Stark (1985, 1993).

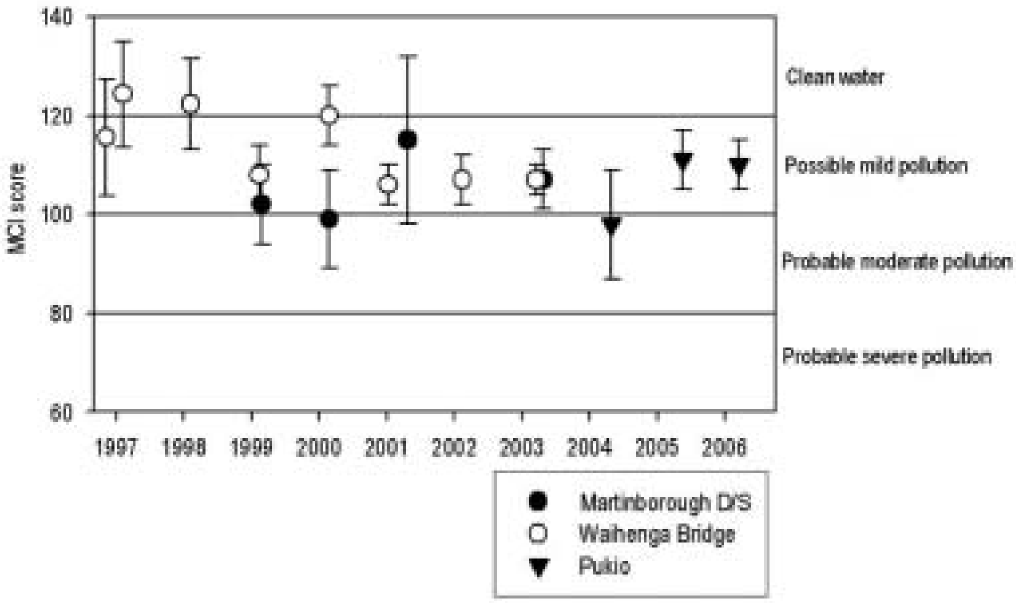

Figure 22: MCI scores (with one standard deviation shown) for sampling sites on the Lower Ruamahanga River

5.4 Periphyton monitoring results

Periphyton is the slimy material attached to the surfaces of rocks and other bottom substrate in rivers and streams. It is comprised of algae, diatoms, bacteria, and fungi and plays a key role in aquatic food webs because it is the main source of food for benthic invertebrates, which in turn are an important food source for fish. Excessive periphyton growths may block intake screens for water supply, and reduce the aesthetic, recreational and ecosystem values of rivers and streams (Milne & Perrie 2005). Periphyton cover is assessed visually on a monthly basis as part of the RSoE monitoring programme, and weekly over the summer months as part of the recreational water quality monitoring programme.

Analysis of monthly observations of percent periphyton cover, for the period September 2003 to August 2006 inclusive, shows that MfE (2000) guidelines[8] for aesthetic and recreational values were almost always complied with, with only one exceedance recorded at Pukio during February 2006. However, intensive (weekly) monitoring of periphyton in the Lower Ruamahanga River as part of the recreational water quality monitoring programme shows that at times during the bathing season the periphyton cover at Morison's Bush and

[8] The MfE (2000) guidelines provide two maximum thresholds for periphyton cover in gravel/cobble bed streams managed for aesthetic and recreational values: 30% filamentous algae >2 cm long, and 60% cover for diatoms/cyanobacteria >0.3 cm thick.

Waihenga exceeds the MfE (2000) guidelines for recreation (Milne 2005, Milne & Wyatt 2006a). The greatest periphyton cover tends to occur in January and February, coinciding with the time of most stable river flows and warm weather.

Annual measurements of periphyton biomass (chlorophyll *a* and Ash Free Dry Weight (AFDW)) collected during the annual biological monitoring in 2004, 2005 and 2006 (Table 10), comply with trout habitat and angling guidelines (MfE 2000) at all four sites. However, the chlorophyll *a* guideline for benthic biodiversity (maximum of 50 mg/m^2, MfE 2000) was exceeded in 2004 at Pukio and in 2005 at Te Ore Ore. It is likely that generally regular low flow freshes in the Ruamahanga River help reduce the risk of problematic periphyton blooms.

Table 10: Chlorophyll ***a*** and Ash Free Dry Weight (AFDW) concentrations for Ruamahanga River RSoE sites, monitored annually in 2004, 2005 and 2006

	Chlorophyll ***a*** (mg/m²)			AFDW (g/m²)		
	2004	2005	2006	2004	2005	2006
McLays	2.46	5.59	0.46	0.65	1.07	0.29
Te Ore Ore	27.28	66.53	11.27	3.30	7.86	3.00
Gladstone	13.19	12.02	4.08	1.95	1.97	1.02
Pukio	61.26	0.25	5.28	5.17	1.82	3.92

5.5 Recreational water quality monitoring results

Water contaminated by human or animal excreta may contain a diverse range of pathogenic (disease-causing) micro-organisms such as bacteria, viruses, and protozoa (e.g., salmonella, campylobacter, cryptosporidium and giardia). These organisms may pose a health hazard when the water is used for recreational activities such as swimming. Compliance with the MfE / MoH (2003) microbiological water quality guidelines for recreational waters should ensure that people using the water for contact recreation are not exposed to significant health risks. The guidelines use bacteriological indicators associated with the gut of warm blooded animals to assess the risk of faecal contamination; the indicator bacteria for freshwater is *Escherichia coli* (*E. coli*) (Milne & Wyatt 2006b).

In addition to the use of quantitative guideline values of bacteriological indicators, the MfE / MoH (2003) guidelines advocate a risk-based approach to managing recreational waters. This involves a qualitative assessment of the susceptibility of a recreational site to faecal contamination, and direct measurements of appropriate bacteriological indicators at the site to generate a "Suitability for Recreation Grade" (SFRG) for the site.

Compliance with the MfE / MoH (2003) guidelines and the SFRGs for high recreational use rivers in the Wellington region were presented by Milne & Wyatt (2006b). The compliance assessment and SFRGs for the Lower Ruamahanga River recreation sites are based on five years (2001-2006) of data for Morison's Bush and Waihenga, and four years (2002-2006) of data for Bentley's Beach (Table 11). All three monitored sites on the Lower Ruamahanga River were assigned 'very poor' SFRGs. The grading was based on a high *E. coli* 95th percentile value (>550 cfu / 100 mL) and a high risk of microbiological contamination from intensive agriculture in the immediate catchment.

Table 11: Summary of recreational water quality (***E. coli***) monitoring results and suitability for recreation grades (SRFG) at recreational water quality monitoring sites on the Lower Ruamahanga River

Site	Number of ***E. coli*** samples	Number of action events*	95th %ile (***E. coli*** / 100 mL)	Key microbiological risks	SFRG†
Ruamahanga River at Morison's Bush	103	10	1209	Intensive agriculture in immediate catchment	Very poor
Ruamahanga River at Waihenga	103	10	1571	Intensive agriculture in immediate catchment	Very poor
Ruamahanga River at Bentley's Beach	77	8	1233	Intensive agriculture in immediate catchment	Very poor‡

*Action level in MfE / MoH (2003) guidelines is when *E. coli* exceeds 550 cfu/100 mL

†Derived as outlined by MfE / MoH (2003) using *E. coli* monitoring results and a qualitative risk assessment

‡Interim SFRG only (guidelines require five years of data)

E. coli counts and exceedances of the MfE / MoH microbiological guidelines at the Lower Ruamahanga River recreation sites are highly correlated with rainfall prior to sampling (Milne & Wyatt 2006b). For example, there were 10 occasions during the 2001-2006 summer bathing seasons when *E. coli* samples exceeded the 550 cfu/100 mL 'action' level at Waihenga; on all these occasions there was at least 5 mm of rainfall[9] in the 48 hours prior to sampling (Figure 23), with at least 20 mm on six occasions. The elevated *E. coli* counts following rainfall are considered to be a result of agricultural runoff to the Ruamahanga River, both directly and indirectly via tributary rivers and streams.

[9] Rainfall recorded at Mt Bruce, north of Masterton.

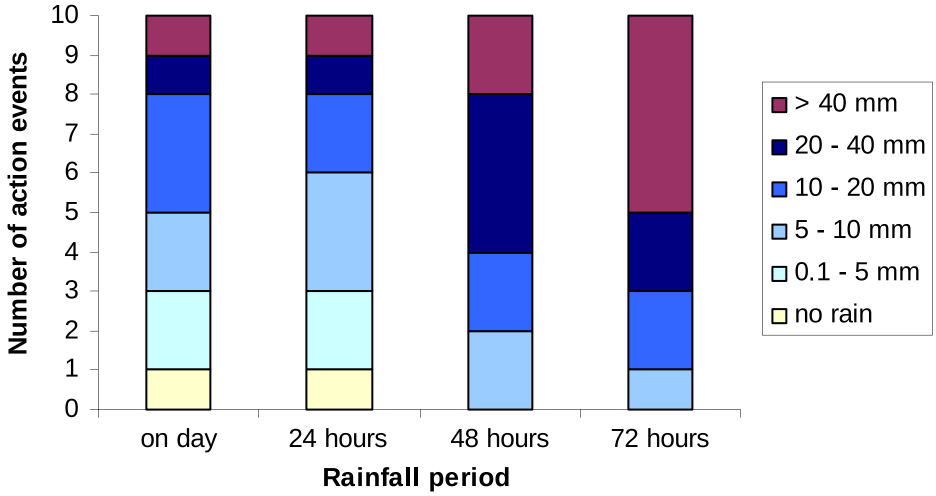

Figure 23: Rainfall on the day and in the hours prior to action level ***E. coli*** results recorded during routine weekly sampling in the Ruamahanga River at Waihenga, 2001 to 2006 bathing seasons

(Source: Milne & Wyatt 2006b)

Removing the 'action' level *E. coli* counts that coincided with more than 10 mm of rainfall in the 72 hours prior to sampling results in the three Lower Ruamahanga River monitoring sites being reclassified as having a SFRG of 'poor' (Milne & Wyatt 2006b). Under the MfE / MoH (2003) guidelines, the Lower Ruamahanga River will always have a grading of 'poor' or 'very poor' because of the intensive agricultural land use in the immediate catchment.

The MfE (2003) 'very poor' SFRG recommends swimming should be avoided. However, the use of the 95th percentile *E. coli* value in deriving the classification means that the grade better reflects the condition of the bathing sites during wet weather rather than in dry weather when recreational activity is greatest (Milne & Wyatt 2006b).

5.6 Summary

As previously reported (e.g., Milne & Perrie 2005), there is a general decline in water quality with distance downstream in the Ruamahanga River. This decrease in water quality is attributed to changes in land cover and land use practices, and the influence of point source municipal wastewater discharges. Downstream of the McLays monitoring site, indigenous forest and scrub cover gives way to increasing pastoral cover that supports various agricultural land uses (Figure 24).

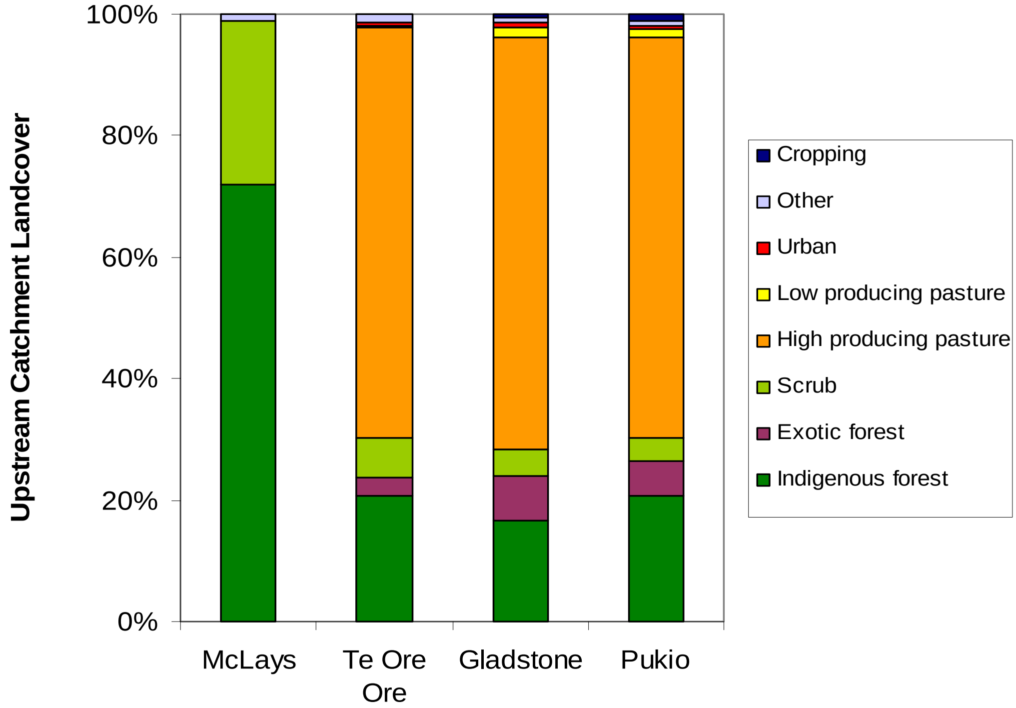

Figure 24: Predominant land cover types in the catchment area of each of the Ruamahanga River RSoE monitoring sites

(Source: Landcover Database Version 2, MfE 2001)

In addition to agricultural inputs, treated municipal wastewater the five main townships of the Wairarapa is discharged into the Ruamahanga River, either directly or indirectly via its tributaries. Analysis has shown that these discharges contribute significant loads of nutrients (particularly phosphorus) into the Ruamahanga River (Watts 2001).

The pristine water quality and high macroinvertebrate health evident in the monitoring data for the McLays monitoring site is typical for a relatively undisturbed headwater catchment dominated by native forest. The three downstream monitoring sites all have catchments that are predominantly high producing pasture (almost 70% cover). Rivers with catchments dominated by agricultural land uses typically have poorer water quality and these sites are no exception; all three regularly exceed trigger values and guidelines for dissolved nutrients and water clarity. The decline in water quality downstream of McLays is also evident in a decrease in MCI and %EPT taxa scores, indicating a degradation of macroinvertebrate community health.

Pukio is the most downstream monitoring site and is representative of the water quality of the Lower Ruamahanga River. This site, not unexpectedly due to its location at the bottom of a predominantly agricultural catchment, has the poorest water quality and based on Greater Wellington's water quality index is classed as 'poor' relative to other sites monitored in the region. Guideline values for clarity and dissolved nutrients were generally exceeded on more than half of the sampling occasions since monitoring began in 2003. The Pukio, Waihenga Bridge, and Martinborough (downstream of the oxidation pond discharge) MCI results indicate 'possible mild pollution', although this may also reflect the degradation in habitat quality as well as poorer water quality in the Lower Ruamahanga River.

Weekly monitoring of three sites on the Lower Ruamahanga River over the summer bathing seasons show that the river tends to fail recreational water quality guidelines (for faecal indicator bacteria) on occasions, particularly following rainfall. The high *E. coli* counts following rainfall are considered to be due to runoff from agricultural areas. All three monitored sites on the Lower Ruamahanga River have been assigned 'very poor' suitability for recreation grades. However, in this case the grading system of MfE / MoH (2003) better reflects the condition of the bathing sites during wet weather, rather than in dry weather when recreational activity is greatest (Milne & Wyatt 2006b).

Nothing is known of the water quality downstream Pukio; there is approximately 30 kilometres of river length before it discharges into Lake Onoke. Tidal movement of saltwater up the Ruamahanga River is likely to be the major change in water quality in this reach, but it is not known to what extent saltwater intrudes up the river and affects the ecosystem.

6. Instream values and current condition

Instream values of a waterway include ecological, landscape, recreational, and Maori customary and traditional values (Ministry for the Environment 1998). There can be considerable overlap in these values.

Ecological value refers to the value of all vegetation and fauna within a river system. The matters in Part II of the RMA that relate directly to ecological values are:

- Section 5(2)(b): The life-supporting capacity of water and ecosystems;
- Section 6(c): Significant habitats of fauna;
- Section 7(d): Intrinsic values of ecosystems;
- Section 7(f): Maintenance and enhancement of the quality of the environment; and
- Section 7(h): The protection of the habitat of trout and salmon.

Landscape (or aesthetic) values refer to the natural character and amenity values of a waterway (Ministry for the Environment 1998).

Recreational value refers to the value of the waterway for activities such as canoeing, kayaking, rafting, angling, swimming, and picnicking.

Maori customary and traditional values include the mauri of a water resource (‘life force’ and life-supporting capacity), importance for mahinga kai (food sources), and waahi tapu (places of special spiritual significance) (Ministry for the Environment 1998).

6.1 How were instream values identified?

There have been limited investigations into instream values of the Lower Ruamahanga River, with most published reports focusing on particular values such as instream ecology (Boffa Miskell 1993), or as regional summaries (e.g., Smith 1989). As part of Greater Wellington’s Framework for Instream Flow Assessment in the Wellington region (working version, 2006), a ‘field assessment’ is conducted to confirm the instream values and identify the flow-related issues. The instream values of the Lower Ruamahanga were identified in the following ways:

- A field trip (18 December 2006) with representatives from Fish & Game New Zealand (B. Abernethy, Field Officer) and Department of Conservation (N. Gibbs, Technical Support Officer - Freshwater & Marine) to discuss ecological and recreational (angling) values and threats to those values;

- Meetings with representatives from Kahutara Canoes (J. McCosh) and Wairarapa Jet Boat Club (B. Eccles and H. Neal) to discuss recreational values; and

- Consultation with iwi representatives to discuss Maori cultural and traditional values (ongoing).

The information gained during the field trip and consultation is included in the value descriptions and current condition summary below.

6.2 Ecological values

The first reach of the Lower Ruamahanga River – from the Waiohine confluence to Bentley's Beach – provides relatively good instream habitat. This includes hydraulic diversity (pool / riffle / run sequences), gravel substrate, and shade from riparian vegetation in places (predominantly willows). From the second reach through the third reach to the confluence at Lake Onoke the habitat value of the river declines due to a lack of hydraulic (and therefore habitat) diversity. In addition, the third reach has limited riparian vegetation. The fish experts present on the field visit felt that the habitat value of the lower reaches of the Ruamahanga River had been reduced due to channel modification and poor water quality (B. Abernethy & N. Gibbs 2006, pers. comm.).

Greater Wellington does not undertake any regular monitoring of fish populations to confirm the value of the river as fish habitat. NIWA's New Zealand Freshwater Fish Database (NZFFD) contains 222 records for the Ruamahanga catchment, comprising 32 species of fish. However, the vast majority of these records relate to tributaries of the Ruamahanga River with only four occurring in the Ruamahanga River itself, and only two of these are for the Lower Ruamahanga River.

More than half of the 32 species recorded in the Ruamahanga catchment have life histories that involve some form of diadromy (migrations between fresh and sea water). Thus while we have little indication of the value of the Lower Ruamahanga River as fish habitat, it is extremely important as a fish 'corridor' and allows many species to travel between upstream freshwater habitats and the sea. It is one of 14 rivers in the Wellington region ranked as 'very important' for native fish migration (Strickland & Quarterman 2001)

Only two species, lamprey and giant kokopu, are recorded in the NZFFD for the Lower Ruamahanga River. However, if further fish surveys were conducted the number of species known to utilise the Lower Ruamahanga River as habitat (e.g., not just passing through) would greatly increase (possibly up to 10 or more species). It is likely that the Lower Ruamahanga River provides important fish habitat for many species, both native and introduced, and both diadromous and non-diadromous, (e.g., brown trout, perch, rudd, longfin eels, shortfin eels, common bullies, inanga, smelt).

The Lower Ruamahanga River in general is important for trout, in particular for providing access to spawning reaches in the tributary rivers (such as the Mangatarere River and Huangarua River) (Boffa Miskell 1993; Strickland & Quarterman 2001). A high proportion of trout in the Ruamahanga catchment are "sea-run" (i.e., diadromous) and therefore – once again – the lower reaches of the river are important as a conduit (B. Abernethy 2006, pers. comm.). Trout support a valued recreational fishery in the Ruamahanga River, as outlined in Section 6.4 below.

6.2.1 Threats to ecological values

Low river flows in the Ruamahanga River, which are exacerbated by abstraction, may threaten ecological values because during times of low flow:

- The amount of available aquatic habitat is reduced;
- Water quality is reduced through less dilution of contaminants, increased susceptibility to high water temperatures, and associated reduced dissolved oxygen (which in turn may threaten life supporting capacity); and
- Periphyton growth is encouraged (which may adversely impact habitat quality).

The extent to which low flows and abstraction have affected the ecological value of the Lower Ruamahanga River is uncertain. Available habitat is likely to be most affected by low flows in reaches 1 and 2 of the river; the uniform habitat in reach 3 with an absence of riffles is not likely to change significantly at low flows (J. Hayes[10] 2006, pers. comm.). The effect of low flows on water quality in the Lower Ruamahanga River has not been thoroughly investigated.

Contaminant discharges to a river may reduce water quality, which in turn may lower habitat quality and threaten the life-supporting capacity of the river. Discharges to the Ruamahanga River and its major tributaries include point-source and non-point source discharges. Point-source discharges include stormwater discharges from various Wairarapa townships, and treated municipal wastewater from Masterton (via Makoura Stream), Carterton (via Mangatarere River), Greytown (via Papawai Stream), Featherston (via Lake Wairarapa) and Martinborough. These discharges contribute to the river's nutrient and microbial loads. Agricultural runoff may also contribute significantly to nutrient enrichment, microbial contamination and sediment accumulation. In addition, direct stock access to rivers and streams can add to the degradation through direct deposit of faecal matter into the water and damage to banks (Milne & Perrie 2005).

The 'poor' water quality rating assigned to the Lower Ruamahanga River – based on water quality data collected at Pukio – indicates that the life-supporting capacity of the river may be threatened. The poor water quality rating is supported by relatively low MCI scores, indicating possible mild pollution. At this stage there are no continuous dissolved oxygen or water temperature data, key variables in the assessment of life supporting capacity. Along with low dissolved oxygen and high water temperatures, nutrient enrichment and its impacts on ecological value of the Lower Ruamahanga River were key concerns of the fish experts consulted during the field assessment.

Channel modification of the Lower Ruamahanga River has no doubt had positive implications for flood control in the lower Wairarapa valley. However,

[10] Fisheries Scientist, Cawthron Institute

channel straightening, stopbanking, and diversion of flood flows can affect instream habitat and ecological values by generally causing:

- A loss of hydraulic diversity (pool / riffle / run sequences);
- A change in bank and stream bed composition;
- Less undercutting of banks and gravel deposition (associated with meandering);
- Loss of connectivity with wetlands and/or oxbow lakes; and
- A loss, or change in the type of, riparian vegetation.

As discussed above, the river control works have had a major impact on the difference in ecological values between the three reaches of the Lower Ruamahanga River (Boffa Miskell 1993). However, it is not known exactly how much these control works have contributed to the change in hydraulic diversity (pool / riffle / run sequences) between the reaches. The decreased hydraulic diversity and lack of gravel beaches in the lower reaches means that there is less diverse habitat available for fish. In addition, loss or lack of riparian vegetation in the Ruamahanga Diversion area means there is limited shading for fish habitat (B. Abernethy 2006, pers. comm.).

6.3 Landscape values

The Ruamahanga River is highly valued by the Wairarapa community for the landscape value it provides. Angling surveys have shown that the river is highly rated for its peace, solitude and scenic value (Smith 1989), particularly in its upper and 'middle' (Waingawa confluence to Tuhitarata Bridge) reaches[11]. Much of the Lower Ruamahanga River has riparian vegetation, in the form of willows, which add to the landscape values.

Although landscape values are very subjective, the aesthetic value of the river arguably declines downstream of about Tuhitarata Bridge. In this reach the effects of river modification are dominant (particularly the artificial Ruamahanga Diversion), and the river often appears turbid which reduces the aesthetic value. During routine monitoring of the Lower Ruamahanga River water clarity guidelines were exceeded approximately 80% of the time (at Pukio). The poor clarity may be related to upstream river works, runoff from agricultural areas following rainfall, and stock access to the river.

6.4 Recreational values

The Lower Ruamahanga River receives high usage for recreational purposes, because it is a large, accessible, gravel-bed river. The entire Lower Ruamahanga River is recognised in the Regional Freshwater Plan as having regionally important recreation and amenity values. The main types of recreational use are:

- Swimming and picnicking;
- Angling;

[11] Ruamahanga River reaches as classified by Fish & Game New Zealand

- Canoeing and kayaking; and
- Power boating.

The Lower Ruamahanga River is very popular for swimming and picnicking during summer months because it is an accessible river which is deep enough for swimming. Some of the most popular locations for swimming are the accessible gravel beaches at Morison's Bush, Waihenga Bridge, and Bentley's Beach.

The Ruamahanga River in general is considered to be of very high value for angling purposes and is the principal trout fishery in the Wairarapa (Fish & Game New Zealand n.d.; B. Abernethy 2006, pers. comm.). The main stem of the Ruamahanga River ranked second, in terms of angler days, among 58 water bodies in the Wellington region[12] in the latest national angler survey (Unwin & Image 2003), behind the Manawatu River. The majority of fishing effort is concentrated in the reaches between Masterton and Martinborough.

The river is highly valued for angling due to its ease of access and scenic beauty (Smith 1989). The first and second reaches of the Lower Ruamahanga River – from the Waiohine confluence to Tuhitarata Bridge – have some excellent fly and spin fishing. Downstream of Tuhitarata Bridge trolling is popular, especially in autumn when sea run brown trout move into the river. Some of the best perch fishing in the Wellington region is found in this bottom reach of the Lower Ruamahanga River (Fish & Game New Zealand n.d.).

Canoeing and kayaking are popular throughout the year. In particular, the reach between Bentley's Beach and Tuhitarata Bridge is highly used, and Kahutara Canoes operate tours in this part of the river (J. McCosh 2007, pers. comm.).

The Lower Ruamahanga River has high value for jet boating, and is considered one of the best rivers in the North Island for this use (B. Eccles & H. Neal 2007, pers. comm.). Popular access points are Morison's Bush, Waihenga Bridge, and the Ruamahanga Diversion.

6.4.1 Threats to recreational values

Low flows in the Ruamahanga River threaten recreational values because during times of low flow:

- Water depth and velocity are reduced;
- Water quality may be reduced; and
- Periphyton growth may be encouraged.

Recreational users of the Lower Ruamahanga River find that, during times of very low flow, water depth over riffles is reduced so that canoeing and jet boating are affected (J. McCosh, B Eccles & H Neal 2007, pers. comm.). Low flows are unlikely to affect swimming through low water levels, because pool depth generally varies relatively little with flow. However, the recreational value for swimming may be reduced due to poor water quality and high

[12] Fish & Game region boundary for Wellington, which includes that Manawatu

periphyton growth, which may be linked to low flows (and associated high water temperatures). Monitoring has shown that at times periphyton cover in the Lower Ruamahanga River exceeds guidelines for aesthetic and recreational values (Milne 2005, Milne & Wyatt 2006a).

Contaminant discharges and stock access contribute to poor water quality in the Lower Ruamahanga River, which threatens recreational values. The three monitored recreational sites on the Lower Ruamahanga River (Morison's Bush, Waihenga and Bentley's Beach) are classified as having poor suitability for recreation grades (following the grading system of MfE / MoH, 2003). As described in Section 5.5, the risk to recreational users from microbiological contamination is highest following rainfall (Milne & Wyatt 2006b).

Channel modification has no doubt changed the recreational values of the Lower Ruamahanga River. In its lower reaches, particularly downstream of Tuhitarata Bridge, gravel beaches are largely absent and access is impinged by stopbanks. This means that swimming and picnicking are less popular than further upstream. However, the Ruamahanga Diversion has created a popular reach for power boating, and has therefore increased the recreational value in this part of the river.

6.5 Maori customary and traditional values

Maori customary and traditional values of the Lower Ruamahanga River have yet to be assessed. Consultation with local iwi representatives has been initiated but not completed at the time this report was being completed.

The Ruamahanga River, being the main river of the Wairarapa valley, is likely to be of significant spiritual value to Wairarapa iwi (and indeed, the community as a whole). However, reduced water quality and the discharge of treated human waste to the river are likely to have reduced the 'mauri' (life force) of the waterway and degraded the mahinga kai (food gathering) environment.

6.6 Summary of instream values and current condition

Ecological values of the Lower Ruamahanga River, particularly in its bottom reach, have been significantly affected by poor water quality and channel modification. Low flows have had an indirect effect on ecological values due to further impaired water quality during times of low flow. However, the river retains an important function of providing a 'corridor' for diadromous fish to travel between upstream reaches and the sea. The river also potentially provides habitat for non-migratory fish, and relatively good habitat diversity is retained downstream to about Bentley's Beach. It is unknown to what extent this habitat is affected by low flows and poor water quality.

Despite the 'very poor' suitability for recreation classification, due to the risk to users from poor water quality, the Lower Ruamahanga River has extremely high recreational values. The types of recreational use vary along the river, with swimming, angling, canoeing and power boating all popular. At times of low flow certain types of recreational use – namely canoeing and power boating – may be adversely affected due to low water depth over riffles. During low flows, particularly in the absence of 'flushing' flows, periphyton cover is encouraged which may also reduce the recreational values of the river.

Landscape values associated with the Ruamahanga River are high, although the aesthetic value of the river in its lower reaches has been reduced due to channel modification. Poor water clarity also threatens the aesthetic value of the river.

Maori customary and traditional values associated with the Lower Ruamahanga River have not yet been assessed. These values are likely to be significant, although poor water quality has potentially degraded the mauri of the river.

6.6.1 Flow-related issues

The assessment of instream values and their current condition has highlighted the following flow-related issues:

- Low flows and abstraction may further degrade the water quality of the Lower Ruamahanga River;
- Periphyton growth is encouraged during low flows particularly in the absence of 'flushing' flows;
- During times of low flow, the amount of habitat is reduced. This effect is likely to be greatest in reaches 1 and 2 of the Lower Ruamahanga River, where pool / riffle / run sequences exist;
- Recreational use of the river may be adversely affected during low flows, due to low water depth over riffles; and
- Following rainfall and during times of high flow in the Lower Ruamahanga River, there is a potential risk to recreational users from microbiological contamination.

7. Proposed instream flow objectives

The instream flow objectives outline the values to be sustained by a recommended flow regime. Water quality management objectives for Wellington's rivers are set out in the Regional Freshwater Plan; for the Lower Ruamahanga River this objective is to manage water quality for recreation and so that recreational values are improved. In addition, under the RMA, Greater Wellington has a responsibility to ensure that the life-supporting capacity of the Ruamahanga River is protected. The development of instream flow objectives as part of this assessment for the Lower Ruamahanga River does not replace these management objectives and responsibilities. Rather, the intention is to have more specific objectives at a technical level, to provide guidance for scientists to investigate instream flow requirements (as recommended by MfE 1998).

The following instream flow objectives are proposed for the Lower Ruamahanga River:

1. *There is adequate water depth for migratory fish passage and recreational boating.*

2. *Sufficient habitat is maintained for fish, in particular brown trout.*

3. *During times of low flow, water quality is suitable for contact recreation and aquatic ecosystem purposes.*

The first objective recognises the importance of the Lower Ruamahanga River as a corridor for fish migration, and as a recreational asset. Some of the stakeholders identified low water depth as an issue during times of low flow.

The second objective acknowledges the importance of the Lower Ruamahanga River for fish, and that low flows may cause habitat loss (particularly in reaches 1 and 2, where habitat diversity is greatest). The proposed objective specifically mentions brown trout but it is recognised that the river is likely to provide important habitat for other species of fish; the proposed investigations outlined in Section 9 will include other species.

The third objective recognises that low flows in the Ruamahanga River can contribute to the state of its water quality. At low flows, water quality can be degraded because of periphyton growths and poor water clarity. The objective does not mean that water quality degraded from contaminants in land runoff and point-source discharges should be addressed through providing adequate river flows for dilution. However, the objective does mean that flow-related declines in water quality should be avoided. Further investigations should determine how realistic this objective is.

8. Constraints

8.1 Key information gaps

There are a number of key information gaps which may act as constraints to assessing instream flow requirements for the Lower Ruamahanga River:

- There is currently no information on unimpacted river flows, and therefore an estimate of natural mean annual low flow cannot be made. The natural mean annual low flow is useful as a ‘reference point’ against which to assess predicted habitat availability and water depths under various minimum flow scenarios.

- Interactions between the Lower Ruamahanga River and groundwater systems are poorly understood. The impact of groundwater abstractions on flow in the Lower Ruamahanga River is therefore unknown.

- The relationship between flow and water quality in the Lower Ruamahanga River is poorly understood. Water quality monitoring data are collected on a monthly basis, and therefore the extremes in water quality (such as high water temperatures during times of low flow) may not be sampled.

- The effect of low flows on hydraulic conditions in the Lower Ruamahanga River is unknown. Information on how changes in flow affect water depth and velocity would be useful for assessing how low flows affect habitat availability and recreational use.

- There is a general paucity of fish data for the Lower Ruamahanga River. Therefore the ecological significance of the river and habitat values are unknown.

8.2 Constraints imposed by non-flow related issues

Non-flow related issues will act to constrain the benefits possible through the implementation of instream flow recommendations. Poor water quality and historic channel modification may limit the recovery of ecological and recreational values of the Lower Ruamahanga River. Although low flows and abstraction may affect water quality, the poor water quality observed in the Lower Ruamahanga River is largely controlled by point-source discharges, a moderate degree of stock access, and runoff from agricultural areas. The benefits of implementing instream flow recommendations may not be fully realised until these aspects are addressed.

A further constraint is that this assessment focuses on the lower section of the Ruamahanga River only. Upstream abstraction affects flow in the Lower Ruamahanga River. It is possible that the flow recommendations resulting from the instream flow assessment may not be achievable without reviewing water allocation policies from the upstream reach and its tributaries.

9. Proposed investigations and next steps

9.1 Investigations targeted to the instream flow objectives

The scientific investigations for an instream flow assessment should be targeted so it is possible to determine flow regimes (such as minimum flows) that will achieve the instream flow objectives.

Proposed instream flow objective 1 is **there is adequate water depth for migratory fish passage and recreational boating**. Proposed scientific investigations:

- Modelling of the effect of changes in flow on water depth, particularly over riffles in reaches 1 and 2 of the Lower Ruamahanga River. The RHYHABSIM model developed to predict changes in habitat is also able to be used for this purpose[13].

Proposed instream flow objective 2 is **sufficient habitat is maintained for fish, in particular brown trout.** Proposed scientific investigations:

[13] Initial fieldwork to calibrate a RHYHABSIM model was collected during the 2006/07 low flow season

- Estimation of an unimpacted (naturalised) mean annual low flow. Determining 'sufficient' habitat availability requires an assessment of the amount of habitat that would be available under natural (no abstraction) conditions.

- Modelling of the amount of habitat available in reaches 1 and 2 at different flows and at the current minimum flow. In these reaches, changes in flow will result in changes in depth and velocity; more significantly so than in reach 3 (which is highly modified and lacks hydraulic diversity). It is proposed that a physical habitat simulation model (RHYHABSIM; Jowett 1989; Clausen et al. 2004) is used for this investigation.

Proposed instream flow objective 3 is **during times of low flow, water quality is suitable for contact recreation and aquatic ecosystem purposes**. Proposed scientific investigations:

- Collection of continuous water quality (temperature and dissolved oxygen) data for the Lower Ruamahanga River. Continuous water quality information will aid in identifying any links between flow and water quality in the Lower Ruamahanga River[14].

- An assessment of the risk factors leading to periphyton proliferations in the Lower Ruamahanga River, and determination if the risk can be reduced by water management policies.

9.2 Other information required

There is a general lack of data relating to fish in the Lower Ruamahanga River, particularly which native fish species may utilise the river as habitat. The Department of Conservation may wish to work with Greater Wellington in improving our knowledge in this area, through some targeted fish surveys of the river.

Greater Wellington has a longer term project underway to improve our understanding of groundwater – surface water interactions in the Wairarapa valley, including in the Ruamahanga River system. The regional conceptual and numerical model of the Wairarapa groundwater system (as outlined by Jones & Gyopari 2006) is expected to be completed by mid-2009 (D McAlister[15] 2007, pers. comm.). Although the results of the groundwater modelling will not be available for this instream flow assessment, it is intended that any implications of the modelling will feed into the review of the Regional Freshwater Plan (due to commence in 2009).

9.3 Instream flow assessment proposed timetable

The following timetable is proposed for completing the instream flow assessment for the Lower Ruamahanga River.

[14] A continuous dissolved oxygen and temperature monitor was installed in the Lower Ruamahanga River at Pukio in December 2006, to collect information for the 2006/07 low flow season. The data were not available for inclusion in this Stage 1 report.
[15] Environmental Scientist – Groundwater

July/August 2007:	Consultation on issues report, including proposed instream flow objectives and scientific investigations. Ongoing consultation with iwi representatives regarding Maori cultural and traditional values associated with the Lower Ruamahanga River.
1 February 2008:	Complete scientific investigations and produce technical report which will include instream flow recommendations. This report will be sent to stakeholders.

It is proposed to have the instream flow assessment completed prior to the review of the Regional Freshwater Plan in 2009.

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Scott Ihaka (Environment Policy, Greater Wellington) conducted interviews with stakeholder groups, comments from which are included in this report.

The final version of the report was reviewed by Juliet Milne (Team Leader, Environmental Science, Greater Wellington), Ted Taylor (Manager, Environmental Monitoring & Investigations Department, Greater Wellington) and Murray McLea (Acting Manager, Environment Policy, Greater Wellington). The report was formatted by Marianne Miller.

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Appendix 1: Relevant Regional Freshwater Plan policies

Policy 4.2.15: To avoid, remedy or mitigate any adverse effects of use and development on the water bodies identified in **Appendix 5** [of the Regional Freshwater Plan] as regionally important for their amenity and recreational values, by:

- Managing water quality so that **Policy 5.2.4** is satisfied; and
- Managing the flows and levels of water bodies so that [**Policy 6.2.1**] is satisfied; and
- Having particular regard to offsetting adverse effects on amenity and recreational values; and
- Having particular regard to the timing of use and development so that, where practicable, adverse effects on amenity values and recreational use are minimised.

Policy 5.2.4: To manage water quality for contact recreation purposes in those water bodies identified in **Appendix 5**… .

Appendix 5 identifies the Ruamahanga River as having regionally important amenity and recreational values:

- from the confluence with the Waingawa River to Tuhitarata (covering much of the 'lower' Ruamahanga River) for canoeing, kayaking and angling;
- from Tuhitarata to Lake Onoke for canoeing, kayaking, power boating and angling.

Policy 5.2.9: To manage the quality of the fresh water of the rivers, or parts of rivers, identified in **Appendix 7** so that water quality is enhanced to satisfy the purposes identified in the Appendix.

Appendix 7 (Water Bodies with Water Quality Identified as Needing Enhancement) includes the entire lower Ruamahanga River, for contact recreation purposes.

Policy 6.2.1: To manage the allocation of water and flows in the parts of the rivers and streams shown in column 1 of **Table 6.1** [of the Regional Freshwater Plan] by:

(1) recognising the flows shown in column 3 as minimum flows that should be achieved in low flow conditions; and

(2) authorising, through resource consents, the taking of no more than the core allocation shown in column 4 (except where the requirement for supplementary allocation in clause (3) of this policy are satisfied; and

(3) authorising, through resource consents, the taking of a supplementary allocation when the flow exceeds that shown in column 5 (which is additional to the core allocation provided for in clause (2) of this policy); and

(4) authorising, through resource consents, the taking of no more than the first and second stepdown allocations shown in columns 6 and 7, respectively, when the river or stream is below the stepdown flows, also shown in columns 6 and 7 respectively.

Table 6.1 of the Regional Freshwater Plan (Lower Ruamahanga River policy only)

Column 1	Column 2	Column 3 Policy 6.2.1(1)	Column 4 Policy 6.2.1(2)	Column 5 Policy 6.2.1(3)	Column 6 Policy 6.2.1(4)		Column 7 Policy 6.2.1(4)	
Part of the river / stream within which allocations in columns 4, 5, 6 & 7 apply	The location of recorders where flows in columns 3, 5, 6 & 7 are measured	Minimum flow (L/s)	Core allocation (L/s)	Flow required for supplementary allocation (L/s)	Flow below which first stepdown allocation takes effect (L/s)	First stepdown allocation (L/s)	Flow below which second stepdown allocation takes effect (L/s)	Second stepdown allocation (L/s)
Ruamahanga River between the confluence with the Waiohine River and the boundary of the coastal marine area	At Waihenga	8500	1500	11000	9800	1300	9200	1000