Instream flow assessment for Otukura Stream and Battersea Drain

Stage 1: Instream Flow Issues Report

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1. Introduction

1.1 Context for an Issues Report

The values relating to the environment of a stream (including the channel, stream bed and water) are called instream values, and these include ecological, aesthetic and Maori cultural values. Instream values can be adversely impacted by activities such as damming, abstraction of water, and 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 Otukura Stream and Battersea Drain. The information gained in this assessment will be used by Greater Wellington's Environment Management Division when proposing water allocation policies for the waterways.

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 stream values and gain an impression of flow-related issues in the catchment.

3. Propose an instream management objective. The objective includes the key value(s) to be protected by the management regime.

4. Plan scientific investigations. These are the investigations to determine what flows are required to achieve the instream management objective.

5. **Prepare an Instream Flow Issues Report**, 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. Recommend a flow that will sustain instream values, and prepare a supporting Instream Flow Assessment Technical Report.

This report fulfils Step 5 of the Framework, and includes the information collected in the earlier stages of the instream flow assessment. The field assessment for this report (Step 2 of the Framework) was carried out on 22 December 2004 and was attended by aquatic ecosystem experts from Fish and Game NZ and Department of Conservation. The issues raised during the Field Assessment are referred to in this report.

1.2 What is this report about?

The overall objective of this project is to determine the environmental flow requirements of Otukura Stream and Battersea Drain. More specifically, the Instream Flow Issues Report:

- Describes the existing data relating to hydrology, ecology, and water quality of Otukura Stream and Battersea Drain;
- Identifies instream values of Otukura Stream and Battersea Drain and threats to those values;
- Recommends an instream management objective for the waterways; and
- Proposes scientific investigations and next steps for the instream flow assessment of Otukura Stream and Battersea Drain.

1.3 Why is an Instream Flow Assessment needed?

The water resources of the Otukura catchment are used extensively, particularly for stock water and irrigation. The Otukura catchment has historically experienced water allocation difficulties and during severe low flows the stream is unable to sustain demand in some places. A number of applications for consents to abstract water are currently on hold, awaiting the development of a water allocation strategy for the catchment. However, knowledge of flow requirements to protect instream value(s) is required before decisions relating to water allocation can be made.

1.4 Policy framework

Under the Resource Management Act 1991, Greater Wellington has a responsibility to manage the region's water resources in a sustainable manner. The Regional Freshwater Plan (Wellington Regional Council, 1999) sets out policies and recommendations to help Greater Wellington meet this responsibility. The parts of the Regional Freshwater Plan that are pertinent to the management of Otukura Stream are:

Policy 4.2.14: To avoid, remedy or mitigate any adverse effects on important trout habitat in the Region, identified in Appendix 4, by:

- Managing water quality so that Policy 5.2.3 is satisfied; and
- Managing the flows and levels of water bodies so that [Policy 6.2.2 is] satisfied; and
- Having particular regard to offsetting adverse effects on trout habitat; and
- Having particular regard to maintaining the same, or similar, river bed configuration in the rivers identified.

Policy 5.2.3: To manage water quality for trout fishery and fish spawning purposes in those rivers, or parts of rivers, identified in Appendix 4 (subject to

Policy 5.2.10). Appendix 4 includes Otakura (*sic*) Stream upstream of its confluence with Lake Wairarapa.

Policy 6.2.2: To manage the flows in rivers and streams not identified in Policy 6.2.1 by having regard to:

- The significance of natural, amenity, and tangata whenua values; and
- The scale/magnitude of any adverse effects on natural, amenity and tangata whenua values; and
- The reversibility of any adverse effects on natural, amenity and tangata whenua values.

Method 8.5.5: Where practicable, obtain more information to establish desirable minimum flows and approaches to water allocation… for the following water bodies where there is potential for water shortages to occur (includes the Moroa/Battersea/Otakura (*sic*) Stream system).

An instream flow assessment for Otukura Stream is therefore strongly supported by the Regional Freshwater Plan, in particular by Method 8.5.5.

1.5 Spatial extent of the assessment

The instream flow assessment is for Otukura Stream and one of its major tributaries, Battersea Drain. Other major tributaries of Otukura Stream are Stonestead Creek (also known as Dock Creek) and tail races of the Moroa water race. The allocation of water from the water race is managed by South Wairarapa District Council. Stonestead Creek enters the Otukura Stream near its confluence with Lake Wairarapa. The flow characteristics of Stonestead Creek are quite different from those of the Otukura Stream, because it is linked via groundwater to the Tauherenikau River. Therefore, instream flow requirements of Stonestead Creek will be considered separately.

2. Catchment characteristics and reach delineation

2.1 Catchment characteristics

Otukura Stream is a small lowland Wairarapa stream which rises from springs in the Fabians Road area, and discharges to Lake Wairarapa. The catchment lies between the Tauherenikau and Ruamahanga Rivers, to the south of Greytown and to the west of Bidwill Hill (Figure 1). Major tributaries of Otukura Stream include the Battersea Drain, Stonestead Creek and tail races of the Moroa water race (which is fed from the Waiohine River).

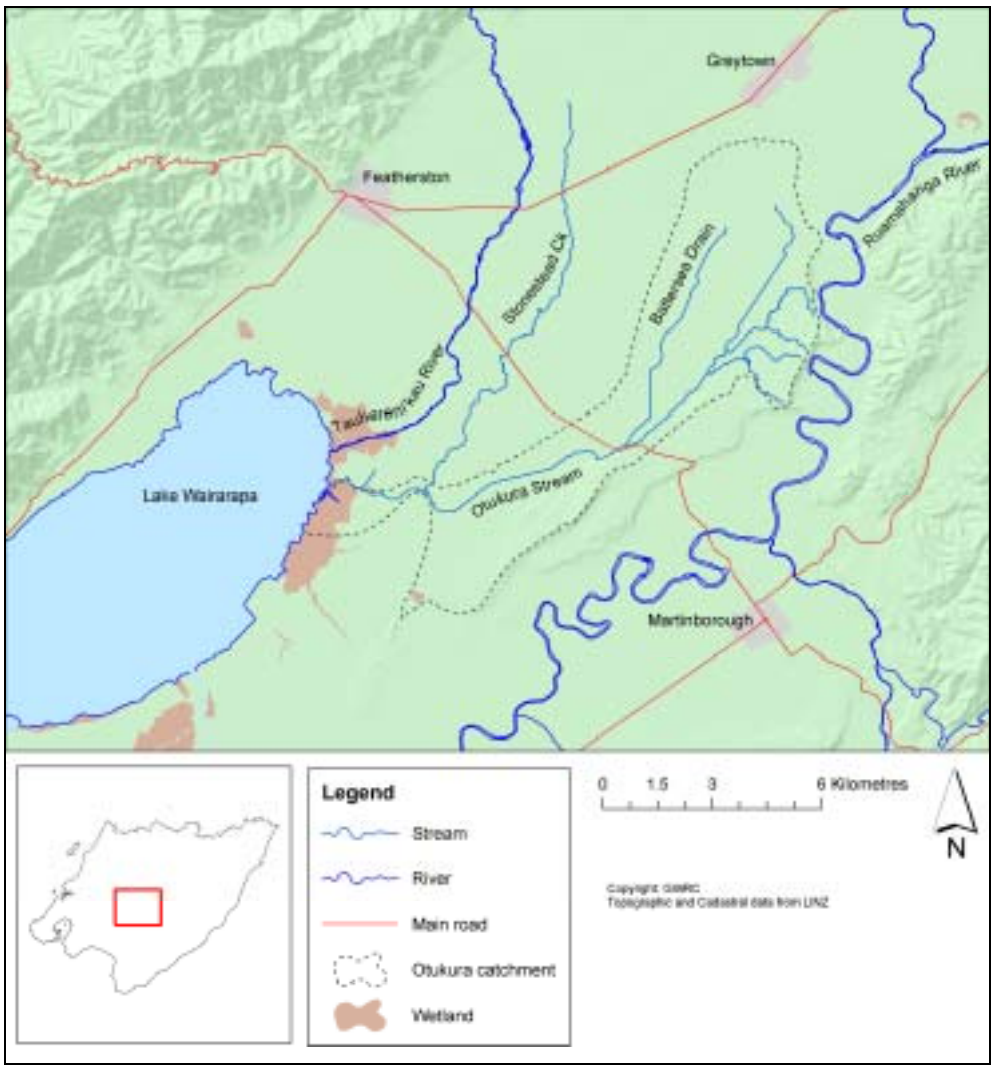

Figure 1: Location of Otukura Stream and Battersea Drain. Note the Otukura catchment boundary shown does not include the catchment of Stonestead Creek.

Both Battersea Drain and Otukura Stream are main channels of the Battersea Drainage Scheme, the management of which was taken over by the Wairarapa Catchment Board (now Greater Wellington Regional Council) from the Featherston County Council in 1956. The Battersea Drainage Scheme (totalling 1100ha) was created for the purpose of lowering high water tables in winter, and Battersea Drain is therefore a highly modified (if not totally man-made) channel. Otukura Stream is considered part of the Battersea Drainage Scheme

(as operated by Greater Wellington) and the stream was modified to enhance drainage in the Battersea area during the 1950s.

2.1.1 Climate

Mean annual rainfall in the Otukura catchment is approximately 900 to 1000 mm. The driest months are December to March, with the average rainfall during this period being about 290 mm. Rainfall in the catchment is highest during winter (June to August), due to the predominance of southerly frontal rainfall during this time (Figure 2). The low rainfall in the catchment over summer, combined with relatively high temperatures, results in an annual rainfall deficit (Figure 3). The deficit means that there is a high demand for water for irrigation in the catchment.

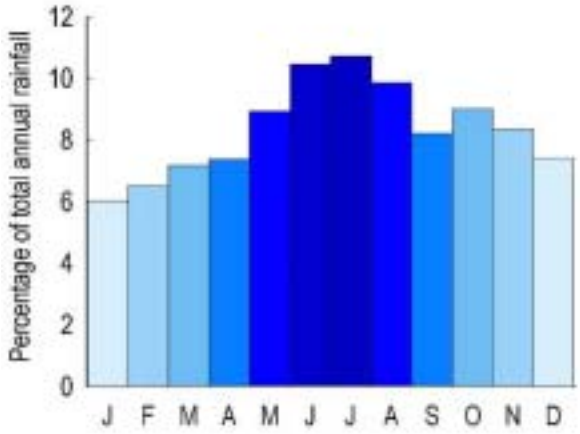

Figure 2: Interannual rainfall distribution in the Otukura catchment (as indicated by rainfall record at ***Alloa***)

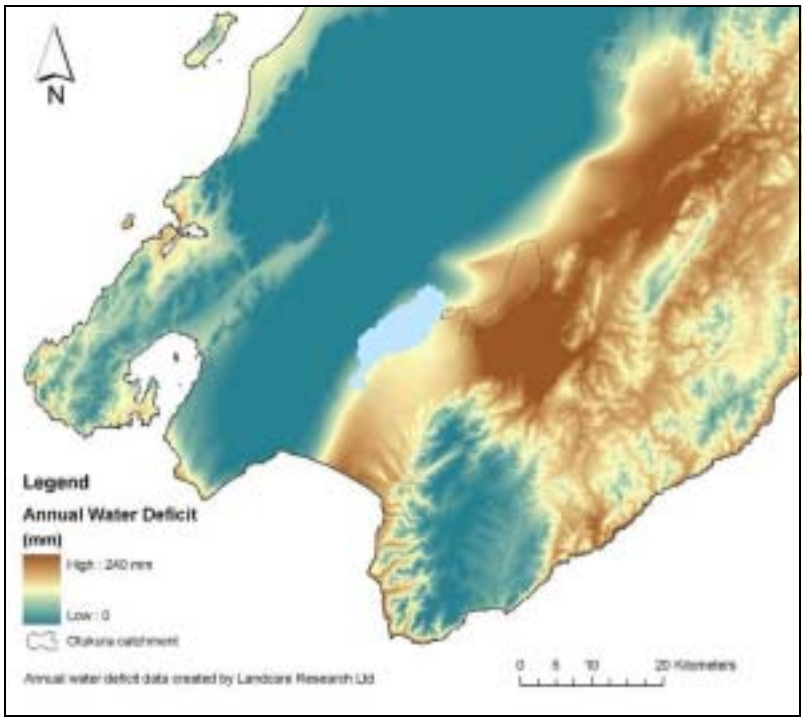

Figure 3: Annual Water Deficit in Wellington region (Otukura catchment marked)

2.1.2 Geology

The geology of the Otukura catchment is generally coarsely-sorted alluvial deposits. Te Maire Ridge, a basement high overlain by loess, runs to the south east of the catchment. Near its mouth the stream runs through old swamp deposits on the eastern shores of Lake Wairarapa.

2.1.3 Land use

Land use in the catchment consists of dairy, beef and sheep farming (Figure 4). There are no major urban areas in the Otukura Stream and Battersea Drain catchments. Irrigation occurs on both dairy and beef farming properties.

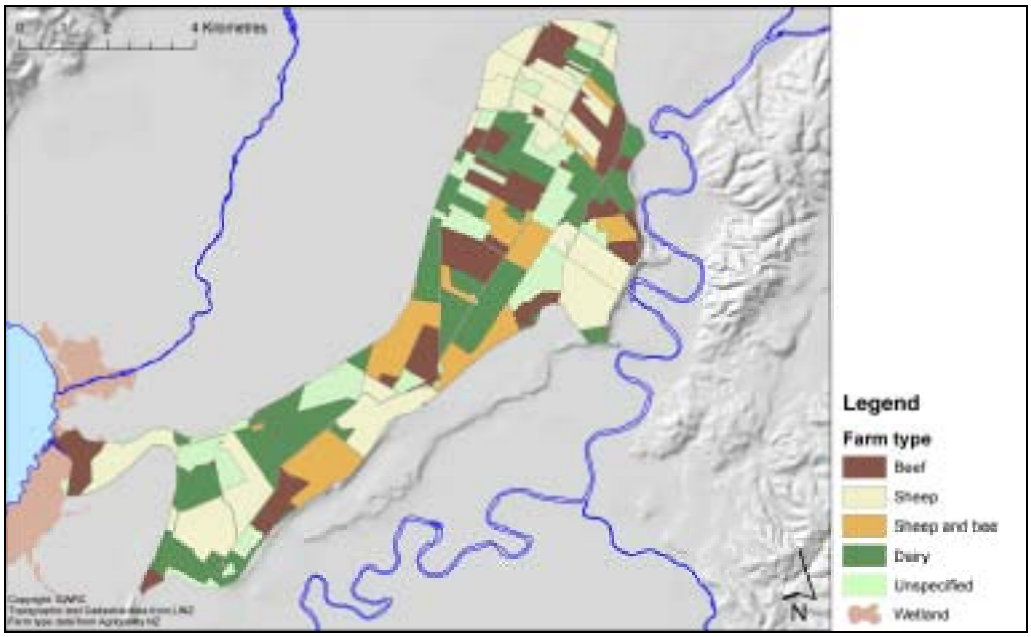

Figure 4: Land use in the Otukura Stream and Battersea Drain catchment

2.2 Reach delineation

The following stream reaches were defined for the purposes of this instream flow assessment (Figure 5):

- Battersea Drain, to its confluence with Otukura Stream;
- Otukura Stream, from its headwaters near Fabians Road to the confluence with Battersea Drain near Wards Line (Reach 1);
- Otukura Stream, from its confluence with Battersea Drain near Wards Line, to the confluence with Stonestead Creek (Reach 2);
- Otukura Stream from confluence with Stonestead Creek to its mouth at Lake Wairarapa (Reach 3).

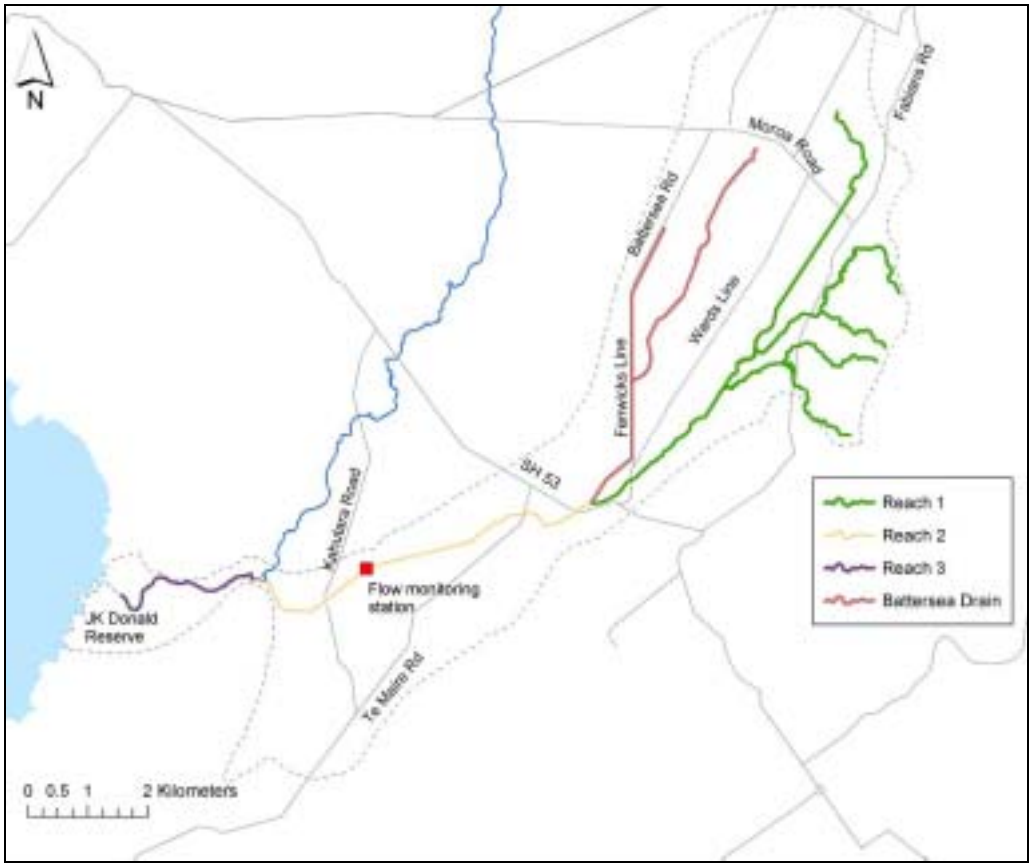

Figure 5: Reaches of the Otukura Stream, for the purposes of this study

2.2.1 Battersea Drain

Battersea Drain is a short waterway that flows between Battersea Road and Wards Line, then along Fenwicks Line before entering the Otukura Stream. As the term 'drain' implies, it is a highly modified watercourse, confined to a very straight channel (Figure 6). In its upper reaches the drain has a gravel base and some shading from trees. Where the drain runs along Fenwicks Line there is no riparian shading and the drain is diverted into paddocks in places for stock watering purposes. In its lower reaches, the drain widens and banks are low, and stock have access in many places. The stock access has resulted in slumping stream banks, and the gravel bed of the drain is generally covered in thick silt.

Figure 6: Battersea Drain at Fenwicks Line. Left – shows the straight, open channel. Right – near the confluence with Otukura Stream there is stock access and eroding banks.

2.2.2 Reach 1: Upper Otukura Stream

Otukura Stream in its upper reaches is a straight, channelised stream. Although there is some sparse scrub and a few larger trees, there is generally limited shading. However, where the stream is fenced off from stock streamside vegetation is recovering (specifically broom, gorse and small shrubs), and minor pool-riffle sequences are noted downstream of Moroa Road (Figure 7). Further downstream at Wards Line there is bank erosion where stock have access to the stream (Figure 8), and visual observations indicate that water quality has declined significantly over the length of this reach.

Figure 7: Otukura Stream at Moroa Road – upstream (left) and downstream (right)

Figure 8: Otukura Stream looking downstream from Wards Line

2.2.3 Reach 2: Otukura Stream from Battersea Drain confluence Stonestead Creek

Downstream of Wards Line, Battersea Drain enters Otukura Stream, and the stream widens. Although the stream has a gravel base in this reach, in many places this has a thick layer of sediment cover. There is a high level of stock access to the stream, and banks are eroding. The stream meanders slightly upstream of the Greater Wellington flow monitoring station. Downstream of the station the stream is highly modified – a very straight channel with practically no riparian vegetation.

Figure 9: Otukura Stream in Reach 2. Left – looking downstream from Te Maire Road. Right – looking upstream from Kahutara Road towards the flow monitoring station.

2.2.4 Reach 3: Otukura Stream from Stonestead Creek to Lake Wairarapa

The lower Otukura Stream has a more meandering, deep channel downstream of the confluence with Stonestead Creek. In this reach there is reasonable stream shading and diverse riparian vegetation, including shrubs, willows and overhanging grasses.

About 500 metres upstream of the confluence at Lake Wairarapa, water is diverted from Otukura Stream into the neighbouring JK Donald Reserve wetland. Due to the highly modified nature of the stream, there is no other surface connection with the wetland, and the stream flows around the margins of the JK Donald Block before entering the lake.

Figure 10: Otukura Stream Reach 3

2.3 Water resource use

2.3.1 Abstraction of surface water

There are six consented takes from Battersea Drain and Otukura Stream totalling 56 L/s (Table 1, Figure 11). Three of those consents have expired, and the replacement consent applications remain on hold under Section 92 of the Resource Management Act 1991.

As shown by Table 1, four of the six consented abstractions are from Battersea Drain, and at times during the irrigation season there is insufficient water to sustain the abstractions. As a result, a consent for the abstraction of 18 L/s from Battersea Drain has recently been surrendered in favour of a groundwater take.

Two of the consents (WAR010240 and WAR020123) have apparently not been exercised in recent years. Therefore the pressure on the Otukura Stream from abstraction is probably not as great as the table suggests.

Table 1: Consents to abstract water from the Otukura catchment[1]

Consent number	Name	Watercourse	Rate of take (L/s)	Expiry date	Comments
WAR010115	Mensen	Battersea Drain	3	30/09/2009	Subsurface irrigation
WAR010240	Svenson	Battersea Drain	2	30/09/2009	Subsurface irrigation
WAR060114	O'Neale	Battersea Drain	2	30/09/2009	Subsurface irrigation
WAR020179	O'Neale	Battersea Drain	9	Expired	Replacement application has been made
WAR020124	D B Osborne Trust	Otukura Stream	30	Expired	Replacement application has been made
WAR020123	Doherty	Otukura Stream	10	Expired	Replacement application has been made

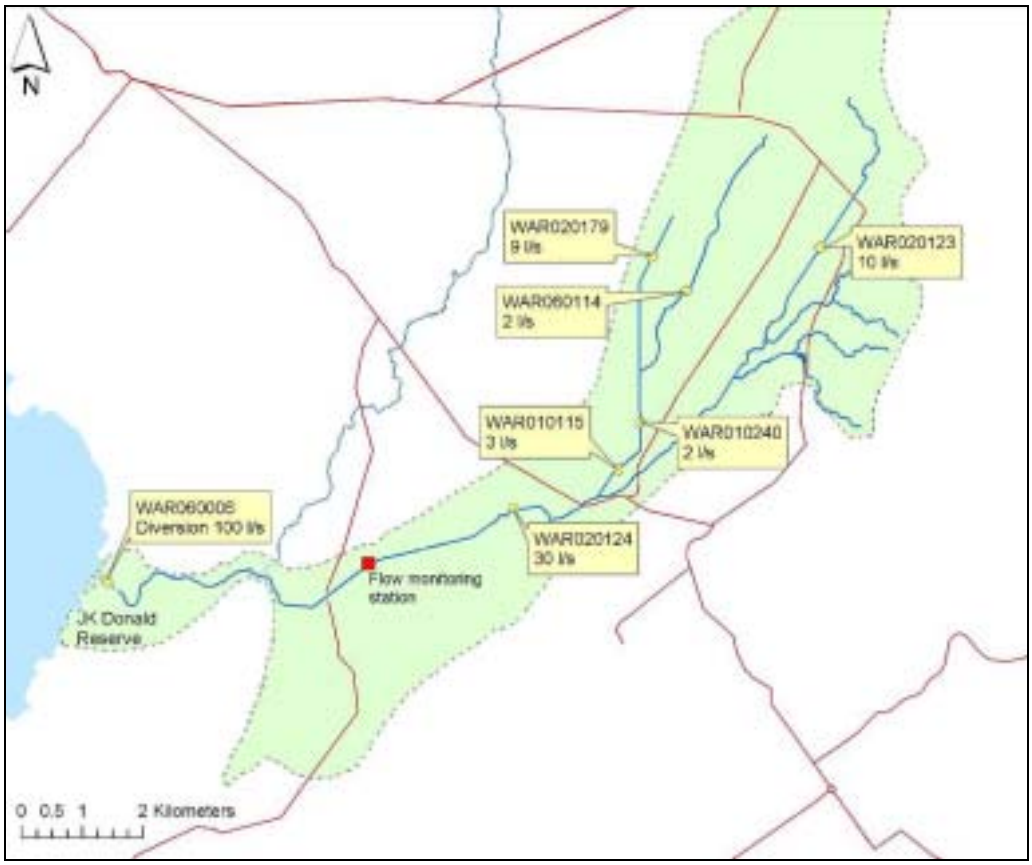

Figure 11: Consented water takes from the Otukura Stream and Battersea Drain

[1] Does not include abstraction from the Moroa water race and Stonestead Creek

There are three consents to take water from Battersea Drain for subsurface irrigation, which require temporary weirs to be put in place[2]. The amount abstracted for this type of irrigation is estimated only (but a relatively small amount at 2-3 L/s), and cannot be easily controlled. The weirboards are kept in place over the irrigation season and the abstractions are not subject to low flow restrictions.

Figure 12: Aerial photograph showing the effect of subsurface irrigation from the Battersea Drain, during summer 2001/02.

A low flow restriction is implemented on the remaining Battersea Drain abstraction (WAR020179) when flow at the Harvey property on Fenwicks Line falls below 45 L/s. The consents to abstract water from Otukura Stream (WAR020124 and WAR020123) are restricted when flow falls below 150 L/s at the Greater Wellington flow monitoring station.

In addition to the consented surface water takes, there is likely to be some permitted activity abstraction from the Otukura Stream and Battersea Drain, particularly for stock water. The permitted activity use has not been quantified.

2.3.2 Diversion of surface water

Wellington Fish and Game Council hold a consent (WAR060006) to divert water from Otukura Stream into the neighbouring JK Donald Reserve, which is owned by Department of Conservation. The diversion of water is to maintain water levels in a wetland in the reserve, to enhance waterfowl habitat. The rate

[2] The temporary weirs elevate the water level in the stream, to promote subsurface seepage into adjacent farmland thereby increasing soil moisture.

of diversion is approximately 100 L/s, and a condition on the consent specifies that the diversion equates to no more than 25% of the flow in Otukura Stream at that point.

2.3.3 Abstraction of groundwater

Groundwater was traditionally used for stock water and domestic supply in the area (Butcher, 2001). Since the early 1980s groundwater has increasingly been used for irrigation purposes, primarily due to the increase in dairy farming and the limited surface water resources.

The Battersea Groundwater Zone and Otukura Stream system are well connected. Therefore pumping groundwater will affect flows in Battersea Drain and Otukura Stream (Butcher, 2001), although the cumulative effect has not been quantified.

3. Review of environmental data

3.1 Hydrology

3.1.1 Flow regime

Flow in Otukura Stream has been continuously monitored by Greater Wellington at *Otukura Stream at Weir* (site 292069) since December 1997. A concrete rectangular weir was constructed at the site in May 1999 to improve data accuracy. The purposes of the site are to monitor low flows for State of the Environment reporting (as a representative Wairarapa lowland stream) and to aid in implementing low flow restrictions.

Figure 13: Greater Wellington flow monitoring station Otukura Stream at Weir

Figure 14 gives a picture of the seasonal flow variability in the Otukura Stream, as indicated by the monthly average flows. The lowest flows tend to occur between January and March, with the highest flows in winter and a secondary peak in spring due to northwesterly frontal rainfall that tends to occur at that time. The mean monthly stream flows have a July to February ratio of 8.9. This annual variation is high relative to that of the Tararua range-fed rivers (for example, a ratio of 1.5 for the Waiohine River), but not as extreme as the seasonal variability of eastern Wairarapa rivers (a ratio of 18 for the Whareama River).

The main control on flow variability is likely to be rainfall (and very low rainfall totals in the Otukura catchment during summer months), but catchment characteristics of land use (e.g. vegetation cover) and connections with groundwater systems are also influencing factors.

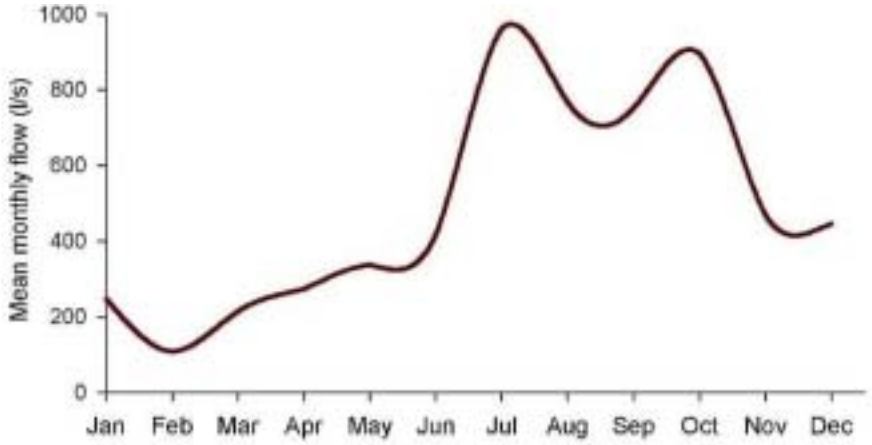

Figure 14: Intra-annual variation in mean monthly flows, Otukura Stream at Weir (1997-2005)

3.1.2 Low flows

Although there is a considerable amount of missing data from the nine year record at Otukura Stream at Weir, the statistics to date are:

Lowest recorded flow:	3 l/s on 28 February 2006
Instantaneous MALF[3]:	62 l/s
1 day MALF:	76 l/s
7 day MALF:	87 l/s
Mean annual flow:	524 l/s.

Low flows in the Otukura Stream vary significantly from year to year (It is not possible to naturalise the flow record, because abstraction data are not available. However, with the cumulative impact of the subsurface irrigation abstractions (which cannot be restricted), groundwater takes near to Otukura Stream, and permitted activity use, the naturalised 1-day and 7-day mean annual low flowss are estimated to be 100 L/s and 120 L/s respectively, at Otukura Stream at Weir.

Low flow statistics for other locations in the catchment can not be accurately determined. Gaugings of the Battersea Drain at Fenwicks Line during low flow conditions vary between about 10 L/s and 55 L/s. There are no other sites that are gauged on a regular basis.

Table 2), and are generally related to summer rainfall (Figure 15). However, it is difficult to establish a clear relationship between low flows and rainfall because the flow record for Otukura Stream at Weir has not been naturalised. It is likely that the lowest recorded flow of 3 L/s was influenced by upstream permitted activity abstraction and streamflow depletion caused by groundwater pumping.

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[3] Mean annual low flow

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Low flow statistics for other locations in the catchment can not be accurately determined. Gaugings of the Battersea Drain at Fenwicks Line during low flow conditions vary between about 10 L/s and 55 L/s. There are no other sites that are gauged on a regular basis.

Table 2: Annual low flow statistics for Otukura Stream at Weir, 1997 – 2006

	Minimum recorded flow (l/s)	Lowest 7-day flow (l/s)
1997/98	21	37
1998/99	19	51
1999/2000	108	138
2000/01	7	27
2001/02	119	180
2002/03	19	24
2003/04	175	202
2004/05	87	109
2005/06	3	17

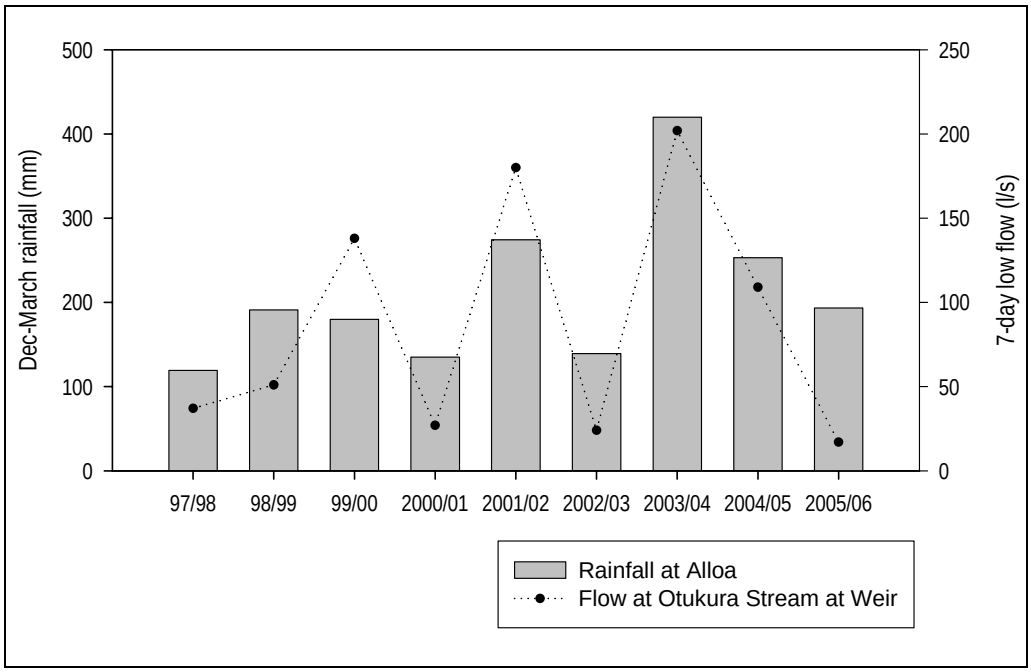

Figure 15: Annual summer (December to March) rainfall and low flows in the Otukura catchment, 1997 – 2006

Low-flow surveys of the catchment (concurrent gauging runs) have been performed on several occasions over the last 25 years, but are difficult to

compare because the locations have not been kept consistent and it is unknown how many abstractions were occurring at the time. However, in general the surveys indicate that flow in Otukura Stream remains fairly constant between Moroa Road and Wards Line, i.e. there are no major losses or gains upstream of the Battersea Drain confluence. Similarly, there are no major flow losses or gains downstream, apart from minor contributions from the Moroa water race, until Stonestead Creek enters Otukura Stream. Stonestead Creek has significantly different flow characteristics to Otukura Stream. Because it is fed from seepage from the Tauherenikau River it tends not to suffer extreme low flows. Gaugings of Stonestead Creek indicate a typical low flow is around 500 L/s[4]. Thus the (naturalised) mean annual low flow of Otukura Stream below the confluence with Stonestead Creek is probably in the range 580-700 l/s.

3.1.3 Flushing flow frequency

The frequency of flushing flows in a stream can have implications for periphyton accumulation and biotic community composition. The frequency of flushing flows equal or greater than three times the median flow, referred to as FRE_3, has been promoted as a useful statistic for classifying habitat (Clausen & Biggs, 1997).

On average, Otukura Stream experiences a flushing flow (of greater than three times median flow) three times per low flow season (September to April). However, most of these flushing flows occur during September to December, and it is common for no flushing flows to occur during the period January to April (such as occurred in 2001, 2002, 2003 and 2006 – for example, Figure 16). Instream temperatures will be at their highest during this period, leading to a greater likelihood of periphyton growth.

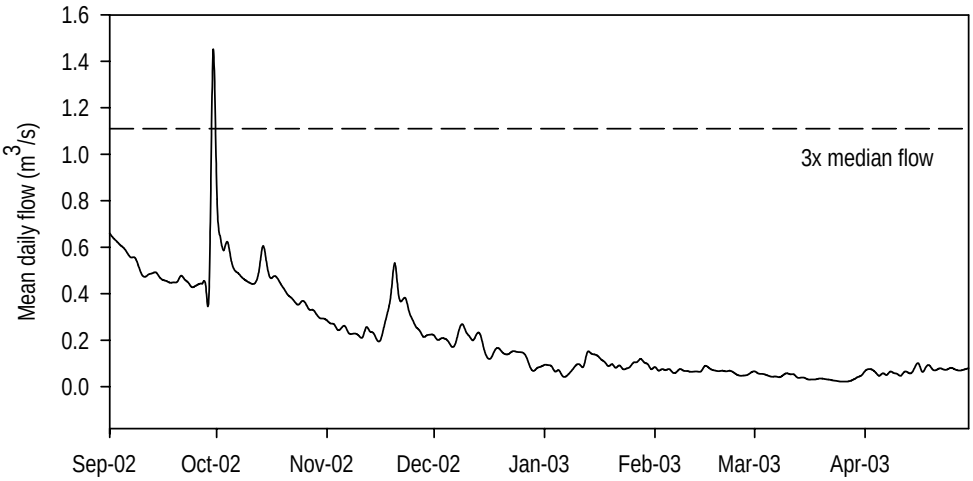

Figure 16: Average daily flows recorded at Otukura Stream at Weir, September 2002 to April 2003

[4] The gaugings for Stonestead Creek have not been naturalised. There is 207 l/s allocated from the creek, but the consents are subject to a flow-sharing regime during times of low flow. The maximum instantaneous take at flows below 500 l/s is 115 l/s.

3.1.4 Groundwater – surface water interactions

Information relating to groundwater – surface water interactions in Otukura catchment is generally anecdotal only. Otukura Stream rises from springs in the Fabians Road area, between Kemptons Line and Greytown Bidwills Cutting Road. However, the majority of flow in the Otukura Stream and Battersea Drain is from land drainage.

Low flows in Otukura Stream may be influenced by springs. However, during summer months it is possible that groundwater levels may be too low to have a significant impact on flow in the stream, and this is evident by the severe low flows observed in February 2006 which coincided with the lowest groundwater levels on record in the Battersea aquifer[5]. The low levels are likely to be a combined effect of low summer rainfall and increased groundwater pumping.

The hydraulic connection between Otukura Stream and the Battersea aquifer is good, and it is likely that pumping groundwater will induce streamflow depletion (Butcher, 2001). There are no pump test data on the Greater Wellington hydrological database to determine the degree of streamflow depletion.

3.2 Fish

Two electric fishing surveys have been carried out on Otukura Stream. The first of these, on 8 April 2003, found abundant short-finned eels and koura, one long-finned eel and two common bullies. The second survey took place on 18 January 2005, and had similar findings to the first survey (Table 3).

Table 3: Results from 2005 electro-fishing survey

	Species caught
Otukura Stream @ Moroa Rd (Reach 1)	Shortfin eel Koura
Otukura Stream upstream of Battersea Drain confluence (Reach 1)	Shortfin eel Koura Common Bully
Battersea Drain just upstream of Otukura Stream confluence	Shortfin eel Koura Common Bully
Otukura Stream @ Greater Wellington flow monitoring station (Reach 2)	Shortfin eel Longfin eel Koura Common Bully
Stonestead Creek at confluence with Otukura Stream	None

In addition to the species listed in Table 3, inanga were observed near the mouth of Otukura Stream during the field assessment in December 2004.

[5] Indicated by the groundwater levels in the bore *Battersea aquifer at J Simmonds*, 1983 – 2006.

Wellington Fish and Game Council have identified the presence of brown mudfish in the lower reaches of Otukura Stream[6].

Water quality in Otukura Stream is to be managed for the protection of trout habitat, as specified in the Regional Freshwater Plan. However, no trout were found during the surveys. One local resident suggested that trout abundance has declined in recent years.

No pest fish (rudd and goldfish) were found during the survey. However, there is potential for these species to be present in the Otukura Stream, particularly in its upper reaches (Abernethy, B 2004, *pers. comm*., 22 December). The presence of pest fish may have an adverse affect on populations of other fish, particularly native fish.

The Point-Click-Fish model (McLea & Joy, 2004) predicts the presence of seven fish species in Otukura Stream (Table 4). The most probable fish species, according to the model, are shortjawed kökopu, giant kökopu, and brown trout. Both species of kökopu (the juveniles of which are whitebait) are threatened native fish, and may migrate upstream from Lake Wairarapa. Only three of the predicted species (eels and koura) were found during the electric fishing surveys. Factors which may be affecting fish presence and abundance are discussed in Section 4.2.

Table 4: Fish species predicted to be present in Otukura Stream

Species	Predicted probability
Short-finned eel	0.82
Long-finned eel	0.71
Giant kokopu	0.99
Shortjawed kokopu	1.00
Red-finned bully	0.83
Freshwater crayfish (koura)	0.73
Brown trout	0.93

3.3 Aquatic macroinvertebrate communities

No macroinvertebrate surveys have been carried out in Otukura Stream or Battersea Drain.

3.4 Water quality

On 10 December 2004 spot measurements of temperature, pH, electrical conductivity and dissolved oxygen were taken (Table 5). The average flow at Otukura Stream at Weir during sampling was 595 l/s, therefore the water quality measurements are not considered typical of low flow conditions. The results show no obvious differences in water quality between the reaches, other

[6] Greater Wellington Regional Council report on consent application WAR060006

than an increase in conductivity with distance downstream. Although based on one sample only, the conductivity and dissolved oxygen results show that water quality declines between Moroa Road and Wards Line, as noted during the field assessment (see Appendix 1).

Table 5: Results from water quality measurements on 10/12/04

	Site	Temperature °C	pH	Conductivity µs/cm	Dissolved Oxygen %	Dissolved Oxygen mg/L
Reach 1	Otukura Stream @ Moroa Rd	14.2	7.5	132	91	9.3
	Otukura Stream @ Wards Line	14.8	7.4	157	79	8.0
Reach 2	Otukura Stream @ SH53	16.4	7.4	171	100	9.8
	Otukura Stream @ weir	17.4	8.0	175	94	9.0
Reach 3	Otukura Stream near Stonestead Creek confluence	15.6	7.4	170	93	9.2
	Battersea Drain	18.3	7.9	172	102	9.7

In attempt to better define the relationship between flow and water quality, a continuous water quality monitoring device (sonde) was installed at Otukura Stream at Weir for the period 23 December 2004 to 17 February 2005. The sonde measures water temperature, turbidity, conductivity and dissolved oxygen. However, due to problems with the equipment the record is incomplete and is generally only reliable up until about 15 January. There were problems with the turbidity sensor throughout the monitoring period, and as a result the turbidity data are not included in this report.

To determine any variations within the catchment, water temperature was continuously monitored in Battersea Drain just upstream of its confluence with Otukura Stream, in Otukura Stream in Reach 1 (at Moroa Rd) and at two locations in Reach 2 (State Highway 53 and Otukura Stream at Weir) from 10 December 2004 until 22 April 2005[7]. However, some of the temperature record was lost from Otukura Stream at Weir during January and February due to equipment failure.

3.4.1 Water temperature

Information on instream temperature is useful as it shows the suitability of the stream for supporting aquatic ecology. Sensitive macroinvertebrate species such as mayflies and stoneflies are adversely affected by temperatures over 20˚C (Quinn & Hickey 1990). Spawning of trout and native fish species is adversely affected by temperatures exceeding 25˚C. At all sites temperatures

[7] A temperature logger was also installed in Reach 3 but this was lost during a major flood on 31 March 2005.

over these thresholds were recorded. Instream temperatures exceeding 20˚C were recorded on 50-60% of days in the monitoring period at all sites. Temperature reached 25˚C for 6% of the time in Reach 1, 11% of the time in Reach 2 (State Highway 53), and 14% of the time in Battersea Drain. Peak instream temperature at three of the monitoring sites exceeded 27°C (Table 6).

Table 6: Water temperature monitoring results, December 2004 – April 2005

Site	Maximum Temperature (°C)	Minimum Temperature (°C)	Mean Temperature (°C)
Otukura Stream @ Moroa Rd	27.7	10.1	17.5
Otukura Stream @ SH53	28.5	9.1	18.2
Otukura Stream @ Weir[8]	24.5	10.2	17.0
Battersea Drain	28.6	6.6	16.5

Average daily instream temperatures showed a consistent pattern between the sites (Figure 17). Temperatures tended to increase with distance downstream, and were highest in Battersea Drain. This pattern is probably due to lower flow and generally less shading in Battersea Drain than in Otukura Stream. It is possible that temperatures in Reach 3 of Otukura Stream are significantly lower than in the upper reaches, due to the influence of cool waters from Stonestead Creek. However, this cannot be shown as the temperature logger installed in Reach 3 was lost in a flood before the data were retrieved.

[8] Maximum temperature appears lower than at the other sites; this is because data from the hottest part of the summer (January-February) is missing

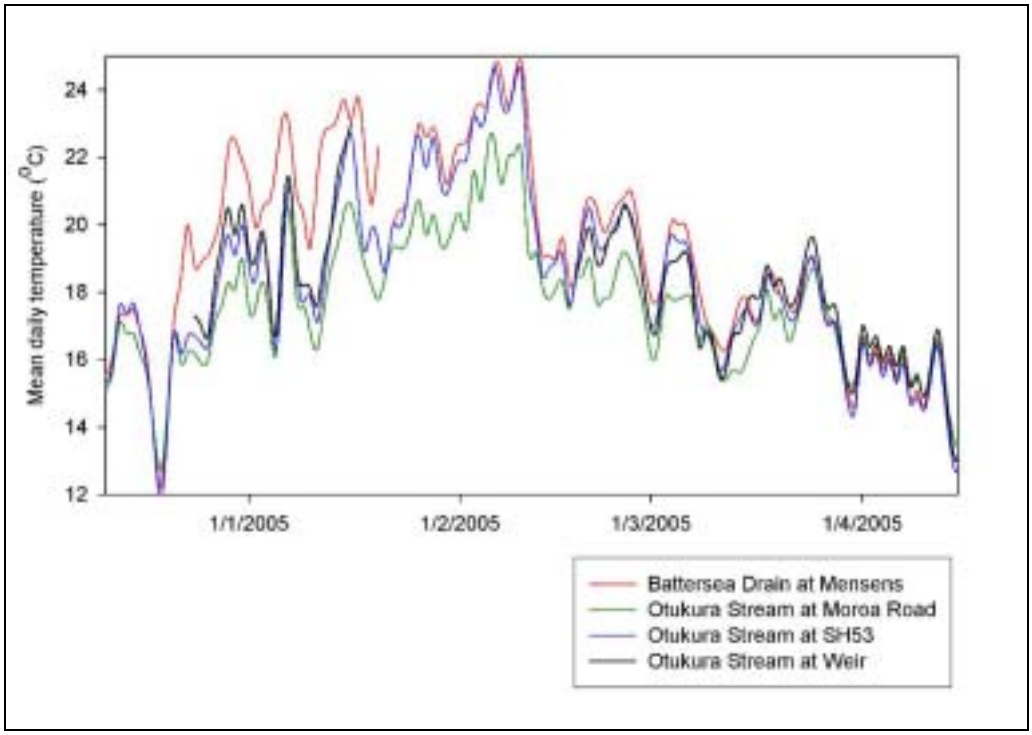

Figure 17: Instream temperature, Otukura Stream and Battersea Drain, December 2004 – April 2005

3.4.2 Dissolved oxygen

Dissolved oxygen is essential to all forms of aquatic life and varies with water temperature and biological activity (e.g. photosynthesis and respiration of plants). Concentrations below 5 mg/L may cause stress on aquatic life. Schedule Three of the Resource Management Act 1991 specifies that any discharge of contaminants should not require dissolved oxygen to fall below 80% saturation[9] in waterways being managed for aquatic ecosystem and fish spawning purposes (implying that dissolved oxygen saturation below this level may be detrimental to aquatic life).

The dissolved oxygen data collected at Otukura Stream at Weir show considerable diurnal fluctuation (Figure 18). Such fluctuations are expected in a waterway like Otukura Stream, which is dominated by macrophytes in some reaches. During the day when aquatic plants are photosynthesising they release oxygen into the surrounding water, but at night dissolved oxygen levels can drastically reduce.

[9] After reasonable mixing

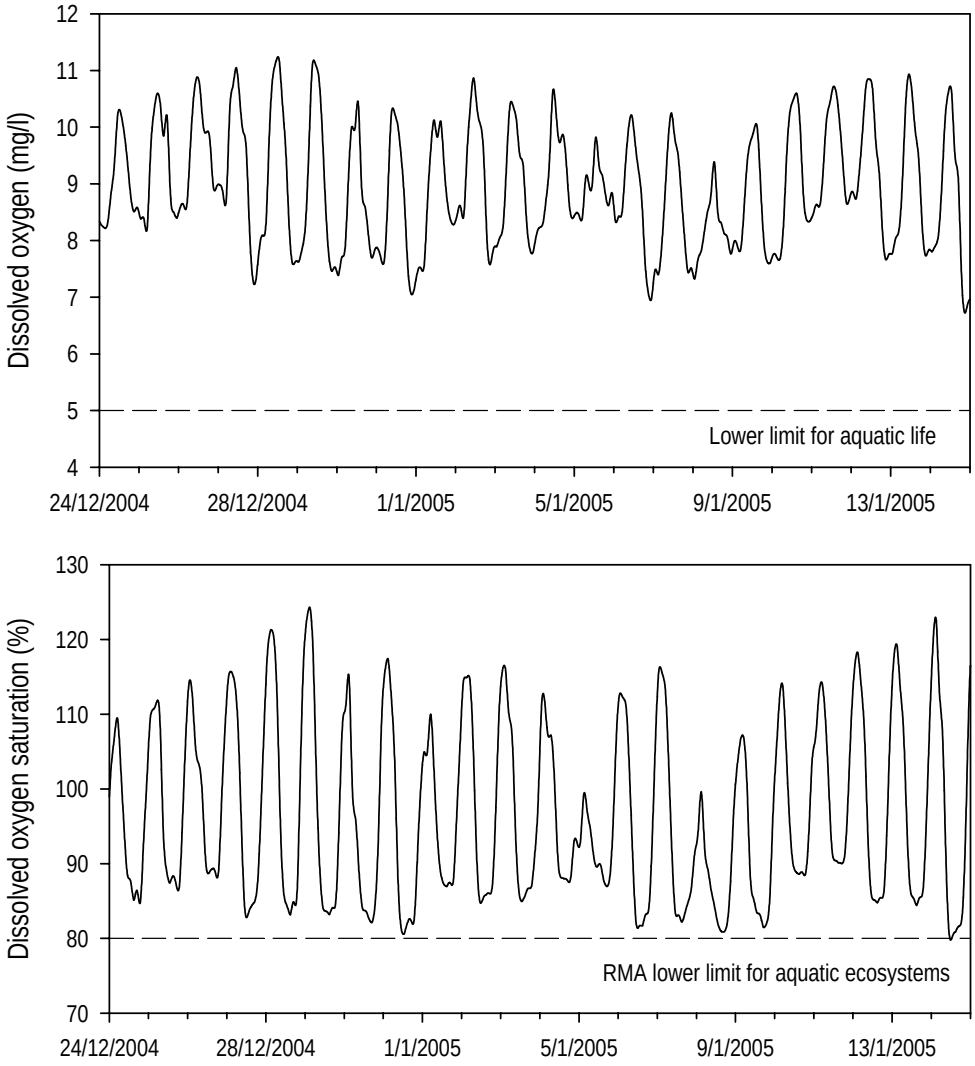

Figure 18: Dissolved oxygen in the Otukura Stream at Weir, December 2004 – January 2005

During the period December 2004 – January 2005 dissolved oxygen remained above the 5 mg/L threshold at all times. However, dissolved oxygen saturation fell to the 80% threshold during the night time on several occasions. It is possible that the data do not reflect the 'worst' conditions; instream temperatures were found to peak in February thus dissolved oxygen saturation may have reached even lower levels during that time. Thus at times, it is probable that dissolved oxygen levels become unsatisfactorily low in Otukura Stream.

Figure 19 shows the relationship between dissolved oxygen and temperature in the Otukura Stream during the period December 2004 – January 2005. The graph demonstrates that increasing instream temperature results in decreasing dissolved oxygen concentrations.

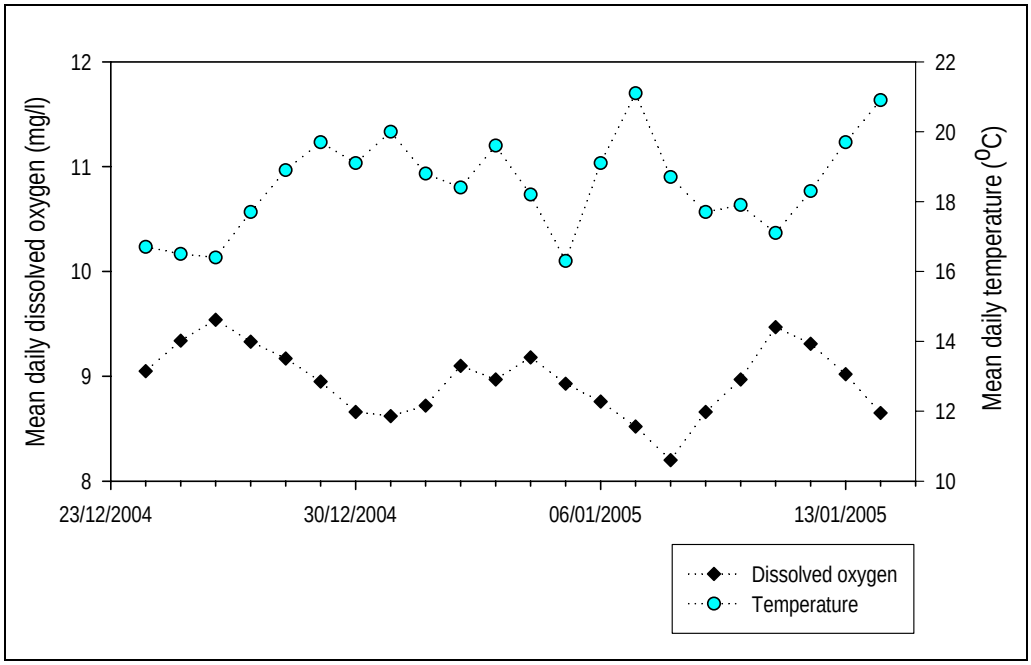

Figure 19: Mean daily temperature and dissolved oxygen in the Otukura Stream, December 2004 – January 2005. NB Temperature recorded at State Highway 53 and dissolved oxygen recorded at Otukura Stream at Weir.

3.4.3 Conductivity

Conductivity is an indicator of total mineral content and is often used as a surrogate indicator of the nutrient levels in a waterway. Temporal variation in conductivity recorded in the Otukura Stream tended to be related to flow conditions (Figure 20). Conductivity increased during 'freshes' in the stream (e.g. following the rainfall and elevated flows of 9-10 January 2005), which is to be expected due to runoff entering the stream.

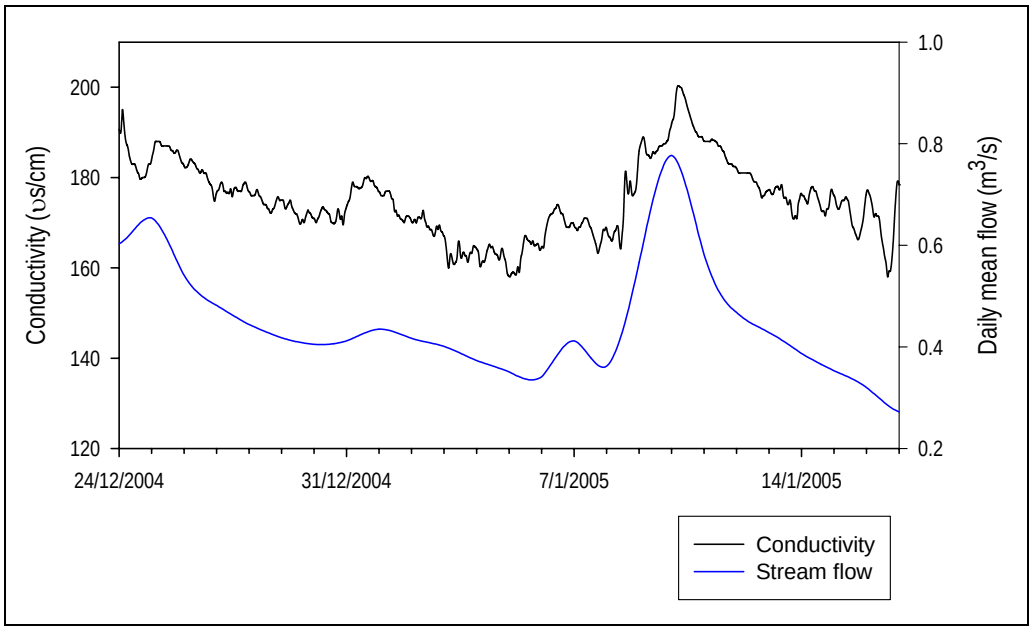

Figure 20: Conductivity and flow recorded at Otukura Stream at Weir, December 2004 – January 2005

The median conductivity at Otukura Stream at Weir during the monitoring period was 172 uS/cm. The median falls within the expected range for catchments with predominantly rural land use in the Wellington region (Milne & Perrie, 2006).

3.5 In-channel vegetation

The field survey in December 2004 noted the aquatic vegetation of the Otukura Stream and Battersea Drain (Table 7). Macrophyte growth was dominant in the upper reaches of the stream, but rare or sparse downstream of State Highway 53.

Table 7: Summary of vegetation observations

Site	Macrophytes	
	Rooted emergent	Rooted submergent
Otukura @ Moroa Rd	None	Abundant
Otukura @ Wards Line	Abundant	Common
Otukura @ SH53	None	Common
Otukura @ GW weir	None	None
Otukura downstream of Kahutara Rd	Sparse	None
Battersea Drain near confluence	None	None

4. Instream values and current condition

4.1 Instream values

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. The following descriptions of instream values are adapted from Ministry for the Environment (1998).

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.
- Section 7(h): The protection of the habitat of trout and salmon.

Landscape values refer to the natural character and amenity values of a waterway.

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).

4.2 Threats to instream values

4.2.1 Low flows

Extremely low flows in Otukura Stream and Battersea Drain are a threat to instream values because:

- The availability of aquatic habitat is reduced;
- Water quality is reduced (which may threaten life-supporting capacity); and
- Periphyton growth is encouraged (which reduces habitat quality and amenity value).

Otukura Stream, upstream of the Stonestead Creek confluence, is subject to extreme low flows at times. The low flows are in part a natural occurrence, due to low rainfall and limited groundwater discharge to the stream when

groundwater levels are low in summer and autumn. However, there is no doubt that low flows in Otukura Stream and Battersea Drain are exacerbated by abstraction.

The current level of allocation from the Otukura Stream and Battersea Drain (56 l/s) equates to about 50-60% of the estimated MALF at Otukura Stream at Weir. Although the consent conditions require some restrictions during extreme low flows, abstraction will still affect the stream during moderate flow conditions. In addition, even when restrictions are in force, low flows will be exacerbated by:

- Takes for subsurface irrigation, which are not restricted;
- Permitted activity abstractions; and
- Groundwater pumping.

The extent to which these latter two activities affect low flows in Otukura Stream and Battersea Drain is unknown.

4.2.2 Discharges to water

There are no existing consents for discharging contaminants to water in the Otukura catchment. However, runoff from agricultural land and other rural areas can contribute significantly to nutrient enrichment, microbial contamination and sediment accumulation in waterways. Due to the lack of riparian vegetation in the Otukura catchment to act as a buffer strip, it is likely that rural runoff is having a significant impact on water quality. In turn, the reduced water quality may be adversely affecting life-supporting capacity, habitat values, and amenity value of the streams.

4.2.3 Stock access

In many places, stock (predominantly beef cattle) have unlimited access to Otukura Stream and Battersea Drain, particularly in the upper reaches of the stream where it is shallow enough for stock to enter (Figure 21). In some places Battersea Drain has been diverted into paddocks to allow stock access.

Figure 21: Cattle in the Otukura Stream near Wards Line

Uncontrolled stock access to streams results in large amounts of sediment entering the waterway, which smothers the aquatic ecosystem. High sediment concentrations can also reduce amenity value of a waterway, by reducing water clarity. Faecal contamination and increased nutrient loadings will degrade water quality.

4.2.4 Stream modification

Stream modification has had a large negative impact on amenity values of Otukura Stream. The stream has been extensively straightened so that in places it resembles little more than a farm drain. Modification has also undoubtedly affected aquatic habitat value of the stream. Stream channelisation results in loss of aquatic habitat and species diversity because it generally causes:

- A loss of hydraulic diversity (pool/riffle/run sequences);
- A change in streambed composition; and
- Less undercutting of banks (associated with meandering).

Modification of Otukura Stream has also resulted in loss of riparian vegetation, which provides shade and food for aquatic macroinvertebrates. High temperatures recorded in the stream during early 2005 are a combined effect of low flows and lack of stream shading.

4.2.5 Barriers to fish passage

Fish passage barriers are a threat to aquatic habitat values. The first potential impediment to fish passage in Otukura Stream, moving upstream from Lake Wairarapa, is a consented wooden weir at the JK Donald Reserve Block which is in operation between October and April each year. However, the consent (held by Wellington Fish and Game Council) minimises the threat to fish passage by including the following conditions (paraphrased):

- The weir must be removed for a period of at least 7 days in succession during March and April, to allow inanga to run.

- During extreme low flows in Otukura Stream, if the water level falls below a certain point (which will impede fish passage), the weir must be removed.

The second potential impediment to fish passage is the Greater Wellington flow monitoring weir, upstream of Kahutara Road, which has a vertical drop of 0.15 metres. During the field assessment the fish experts noted that the weir may impede upstream migration of native fish, but should not be a problem for trout to pass.

Other potential impediments to fish passage are the temporary weirs installed for subsurface irrigation (between October and April) at three locations on the Battersea Drain (for example, Figure 22). All the consents for temporary weir installation require fish ramps to be installed. However, during the field assessment when one of the weirs was assessed, the experts doubted the adequacy of the ramps for native fish migration (see Appendix 1).

Figure 22: Fish passage on a subsurface irrigation weir, Battersea Drain

4.2.6 Pest fish

Pest fish, such as rudd and goldfish, have the potential to threaten native fish and trout through competition for resources and predation. No pest fish were found during the fish surveys. However, anecdotal evidence from landowners suggests that rudd are found in the streams (see Appendix 1).

4.2.7 Moroa water race

Tailraces of the Moroa water race discharge into Otukura Stream and Battersea Drain, and concerns have been raised over the impact of the water race on receiving water quality[10]. However, this is unlikely to be a huge impact, because Otukura Stream has generally poor background water quality as a result of several other factors.

The Moroa water race is fed from the Waiohine River, and by discharging into the Otukura Stream it means that waters from different catchments are being mixed. The unnatural mixing of waters, and mixing of waters from different sources with separate mauri, is prohibited in the Maori conception; these activities are seen to degrade the mauri of the waters (Ministry for the Environment, 1998).

In the assessment of the Moroa water race consent application, Greater Wellington found that it was difficult to address the issue of mixing waters because of the design of the water race system. In addition, without minimising the issue, it was noted that the waters all ultimately enter the Ruamahanga River, and therefore are not completely separate catchments. The assessment also noted the potential beneficial affect on Otukura Stream from the Moroa water race, by supplementing flow to the catchment during severe low flows.

4.3 Current condition of Otukura Stream and Battersea Drain

4.3.1 Ecological values

The ecological values of Otukura Stream and Battersea Drain are considered to be generally **low**. The classification is based on the following findings of this report:

- Low observed species diversity and fish abundance;
- Poor water quality (high instream temperatures and low dissolved oxygen) during times of low flow;
- Lack of habitat diversity (absence of pool-riffle-run sequences).

Otukura Stream is identified as a water body with important trout habitat (including spawning areas) in the Regional Freshwater Plan. Although the plan does not make the distinction, it is assumed that Otukura Stream is included for spawning rather than adult trout habitat value. Due to the current condition of Otukura Stream it is unlikely that the stream provides important spawning areas upstream of Stonestead Creek confluence. In particular, poor water quality and barriers to fish passage are likely to adversely impact the fish spawning value of the waterway.

It is worth noting that the ecological values of Otukura Stream are higher in Reach 3 (downstream of Stonestead Creek) than in the upper reaches. The

[10] Submissions to Greater Wellington on the application from South Wairarapa District Council to discharge water containing contaminants to the Otukura Stream, as part of the consents for the Moroa Water Race.

improvement in habitat quality is due to the significant flow contribution of Stonestead Creek, and a greater amount of riparian vegetation in this reach.

4.3.2 Landscape values

The watercourses have **very low** natural character and amenity value in their current condition.

4.3.3 Recreational values

In general Otukura Stream and Battersea Drain are of **very low** value for recreational use. In its upper reaches, extreme low flows and channel characteristics mean that the stream is unsuitable for any type of instream recreation. Below the confluence with Stonestead Creek, Otukura Stream may be of limited value for angling and whitebaiting purposes, although access is limited due to the stream flowing through private property[11].

4.3.4 Maori customary and traditional values

The value of the waterways to Maori have yet to be assessed. The values are likely to have been affected by the highly modified nature of the stream and the impact of the Moroa water race on the streams' mauri.

Battersea Drain contains abundant watercress in places, and is easily accessed from the road. Otukura Stream was found to have good populations of koura (freshwater crayfish). Therefore, the streams may be of value for mahinga kai, although this has yet to be confirmed by iwi representatives.

[11] There is no public access from the Lake Wairarapa domain to the Otukura Stream. Wellington Fish and Game Council allow duck hunters to access the JK Donald block at certain times of the year.

5. Proposed instream management objective

The proposed instream management objective is **to manage water quantity in Otukura Stream and Battersea Drain so that the ecological values of the waterways are improved**.

Therefore, the instream flow assessment will aim to determine environmental flows that will not result in flow-related declines in life-supporting capacity.

The proposed instream management objective recognises:

- It is desirable for ecological value to be improved, rather than maintained in the current condition; and

- It is unlikely that ecological value could be completely restored to its natural state through water allocation policies alone (hence the objective is to 'improve' rather than 'restore') – other actions that will be needed include increasing riparian vegetation, and reducing the level of stock access.

According to the Regional Freshwater Plan, Otukura Stream has important trout habitat (including spawning areas) and the water quality is to be managed for fishery and fish spawning purposes. This issues report has found that the stream is unlikely to provide significant trout or fish spawning habitat in its current state. The proposed instream management objective is a more realistic objective and aims to ensure that the impacts of water abstraction on ecological values are minimised.

6. Constraints and information gaps

6.1 Constraints

The assessment will not directly address non-flow related issues which impact on stream health. In particular, stream modification, lack of riparian vegetation, and a high level of stock access are likely to impact on water quality and ecological value of Otukura Stream and Battersea Drain. Although Greater Wellington recognises that it is a regional council's responsibility to manage the water quality of the waterways, it should be acknowledged that the instream flow assessment and any resulting water allocation policies are only one step in achieving a healthy aquatic ecosystem.

6.1.1 Key information gaps

- Detailed information on the relationship between low flows and stream water quality.
- Information on nutrient concentrations in the stream, and macroinvertebrate indices, to more specifically determine stream health.
- Detailed information on flow losses and gains within the catchment, in particular the contribution of the Moroa water race.
- Quantitative assessment of the cumulative impact of groundwater pumping on flow in Otukura Stream.

7. Proposed investigations

Although we are lacking detailed scientific information for Otukura Stream and Battersea Drain, the catchment is only one of Greater Wellington's priorities for instream flow assessment. Under the Framework for instream flow assessment in the Wellington region (Greater Wellington, 2006), the level of scientific investigation into instream flow requirements should be based on both the level of stress caused by water abstraction and the significance of instream values.

It is clear from the findings of this report that the catchment is under a high degree of stress from water abstraction, and also that the significance of instream values is low as a result of many factors. Although it is desirable to rehabilitate the catchment as much as possible, it is acknowledged that not all the information gaps can be filled.

The proposed that additional scientific investigations for the instream flow assessment are:

- One low flow survey, to more thoroughly determine flow losses and gains in the catchment.
- A basic quantitative assessment of the likely cumulative impact of groundwater pumping on flow in the Otukura Stream.
- Basic assessment of the relationship between low flows and water temperature using existing data, possibly using the model WAIORA.

7.1 Timeframes

The proposed timetable for Otukura Stream and Battersea Drain instream flow assessment is:

March 2007: consultation on the instream flow issues report for the Otukura Stream and Battersea Drain.

January to May 2007: conduct additional field work including a low flow survey. Require irrigation records to be kept so that low flows can be naturalised. Collect any additional information to calibrate an instream temperature model. Carry out a basic assessment of the likely impact of groundwater takes on flows in Otukura Stream and Battersea Drain.

30 June 2007: complete instream flow assessment technical report for Otukura Stream and Battersea Drain. The report will recommend the flow requirements to sustain the instream management objective. The report will be sent to key stakeholders including local iwi, Department of Conservation, Fish & Game New Zealand, and holders of consents to abstract water in the Otukura catchment.

7.2 Additional recommendations

Although separate from the instream flow assessment, it would be desirable for Greater Wellington to:

- Investigate sources of water quality degradation in Otukura Stream particularly between Moroa Road and Wards Line.
- Carry out a stream walk over to map permitted activity abstractions in the catchment.
- Consider approaches to reducing stock access to Otukura Stream and Battersea Drain.
- Consider approaches to improving riparian vegetation alongside the stream.
- Consider how consents to abstract groundwater could be managed to avoid, remedy or mitigate impacts on flow in Otukura Stream (where there is potential for the groundwater pumping to induce stream flow depletion).
- Assess the fish ramps on subsurface irrigation weirs and discuss options for improving fish passage if these are deemed inadequate.
- Investigate options for installing a fish ramp on Greater Wellington's Otukura Stream flow monitoring weir and assess the potential benefits this would have.

Acknowledgements

Blake Abernethy (Wellington Fish and Game) and Tony Silsbury (Department of Conservation) attended the Field Assessment. The information they shared relating to values of Otukura Stream and threats to those values was extremely helpful in the preparation of this report.

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Appendix 1: Notes from fieldtrip 22 December 2004

SUBJECT **Otukura Stream fish habitat – notes from the field trip**

WHEN Wednesday 22 December 2004

TODAY'S DATE 23 December 2004

FILE NUMBER ENV/05/04/18

Present:

Darryl Squires (Greater Wellington)
Raelene Hurndell (Greater Wellington)
Murray McLea (Greater Wellington)
Laura Watts (Greater Wellington) (note taker)
Blake Abernethy (Fish & Game NZ)
Tony Silbery (Department of Conservation)

Stop 1: Otukura Stream @ Moroa Road

Although trout will be found in the lower reaches of the stream, Blake thought it was unlikely trout would be found this high up in the catchment due to the poor water quality downstream, and lack of suitable habitat. At this site there are likely to be longfin eels and koura, and mudfish in the bordering wetlands. The predominance of macrophyte (curly pond weed) which doesn't choke the waterway is good, as it will provide cover for fish and substrate / food for snails. There is the potential for pest fish (rudd and goldfish) to be found in this area.

Stop 2: Otukura Stream @ Wards Line

There were cows in the stream at this site, and water quality was visibly poor (turbid and discoloured water). The poor water quality means the reach is unlikely to support trout or native fish populations, and in addition there is no riparian cover and the stream is channelised. In terms of native fish migration to better quality water upstream: Tony thought they would probably survive travelling through the reach but it is not ideal. The water is probably not of good enough quality to support inanga migration. Water quality sampling (in particular for ammonia) would be useful to support the instream flow assessment.

Battersea Drain @ Mensens

The weir for subsurface irrigation was in place, but water level was not yet at its highest. The experts thought that the stream is likely to support inanga, kökopu, eels, bullies and koura. The fish passage over the weir is not suitable and unlikely to provide proper passage for these species. Chris Mensen gave anecdotal evidence of small rudd in the stream, and that there used to be trout in it but not anymore.

Stop 3: Otukura Stream @ State Highway 53

The site has poor water quality and lacking in riparian cover and therefore unlikely to provide good habitat. Macrophytes are dominant (oxygen weed and Horses Mane), which will provide substrate for snails.

Stop 4: Otukura Stream @ Bicknells Road

There was concern from Blake about fish passage over the flow monitoring weir – he did not believe that inanga would be able to pass over this structure, but it would not be a problem for trout. Murray suggested the possibility of investigating a fish passage solution for the site. However, it was discussed that the value of the habitat upstream of the weir is questionable anyway, due to the poor water quality, lack of shade, and uniform channel.

Stop 5: Otukura Stream @ Walls

Here the water seems to be significantly better quality than up at SH53. The stream is fenced off in this reach, and there is more shade. The banks are undercut providing habitat, and the water is deeper (and therefore likely to be cooler at depth). Tony said the thick pond weed is not a problem, as it is not a smothering weed.

Matt Wall said he has never seen trout in the Otukura Stream above the confluence with Dock Creek, although there are lots of eels. Blake and Tony agreed that there are also likely to be inanga, bullies and koura in this reach.

Stop 6: Otukura Stream @ Gillett's

The undercut grassy banks are likely to provide good habitat here, and there is shade from the willow trees. This reach (downstream of Dock Creek) will support good trout habitat. We saw a shoal of inanga under the bridge. Tony and Blake also thought there is a possibility of finding giant bullies and giant kökopu in the reach.