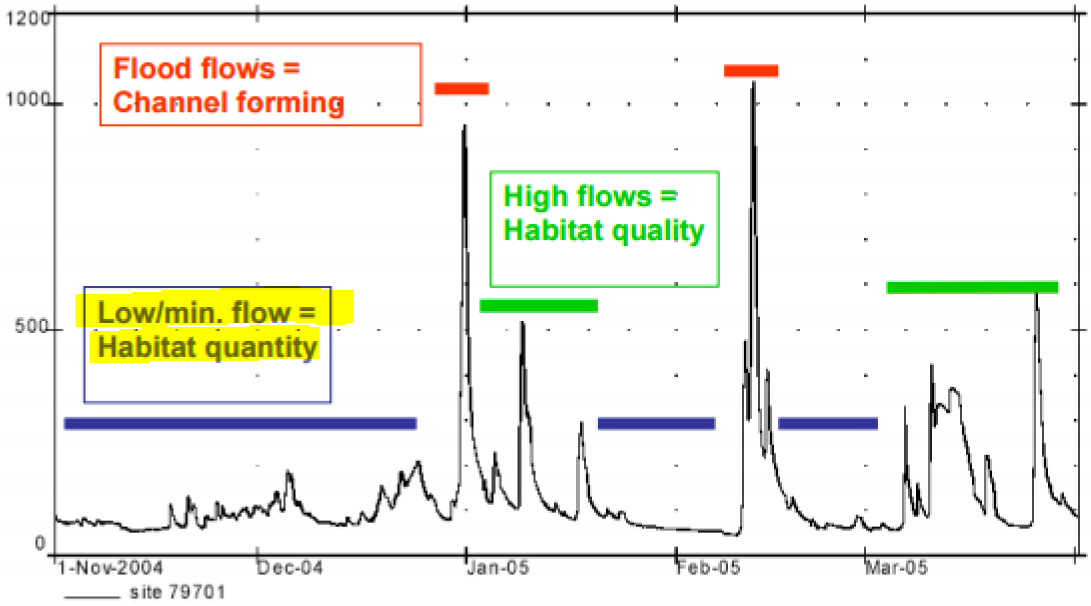
Ruamāhanga Whaitua Committee

Allocation modelling to support RWC decision making

Modelling of water takes and minimum flows for the Ruamāhanga Whaitua Committee (RWC) is being done primarily using EFSAP (**E**nvironmental **F**lows **S**trategic **A**llocation **P**latform). EFSAP is a model developed by NIWA to help decision makers understand the likely consequences of different minimum flow and allocation scenarios on instream ecological values and reilability of supply. The RWC will be supplied with information using EFSAP to look at how the existing minimum flow and allocation amounts (allocation regime) in the major rivers of the Ruamāhanga whaitua provide for instream ecological values.

The graph below provides a simplified depiction of how different types of flows (low, high and flood) have different impacts on river characteristics. EFSAP modelling focuses on low flows (highlighted in yellow) and the management of water takes during these times.



What information does the EFSAP model provide?

EFSAP is focused on instream ecology (physical habitat quantity for fish) and reliability of supply. It provides an indication of changes expected in stream flow and instream habitat area under different combinations of minimum flow and allocation amounts. For example, will mean annual low flows decline significantly if allocation increases by x amount? For how much longer each year will low flows occur?

EFSAP is useful for looking at average results across catchments and relative changes between scenarios, rather than providing absolute numbers or being meaningful at the scale of individual river reaches.

EFSAP results do not tell you 'the best number' for minimum flows and allocation limits. EFSAP also does not explicity tell you how measures of other instream values besides fish habitat may respond to different allocation regimes.

What assumptions are made in EFSAP?

Stream ecosystems are highly complex and spatially variable. EFSAP modelling is a very simplified representation of the real world and uses generalised relationships between flow and habitat.

A fundamental assumption when using EFSAP to assess flow management regimes is that **the amount of habitat available at low flows** is an important driver of biological health. There is an intuitive as well as established scientific rationale in NZ for making this assumption. New research emerging from Cawthron and NIWA suggests that flow limits set on the basis of habitat alone may be underestimating the minimum flow requirements of drift-feeding fish. However, consensus has not yet been reached on this new science and how it might best be applied throughout the country.

It is also important to note that stream values with some flow-dependency are also usually influenced by more than just the amount of water in the channel, even during low flows. For example, channel engineering works, removal of shade provided by riparian vegetation and diffuse discharges of nutrients and sediment can all significantly impact stream habitat and aesthetic qualities at times of low flow. Attributing the relative importance of all these variables to stream condition is very difficult.

What are existing minimum flows based on?

The rationale and basis for existing minimum flows in the Proposed Natural Resources Plan (PNRP) are pertinent to future decisions about revising limits. This information has been summarised for the Committee in the past and is also appended to this document (Attachment 1).

What are existing allocation limits based on?

Allocation limits in the Proposed Natural Resources Plan (PNRP) are based on application of a 'default' rule in the proposed *National Environmental Standard for ecological flows and water levels* (Ministry for the Environment 2008);

Allocation is equal to whichever is the greater of:

- either 30% (smaller rivers) or 50% (larger rivers) of the natural mean annual low flow, or
- existing allocation from the catchment.

The general premise of the limits (30% and 50% of MALF) is that, when combined with reasonably conservative minimum flows (80-90% MALF), the more significant detrimental impacts associated with abstractive takes are less likely to occur.

Using EFSAP to model impacts on instream ecology for the RWC

Selecting fish species

At the RWC meeting on 22 May 2017, the Committee were told which fish species could be modelled within EFSAP. From this list, the following species were confirmed by the Committee as being of particular interest due to their widespread distribution in the Ruamāhanga catchment, value and sensitivity to flow.

Fish species	Flow demand
Torrentfish	High
Brown trout	High
Longfin tuna (eel)	Moderate
Shortfin tuna (eel)	Moderate
Inanga	Moderate to low (food producing habitat)
Lamprey	Low

Taken together, these species are considered likely to represent the range of flow preferences held by typical fish communities in the Ruamāhanga catchment. In other words, if these species are catered for, so will any other species that are not modelled.

Selecting level of habitat protection

Once species have been selected for modelling it is necessary to select the level of habitat protection that is desired. This is difficult as there is usually no clearly defined point at which instream conditions go from good to bad as a result of flow. Rather, habitat simply gets worse as flow declines. Very broadly speaking, research in NZ indicates that a habitat retention level of 90% (compared to what is available at MALF) will maintain populations of fish with high flow demands (all other factors being favourable). Retention levels of less than 50% are likely to be harmful to fish of all flow preferences. Between 50% and 90% are a range of possible protection levels that may or may not be appropriate depending on the values and significance of the fish communities.

The Committee confirmed that they would like to model (for the above listed species) flows that preserve **at least 90% of the habitat available** at mean annual low flow (MALF). This can be considered a habitat quantity 'optimum'. Alternative habitat rentention levels of 80% and 70% will also be modelled. GWRC advice to the Committee is that rentention levels of no less than 70% should be considered as a bottom line in providing for ecosystem health.

Past flow studies have also shown that if the habitat needs of fish with the highest demands are met then it is likely that some other flow-dependent values will be guarded to a reasonable degree (as long as other factors affecting those values remain favourable). For example, boat passage in the lower Ruamāhanga River was considered adequately proteced by the existing minimum flow, as was water depth for swimming at the local marae in the Papawai Stream.

Attachment 1. Basis for existing minimum flows

General approach

Minimum flows have been set in a variety of ways from default values based on flow statistics to catchment specific investigations. In general, more rigour has been applied where demand for water is highest. Many minimum flows originate from 'Catchment Management Plans' developed throughout the 1980s, 90s and 2000s. These plans usually drew on a combination of river habitat survey (IFIM) and water quality modelling (WAIORA) data as well as knowledge of river values and uses at the time. The approach taken for specific rivers and streams is described in more detail in Table 1.

IFIM and WAIORA?

Instream Flow Incremental Method (IFIM) is a tool for determining physical habitat requirements under different flow regimes.

Water Allocation Impacts on River Attributes (WAIORA) is a model developed by NIWA that, like IFIM, provides guidance on physical habitat but it also predicts other environmental responses to flow change (such as dissolved oxygen and water temperature). These responses can be related to guideline thresholds for ecosystem health to help understand the impact of flows and allocation scenarios. Some caution has been exercised in the interpretation of WAIORA results for flow setting as the tool was in its development stage when applied in the Wellington region.

Recent methods

More recent instream flow assessments by GWRC (Otukura and Papawai streams, Lower Ruamāhanga, Waiohine and Tauherenikau rivers) have also used IFIM and water quality modelling techniques but have applied more conservative criteria in some areas, especially habitat retention, in accordance with advances made in flow setting methods in NZ.

Ruamāhanga Whaitua Committee

Table 1. Minimum flow derivations

River/stream	Management point	Minimum Flow The number in the brackets is the higher flow at which restrictions are applied. In some cases (water supply catchments) the higher number is the effective minimum flow for non-essential takes and is bolded instead.	Proportion of natural 7d MALF	Basis
Upper Ruamāhanga River	Wardells	**2,400 L/s** [2,700 L/s]	**67%**	IFIM modelling in 1993 identified flow requirements for sustaining minimum food producing and adult brown trout habitat. WAIORA modelling (in 1998/99), as well as consideration of some recreational values (boating, tubing, kayaking), supported the minimum flow of 2,400 L/s.
Lower Ruamāhanga River	Waihenga Bridge	**8,500 L/s** [9,800 L/s]	**68%**	Originally the minimum flow was based on a rule of thumb (flow statistic). A more thorough assessment of instream values and an IFIM study was conducted in 2007. It considered a wider range of fish species (as well as recreational values) and identified that adult brown trout had the highest flow demands and that the minimum flow of 8,500 L/s was appropriate for retaining approximately 90% of adult brown trout habitat available at 1Day MALF. Note, it is now considered better practice to use 7Day MALF as a reference statistic, in which case habitat retention appears less favourable (68%).
Waingawa River	Kaituna	1,100 L/s **[1,700 L/s]**	80% **[120%]**	Minimum flow established by the Waingawa Catchment Management Plan in 1988 with reference to swimming suitability and dilution of effluent from the Waingawa Freezing Works. IFIM study of two river reaches (Kaituna and the lower river near Masterton) was carried out in 1993 and confirmed the adequacy of the minimum flow for sustaining fish habitat space. A more recent reassessment of the original IFIM survey data against recently developed criteria also suggests that the minimum flow is broadly adequate, although only physical habitat space was considered. Note that in this catchment the higher flow (1,700 L/s or 120% MALF) is effectively the minimum flow for non-essential takes (including irrigation takes), hence it has been bolded.
Waipoua River	Mikimiki Bridge	**250 L/s** [300 L/s]	**68%**	Minimum flow established by the Waipoua Catchment Management Plan in 2001, primarily on the basis of WAIORA modelling and survey of two reaches in the mid and lower sections. Relative to other small rivers, the minimum flow is quite low as a proportion of 7dMALF.
Waiohine River	Gorge	2,300 L/s **[3,040 L/s]**	65% **[85%]**	Minimum flow (2,300 L/s) is based on some limited IFIM survey in 1993 as well as correlation of flows with the Ruamāhanga River. The early IFIM work identified used food producing and adult brown trout habitat as the reference point for flow setting. A more thorough assessment of instream values and

Ruamāhanga Whaitua Committee

River/stream	Management point	Minimum Flow The number in the brackets is the higher flow at which restrictions are applied. In some cases (water supply catchments) the higher number is the effective minimum flow for non-essential takes and is bolded instead.	Proportion of natural 7d MALF	Basis
				IFIM survey was carried out in 2009. It considered a range of recreational and cultural values although specific objectives were ultimately linked to fish habitat and migration. The recommendation of that study was to increase the minimum flow to 2,765 L/s. This number was not carried through to the proposed NRP because of concerns from some stakeholders that the impacts on reliability of supply had not been fully worked through. Note that in this catchment the higher flow (3,040 L/s or 85% MALF) is effectively the minimum flow for non-essential takes (including irrigation takes), hence it has been bolded to the left.
Tauherenikau River	Gorge	**1,100 L/s** [1,350 L/s]	**85%**	Minimum flow is based on some limited IFIM survey in 1993 as well as a Catchment Management Plan from 1984. An assessment of instream values and generalised habitat survey was carried out in 2011. That study considered the existing minimum flow to be generally adequate for supporting values associated with physical habitat and fish passage.
Mangatarere River	Gorge	**240 L/s - Upper** **200 L/s - Lower**	**145%** **120%**	IFIM and WAIORA modelling was carried out in 2002 and informed minimum flow recommendations made in a 2003 Catchment Management Plan. The overall instream flow management objective was to "*enhance water quality, maintain water quantity and support trout habitat, fishing/spawning and aquatic ecosystems*". Adequate dilution of the Carterton Wastewater discharge at low flows was also considered.
Kopuaranga River	Gorge	**270 L/s**	**90%**	WAIORA modelling was carried out in 1998/99 and recommended 250 L/s as a minimum flow. This was based on habitat availability and water quality predictions, taking into consideration the dilution requirements of effluent discharges at the time. The WAIORA minimum flow was subsequently revised upwards slightly to ensure adequate water depth for trout migration.