REPORT

Tonkin+Taylor

Resource Consent Applications

River Management Activities in the Waikanae River and Waimeha Stream

Prepared for

Greater Wellington Regional Council (Flood Protection)

Prepared by

Tonkin & Taylor Ltd

Date

Revised December 2016 / lodged 22nd May 2013

Job Number

85484.001.v3

Exceptional thinking together

www.tonkintaylor.co.nz

Distribution:

Greater Wellington Regional Council (Flood Protection)	2 copies
Greater Wellington Regional Council (EREG)	2 Hard copies / 1 Electronic
Tonkin & Taylor Ltd (FILE)	1 copy

Table of contents

List of Tables

List of Figures

Executive summary

Context

This application is for resource consents for all of the river management activities undertaken by GWRC in the Waikanae River corridor, between the Waikanae Water Treatment Plant weir and the river mouth (covering approximately 7 km lineal distance in total). The application is largely to renew GWRC's existing consents held for these activities, and to seek consent for some new activities including gravel extraction from the active river channel in the Waikanae River, and for works in the Waimeha Stream. The application also seeks to allow for the use of new methods over time via an agreed process, as explained further below.

Specific large capital works (such as the construction of new stopbanks) and the use of herbicides for control or removal of vegetation are not included in the application.

The application is one component of a wider GWRC Consent Project, which covers eight consents for flood protection operations and maintenance activities and three gravel extraction consents; all of these are due for renewal between April 2013 and September 2016. The existing consents cover several rivers in the western and eastern parts of the Wellington Region. Work on re-consenting the western consents started in April 2012, while work on the eastern consents (with the exception of one short-term consent for the Waingawa River) started in late 2014.

Included in the consent renewal project is the development of a region-wide environmental monitoring programme to better understand the effects of flood protection works. To assist this, a 'Science Group' comprising representatives from Department of Conservation, Fish & Game NZ, Massey University and GWRC Biodiversity and Science staff, together with a consultant ecologist and consultant river engineer, has been established by GWRC to help design and oversee monitoring work and provide feedback and input into the consent applications. The work of the Science Group has resulted in the initiation of a number of new environmental investigations focused on river management activities, particularly channel management and gravel extraction. It has also given rise to further new studies to address areas where general biological resource information was lacking, particularly in relation to the distribution of native fish and river birds in the western rivers. It should be noted that the statements in this report do not necessarily reflect the opinions of individual members of the Science Group.

Another key component of the resource consent project is focused on updating GWRC's existing Code of Practice (COP) for undertaking river management activities. The new COP will be region-wide and will inform all river management activities undertaken by GWRC. A Draft Code has been prepared and work on development of the COP will continue throughout the processing of the resource consent applications and beyond, in response to on-going consultation.

A term of 35 years is sought for the new resource consents.

A new COP will sit alongside the Waikanae Floodplain Management Plan and Environmental Strategy, annual works and maintenance plans, and environmental monitoring programme, to guide and direct GWRC's works and maintenance activities. In particular, the COP, rather than the conditions of the resource consents, will provide much of the specific detail and direction on the methodology to be adopted for individual activities. The resource consents will provide for a review process by which the COP and environmental monitoring programme may be updated on an agreed basis, based on the information supplied by on-going monitoring and engagement with iwi and key stakeholders. In that way, the Code will be a living document to drive good practice while also remaining flexible and responsive to the dynamic nature of the river environment.

Proposed activities

Flood protection works have been undertaken in the Waikanae River and Waimeha Stream for almost 60 years, and today the floodplain is protected by flood protection infrastructure that is valued at $4.8M . The settlement and growth of adjacent urban areas is dependent on an expectation that the risk of flooding is maintained at a known and acceptable level. To achieve this, these watercourses will continue to require management to protect the communities living adjacent to them for the foreseeable future.

The requirement to address the flood hazard associated with rivers is enshrined in legislation, with the Greater Wellington Regional Council (GWRC) assuming responsibility for this function in the Wellington Region. Flood protection and control works make up 6% (or nearly $28 M) of the council's expenditure for the current (2015/16) financial year. GWRC proposes to continue to undertake all of these activities for flood protection and erosion control purposes on an as required basis. Only those works that are necessary will be undertaken, and GWRC is committed to operating in a manner that reflects good practice and results in the management and minimisation of adverse effects.

As part of this application GWRC proposes an initial gravel extraction operation to remove approximately 43, 700 m³ of gravel that has accumulated between the CMA boundary and the upstream end of Jim Cooke Memorial Park at XS 300 since 1991 (despite on-going gravel extraction over this time). The presence of this gravel has raised river bed levels and reduced the flood carrying capacity of the river channel, which in turn has increased flood risks and the frequency of works to address flood damage. GWRC considers it is preferable to undertake the initial extraction in the proposed manner rather than over a longer time to limit the impacts in terms of time and to maximise the length of time that the advantages and benefits flowing from the work will be available over the life of the new consent.

Effects

The effects of the activities individually, and as a whole, have been assessed using existing environmental information, and new information made available through the environmental investigation work undertaken by GWRC.

The positive effects of the works overall are significant and include the direct reduction of the flood hazard and risks to life, property and the economy of the Waikanae area and the wider Wellington Region. They are a key component of the continued economic and social well-being of the Kapiti Coast in particular and the Wellington Region as a whole.

Six key aspects of the environment are potentially affected by the proposed activities:

- Water quality;
- Aquatic ecology;
- Birds;
- Recreation;
- Neighbouring community; and
- Cultural.

Details of these effects are as follows:

- Water quality. These effects arise from the input of suspended sediments to the water column as a result of the direct disturbance of the bed, or from works on banks or in culverts. The operation of machinery (particularly bulldozers) in the river bed give rise to the greatest effects in this regard. Generally such work will be undertaken for a few weeks per annum (on average). Suspended solid concentrations of up to 700 mg/l can be generated for short

periods. The aquatic biota are naturally adapted to cope with such variations in turbidity; available information to date suggests that in general the overall effect of short duration increases of suspended solids in the water is relatively minor and can be mitigated to a reasonable degree by restrictions of operations to no more than half of every 24 hour period, and scheduling works to avoid periods of peak sensitivity.

- Aquatic ecology. These effects arise from direct disturbance of the river bed habitat associated with construction activity, gravel extraction or bed recontouring. Activities such as gravel extraction have a significant impact on the habitat and ecology of the affected reaches, however available information to date suggests that such effects may be relatively short-lived, with the river acting to re-work the bed naturally and the aquatic biota re-colonising impacted areas relatively quickly. Mitigation is currently focused on the continuance of good practice, as formalised in the COP, particularly incorporating final shaping of affected reaches to provide for more complexity of habitat to assist recovery. GWRC is committed to continued investigations into the impacts of in-river works on aquatic ecology, which will ultimately help to improve practice and enhance mitigation.
- Birds. Potential effects may arise from disturbance of roosting or nesting birds, or from changes to potential nesting habitat on the river bed. Actual adverse effects on river birds are likely to be relatively minor, largely due to the absence of threatened or vulnerable species in the Waikanae River upstream of the estuary. On-going regular survey work is proposed to identify any changes in river bird populations.
- Recreation. Adverse effects on recreational activities are most likely to be relatively infrequent, involving restriction of access to small sections of the river or river berms. In the longer term, the impacts on off-river recreational users are likely to be positive, as the development of the river corridor in accordance with the Waikanae River Environmental Strategy progresses.
- Neighbouring community. Based on past experience and the one recorded complaint that has been received over the past thirteen years in relation to GWRC's river works and maintenance activities, the adverse effects on the neighbouring community are anticipated to be less than minor overall. This reflects the use of good practice, as outlined in the COP.
- Cultural (arising from changes to traditional areas of use and disturbance of areas of significance). GWRC has an established relationship with iwi and continue to work with iwi to better understand their concerns, share knowledge and make provision for recognition of cultural values within the COP. This consultation is on-going.

Other potential adverse effects of the works on the landscape and visual amenity values of the river corridor are considered to be less than minor, particularly in the context of the other landscape enhancement work associated with implementation of the Waikanae River Environmental Strategy that GWRC undertakes in conjunction with Kapiti Coast District Council (KCDC).

The short-term initial gravel extraction operation has potential to create relatively short term adverse effects of some significance on the aquatic ecology of the river and on recreational and possibly commercial tourism activity over one summer period. GWRC proposes to manage and mitigate these effects as much as is practicable through the development of detailed excavation plans which will aim to minimise the amount of time necessary for operation of machinery in the active channel, and through on-going consultation with the affected community which will inform the optimisation of sequencing and timing of the extraction operation. The benefits of the proposed gravel extraction approach will include lowered flood risk, and less need for works in the lower reaches of the river (meaning less disturbance of the aquatic ecology and recreational use and less on-going operational costs over the longer term).

Consultation

Consultation with affected parties and interested groups has been undertaken in the preparation of this application and the feedback received has been taken into account in the preparation of this application. Consultation will be on-going in many cases throughout the processing of the application. GWRC is committed to consultation with iwi in relation to the Waikanae River. GWRC has requested that the application be notified to ensure any other affected or interested parties have the opportunity to have input in the resource consents process.

Summary

The proposed suite of activities has overall status as a Discretionary Activity (based on the principle of bundling activities to the highest activity status).

This application has illustrated that the proposal is in keeping with the purposes of the RMA and the objectives and policies of the regional policy statement and plans and will deliver the anticipated environmental results that the policies of the regional plans are expected to achieve. Accordingly, we respectfully request that this resource consent application be granted.

1 Introduction

1.1 The need for river management activities

Flood protection works have been undertaken in the Waikanae River and Waimeha Stream for almost 60 years, and today the floodplain is protected by flood protection infrastructure that is valued at $4.8M[1]. The settlement and growth of adjacent urban areas is dependent on an expectation that the risk of flooding is maintained at a known and acceptable level. To achieve this, these watercourses will continue to require management to protect the communities living adjacent to them for the foreseeable future.

The requirement to address the flood hazard associated with rivers is enshrined in legislation[2], with the Greater Wellington Regional Council (GWRC) assuming responsibility for this function in the Wellington Region. Flood protection and control works make up 6% (or nearly $28 M) of the council's expenditure for the current (2015/16) financial year.

The overarching vision and strategy for flood protection work in the Waikanae River and Waimeha Stream is contained in the Waikanae Floodplain Management Plan (WFMP)[3] - a document that has been developed through consultation and agreement with the local communities. This document establishes the level of protection from flooding that has been determined necessary by the community, and it outlines the measures by which it will be achieved. These measures include capital works such as construction of stopbanks, operational works within the river, and other off-river works (such as moving people and infrastructure away from the flood risk). In turn, these requirements are reflected and developed further in the GWRC's Long Term Plan, Asset Management Plan and annual work programmes. The operations and maintenance works undertaken by GWRC are required to respond to the challenges of a dynamic river system; these include repairing damage caused by periodic flood events, and managing the continuous transport of gravel through the river system and the deposition of gravel in the lower reaches.

The Waikanae River Environmental Strategy forms an important part of the WFMP. It provides a vision for development of the river corridor which further guides GWRC's works and maintenance activities, particularly in respect of the management of vegetation, access, visual amenity and recreational opportunities.

1.2 The wider context of this application

This application is one component of a wider GWRC resource consent renewal project, which covers eight consents for flood protection operations and maintenance activities and three gravel extraction consents, all of which are due for renewal between April 2013 and September 2016. The existing consents relate to rivers in both the western and eastern parts of the Wellington Region.

The project comprises five work streams as follows:

Work Stream 1: To re-consent GWRC's existing operations and maintenance resource consents in the western and eastern parts of the Region.

[1] As at June 2012

2 GWRC has statutory responsibility for the minimising and preventing of flood and erosion damage under the Soil Conservation and Rivers Control Act 1941 (sections 10 and 126), and avoidance or mitigation of natural hazards under section 30 of the Resource Management Act 1991 (RMA). By definition, 'natural hazards' include flooding.

[3] (Wellington Regional Council, 1997) and (Greater Wellington Regional Council, 2010). See Section 2.1 for further details.

The western rivers consents include those for the Hutt River [WGN 980255 and WGN 060334], Stokes Valley Stream [WGN 060291], Waikanae [WGN 980256], Otaki [WGN 980254] and Wainuiomata [WGN 020143] Rivers.

The eastern rivers consents cover those in the Waingawa River [WAR970137], Waiohine/Mangatarere/Kaipatangata Rivers [WAR000363], Waipoua River [WAR000364], Upper Ruamahanga River [WAR000365], Ruamahanga River [WAR 990026] and Kaipatangata Stream [WAR 990313].

Work on re-consenting the western river resource consents started in April 2012 and these applications also include seven smaller tributaries of the Hutt, Waikanae and Otaki Rivers. Work on the eastern consents (with the exception of the Waingawa River short-term consent- see Work Stream 2 below) which started in late 2014.

Work Stream 2: Waingawa Short-term Resource Consent Application

A short-term resource consent to enable works in the Waingawa River to continue was granted in April 2013; this consent is required until the development of the Floodplain Management Plan (FMP) for this river (currently underway) is sufficiently advanced to support a long-term resource consent application.

Work Stream 3: Environmental Monitoring

This work stream involves the development of a region-wide environmental monitoring programme to better understand the effects of flood protection works. Environmental monitoring is being undertaken to characterise existing biological resources of the river systems and enable the potential effects of the proposed activities to be adequately assessed. To assist this process a 'Science Group' comprising representatives from Department of Conservation (DOC), Fish & Game NZ, Massey University and GWRC Biodiversity and Science staff, has been established by GWRC to help oversee monitoring work and provide feedback and input into the consent applications, including the Waikanae River application. The work of the Science Group has resulted in the initiation of a number of new environmental investigations focused on river management activities, particularly gravel extraction. The Group also identified areas where general biological resource information was lacking, particularly in relation to the distribution of native fish and river birds in the western rivers, leading to the development or re-focusing of studies by GWRC.

In addition, GWRC funds annual trout surveys by Fish & Game NZ in the Waikanae River and has undertaken a review of recreational use in Wellington's western rivers to update resource information for the consents project. The Science Group is also supporting work to develop a 'natural character index' or NCI for Wellington's western rivers, which will be extended to eastern rivers in due course. This is a means of quantifying a number of the natural features of a river to provide a measure that might eventually enable assessment of the effects of activities.

Work Stream 4: Code of Practice

Updating GWRC's existing Environmental Code of Practice for flood protection works forms another key component of the work being undertaken to support all of the resource consent applications. The new COP will be region-wide and will inform all activities undertaken by GWRC. A working draft of the Code has been prepared, and is included as Annex 1 to this application. Initial comment from iwi and some key stakeholders has been sought and considered in the development of this draft, and it is anticipated that further development of the Code will continue in response to on-going consultation throughout the processing of the resource consent applications, and beyond.

Work Stream 5: Floodplain Management Plans

FMP's already exist for the Hutt, Waikanae and Otaki rivers. Under this work stream, additional information to support either a resource consent renewal process or plan process will be prepared

as necessary for the western rivers. In addition, development of FMPs for the Waiohine River and those rivers in the upper part of the Wairarapa Valley (Kopuaranga, Waingawa, Waipoua, Whangaehu, Taueru and the upper reaches of the Ruamahanga River) in the eastern part of the region is underway and will continue.

1.3 Term and scope sought for new consents

Since the introduction of the Resource Management Act (RMA) in 1991, GWRC has been required to undertake its rivers works and maintenance activities according to resource consents that have been used to prescribe and set the parameters for these activities. To date, the timeframe for these consents has been less than the maximum currently allowed, which has placed additional costs associated with re-consenting/consent renewal unnecessarily on the regional community.

The application which is the subject of this report seeks new resource consents over a 35 year term for GWRC's operations and maintenance activities. In conjunction with this GWRC proposes that much of the detail and prescription for the methods to be employed are to be included in the COP, rather than in the resource consent itself. The COP will be a living document representing good environmental practice. It will be supported by an on-going programme of investigation and monitoring and review, which provide a process by which it can evolve over time. Such an approach will allow greater flexibility to test and refine methods without the need to vary and/or seek new resource consents.

1.4 Applicant and area covered by application

GWRC employs a variety of structural and non-structural methods, outlined in the WFMP, to manage the flood hazard from the Waikanae River. The Council's Flood Protection Department (Flood Protection) has particular responsibility for management of the Waikanae River bed, berms and banks, from the mouth to the SH1 bridge, within this framework. The Council also undertakes works in the reach from the SH1 bridge upstream to the Waikanae Water Treatment Plant weir[4] (in conjunction with landowners), and also actively manages a number of other smaller watercourses on the Kapiti Coast (including the Waimeha Stream to the north of the Waikanae River) for the purposes of flood protection.

GWRC is currently undertaking works and maintenance activities under resource consents WGN 980256 (01), (02), (03), (04) (05) & (06)[5], in which cover the bed of the Waikanae River, the berms and stopbanks outside the river bed, and in the coastal marine area (CMA), in the area lying between the KCDC Water Treatment Plant weir and the river mouth – a distance of approximately 7 km.

This application is for resource consents to allow continuance of GWRC's operational and maintenance activities in these areas. It also seeks resource consent for operational and maintenance activities in the Waimeha Stream.

The application does not cover specific large capital works such as the construction of new stopbanks and does not seek consent for the use of herbicides for control or removal of vegetation

The required forms for this application are included in Appendix A.

The application covers:

- Land in the Waikanae River corridor downstream of the KCDC Water Treatment Plant weir
- The bed and adjacent banks of the Waimeha Stream downstream from Park Avenue and Te Moana Road, and

[4] This plant and weir is operated by Kapiti Coast District Council.
[5] These consents expired in November 2013, but continuance is allowed pursuant to s124 of the RMA while this application is processed.

- The parts of those rivers lying within the CMA

Aerial photographs of these areas and details of land ownership are provided in Appendix B; further details of boundaries and land tenure are included below.

Table 1: Application details

Applicant	Wellington Regional Council[6]
Owner of application site	The Crown, Greater Wellington Regional Council, Kapiti Coast District Council and others. Certificates of Title are included in Appendix C[7].
Site address / map reference	Bed and adjacent banks of the Waikanae River within the river corridor, and those parts of the coastal marine area, lying between the Waikanae Water Treatment Plant weir (NZTM grid reference 1774570.10 E, 5471546.10 N) and the Waikanae River mouth (NZTM 5473501.0 N, 1769120.5 E approximately). Bed and adjacent banks of the Waimeha Stream, between the Waimeha Stream mouth (5475072.94 N, 1770594.26 E approximately) and the points where the stream branches are crossed by Te Moana Rd (at NZTM grid reference 1771560.91 E, 5473482.51 N) and Park Avenue (at NZTM grid reference 1771937.80 E, 5473483.50 N); and the coastal marine area downstream of the Waimeha Stream mouth.
Address for service and invoicing	Greater Wellington Regional Council Flood Protection Department Attention: Tracy Berghan

Further details relating to specific parts of the application area are given below.

1.4.1 Waikanae River corridor

The Waikanae River corridor comprises the river bed and adjacent land, as shown in Appendix B. For the purposes of this application, the application area includes the river corridor between its downstream extent at the CMA boundary and the weir adjacent to the KCDC Water Treatment Plant.

The majority of the land in the river corridor is in public ownership, and is administered by Greater Wellington Regional Council, Kapiti Coast District Council or the Department of Conservation. However a significant portion of the river corridor between SH1 and the Water Treatment Plant weir is privately owned. Certificates of Title are included in Appendix C.

Further details of the river corridor are shown on the aerial photographs and maps in Appendix D.

1.4.2 Waimeha Stream

The application area covers the bed and adjacent banks of the Waimeha Stream downstream from the culverts under Park Avenue and Te Moana Road.

Certificates of Title are included in Appendix C.

According to GWRC records[8], a drainage easement 50 links wide (or 10.06 metres) was applied to sections adjoining the stream when subdivision was first carried out. The easement gives the maintaining authority (currently GWRC) the right to take machines over the land defined for the purpose of maintaining the stream, and no obstructions are permitted that will hinder a dragline or any other machine.

[6] Note that this is the correct legal name for the regional council. Elsewhere in this application document, the council is referred to by its promotional name of 'Greater Wellington Regional Council'.
[7] The official copy of the application includes Schedules of the Certificates of Title and copies of each title; other copies only include the Schedules.
[8] GWRC Internal Memo N/60/01/01; 21 July 2004

1.4.3 River mouths

The mouths of the Waikanae River and Waimeha Stream form the downstream extents of the application area.

Appendix 1 (River Mouths) of the Regional Coastal Plan for the Wellington Region (RCP) defines the position of the Waikanae River mouth at grid reference NZMS 260 R26 791. This equates approximately to grid reference NZTM 5473501.0N 1769120.5E. This is depicted in Figure 1.24 of the same RCP Appendix 1 (see Appendix D of this report).

The RCP prescribes the location of the Waimeha Stream mouth at grid reference NZMS 260 R26 811 366. This is depicted in Figure 1.23 of the same RCP Appendix 1 (see Appendix D of this report).

1.4.4 Coastal marine area

The CMA boundary within the Waikanae River is depicted in Figure 1.24 of Appendix 1 of the RCP (see Appendix D of this report). It lies approximately 460 m downstream of the Otaihanga Boating Club building, which is located on the true left bank of the river (at grid reference NZTM 5473187.5N 1769216.6E). This means that the lowest reach of the application area lies within the CMA (see Figure 11 in Appendix D).

The CMA boundary in relation to the Waimeha Stream is depicted in Figure 1.23 of Appendix 1 of the RCP (see Appendix D of this report) and is defined (in the RCP) as 'the seaward edge of the Field Way Road Bridge at NZMS 260 R26 811 366.' (Note this is the same point as the river mouth).

1.4.5 Waikanae Estuary Scientific Reserve

The Waikanae Estuary Scientific Reserve covers over 60 ha of land in a number of parcels at the mouth of the Waikanae River (see Appendix D). This land is administered by the DOC under the Reserves Act 1977.

From the aerial photograph in Appendix D it can be seen that the reserve extends over the entire lower reach of the Waikanae River (which is included within the application area) as well as areas of the adjacent land (which is not). The river channel enters the reserve at a point approximately 50 m downstream the Otaihanga Boat Club (and enters the CMA approximately 400 m further downstream beyond the reserve boundary).

1.5 Summary of regional resource consent requirements

Resource consents are sought to cover all of the operations and maintenance activities undertaken by GWRC that require consent under the Operative Regional Plans. These are summarised below.

A variety of activity statuses apply across the range of activities. The most onerous is Discretionary and accordingly the entire suite of activities should therefore be considered a Discretionary Activity.

Table 2: Resource consent details

Type of Consent	Relevant Plan & Rule	Activities
Land Use	Regional Freshwater Plan (RFP): Rule 43 – Maintenance, repair, replacement extension, addition to, or alteration of any structure	Construction in/on the river beds of: · impermeable erosion protection structures · rock/concrete grade control structures · drainage channels and minor culverts associated with walkway developments Construction in/on the river beds of:

Type of Consent	Relevant Plan & Rule	Activities
	Rule 44 – Removal or demolition of structures Rule 48 – Placement of impermeable erosion protection structures Rule 49 – All Remaining Uses of River Beds	· permeable erosion protection structures: · debris fences · debris arresters Planting of willows in the river beds Layering, tethering and cabling of willows in the river beds Recontouring of the river beds Cutting of diversion channels Disturbance of river beds by mechanical ripping Shaping and repair of bank edges Trimming or removal of vegetation from the river beds Clearance of flood debris from the river beds and stream culverts Extraction of gravel from the river beds Maintenance, repair, replacement, extension, addition, alteration of structures on the river beds Demolition and removal of structures from the river beds Construction of footbridges Undertaking of urgent works in the river beds Operation of machinery in river bed for the purpose of trimming and mulching vegetation on the banks Entry & passage on river bed for operations & maintenance purposes
	Regional Soil Plan (RSP): Rules 1 - 4	Repairs etc. of banks, berms and stopbanks Construction of earth training banks, concrete flood walls or retaining walls, drainage channels and minor culverts (not in river bed) Construction of walkways, cycle ways, bridle paths on the river berms Construction of boundary fences Excavation and lowering of berms in the Waikanae River corridor Disturbance of vegetation on berms, including mowing Excavation, disturbance of, and deposition of sand on the (beach) above mean high water springs sea level in the Waikanae River and Waimeha Stream
Water Permit	RFP Rule 16	Diversion of water associated with the above activities as necessary.
Discharge Permit	RFP Rule 5	Discharge to the rivers of silt and sediments associated with: · all construction works · all planting works · all maintenance works · all demolition works · all urgent works · repair of structures on the river berms

Type of Consent	Relevant Plan & Rule	Activities
		Discharge of stormwater into surface water associated with works outside the river bed.
Coastal permit	RCP Rule 34	Disturbance of foreshore and seabed, including any associated deposition of natural material and diversion of water, which is carried out for the purpose of realignment of the Waikanae River, namely: · excavation of a new channel across the foreshore (intertidal zone) when the trigger levels defined at Table 7.1 of the RCP are equalled or exceeded · deposition in the intertidal zone of sand and sediment excavated from the foreshore
	RCP Rules 13	Maintenance of existing structures (e.g. mouth alignment control groynes and rock lining etc.) (in area of Significant Conservation Value at Waikanae River mouth) not meeting permitted activity requirements of Rule 6.
	RCP Rule 14	Demolition of structures (in area of Significant Conservation Value at Waikanae River mouth) not meeting permitted activity requirements of Rule 7 (Permitted).

Consent is sought for GWRC's complete suite of flood protection operations and maintenance activities, as outlined in the table above. It should be noted that some of these activities are classed as permitted activities to a certain threshold. Others are allowed as of right under the provisions of the current plans and rules. For information purposes the latter are listed in Table 3.

Table 3: Permitted activities

Relevant Plan & Rules	Permitted Activities
RFP Rule 1	Discharge of water and minor contaminants from maintenance (e.g. water blasting) of structures.
RFP Rule 2	Discharge of stormwater into surface water (provided it doesn't originate from an area of bulk earthworks greater than 0.3 ha).
RFP Rule 9	Diversion of less than 1.5 m^3/s of fresh water from an intermittently flowing river or stream including any associated disturbance of the river bed or erection or placement of a structure.
RFP Rule 9A	Diversion of water from an artificial watercourse or drain.
RFP Rule 31	The erection and maintenance of any bridge over a river bed (less than 6m in length).
RFP Rule 35	Entry or passage across river bed not covered by any use specified in Rules 22 -48 or s.13 of the Act.
RFP Rule 36	Disturbance of river beds associated with clearance of flood debris.
RFP Rule 37	Disturbance and recontouring of beaches in the river bed. (This includes ripping and 'scalping')
RFP Rule 39	Maintenance of drains.

Relevant Plan & Rules	Permitted Activities
RFP Rule 40	Removal of vegetation from river bed (including cutting of stakes and poles for re-planting)
RFP Rule 42	Urgent works within 10 days of a natural hazard event, including: · Repair of any bank protection works · Recontouring of the river beds · Disturbance of the river beds · Deposition on the river beds
Regional Soil Plan Rules 1, 2 & 3	Repairs of stopbanks and berms (outside the river beds). Construction of walkways, cycle ways and bridle paths on the river berms (outside of the river beds) Construction of boundary fences Disturbance of vegetation on berms, including mowing Landscaping and/or planting on berms
Regional Coastal Plan Rule 6	Maintenance, repair, replacement, extension, addition or alteration to or of structures including associated disturbance of foreshore or seabed.
Regional Coastal Plan Rule 7	Removal or demolition of structures including associated disturbance of foreshore or seabed.
Regional Coastal Plan Rule 30	Disturbance of foreshore and seabed, including any associated deposition of natural material and diversion of water, which is carried out for the purpose of realignment of Waimeha Stream, provided the foreshore is not disturbed to a depth greater than 1 m below the natural water table or to a width > 5m.

1.6 Interpretation

Definition of commonly used terms in this report is included in this section for reference purposes.

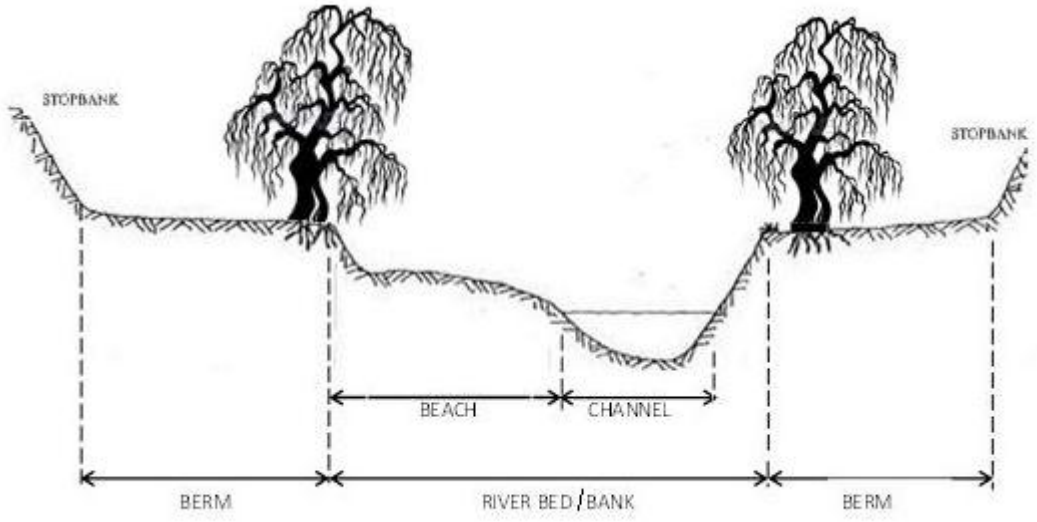

Figure 1: Explanation of terms

Bed	The RMA and the Regional Freshwater Plan for the Wellington Region (RFP) define the bed of a river (for purposes other than esplanade reserves, esplanade strips and subdivision) as: 'the spaces of land which the waters of the river cover at its fullest flow without overtopping its banks.' See Figure 1 for a visual representation.
Bank	The RMA does not define this; the RFP defines bank in relation to the bed of any river as having 'the same meaning as in the interpretation of "bed" in the Act.'
Beach	Neither the RMA nor the RFP define 'beach', but based on the definition of 'beach recontouring' in the RFP (see below) it can be assumed to be 'the part of the river bed not covered by water at any particular time.' See Figure 1 for a visual representation.
Berm	Neither the RMA nor the RFP define this. For the purposes of this application it is defined as 'the area of land between the river bed and the inner toe of a stopbank.' See Figure 1 for a visual representation.
Beach recontouring	The RMA does not define this; the RFP defines it as 'disturbance of any river bed by the mechanical movement of sand, shingle, rock, gravel or other natural material, to realign that part of the bed that is not covered by water at the time of disturbance, for the purpose of remedying or mitigating the adverse effects of flooding or erosion.'
Bed recontouring	The RMA does not define this; the RFP defines it as 'disturbance of any river bed by the mechanical movement of sand, shingle, rock, gravel or other natural material, to realign that part of the bed that is covered by water at the time of disturbance, for the purpose of remedying or mitigating the adverse effects of flooding or erosion.' This activity is also referred to as 'cross-blading'. It covers any work that comes in contact with the active channel and results in reshaping of the active channel.
Flooding	The RMA does not define this; the RFP defines it as having 'the same meaning as in the interpretation of 'natural hazard' in the Act. Reference to the flood hazard or flooding in the Plan includes erosion associated with river beds and their banks.'
Flood Mitigation works	The RMA does not define this; the RFP defines it as 'any structure or work that is used for the purpose of mitigating the adverse effects of flooding. Flood mitigation works include (but are not limited to) any stopbank, bank protection structure, training wall or groyne.'
Flood debris	The RMA does not define this; the RFP defines it as 'material deposited on the river bed as a result of wreckage or destruction resulting from flooding. Flood debris can include trees, slip debris, collapsed banks, and the remains of structures but does not include the normal fluvial build-up of gravel.'

Foreshore	is defined in the RMA as 'any land covered and uncovered by the flow and ebb of the tide at mean spring tides'. It only applies to any such tidally influenced land in a river bed if that land also lies within the Coastal Marine Area.
Removal of flood debris	is any work where flood debris is required to be cleared to remove or reduce a flood or erosion hazard or to protect structures from damage.
Floodplain	The RMA does not define this; the RFP defines it as 'the flat or gently sloping portion of a river valley that is or has the potential to be covered with flood water when the river overflows during flood events.'
Gabion	The RMA does not define this; the RFP defines it as 'an erosion or flood mitigation structure that is a wire mesh basket filled with small rocks and extending more or less parallel to, and against, the river or stream bank.'
Groyne	The RMA does not define this; the RFP defines it as 'an erosion or flood mitigation structure that extends from the bank into the river bed and is designed and constructed to deflect the direction of the flow of water in a river or stream.'
Natural Hazard	The RMA defines this as 'any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.'
Rock rip-rap structure	The RMA does not define this; the RFP defines it as 'a structure that is built from large rocks extending more or less parallel to and against the river or stream bank to resist erosion.'
Stopbank	The RMA does not define this; the RFP defines it as 'a structure constructed on a floodplain, or alongside a river, designed to contain flood flows and prevent high river flows flooding onto adjacent land.'

2 Background

2.1 The Waikanae Floodplain Management Plan

The first river management works in the Waikanae River were undertaken as part of an erosion and flood control scheme constructed between 1956 and 1964 by the Manawatu Catchment Board. This was instigated in response to a large flood in 1955 that extensively damaged houses on the floodplain. Despite this scheme, medium sized floods (e.g. 10 to 20 year return period floods) continued to cause damage in subsequent years.

The pressures generated by population growth and demand for flat land in the lower (flood-prone) Waikanae catchment, and the associated increasing demand for security from flooding led increasingly to the realisation by local authorities that new methods were required to address these challenges. This culminated in the early 1990s to the instigation by GWRC of a process to develop a comprehensive floodplain management plan for the Waikanae River corridor.

The WFMP was published in October 1997, after five years of work by the Waikanae River communities, iwi and local authorities. The Plan provides a blueprint for management of the river and floodplain, and GWRC adopted a 40 year timeframe to fully implement it (. to 2037).

The WFMP proposes three principal methods to reduce the flood hazard from the Waikanae River:

- Non-structural methods, which are related to controlling land use and building construction and which address issues of community awareness, disaster preparedness and emergency response. Flood hazard categories have been identified on the Waikanae floodplain and have been included in the Kapiti Coast District Plan since 1995.
- Structural methods. The WFMP identifies structural measures to provide an agreed level of protection (based on a 1 in 100 year flood) to existing development on the Waikanae floodplain, including:
  - Stopbanks
  - House raising
  - Road raising
  - Bridge lengthening.
- River Management methods. This includes all the routine work to maintain flood mitigation structures and channel alignment and capacity. It includes bank edge protection works, gravel extraction, bed recontouring and periodic realignment of the river mouth (when required).

The WFMP also proposed development of a Waikanae River Environmental Strategy, which was subsequently published in 1999. This Strategy is a non-statutory document, the key purpose of which is to provide a structure for enhancing the environmental values of the river corridor downstream of the Water Treatment Plant. It complements the WFMP by providing direction for environmental enhancement works that are undertaken in conjunction with capital projects, and also provides overall vision and guidance for the management activities of GWRC and other stakeholders involved with the wider catchment and river environment.

The Strategy has been reviewed and updated (Greater Wellington Regional Council & Kapiti Coast District Council, 2014). Part B of the Strategy identifies seven specific reaches within the river corridor and identifies opportunities for protecting and enhancing it, with particular focus on vegetation management, access and recreation.

The Waikanae River Ecological Strategy report was produced shortly after the original Environmental Strategy (as required by Condition 39 of the consent WGN 980256 (01)) to provide the overall framework for the long-term ecological restoration of the river corridor. In this respect it

supplemented the original Waikanae River Environmental Strategy, which was broader in nature. The intent and recommendations of the Ecological Strategy have (where appropriate) now been incorporated into the updated Waikanae River Environmental Strategy document.

The Friends of Waikanae River (FWR) is an advisory group established by GWRC to ensure continued community involvement in the WFMP. FWR has a Memorandum of Understanding with GWRC and its functions are outlined in a Terms of Reference. It acts as a channel of communication between GWRC, KCDC, tangata whenua, DOC and the community. Meetings are held on an agreed basis and the group is reviewed every 3 years.

It was intended that the WFMP would be a living document, and as such was to be reviewed every ten years or when the flood hazard was significantly altered. As part of the first review of the Plan GWRC undertook hydrology and hydraulic remodelling reviews of the Waikanae River and an evaluation of the effectiveness of the measures completed to date. The outcome of this work was presented in a Summary Report (Greater Wellington Regional Council, 2010), which was subsequently used as a basis for consultation with stakeholders. The updated WFMP was completed in March 2013.

2.1.1 Design standard

The WFMP specifies that the agreed design standard for the Waikanae River is the 1 in 100 year flood, which equates to a flow of approximately 395 m^3/s at the KCDC Water Treatment Plant weir (see Section 3.5.1).

GWRC's capital works programmes and annual river works and maintenance programmes are formulated within the context of this standard.

2.1.2 Preferred channel alignment

The WFMP defines a preferred channel alignment, consisting of a 35m wide design channel with a 20 m wide vegetative buffer on either side for the Waikanae River. This is marked on the aerial photographs in Appendix D. One of the key aims of the river works programme is to maintain the course of the river on this preferred channel alignment, and works are undertaken within this context.

2.1.3 Optimum bed levels

Optimum Bed Levels (OBLs) are a third design parameter that GWRC uses to manage both flood risk and the risks to the flood protection scheme. OBL's have been developed for the Hutt River and are currently under development for the length of the Waikanae River within the application area. They define a lower and upper bound (i.e. an envelope) within which GWRC aims to maintain the actual mean river bed levels (MBLs). Target MBLs for the river are based (more or less) on the MBLs that existed in 1991.

The OBLs take into account factors such as:

- Thalweg[9] levels;
- Stopbank capacity (determined by the WFMP);
- Toe levels of any rock riprap or groynes;
- Existing berm levels (and frequency of inundation);
- Visual considerations;
- Ecological effects;

[9] The thalweg is defined as the line joining the lowest points along the length of a river bed

- Lateral bank edge erosion;
- Service crossings; and
- Geomorphology.

The purpose of the OBLs, which vary from reach to reach, is to maintain a balance between:

- Flood capacity: if riverbed levels increase, the capacity of the channel is reduced and the chance of overtopping or breaching of the stopbanks is increased. Consequently the risk of significant floodplain damage is also increased
- Channel asymmetry: if the asymmetry of the channel increases, the degree of berm damage and maintenance required to protect bank edges increases
- Erosion potential: if riverbed levels drop, the risk of damage to rock protection and berms is increased, leading to greater maintenance and repair costs and erosion risk to stopbanks

The OBLs will provide a reference point from which the patterns of gravel deposition and degradation in the bed of the Waikanae River will be managed, and future decisions relating to gravel extraction will be made in this context.

Because the riverbed is dynamic, it is expected that OBLs may be adjusted over time to take into account new information on riverbed behaviour, especially after a significant flood event. The regular river bed surveys that GWRC undertakes provide key information to inform such changes.

2.1.4 Survey cross sections

GWRC conducts regular cross-sectional surveys of the Waikanae River at approximately 58 locations (approximately 100 m apart) along the reaches below the Water Treatment Plant. These are marked (as XS nn) on the photographs in Appendix D. Data from these surveys are used to analyse trends in river bed levels, and also channel form, aggradation and degradation.

The application area extends between XS 00 and XS 540 (approximately).

2.2 Scale and impacts of flood hazard

The WFMP contains a map showing the likely extent of flooding associated with a 1 in 100 year flood[10]. At the time of publication (1997), the Plan estimated a figure of $1M for annualised flood damages; the figure is likely to be much higher today.

In addition to financial costs, the risks to life and property from flooding in the Waikanae area would be significant. The flow-on effects on community well-being and health would be wide ranging and long lasting.

GWRC's ongoing operations and maintenance work on the Waikanae River has been identified in the WFMP as an essential part of the range of tools that have been adopted by the community to address the existing flood hazard and manage its risks.

2.3 Exiting consents

Details of the resource consents currently held by GWRC for operations and maintenance works are listed below.

[10] Figure 3 in (Wellington Regional Council, 1997)

Consent No WGN 980256	Purpose	Granted	Expiry
(01) Land Use	To undertake routine operations and maintenance in the bed of the Waikanae River, including construction, repair and maintenance of bank protection works (such as groynes, rock linings, gabion baskets, and block linings), maintenance and extension of existing structures, reconstruction and repair of river berms and stopbanks, removal or demolition of obsolete bank protection structures, cross blading, gravel extraction, tree planting, layering and tethering, beach scalping, clearance of flood debris, vegetation removal, beach recontouring and urgent works.	30 October 1998	23 November 2013
(02) Land Use	To undertake routine operations and maintenance activities on berms and stopbanks outside the bed of the Waikanae River and the coastal marine area, including repairs, reconstruction and maintenance of stopbanks and berms (including excavation), and urgent works.		
(03) Water Permit	To temporarily and permanently divert the normal flow of the Waikanae River during, and as a result of, activities associated with undertaking river operation and maintenance activities.		
(04)Water Discharge Permit	To discharge silt and natural stream bed sediments into the Waikanae River during, and as a result of, activities associated with undertaking river operation and maintenance activities.		
(05) Air Discharge Permit	To discharge herbicides (glyphosate and triclopyr) to air to control noxious weeds and young willow growth on river beaches.		
(06) Coastal Permit	To periodically excavate a diversion cut through the foredune at the mouth of the Waikanae River and any associated deposition of natural material, draining of the sea bed, damming, diversion of water for the purpose of river mouth realignment, maintaining the existing mouth alignment control groynes at the mouth of the Waikanae River, foredune lowering, placement of rip-rap and toe rock construction in the coastal marine area at the mouth of the Waikanae River, and to undertake urgent works in the coastal marine area of the Waikanae Estuary.		

The conditions of these consents require GWRC to do the following, in relation to engagement of community groups, monitoring and reporting:

- Conduct an annual walkover of the river, to which the following groups are invited: DOC, Fish & Game, Te Runanga o Te Ati Awa ki Whakarongotai Inc., Kapiti Coast District Council, local residents and interest groups who have registered interest, Federated Farmers and the GWRC Consents manager;

- Conduct an additional six monthly assessment of works with Kapakapanui11;
- Submit an annual monitoring report (for the period 1 July to 30 June) on or before 1 September each year which includes:
  - details of all monitoring undertaken during the preceding year
  - quantities of all the works conducted in the preceding year
  - details of any significant complaints received and action taken to avoid, remedy, or mitigate any adverse effects
  - a summary of issues and concerns arising from the annual walkover
- Submit quarterly reports giving details of work completed in the preceding quarter and work planned for the next quarter
- Conduct pool and riffle counts at least every 3 years
- Provide information detailing the quantities of gravel extraction required to maintain the flood carrying capacity of the channel on the 2nd, 7th and 12th anniversaries of the consents
- Obtain aerial photos of the river mouth and adjacent coastal zones at least every two years
- Submit an independent report 12 months after completion of any river mouth diversion works describing the effects on the coastal marine area.

Based on the available GWRC records, the following have been carried out:

- ü Review of activities against the Environmental COP;
- ü Coloured aerial mosaics flown as needed;
- ü Specific activities undertaken, including pool and riffle counts and drift dives; and
- ü Annual walkovers every year, unless there was a public open day.

The following compliance ratings have been received over the life of the consent (14 records, 1998 – 2013):

- ü 11 fully complying;
- ü 1 mainly complying: late submission of reports (i.e. no environmental non-compliance); and
- ü 2 non-complying: This related to one instance of non-delivery of report (i.e. no environmental non-compliance), and to one instance of unauthorised work that was inadvertently undertaken in 2005 by a new operator working for the contractor. This incident highlighted the need to ensure protocols for contractors relating to environmental works were in place; this was actioned and there have been no further problems in this regard.

[11] This name is no longer used by the iwi.

3 Existing Environment

3.1 Catchment overview

3.1.1 Waikanae River

The Waikanae River arises in the south-western foothills of the Tararua Ranges, and flows westwards to the Tasman Sea. The river is approximately 25 km long, and the extent of the catchment, covering a total area of 149 km², is shown in Figure 2.

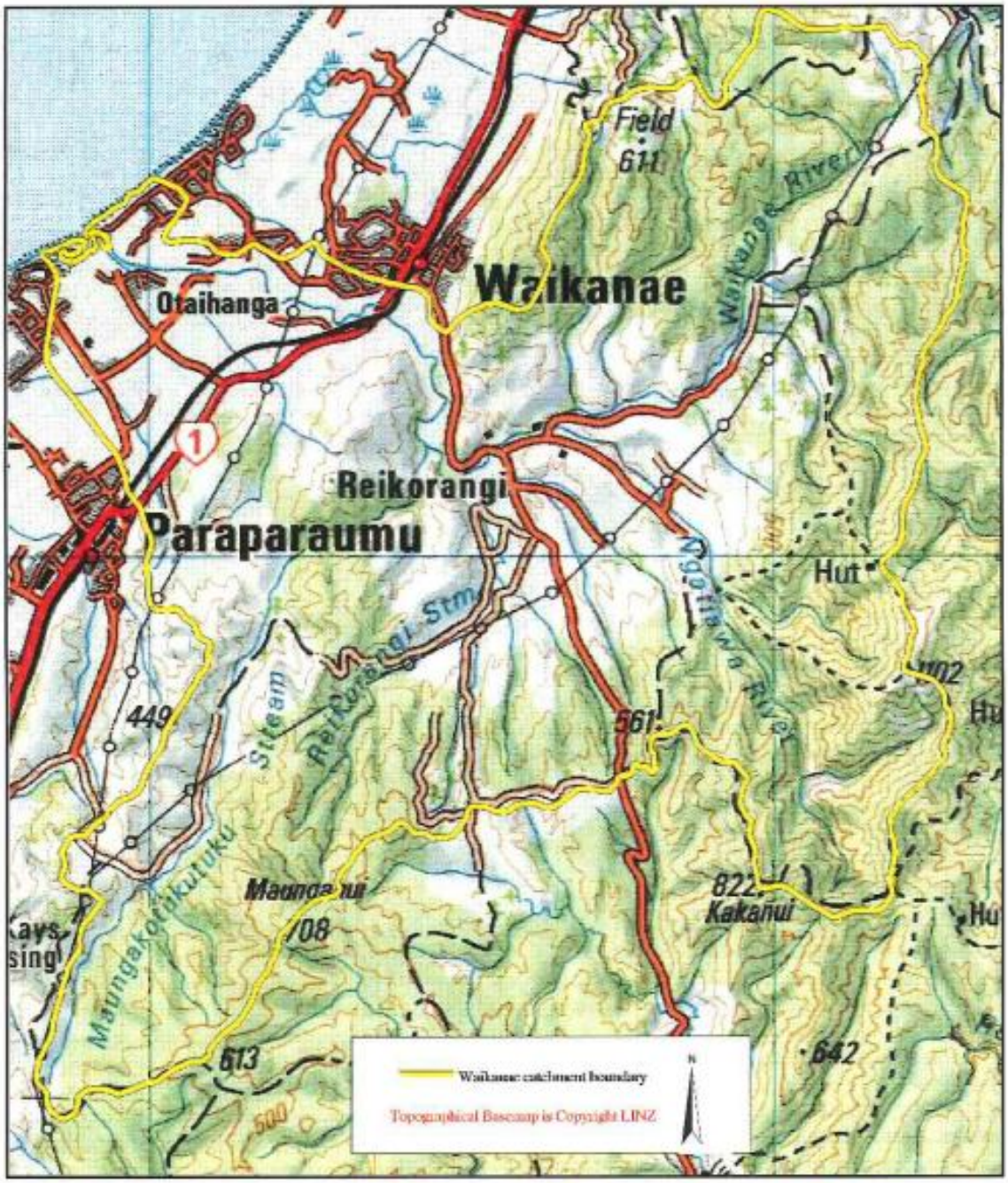

Figure 2: Waikanae Catchment. Source: (Wellington Regional Council, 1997)

The main tributaries are the Ngatiawa and Rangiora Rivers, and the Reikorangi and Maungakotukutuku Streams. These all join the main stem of the river in the steeper, upper part of the catchment upstream of the application area.

Within the application area, downstream of the Water Treatment Plant weir, the river meanders for approximately 7 km across a low gradient alluvial floodplain to an estuary lying between the coastal settlements of Waikanae Beach (to the north) and Paraparaumu Beach (to the south).

Tidal influence affects the Waikanae River as far upstream as XS 120 (approximately), see Appendix D of this AEE Report.

3.1.2 Waikanae Estuary

According to (Cameron, D, 2015), the Waikanae River flows into a moderate sized 'tidal river mouth' type estuary which drains onto a broad flat beach just north of Paraparaumu. Longshore drift along the Kapiti Coast tends to cause the mouth to migrate south (Williams 1992). The channel is periodically artificially opened to the sea at the north end to protect land to the south, but this is a relatively rare event which last occurred in December 2001. High flow events in the river occasionally have the power to open the channel naturally, as occurred during the January 2005 flood event, but it is estimated that flood events with a 20 year average return interval (ARI) or greater may be required to achieve this (Williams *pers com* 2013).

Human and ecological use of the estuary is high. It is one of the few estuary/wetland areas of any size in the south-western North Island, and is a Nationally Significant Wetland habitat for waders, seabirds and waterfowl, both local and migratory (Department of Conservation, WERI database). More wild birds visit the Waikanae Estuary and associated wetlands than any other area in the Wellington region (Roberston & Stevens 2012) Invalid source specified..The Waikanae Estuary Scientific Reserve encompasses and affords protection to the estuary area (saltwater lagoon and marshes, tidal sand flats and sandy beach) and adjacent mosaic of freshwater lakelets and wetland areas at the mouth of the Waikanae River. The Department of Conservation has ranked the area in its WERI database (Wetlands of Ecological and Representative Importance) as 'nationally significant wetlands'. The reserve covers an area of 58.5 hectares including the lower reach of the application area below XS80.

3.1.3 Waimeha Stream

At the end of the 19th century, the Waikanae River branched into two separate channels just downstream of the current SH1 bridge. The more northerly channel meandered across the floodplain, and followed much of the course of the present Waimeha Stream where it lies to the north of, and approximately parallel to, Te Moana Rd. Near the intersection of Te Moana Rd and Rauparaha St the channel turned south-westwards, flowing through the Waimeha Lagoon and the area which is now the Waimanu Lagoon, before joining the main stem of the Waikanae River again, near the present estuary. From here the united river flowed south through an extensive estuary and reached the sea near Kenakena (now Mazengarb Rd in the Paraparaumu Beach settlement).

Land use changes in the late 19th century associated with European settlement, including forest clearance and land drainage, led to the drying up of the upper section of the Waikanae River northern channel, isolating the lower section of the channel that became the separate Waimeha Stream. The latter was reduced to a local drain, presumably following the older river alignment, and it remained in this form until 1921 when it was diverted directly to the sea along the line of Huiawa Street to permit the subdivision and formation of the Waimeha Township. The truncated Waimeha Stream outlet (called the Waimea Stream), which included the Waimeha Lagoon area, remained as a separate minor catchment, while the development of a new estuarine area for the Waimeha Stream commenced and is still continuing. Repeated mouth realignments had been made to retain the

outlet at the centre of the estuary.The Waimeha Stream is approximately 3 km long. Together with its major tributary the Ngarara Stream it now drains a small local catchment on the floodplain that extends northwards to the boundary of the Pekapeka Stream catchment. The topographic catchment area for the Waimeha has not been well defined (Greater Wellington Regional Council, 2010). The tidal influence of the Stream extends upstream approximately as far as the Waikanae Golf Course.

The Waimeha/ Ngarara Estuary is a small tidal estuary located on a sandy beach just north of the Waikanae Estuary. The estuary is narrow (5-10 m) and shallow, situated between high marram grass and lupin dunes near the beach. Further inland the estuary is highly modified, channelised and bordered by houses and parkland. Human use of the estuary is moderate; it is a picnic spot and is used for bathing and white-baiting.

The nature of the Waimeha Stream has been changed with increasing housing development over the past fifty years. Today it has a generally well formed and distinctive channel as it wends though and alongside extensively built-up areas. As land-use has intensified, the swampy appearance of most of the stream surrounds that can be observed in early photographs has changed to one of subdivided sections with houses, some of which lie very close to the stream.

3.1.4 Other wetlands

In addition to the wetlands within the Waikanae Estuary Scientific Reserve noted above, there are a number of other small lagoons, ponds and wetlands in the floodplain of the Waikanae River and Waimeha Stream. These include:

- The Waimeha Lagoon, which lies in part of the former south-flowing course of the Waimeha Stream, and which is fed by drains in the Waikanae Beach settlement and drained by a small stream to the Waimanu Lagoon
- The Waimanu Lagoon, also in the former course of the Waimeha Stream, and which was developed in the 1970's by draining swamp land and enlarging the watercourse. The outlet of the lagoon is controlled by a floodgate
- The Otaihanga Oxbow (located on the left bank immediately to the west of residences lying on the northwestern end of Makora Rd) and created as a result of a major flood in 1927 or 1928 that caused the river to cut through a large dune; and several small oxbows on the true right of the Waikanae River
- Weggery Lagoon, located on the north bank, opposite the Otaihanga Boating Club building
- Ponds within the Nga Manu Sanctuary, lying to the northeast of the Waimeha Stream, which have been artificially enlarged to create waterfowl habitat
- Totara Lagoon and associated Te Harakiki Swamp (which includes the Waikanae Sewage Treatment ponds), also lying to the northeast of Waimeha Stream

3.2 River character

The photographs in Appendix D cover seven reaches of the Waikanae River, which are briefly described below.

- Reikorangi-Water Treatment Plant reach: extending from the Water Treatment Plant downstream to the Rail Bridge. The river is bounded on both sides by rural land, including three areas of remnant bush with high ecological value. There are a number of high river banks on both sides of the river, which are prone to collapse. There is a high level of private ownership in this reach, which restricts public access.
- Parikawau-Edgewater Park reach: extending from the Rail Bridge downstream to Walnut Grove (on the northern bank). The river is visually confined on both sides by vegetated

terraces, which include some native forest remnants. Edgewater Park on the north bank includes open spaces and contains BBQ facilities and playground equipment. Swimming holes are found in this reach. The reach includes a significant bend in the river, between XS 350 and XS370 known as Kebbells Bend. On the south bank immediately west of the SH1 bridge there is a concrete works (Dricon Waikanae Premix Plant) and a house removals storage site (Gold Coast Removals Ltd), which are largely screened from the river by vegetation. The river corridor is bounded on the northern side by residences. Access to the north bank is gained by meandering path and several access points from nearby residential areas. Access to the south bank is gained via a path, GWRC's haul road and a recently created path on top of rock lining.

- Waipunahau-Jim Cooke Memorial Park reach: extending from Walnut Grove to Paretai Grove (on the north bank). On the north bank the berm contains a strip of semi-restored open ground with some kohekohe forest remnants, which continues to broad open ground at Jim Cooke Memorial Park. To the north, beyond the river corridor are mainly residential areas, and one area of grazed land over which transmission lines pass. In contrast, the south bank has a rural/wilderness character, with pasture, bracken, blackberry and some remnant native vegetation. The lower part of this reach, between XS 250 and XS 280, is the inland limit where coastal sand dunes adjoin the river corridor, and the prominent dune on the south bank provides a natural backdrop to the river corridor. Of geological significance is the area at XS 298, which has been identified as a 2500 year old fossil forest.

  Access along the south bank is via an old haul road, and on the north bank via paths and tracks. Erosion around Kebbells Bend may restrict access at times.

- Pukawa reach: extending from Paretai Grove to Kauri Road (on the north bank). In the upper part of the reach, the low river terrace on the north bank is in private ownership, and is rural in character. Further downstream the terrace narrows, and is enclosed between dense garden plantings on adjacent private properties and tangled willow in a backwater formed by an old river channel. The corridor then opens out again at Pukekawa Reserve, which is a low lying area of former wetland, now a passive recreation area. On the south bank, the river corridor bends around the end of the sand dune noted in the reach description above, and opens out to low lying rural land. The walkway along the south bank is tree-lined, and separated from the river by dense willows. In the downstream part of the reach the walkway on the south bank passes a wetland currently under restoration by the Friends of Waikanae River community group. Greenaway Road, in the centre of the reach, provides a central access point to the river corridor and the walkway along the north bank. It also provides access to the GWRC Greenaway Rd water quality monitoring site (RS 10) located on the true right bank.

- Te Aorere-Waikanae Christian Holiday Park reach: extends between the western end of Pukekawa Reserve on the north bank, downstream to residences at the eastern end of the settlement of Otaihanga on the south bank. The majority of the north bank is occupied by the privately owned Waikanae Christian Holiday Park (El Rancho), which is set in a rural parkland landscape with mature poplar and macrocarpa trees. Wetland areas lie at the upstream end of the reach (XS 160) and in an old river meander downstream of El Rancho. The south bank along this reach has been the subject of much restoration planting over recent years. Access is provided by a vehicle track that narrows to a path. A river side walkway provides access along the north bank.

- Arapawaiti-Otaihanga reach: extends from the eastern end of Otaihanga (on the south bank) to approximately XS 50, where the dune on the north bank comes close to the river. This dune defines the 'inland' part of the river from the open estuarine landscape. In the upper part of the reach on the north bank there is an oxbow in a former river meander (XS95), which has been identified as a spawning ground for inanga. Weggery Lagoon, further downstream is another wetland area on the north bank. On the south bank, the river berm is bounded at the upstream end of the reach by Otaihanga Domain, which has a parkland character. Further

downstream the river berm is narrow and is bounded by the main residential area of Otaihanga. At the lower end of the reach the tidal influence in the river marks the end of riverbank willow plantings. Access tracks along the south side of the river link to Makora Rd, just west of the Otaihanga Domain. Access tracks along the north bank link (in an undefined fashion) to Weggery Drive West. There is a footbridge across the river at Otaihanga Domain.

- Kenakena-Estuary reach: extends over the final 50 m of the river, from Mazengarb Stream confluence (on the left bank) to the river mouth. In this reach the river bed and banks are made up of fine sandy material which is highly mobile and easily eroded. Of note on the northern side of the river is the Waimanu Lagoon, which is highly modified but provides valuable wildlife habitat. The berms on this side of the river are covered mainly in rough grass, pampas, marram and reeds with patches of blackberry and gorse. The berm adjacent to the lagoon is mown for passive recreation and boat launching. On the south side of the river, the landscape is dominated by estuarine flats and swampland which is in various forms of public ownership, mostly the Waikanae Estuary Scientific Reserve. Of note also is the Otaihanga Oxbow, located at the eastern end of the Scientific Reserve (on the south bank), which has high conservation values and importance for flood management as a water storage area. This Oxbow is bisected by an extension of the Mazengarb Stream, which has altered the hydrology of the area. Housing extends very close to the river particularly on the northern bank, and new subdivisions are apparent on both sides of the estuary.

3.3 Existing works

3.3.1 Structural measures

The WFMP adopted in 1997 identified a number of structural measures within the Waikanae River corridor, including upgrade of existing stopbanks, construction of new stopbanks or floodwalls, and raising of roads and houses, needed to give protection against a 1 in 100 year flood. Widening of a bridge over the Waimeha Stream and a stopbank along the Waimeha Golf Course were also included in this work. The location and extent of these works is shown in Figure 3.

The progress in completion of these works to 2010 has been reported in (Greater Wellington Regional Council, 2010), and is shown in Figure 4.

3.3.2 Channel works

Five locations where major works were programmed to achieve the preferred alignment are shown in Figure 5. These works were to involve a combination of: channel excavation, rock rip-rap, vegetative planting and gravel extraction. In addition it was intended that a variety of channel maintenance activities would also be employed to actively manage the river within the design channel alignment. These measures were to include: repair of existing protection, tree clearing, willow layering, and willow and native tree planting, beach clearing and ripping, construction of riprap linings, rock and tree groynes, bed recontouring and gravel extraction.

The progress in completion of these works to 2010 has been reported in (Greater Wellington Regional Council, 2010), and is shown in Figure 6.

3.3.3 River mouth management

As noted above, the mouth of the river is a dynamic environment affected by the interaction of tidal and riverine processes. Longshore drift causes a build-up of material that causes the river mouth to migrate gradually southwards. Major flood events also have the potential to generate large movements in the river channel and position of the river mouth. The mouths of the Waikanae River and the Waimeha Stream are actively managed in order to ensure that they operate effectively in passing flood flows, and to ensure they do not create an unacceptable level of risk to the adjacent

residential developments. To this end, the following activities, outlined in the WFMP, are undertaken:

- Maintenance of the rock groyne on the true left bank at the Waikanae River mouth, and of the training wall on the true right bank at the mouth of the Waimeha Stream.
- Periodical cutting of the mouths when trigger levels (as defined in the Table 7.1 of the Regional Coastal Plan) are reached. For the Waikanae River these triggers are when the exit to the sea has migrated more than 500 m to the south, or 200 m to the north of the groyne, or when tide levels at Otaihanga rise to a point where they are 300 mm above normal sea levels. For Waimeha Stream, the triggers are when the exit to the sea has migrated more than 250 m to the south, or 150 m to the north of a centreline defined by the training wall adjacent to Field Way, or when the channel creates a scarp in the adjacent sand dunes greater than 2 m high.
- Realignment of the river mouths may also necessitate some disturbance and re-distribution of sand in the beach areas immediately adjacent to the river channel outlet, to lower the outlet alignment generally below mean high water spring tide level, and to raise and buffer any eroded areas adjacent to the dunes. (Generally this work is done in conjunction with the cutting of the new channel mouth.)

It was expected that a mouth cut might be required in the Waikanae River every 5 years, but only one has been required since the WFMP was adopted. This was undertaken in December 2001. The Waimeha Stream mouth has been cut more frequently: 24 times since March 2000, and up to four times in one year (see Appendix K for details).

3.3.4 Gravel extraction

Extraction of gravel from depositional areas has been an important tool in the management of channel stability, alignment and flood carrying capacity in the Waikanae River over many years.

Since 1998 gravel extraction has been undertaken under two resource consents, with the objective of re-establishing and maintaining river bed levels as they were in 1991:

- Consent WGN 900256(01), granted in 1998, which has permitted skimming or scalping of beaches or bars within the active channel but above the low flow water level (i.e. ‘dry’ extraction).
- Consent WGN 020106, which was granted in 2002 following floods in 1998, to allow a one-off extraction operation over 5 years to restore river bed to 1991 levels. This extraction involved removal of gravel from the active channel (i.e. ‘wet’ extraction).

This is discussed further in Section 4.2.3.1.

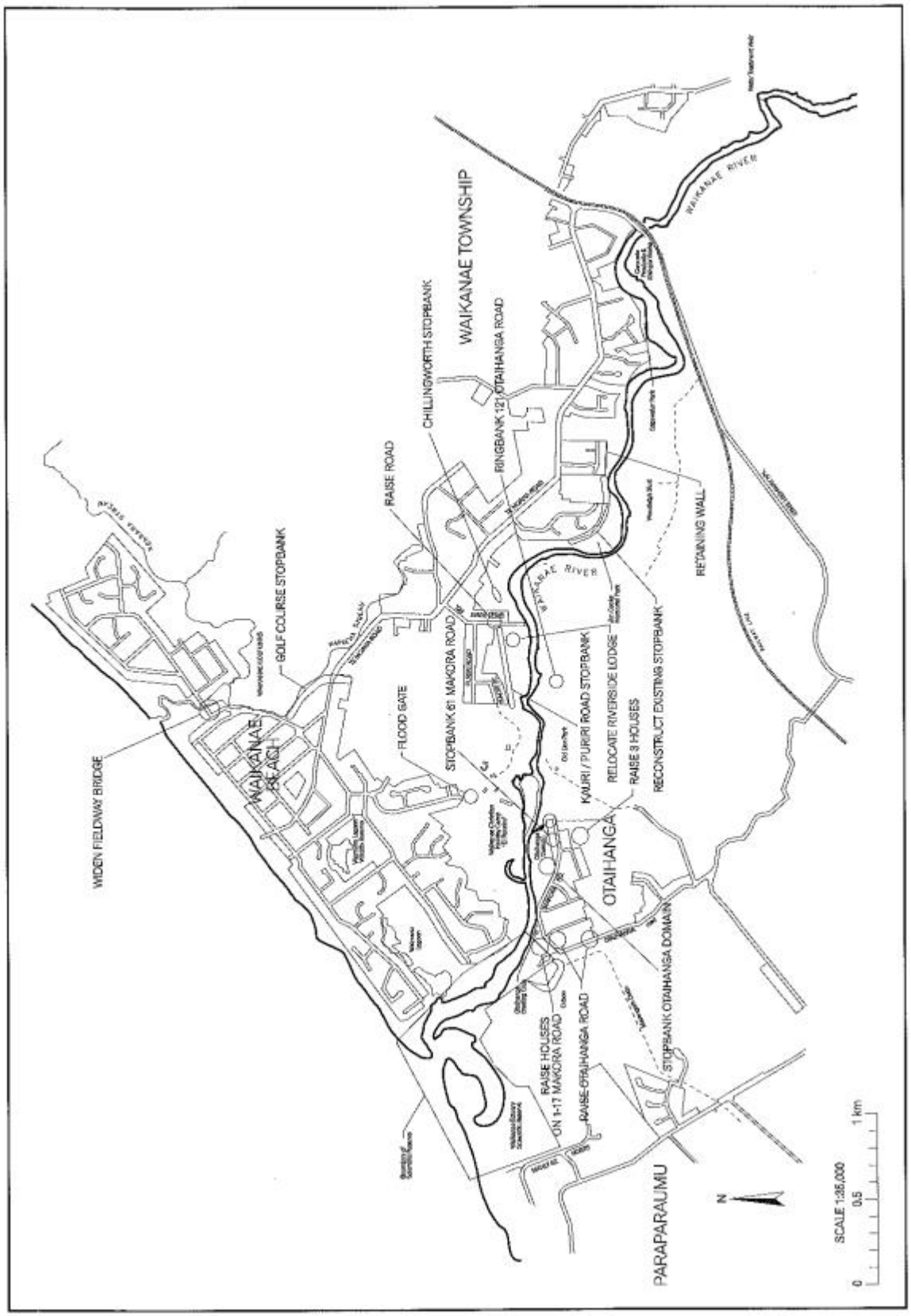

Figure 3: Structural flood protection measures identified in Waikanae Floodplain Management Plan 1997

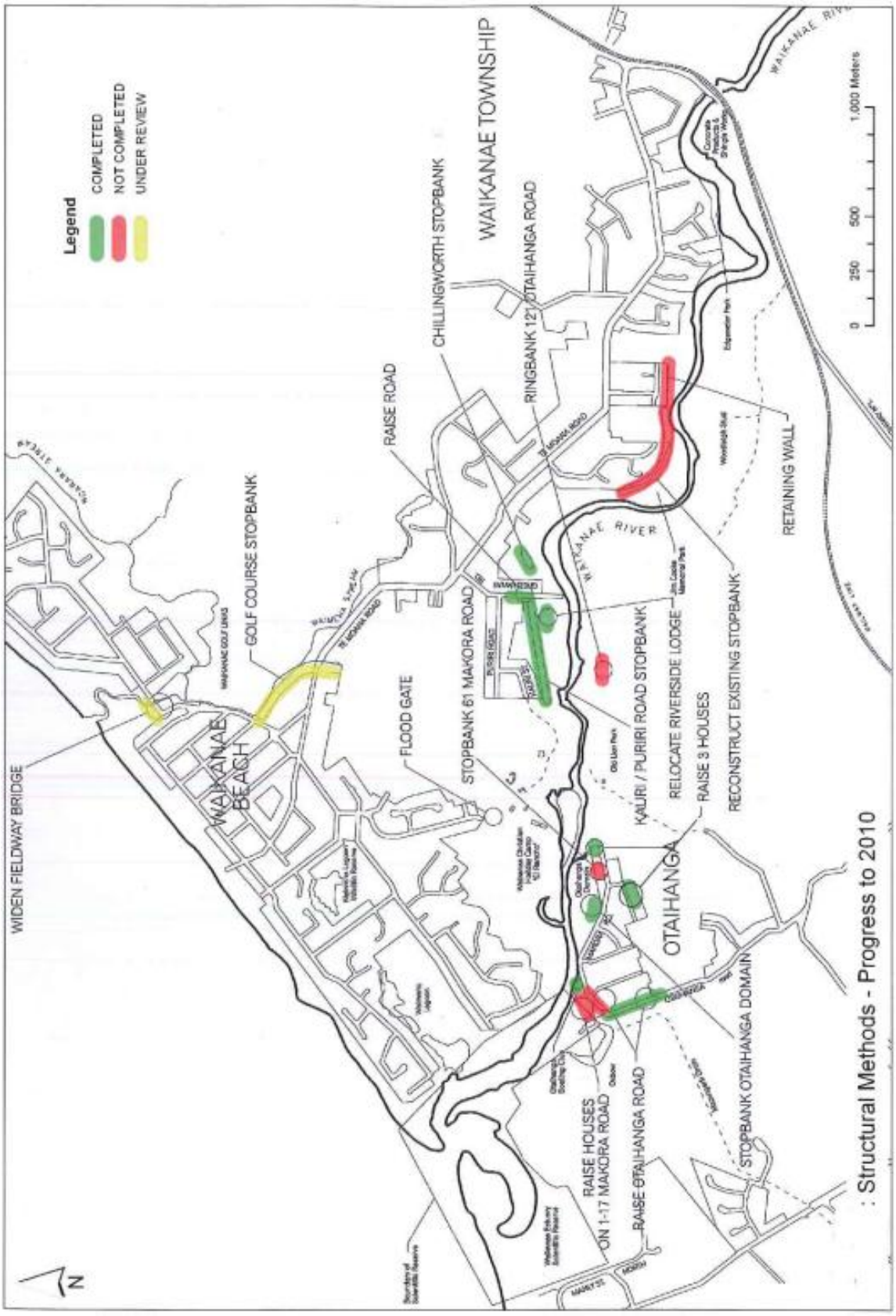

Figure 4: Progress to 2010 in implementation of WFMP structural flood protection measures. Source: (Greater Wellington Regional Council, 2010)

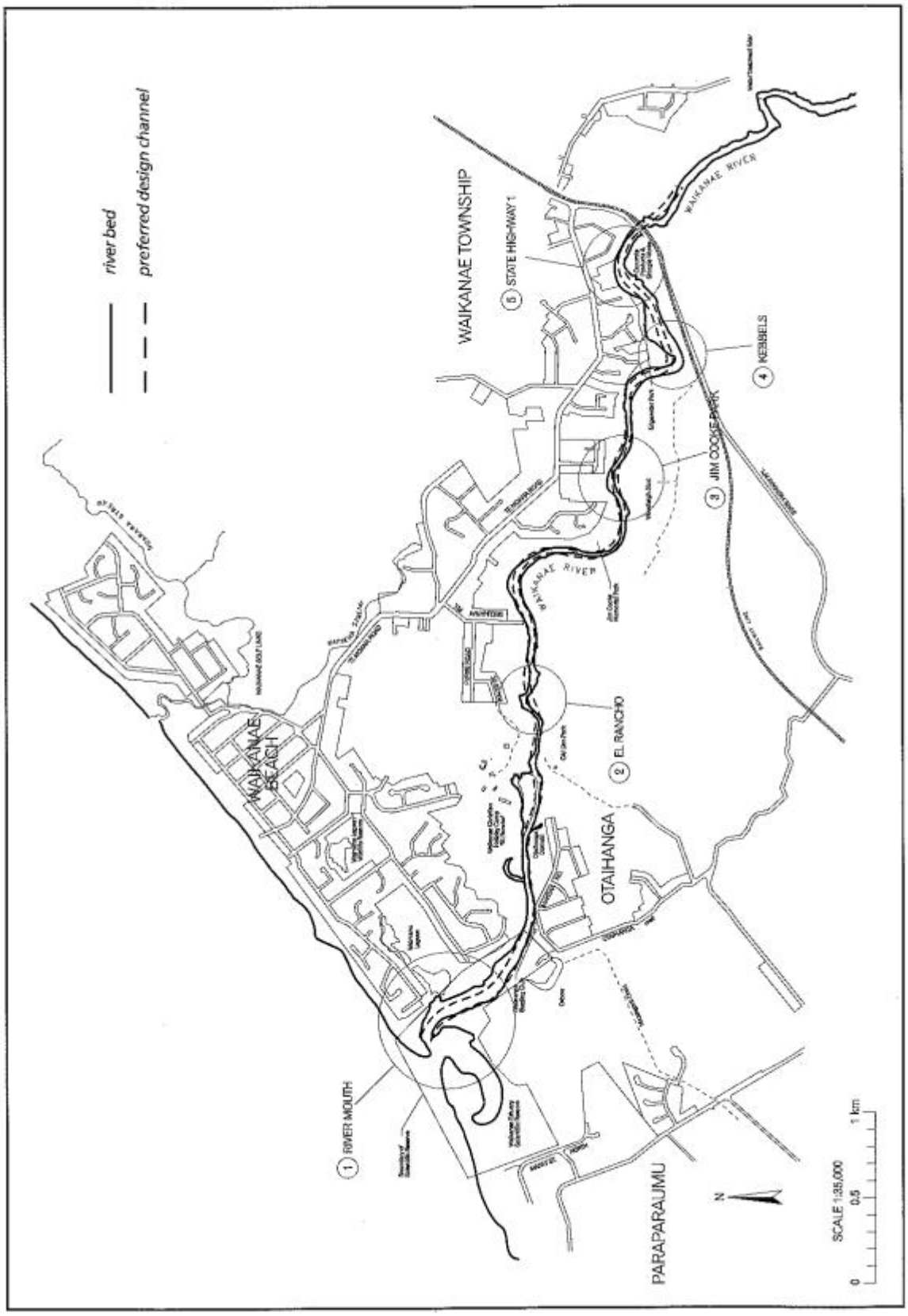

Figure 5: Channel alignment and river management methods identified in Waikanae Floodplain Management Plan 1997

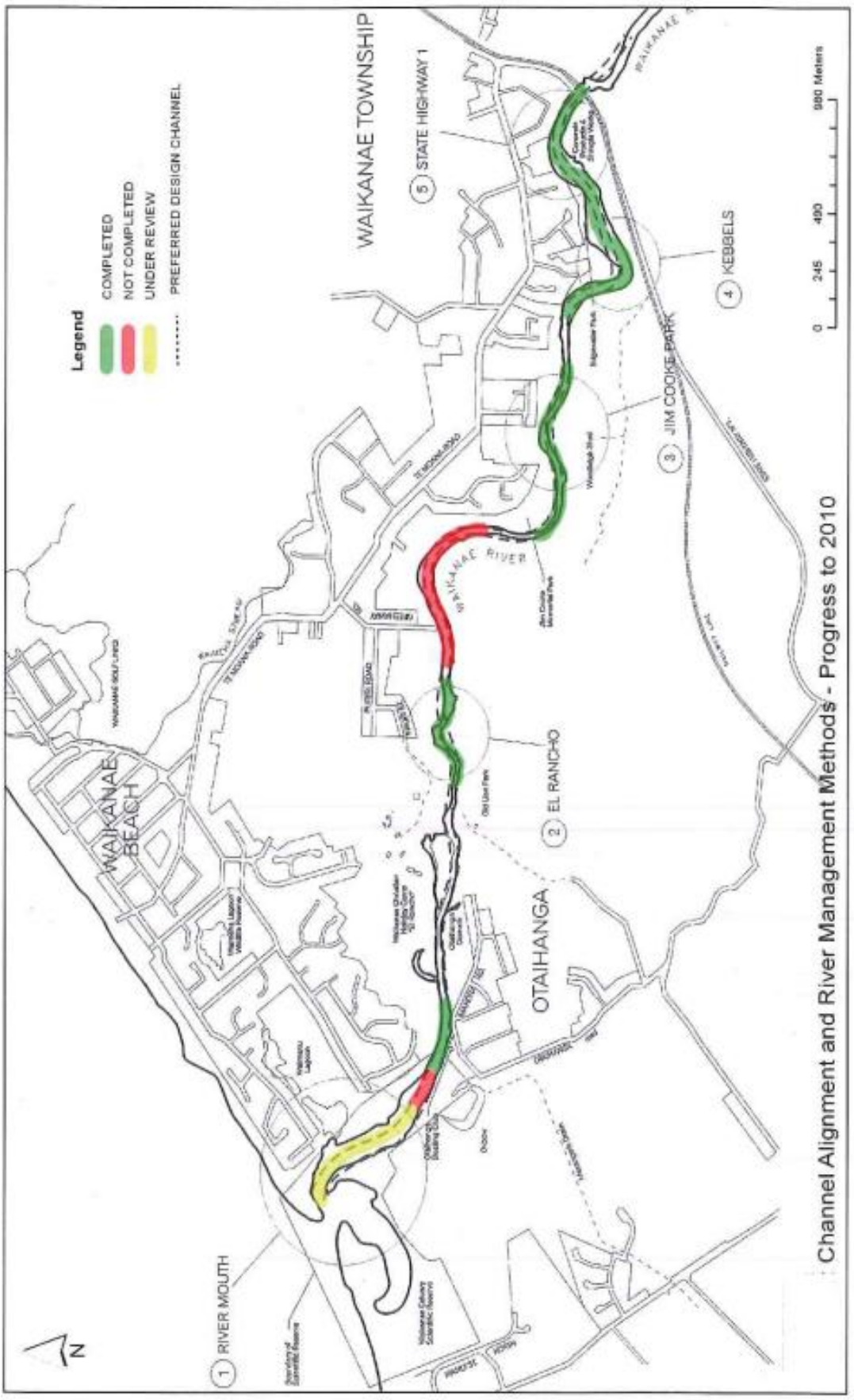

Figure 6: Progress to 2010 in implementation of WFMP channel alignment and river management measures. Source: (Greater Wellington Regional Council, 2010)

3.4 Geology

The basement rocks, exposed in the upper catchment, are greywackes and argillites, which were laid down as sands and muds in a deep ocean trench 180 million years ago (in the Triassic Period) and subsequently uplifted, and then eroded to a plain about 100 million years ago (in the Cretaceous Period). In the Oligocene Age, seas covered the plain and deposited quartzite and greensands, much of which has since been eroded, although some deposits remain in the hills behind Waikanae.

Over the next 30 million years, the land was again covered by sea but uplift began to form the Tararua and Ruahine Ranges. During the early Pleistocene ice ages the Tararua Ranges were subjected to extensive erosion, and large volumes of gravel were carried down the rivers to form thick gravel deposits. These have subsequently been uplifted by fault movement and now occur as thick layers over hills some 300 m high in the foothills of the Reikorangi area.

During the colder periods sea level was well below present level, however between the last two ice ages the intervening interglacial period was warm enough for sea level to rise to the foot of the ranges again. During this time sands drifted down the coasts and accumulated as beaches and dunes which have since consolidated into the rusty brown rock (Otaki Sandstone) found in the Waikanae area.

During the final glacial period, gravel fans were built out from the hills by erosion and thick gravel terraces bordering the Waikanae River were laid down. Cold winds blew dust from the river beds, which was subsequently deposited as loess over the gravel fans.

From the time since the end of the last glacial period sea level has fluctuated, reaching a maximum level several metres above present, approximately 5000 years ago. At this time it cut a prominent low cliff through older formations of the coastal lowland. At Waikanae, Te Moana Rd passes down this old cliff as it turns off SH1, and in the vicinity of the Waikanae River the cliff is bayed, reflecting the early river estuary.

From this time until the present, longshore drift has been moving sand supplied to the west coast by rivers of the central North Island, and this has been added to the beaches and dunes of the Kapiti coast. The coastline has been progressively prograding since that time, with new dunes created at the extending shoreline and older dunes progressively stabilised by vegetation. At times when drainage has been blocked by this process, dune lagoons and wetlands have formed behind new dunes.

3.5 Hydrology

The Waikanae River flow regime is highly variable and typical of a river draining a small and relatively steep hill-country catchment. There are long periods of low flow interspersed with occasional large flood events.

The main hydrometric monitoring station on the Waikanae River is at the Water Treatment Plant. Flows have been measured here since March 1975. Over the 37 year period from January 1976 to December 2011 flows in the Waikanae River at this station have varied from 0.54 m^3/s to 381 m^3/s, with a mean flow of 4.8 m^3/s and a median flow of 3.0 m^3/s. The significant (38%) difference between the median and mean flows reflects the variability of the flow regime, with the median largely unaffected by short duration but high magnitude flood events.

The flow regime can be summarised by a flow duration curve, shown in Figure 7, which shows the proportion of time during which flow is equal or greater to a given magnitude, regardless of chronological order. The overall slope of the curve indicates the flow variability.

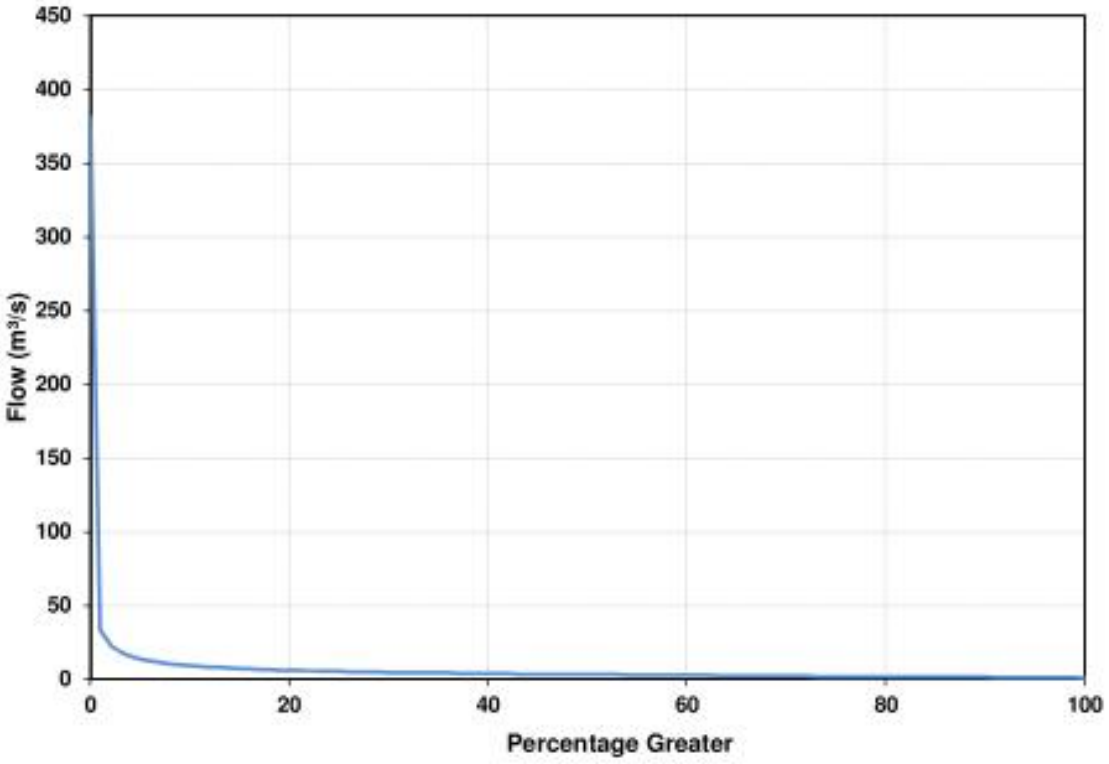

Figure 7: Flow distribution for the Waikanae River at the Water Treatment Plant, 1975-2012. Source: (Opus International Consultants Ltd, 2012)

3.5.1 Flood flows

The flow record from the Waikanae River, shown in Figure 8, shows all the flood events since 1975. Available information on floods prior to this date was collected and presented in (Opus International Consultants Ltd, 2012), and is shown in Table 4. While more subjective in nature, it contributes to the overall understanding of the nature of historic flooding.

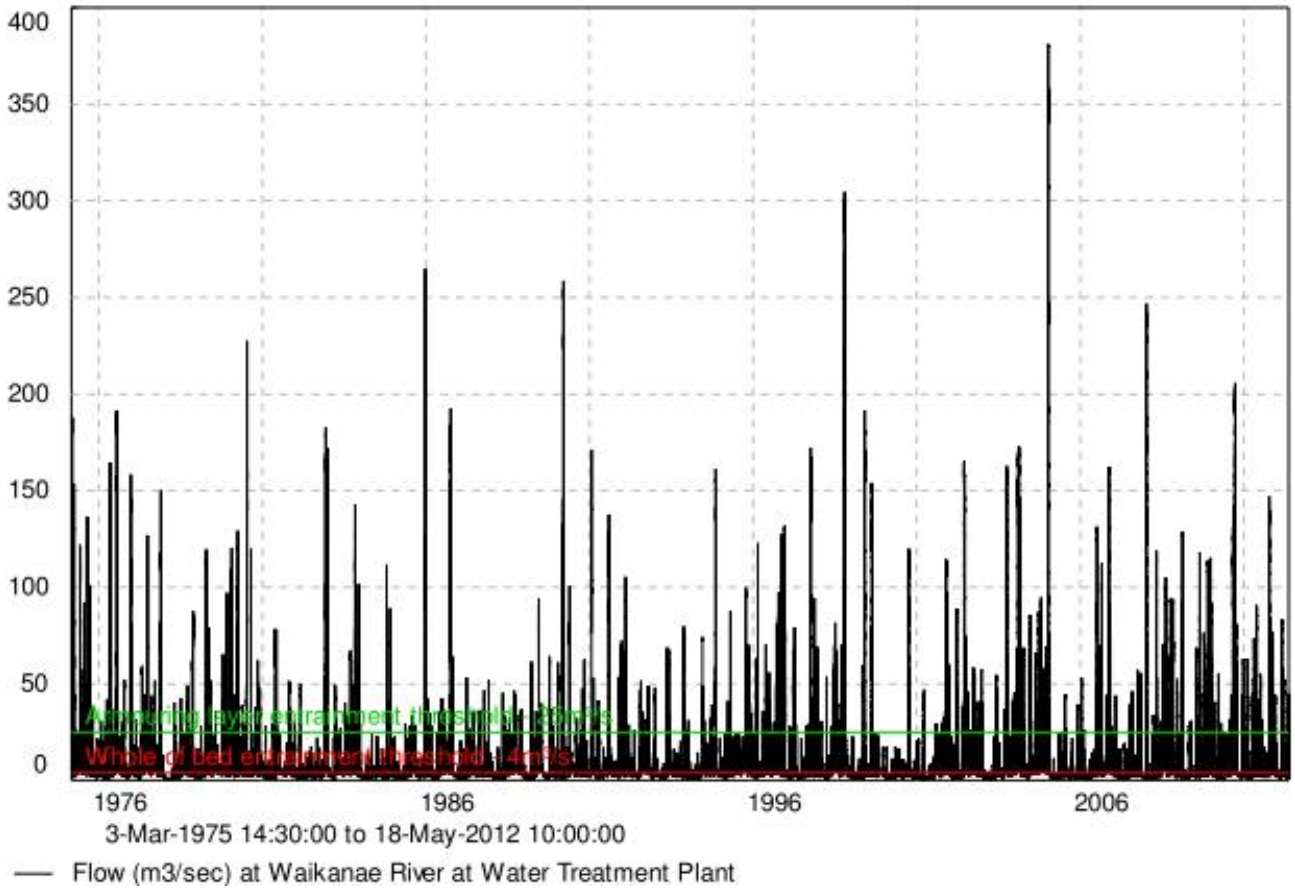

Figure 8: Flow record for Waikanae River at the Water Treatment Plant (1975-2012) with sediment transport thresholds (red = whole of bed & green = armouring layer) from Williams (1992) over-plotted. Source: (Opus International Consultants Ltd, 2012)

Table 4: Major floods in the Waikanae catchment prior to 1976

Date of flood	Summary of available information
1924	Flood resulting in the loss of the "creamery"
31-Jul-1951	Reference to "good flood"
Feb-1955	Estimated at 680m³/s – flooding caused "extensive" damage
May-1955	Floodwaters covered Kauri Road and the western area of Puriri Road
21-Apr-1956	Provisional estimate of 650m³/s
15-May-1956	A way was opened to the old river channel which caused flooding inland
16-Oct-1959	In a letter to SC&RCC MCB describes this flood as the largest since the scheme was started
17-Apr-1961	Flood combined with high tide. Largest since scheme started. No damage to existing works but several new places where protection work was required
13-Jan-1962	Changed course at Greenways Road and washed away part of the reserve
26-Apr-1966	3.5 acres lost upstream of the bridges
3-May-1966	Two floods occurred entering houses at Otaihanga
Apr-1968	Stopbank at Otaihanga was raised by 0.45m after this flood
10-Aug-1976	Three typical flood occurred covering the berms below the stopbanks at Puriri and Kauri Roads to depths of 1.2-1.5m

Source: (Opus International Consultants Ltd, 2012)

(Opus International Consultants Ltd, 2012) also noted that hydrographs for the four largest flood hydrographs on record (2005, 1998, 1985 and 2007), shown in Figure 9, indicate a consistent pattern of runoff response to large rainstorm events on the Waikanae catchment. In each case the large flood had rapidly rising water levels, with one major peak and small secondary and/or subsidiary peaks on the rising or falling limbs of the hydrograph. Figure 9 also shows that the main body of the floods lasted approximately 24 hours.

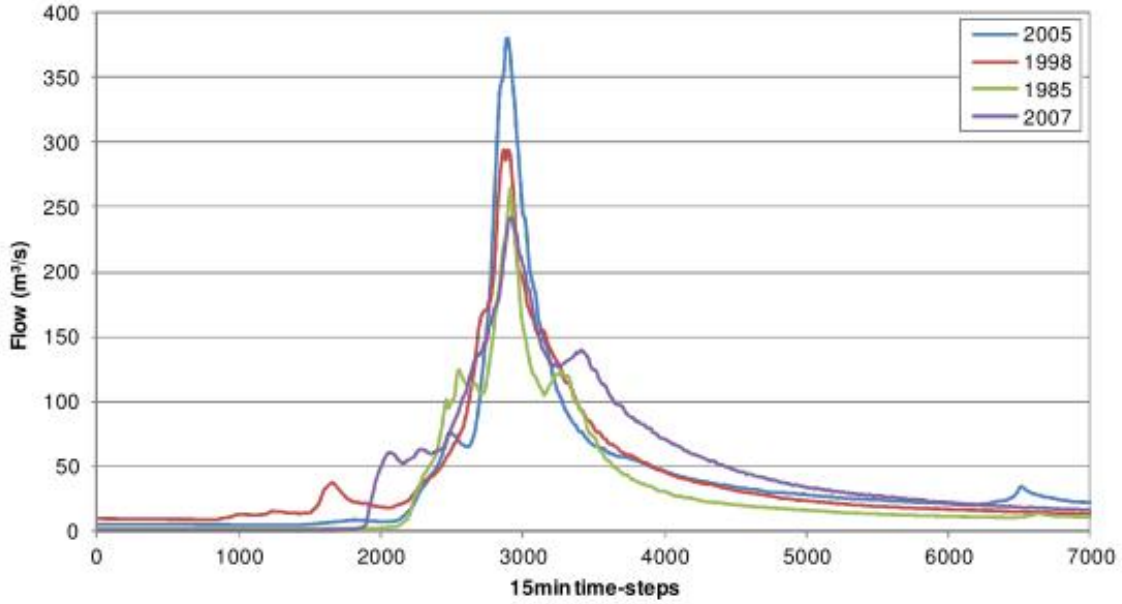

Figure 9: Comparison of the four largest floods since 1976, Waikanae River at the Water Treatment Plant. Source: (Opus International Consultants Ltd, 2012)

High flow frequencies for the Waikanae River at the Water Treatment Plant are given in Table 5 and low flow frequencies in Table 6.

Table 5: Flood frequencies Waikanae River at Water Treatment Plant

Return Period (yrs)	Flow (m^3/s)
2	159
5	211
10	254
20	295
50	348
90	381 (maximum recorded)
100	387

Source: GWRC

Table 6: Low flow frequencies Waikanae River at Water Treatment Plant

Return Period	Flow (l/s)			
	1 Day	7 Day	14 Day	28 day
MALF	955	1048	1129	1342
5 yrs	737	807	867	986
10 yrs	665	727	781	871
20 yrs	612	668	717	787
50 yrs	559	609	653	701
100 yrs	526	572	614	649

Source: GWRC

3.6 Sediment Transport

3.6.1 River bed levels

Analysis of changes in cross sections have shown that between 1991 and 2010, the Waikanae River has tended to degrade in the reaches between the Water Treatment Plant (at XS 550 approximately) and Jim Cooke Memorial Park (at XS 250 approximately – see Appendix D). Bed levels have generally decreased by approximately 1 m, but it should be noted that there are also small areas of aggradation within this zone; for example, in a 250 m reach immediately downstream of the Water Treatment Plant, and a 200 m reach downstream of the SH1 bridge.

Downstream of Jim Cooke Memorial Park, the river has been aggrading over the same time, meaning that more material is entering the river channel than is exiting at the coast or being manually extracted. The current downstream limit of gravel in the river bed is approximately adjacent to the Otaihanga Boat Club.

The lower 1 km reach of the river, downstream of the Otaihanga Boating Club is distinctly different from the rest of the river, as it is characterised by the deposition of fine material. The reach is almost flat and the bed level is in a constant state of flux, in response to sediment supply, flood activity and sea level. Although bed levels have generally been aggrading over this reach since 1991, the 2005 flood event (381 m^3/s, equivalent to a 90-yr ARI event) was large enough to flush out the bed material and cause channel degradation. The greatest change in bed levels occur closest to the river mouth.

3.6.2 Sediment sources

A sedimentation study commissioned by GWRC to provide up-to-date information on the sediment processes occurring in the Waikanae catchment was undertaken by Opus International Consultants Ltd, and reported on in (Opus International Consultants Ltd, 2012). This study notes that only a relatively small amount of sediment moving through the Waikanae River system is derived from erosion in the upper catchment. Currently there are relatively few landslides in the upper catchment, which cover a total surface area of about 10 ha, and only about 50% of these are connected to the drainage network. The majority of material transported down the Waikanae River is derived directly from reworking of alluvial material within the river bed and banks.

Downstream of the Water Treatment Plant the Waikanae River channel lies mostly within material that has been transported and deposited previously. There is therefore a large amount of material

potentially available to the river to erode under high flow conditions and transport further downstream.

3.6.3 Influences on sediment transport

A strong relationship exists between flow velocity and the size of material that can be transported. GWRC consultant Gary Williams has proposed that the threshold flow for entrainment of the sediment forming the entire bed of the Waikanae River was 4 m^3/s; however, taking into account the increased resistance of the larger material which tends to armour the finer underlying bed sediments, the average threshold for bedload transport is approximately 25 m^3/s. These thresholds are shown on Figure 8 (as the red and green lines respectively) with reference to the flow record for the Waikanae River at the Water Treatment Plant. Since 1975 the upper entrainment threshold has been exceeded only 2% of the time, while the lower threshold has been exceeded 35% of the time. This demonstrates that bedload transport tends to occur in discrete pulses during high energy events, and is highly variable, being controlled by the number, magnitude and duration of flood events in any year.

The maximum size of sediment able to be transported at various flows is given in Table 7. The table shows that at flows of 400 m^3/s (which approximates the largest recorded flow at the Water Treatment Plant since 1975), the mean velocity is 4.7 m/s, which can move particles with an intermediate axis diameter of up to about 280 mm.

Table 7: Estimates of maximum sediment size able to be transported at various flows

Flow m^3/s	Mean velocity(at Water Treatment Plant (m/s)	Size mm
50	1.74	60
100	2.42	90
150	2.94	110
200	3.38	130
300	4.11	200
400	4.72	280
500	5.25	380
600	5.73	500

Source: (Opus International Consultants Ltd, 2010)

3.6.4 Sediment Load

There have been no empirical measurements of either bed material or suspended sediment transport in the Waikanae River. The total volumes of sediment (i.e. bedload and suspended sediment) transported past Edgewater Rd and Greenaway Rd over four survey periods have been modelled by Opus, using the BAGS (Bedload Assessment for Gravel-bed Streams) sediment modelling software package for the bedload component and equations developed earlier by Williams for estimating the quantity of suspended sediment in both the Hutt and Otaki Rivers. The results of this analysis estimated that the annual average volume of sediment transported downstream of Edgewater Rd (XS 380) since 1991 was approximately 2,388 m^3, and 1763 m^3 was transported downstream of Greenaway Rd (XS 200) over the same period. Of this, approximately 60% was estimated to be bedload, and the remaining 40% suspended sediment. The difference between the two sections indicated that approximately 650 m^3 of sediment was deposited annually between these points each year over that time.

This figure is an order of magnitude lower than gravel budget analyses based on river bed surveys and extraction records, which indicate that the annual average gravel (i.e. bed load) input for the reach XS 260 to XS 10 is approximately 6,000 m³. Gary Williams (*pers. comm.)* has advised that more reliance should be placed on these findings than on the modelling predictions at this stage, given the large discrepancy between the two.

It should be noted that actual gravel transport and deposition depends on flood events, their magnitude and duration (above about a 2 year flood flow). Much of this occurs in medium to large flood events. The amount of gravel deposited in a reach can increase significantly after large floods, or if there is a period of high flood intensity. This has implications for the way GWRC manages its gravel extraction programme (see Section 4.2.3).

3.6.5 Waikanae Estuary sediments

3.6.5.1 Fine Scale Monitoring and Condition Ratings

Recent fine scale monitoring of the Waikanae Estuary by Robertson and Stevens (2012) addressed sedimentation, eutrophication and toxicity. The authors concluded that the estuary was in a fair condition, but in a more degraded state than the previous year. Since 2011, metal concentrations had increased, and sediment oxygenation had declined. The likely explanation for this declining condition was an increase in suspended sediment loads in 2012 to the estuary, which resulted in nutrient and metal concentration increases. They noted that the source of the nutrient rich fine sediments was uncertain, but was possibly exacerbated by recent forest harvesting in the upper catchment. The condition ratings are summarised in (Cameron, D, 2015) – Appendix E.

3.6.5.2 Sedimentation

Because estuaries are a sink for sediments, their natural cycle is to slowly infill with fine muds and clays. Prior to European settlement they were dominated by sandy sediments and had low sedimentation rates (<1mm/year). In the last 150 years, with catchment clearance, wetland drainage, and land development for agriculture and settlements, New Zealand's estuaries have begun to infill more rapidly. Today, average sedimentation rates in our estuaries are typically 10 times or more higher than before humans arrived Robertson and Stevens

Stevens & Robertson (2014) have tracked changes to sediment indicators in the Waikanae Estuary for the period 2010 to 2014. They report that the overall mean sedimentation rate across the four years of monitoring is an increase of 26.4mm/yr. The authors concluded that although the lower estuary near the open coast remains dominated by clean sands, these results, combined with observations of fresh mud deposits, highlight rapid recent sedimentation infilling of the upper estuary flats. Rapid sediment deposition occurred from 2010 to 2014. The elevated sediment mud content and shallow RPD[12] depth indicate the upper estuary is at high risk of sediment related impacts from poor clarity and muddy intertidal substrates.

3.7 Water quality

Surface water quality is routinely monitored by GWRC at two RSoE[13] monitoring sites in the Waikanae River catchment – one in the upper and one in the lower reaches. Both sites were moved in 2003 from their original locations (at Reikorangi Bridge and Oxbow Ramp respectively) to new locations at Mangaone Walkway (RS 09) and Greenaway Rd (RS 10). A third site (RS 08) is located

[12] The RPD is the grey layer between the oxygenated yellow-brown sediments near the surface and the deeper anoxic black sediments. It is an effective ecological barrier for most but not all sediment-dwelling species. A rising RPD will force most macrofauna towards the surface to where oxygen is available.
[13] "Rivers State of the Environment"

outside of the application area on Ngarara Stream approximately 180 m upstream of its confluence with the Waimeha Stream. See Table 8 for details.

Table 8: RSoE Monitoring Site Details – Waikanae River Catchment

Site no.	Site name	Site co-ordinates (NZTM)		Date started
		Northing	Easting	
RS 08	Ngarara Stream at Field Way	5474620	1771180	Apr-1990
RS 09	Mangaone Walkway	5473638	1779974	Sep-2003
RS 10	Greenaway Rd	5472915	1771223	Sep-2003

Note: shaded sites lie outside the application area and are included for comparative purposes only. Source: (Perrie A, Morar S, Milne JR, Greenfield S, 2012)

Water quality at each site is assessed monthly from a range of physico-chemical and microbiological variables measured at each site. These include:

- Temperature
- Dissolved oxygen (DO)
- pH
- Conductivity
- Visual clarity, turbidity and suspended solids
- Total organic carbon
- Nitrogen (total ammoniacal nitrogen, nitrite, nitrate, nitrate+nitrite, total Kjeldahl nitrogen, total nitrogen)
- Phosphorus (Total phosphorus, dissolved reactive phosphorus)
- Faecal coliforms and E coli
- Heavy metals (dissolved copper, lead, zinc)

Summary statistics for selected core water quality variables measured from 2010 to 2015 are given in Table 9 (Cameron, D, 2015).

Table 9: Summary of water quality data sampled monthly January 2010 – March 2015 for Waikanae River sites

Determinand	Waikanae River @ Mangaone Walkway (RS09) (upstream of application area)			Waikanae River @ Greenaway Road (RS10) (within application area)			Guideline value
	median	min	max	median	min	max	
Water temp. (ºC)	11.6	5.4	16.5	14.5	8.16	22.2	≤19
DO (%saturation)	98.4	80.8	112	102	65.4	117	≥80
pH	7.44	5.85	8.17	7.37	6.65	8.80	6.5-9.0
Visual clarity (m)	3.33	0.21	7.50	3.13	0.15	8.89	≥1.6
Turbidity (NTU)	0.7	0.28	22	0.55	0.21	42	≤5.6
Suspended solids (mg/L)	<1	<1	29	<1	<1	92	--

Determinand	Waikanae River @ Mangaone Walkway (RS09) (upstream of application area)			Waikanae River @ Greenaway Road (RS10) (within application area)			Guideline value
	median	min	max	median	min	max	
Conductivity (µS/cm)	86	62	98.4	103	78	158	--
TOC (mg/L)	1.57	0.71	9.8	1.50	0.67	8.9	--
NNN (mg/L)	0.117	0.031	0.280	0.220	0.020	0.480	≤0.444
Ammoniacal N (mg/L)	<0.005	<0.003	0.036	<0.005	<0.003	0.027	≤0.021
Total N (mg/L)	0.188	0.055	0.560	0.290	0.055	0.820	≤0.614
DRP (mg/L)	0.013	0.006	0.019	0.008	0.002	0.015	≤0.010
Total P (mg/L)	0.015	0.008	0.047	0.009	0.002	0.119	≤0.033
E. coli (cfu/100ml)	11	<1	1200	27	4	15000	≤550

Note: Median values that did not meet a guideline are shown in bold font.

GWRC's water quality index for RSoE sites measures the median values of 6 key water quality variables against relevant guidelines and assigns an overall grade (poor, fair, good or excellent). The annual monitoring report for the year to June 2014 (Heath, 2014) graded Site RS 10 as having "excellent" water quality and Site RS 09 (upstream) was rated as "good". The lower score at the upper catchment site was due to elevated dissolved reactive phosphorus (DRP) concentrations at that location, which may be a natural feature reflecting the underlying geology (a significant area of plantation forestry located immediately upstream of this monitoring site may also affect water quality). RS10 and RS09 were ranked 6th and 23rd respectively, out of the 55 RSoE sites monitored in the Wellington Region.

The Mazengarb Drain is a low gradient, soft bottomed, minor tributary that flows into the Waikanae River within the Waikanae Estuary Scientific Reserve. It drains the low lying land between Otaihanga Road and Mazengarb Road, and also receives treated wastewater from the Paraparaumu Wastewater Treatment Plant. Historically this discharge has been a source of contaminant inputs to the estuary. In 2002 the Kapiti Coast District Council completed a major upgrade of the wastewater treatment plant, including the introduction of nutrient removal and disinfection to the treatment process, which appears to have largely mitigated the adverse effects of the discharge on the water quality of the Waikanae River (Cameron, D, 2015) – see Appendix E.

(Cameron, D, 2015) notes that Site RS 08 on the Ngarara Stream has "poor" water quality arising from low dissolved oxygen content, low visual clarity and elevated nutrient content, which may be attributable at least in part to the natural characteristics of this watercourse (Heath, 2014) ranked RS08 on Ngarara Stream 52nd of 55 RSoE sites.

The Waimeha Stream is the only minor water course included within the application area. Routine water quality data is not available for this site but it is noted that water clarity in Waimeha Stream is normally far greater than its tributary Ngarara Stream, and that the contrast can be striking when observed at the confluence (Cameron, D, 2015).

3.8 Vegetation

In pre-European times the floodplain was a mosaic of wetland areas of open water, raupo swamp and flax, blending into swamp forest containing kahikatea, pukatea, and swamp maire, such as can be seen at Nga Manu today. On the drier, more stable inland dunes coastal forest including tawa and kohekohe could be found. Native sand-binding plants (pingao and *Spinifex hirsutus*) would have been present on the dunes.

The river banks would likely have been forested as they still are in the reach between Reikorangi and SH1. In this area the river is bordered by stands of titoki, kohekohe, tawa and rewarewa, with a few podocarps (e.g. rimu). Similar forest probably lined the banks below SH1 although the meandering nature of the river in some parts of this area may have been more favourable to kahikatea and other species adapted to periodic inundation.

European settlement began on the Waikanae floodplain in the 1880's, and with it came a process of forest clearance and swamp drainage that markedly changed the landscape and vegetation of the area. Vegetation cover within the entire Waikanae catchment is shown in Figure 10.

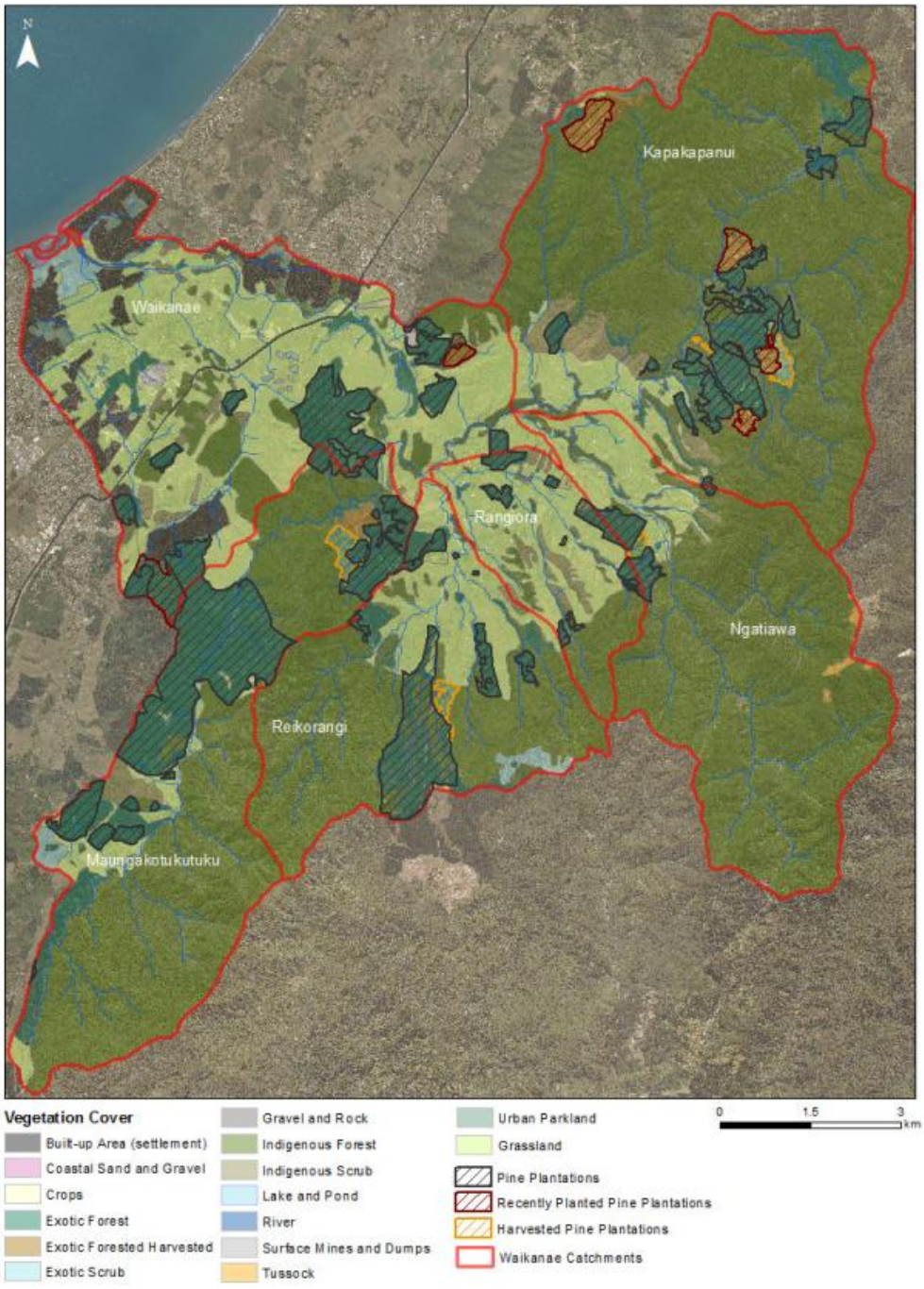

Figure 10: Vegetation cover in Waikanae catchment in 2010. Source: (Opus International Consultants Ltd, 2010)

Today the riverbank vegetation is dominated by willows planted for flood protection, together with a few pockets of kohekohe forest and a mix of native trees such as mahoe and kawakawa. A variety of introduced plants, spread from adjacent farmland can also be found along the river banks.

(Wildland Consultants, 2015) has conducted a detailed survey of the Waikanae River riparian edge vegetation at Jim Cooke Memorial Park (within the application area) and concluded that the area did not contain any significant vegetation values. Most of the vegetation in that area consists of exotic grassland while taller vegetation is dominated by exotic tree species, indigenous species not local to the Kapiti Coast, planted indigenous species up to about 40 years old, and some naturally regenerating indigenous shrubs and trees.

The Waimeha Stream lies within an urban landscape with managed grass edges and exotic trees. The riparian vegetation mostly consists of long grasses with various native and exotic shrubs and weeds, and exotic trees.

The Waikanae River Environmental Strategy (2012) notes that weed infestation is a serious problem along sections of the river margins. Some areas under active management by community groups have been cleared and planted with natives, but many other areas are still to be addressed.

The original swamp and coastal forest of the surrounding floodplain has been replaced by pasture and residential development. The vegetation of the coastal foredunes has been greatly modified by the introduction of marram grass and lupins to help stabilise the sand.

The Waikanae Estuary has a mosaic of vegetation types, including large areas of bare sand flats, periodically inundated by the sea; areas of fixed dune with shrubland; smaller areas of herb field on low saltmarsh; areas of rushland on high salt marsh; a few patches of raupo swamp in freshwater lakelets; and a lagoon with horse's mane weed (Boffa Miskell Partners, 1992). Carpets of remuremu grow in the firm mud along the waters of the estuary. The Estuary provides a home for two regionally rare carex species; *Carex litorosa* and *C. dipsacea* (Jeremy Rolfe, pers.com.), and the threatened (Nationally Endangered) species *Centipeda minima subsp. minima* has been recorded within the Waikanae Estuary Scientific Reserve (Philippa Crisp, *pers comm*.).

Within the application area, along the true left bank of the estuary, salt marsh species have been recorded (Boffa Miskell Partners, 1992). The total area of salt marsh/dune associated with the Waikanae Estuary is estimated at 10 - 20 ha.

3.9 Freshwater ecology – Waikanae River and Waimeha Stream

Ecosystem health is assessed at each of GWRC's 55 RSoE sites in the Wellington Region through biological monitoring. This includes:

- Annual monitoring of periphyton biomass and macroinvertebrate communities during stable/low flows in summer/autumn
- Monthly assessment of periphyton cover in conjunction with the water quality sampling programme described in Section 3.7
- Monitoring of aquatic macrophyte cover at selected sites with soft sediment substrates (this does not apply to the application area)

Biological assessment methods have remained largely unchanged since 2003, except that the number of invertebrate samples at each site was reduced from three to one in 2010. Formal monitoring of aquatic macrophyte cover at selected sites has been undertaken only since July 2011; prior to this only general observations of nuisance growth were recorded during monthly water sampling.

3.9.1 Periphyton

GWRC monitors periphyton cover and biomass at two RSoE monitoring sites, RS09 and RS10, on the Waikanae River. Two data sets are used: monthly observations of percent periphyton streambed cover and periphyton biomass (as indicated by chlorophyll a concentration) from annual surveys. The results are summarised in Tables 3-10 and 3-11 in (Cameron, D, 2015) – Appendix E.

Over the five year period from 2010 to 2014 inclusive, Site RS09 (upstream of the application area) complied with the MfE guidelines for periphyton cover and biomass on all sampling occasions. Over the same five year period Site RS10 (within the application area) also complied with the periphyton cover guideline on all monthly sampling occasions but exceeded the biomass guidelines on one occasion. Percent cover of cyanobacteria mats was recorded only for the 2014 year during which both sites complied with the guideline on all monthly sampling occasions. These results show that excessive periphyton growth occurs rarely on the Waikanae River, which is consistent with the relatively low nutrient levels recorded in river water.

3.9.2 Macrophytes

3.9.2.1 Waikanae River

No nationally threatened aquatic or semi-aquatic plant species are known to be associated with the Waikanae River outside of the estuary. Observations from bankside inspections of the river channel at Jim Cooke Memorial Park and Otaihanga Domain indicate that the River is virtually free of bottom-rooted aquatic macrophytes and that they are not an important feature of the river ecology (D. Cameron pers. obs.).

3.9.2.2 Waimeha Stream

Aquatic macrophytes are a dominant feature of the Waimeha Stream where they occupy up to 100% of the stream channel and can have a major influence on its flood capacity, and its ecology. A survey of the aquatic vegetation of Waimeha Stream was conducted by MWH on 27 July 2015 in the reach between the stream mouth and the Waikanae Golf Club carpark (construction activity associated with the Mackays to Peka Peka Expressway prevented stream access much beyond that point). Vegetation percent-cover values and species recorded are summarised in (Cameron, D, 2015) – Appendix E.

In total seven species of bottom rooted macrophytes were identified, including two introduced submerged species (oxygen weed and Cape pondweed), four emergent species (the introduced parrots feather and water pepper, and indigenous rāupo and oioi), as well as the terrestrial indigenous *Cortaderia toetoe*, which was present at the stream margins.

Both rāupo and toetoe are native species which can potentially enhance fish habitat in Waimeha Stream, and which should be retained at locations where they do not unduly reduce channel capacity. The other introduced species recorded in this reach are pest species which are likely to require ongoing management to limit sprawl and maintain the channel capacity of Waimeha Stream.

3.9.3 Macroinvertebrates

Data on macroinvertebrate communities in the Waikanae River are available from analysis of samples collected annually from 2010-2014 at the RSoE sites. The data uses a Macroinvertebrate Community Index (MCI) as a measure of instream habitat quality, plus three other measures: Quantitative MCI (QMCI), %Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa and %EPT individuals.

The results are summarised in Table 10. Refer to (Cameron, D, 2015) – Appendix E for more detailed data and analysis.

Table 10: Mean macroinvertebrate metric scores (and standard deviation) at the Waikanae River and Ngarara Stream RSoE sites based on GWRC data collected annually in 2010, 2011, 2012, 2013 and 2014. MCI and QMCI quality classes are also included.

Site no.	Site name	N	MCI	QMCI	N. Taxa	N. EPT taxa	%EPT taxa
RS08	Ngarara Stream @ Field Way	5	72.1 (5.74) (Poor)	4.02 (1.30) (Poor/fair)	17.4 (3.51)	2 (1.8)	5.2 (4.57)
W1	Waimeha Stream @ Hona Street	1	76.1 (Poor)	4.79 (Fair)	16	2	13
RS09	Waikanae River @ Mangaone	5	138.5 (5.55) (Excellent)	8.01 (0.21) (Excellent)	28.4 (1.34)	17 (1.87)	65.3 (14.8)
RS10	Waikanae River @ Greenaway	5	113.2 (4.18) (Good)	5.35 (0.79) (Good)	26.4 (6.58)	12.4 (2.30)	48.2 (5.21)

The results show that the Waikanae River upstream of the application area at Site RS09 supports a diverse fauna dominated by sensitive EPT taxa, especially the mayflies *Deleatidium* and *Coloburiscus,* the stonefly *Zelandoperla* and the caddisfly *Olinga.* Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) scores indicate "excellent" quality class in the upper river reflecting the high proportion of indigenous forest land cover, the small proportion of agricultural land-use and an absence of urban development.

The catchment area for lower/middle reach of the River at Site RS10 at Greenaway Road contains urban Waikanae, and nearly 20% in productive pasture. This difference in land-use compared with the upper river catchment is reflected in the macroinvertebrate community composition at Greenaway Road. *Deleatidium* remains the dominant taxa but *Coloburiscus* and *Zelandoperla* are rare and sensitive caddisflies such as *Olinga* are uncommon. The MCI and QMCI metrics indicate "good" quality in this reach, showing that the benthic fauna remains in relatively good condition despite the increased area of agricultural and urban land-use.

Ngarara and Waimeha Streams are both low gradient, spring-fed coastal streams with a soft sediment substrate, and a catchment dominated by agricultural and urban development. There is very little exposed gravel or cobble substrate in these streams; the primary habitat for invertebrates is aquatic plants, which grow very densely, and woody debris. The macroinvertebrate communities reflect these conditions, being dominated by the freshwater snail (*Potamopyrgus*) and crustaceans (copepods, ostrocods, *Paracalliope* and Cladocera). Sensitive EPT taxa are rare in the Ngarara and Waimeha Streams.

The Waikanae River Environmental Strategy (Greater Wellington Regional Council, 2012) notes that "during annual macroinvertebrate sampling in early 2011, a freshwater polychaete [annelid worm] - (*Namanereis tiriteae*) was found in a sample from the Greenaway monitoring site. Not much is known about this polychaete but it appears to have only been found in four river systems (Manawatu, Tukituki, Ngaruroro, Waiapu) to date."

3.9.4 Fish

3.9.4.1 Waikanae River

Records in the New Zealand Freshwater Fish Database (NZFFD) for the Waikanae River are summarised in Table 11. They indicate that the Waikanae River supports a diverse population of fish,

comprising 15 native species and the introduced brown trout. Two species – the lamprey and shortjaw kokopu have a threat status[14] of 'Nationally Vulnerable', while seven of the other native species are assigned a threat status of 'At Risk – Declining' due to declining numbers nationally.

Analysis indicates that the core fish community of the Waikanae River application area consists of longfin eel, shortfin eel, redfin bully, common bully, torrentfish and brown trout. Other species such as inanga, koaro and banded kokopu are likely to be seasonally abundant but not necessarily resident within the application area.

Most of the indigenous fish species recorded in the catchment, except dwarf galaxias and brown mudfish, are diadromous, that is, they migrate to and from the sea at well-defined life stages, and in most cases the migrations are obligatory. Periods of peak sensitivity for migrations are described in (Cameron, D, 2015).

Based on the geographical and geomorphological differences between the application area and upstream reaches, some difference in the fish community is to be expected. In particular, low elevation fish taxa such as inanga, smelt, shortfin eel and common bully are predicted to be rare or absent upstream of the application area while other taxa such as dwarf galaxias, koaro and banded kokopu are predicted to be more common at upstream locations. The records summarised in Table 11 are generally consistent with those predictions.

Table 11: Summary of NZFFD records for the Waikanae River as of June 2015 (n=31) FENZ[15] predictions of occurrence inside and outside of the application area are also provided.

Scientific name	Common name	%Occurrence			Migratory species	Threat status (Goodman *et al* 2014)
		Recorded within application area (n=8)	Recorded outside application area (n=23)	Predicted within/ upstream (FENZ)		
Aldrichetta foresteri	Yellow eyed mullet	0	4.3	n.d.	Marine/ estuarine	Not threatened
Anguilla australis	Shortfin eel	50	13	90/10	yes	Not threatened
Anguilla dieffenbachii	Longfin eel	100	100	100/100	yes	At risk (declining)
Cheimarrichthys fosteri	Torrentfish	63	17	20/10	yes	At risk (declining)
Galaxias postvectis	Shortjaw kokopu	0	22	0/90	yes	Threatened (Nationally Vulnerable)
Galaxias brevipinnis	Koaro	0	52	0/90	yes	At risk (declining)
Galaxias fasciatus	Banded kokopu	0	4.3	0/50	yes	Not threatened
Galaxias divergens	Dwarf galaxias	0	13	0/0	no	At risk (declining)
Galaxias maculatus	Inanga	38	4.3	100/10	yes	At risk (declining)
Geotria australis	Lamprey	38	4.3	10/10	yes	Threatened (Nationally Vulnerable)
Gobiomorphus hubbsi	Bluegill bully	0	8.6	10/10	yes	At risk (declining)
Gobiomorphus cotidianus	Common bully	50	13	90/20	yes	Not threatened

[14] According to the NZ Threat Classification System (Goodman *et al* 2014)
[15] Freshwater Ecosystems of New Zealand Geodatabase (Leathwick et al 2010)

Scientific name	Common name	%Occurrence			Migratory species	Threat status (Goodman *et al* 2014)
		Recorded within application area (n=8)	Recorded outside application area (n=23)	Predicted within/ upstream (FENZ)		
Gobiomorphus huttoni	Redfin bully	100	96	100/100	yes	At risk (declining)
Neochanna apoda	Brown mudfish	0	4.3*	n.d.	no	At risk (declining)
Retropinna retropinna	Common smelt	25	8.6	90/10	yes	Not threatened
Rhombosolea retiaria	Black flounder	25	4.3	10/10	yes	Not threatened
Salmo trutta	Brown trout	63	61	50/100	yes	Introduced/naturalised

Notes: n.d. = no data

*The NZFFD has a single record of brown mudfish in an unnamed wetland within the Waikanae catchment, but not directly associated with the Waikanae River

Source: (Cameron, D, 2015)

3.9.4.2 Waimeha Stream

Ten species of native fish have been recorded within the Waimeha/Ngarara Stream (Table 12). Four of these species (lonfin eel, inanga, giant kokopu and redfinned bully) are considered to be at risk due to declining numbers nationally.

Seven of these fish species have been recorded within the portion of the application area covering Waimeha Stream. The most commonly recorded fish species in this area are shortfin eel (at 75% of survey sites), longfin eel (50%), inanga (50%) and common bully (50%).

Based on NZFFD records the core fish community of Waimeha Stream application area consists of longfin eel, shortfin eel, inanga and common bully. This is consistent with the results a recent fish survey conducted in the Waimeha Stream as part of the Mackays to Peka Peka Expressway investigations, except that inanga were not recorded in that survey (Risi, 2012). Potential areas of inanga spawning habitat are shown in Appendix B of (Cameron, D, 2015) on the Waimeha Stream downstream of the Ngarara confluence and mostly on the true left bank (south).

Table 12: Summary of the NZFFD records for the Waimeha/Ngarara Stream as of June 2015 (n=16). FENZ predictions of occurrence inside and outside of the application area are also provided

Scientific name	Common name	%Occurrence			Migratory species	Threat status (Goodman *et al* 2014)
		Recorded within application area (n=4)	Recorded outside application area (n=12)	Predicted within/ upstream (FENZ)		
Anguilla australis	Shortfin eel	75	92	100/100	yes	Not threatened
Anguilla dieffenbachii	Longfin eel	50	83	60/100	yes	At risk (declining)
Galaxias fasciatus	Banded kokopu	0	17	40/50	yes	Not threatened
Galaxias maculatus	Inanga	50	67	100/100	yes	At risk (declining)
Galaxias argenteus	Giant kokopu	25*	8	10/10	yes	At risk (declining)

Scientific name	Common name	%Occurrence			Migratory species	Threat status (Goodman *et al* 2014)
		Recorded within application area (n=4)	Recorded outside application area (n=12)	Predicted within/ upstream (FENZ)		
Gobiomorphus cotidianus	Common bully	50	58	10/100	yes	Not threatened
Gobiomorphus huttoni	Redfin bully	25	17	30/30	yes	At risk (declining)
Gobiomorphus basalis	Crans bully	0	8	0/0	no	Not threatened
Gobiomorphus gobiodes	Giant bully	25	0	10/10	yes	Not threatened
Retropinna retropinna	Common smelt	0	8	10/10	yes	Not threatened

*Not included in NZFFD but report by Ohau Plants Ltd (2009), Source: (Cameron, D, 2015)

3.9.4.3 Recreational fisheries

Recreational fishing of brown trout and whitebait is undertaken in the application area.

Brown trout

Brown trout (*Salmo trutta)* were first liberated into the Waikanae River in 1886 by the Wellington Acclimatisation Society, and artificial stocking of the river continued almost annually until 1974 (Pilkington S. , 2011).

Brown trout, like torrentfish and bullies, rely on run, riffle and pool associations to provide the necessary variety of habitat. The habitat requirements for brown trout vary with age and size. Young fish (<55 mm FL[16]) usually occupy shallow areas along the edges of channels with coarse cobbles. Larger juveniles (>55 mm FL) occur mostly in water deeper than 0.3 m, and in flows > 0.3 m/s, often in association with white water around boulders, small plunge pools, debris clusters or submerged riparian vegetation (Montgomery Watson, 1998).

Mature brown trout migrate to headwater streams during autumn, where they spawn during winter (May-June). Egg development takes 4-6 weeks, and after hatching the young remain in the spawning gravels for a further two weeks. They emerge into the spawning streams about the beginning of spring.

Trout abundance has been monitored annually (via drift dives) by Fish & Game NZ since 1999, principally for the purpose of assessing the impacts of river works. In 1998 GWRC was granted resource consent to carry out various works in the bed of the Waikanae River (and also the Hutt River in 1999). In response to the concerns of Fish& Game NZ that one activity, "cross-blading", was particularly harmful to the preferred habitat requirements of trout, GWRC agreed (via a Memorandum of Understanding) to fund the monitoring of trout abundance over the term of their consent.

The primary objective of this MoU was:

> *"to explore the relationship between trout abundance and the frequency and extent of river control works, in particular cross-blading".*

[16] FL refers to fork length, defined as the length from the tip of the snout to the end of the middle caudal fin rays. The measurement is used in fishes where it is difficult to tell where the vertebral column ends.

Monitoring results reported by (Pilkington, S, 2014) and summarised in (Cameron, D, 2015) – Appendix E indicate the following:

- The mean number of trout per km observed in 2014 was 13.8 (with a standard error of 4.7) compared with 34.3 (standard error 16.2) in 2013. This change is not considered to be statistically significant.
- The sixteen year trend is neutral showing on average neither increase nor decrease of trout numbers overall.
- Trout numbers were variable at all sites but were typically higher within the application area than upstream of it.

To date the data has not identified any significant negative effects on trout that can be attributed to river management activities in the Waikanae River.

Whitebait

Both the Waikanae River and Ngarara/Waimeha Stream support a popular recreational whitebait fishery, at times attracting over 20 fishers during the whitebait run. Six galaxiid species (whitebait) have been recorded in the two watercourses.

The peak period of upstream galaxiid migration is from the beginning of August to the end of December (the whitebait fishing season opens on 15 August and runs until November 30).

3.10 Estuarine ecology – Waikanae and Waimeha Estuaries

3.10.1 Macroalgae

Macroalgae is an important feature of estuaries, contributing to their high productivity and biodiversity. However when high nutrient inputs combine with suitable growing conditions, nuisance blooms of rapidly growing algae can occur. At nuisance levels such growths can deprive seagrass of light, causing its eventual decline, while decaying macroalgae can accumulate on shore-lines causing local depletion of sediment oxygen, and nuisance odours.

(Cameron, D, 2015) in Appendix E summarises the results of four annual intertidal macroalgal cover surveys of Waikanae River Estuary. This shows that macroalgae is absent from the vast majority of the estuary but that minor localised nuisance conditions (rotting macroalgae, poorly oxygenated and sulphide rich sediments) occurred in one small part of the estuary, in the flap-gate embayment.

No macroalgae data are available for Waimeha Estuary.

3.10.2 Macroinvertebrates

(Cameron, D, 2015) in Appendix E summarises the results of fine scale monitoring of infauna (animals within sediments) from the Waikanae Estuary in 2010, 2011 and 2012 . In all three years the macroinvertebrate community had a low to moderate number of species and a moderate to high mean abundance compared to other New Zealand estuaries. Overall, the three years of monitoring indicates predominantly muddy conditions that favour a macroinvertebrate community dominated by mud tolerant species. Combined with the elevated sedimentation rate, such conditions indicate excessive catchment loads of fine sediment are detrimentally affecting the upper/middle estuary.

No macroinvertebrate data are available for Waimeha Estuary.

3.10.3 Fish

The fish community of the Waikanae River has been described in Section 3.9.4 of this report. Of the 35 NZFFD records available for the catchment only two were located within the estuarine reach

(<2km from the sea). Six fish species were recorded; these are longfin eel, shortfin eel, inanga, common bully, redfin bully and black flounder. The most abundant fish were shortfin eel and common bully. Potential areas of inanga spawning habitat are identified downstream of Otaihanga Domain, predominantly on the true right bank, refer to (Cameron, D, 2015).

Habitat diversity of the Waimeha Estuary is low, given the highly modified upstream channels and the absence of tidal flats and salt/marsh vegetation, the regularly modified beach channel and lagoon and the high incidence of weeds. Nevertheless, potential areas of inanga spawning habitat have been identified on the Waimeha Stream downstream of the Ngarara Stream confluence and mostly on the true left bank (south) – refer to (Cameron, D, 2015) in Appendix E.

3.11 Birdlife

3.11.1 Waikanae River

3.11.1.1 Survey design

GWRC has recognised that there is potential for river management activities to have both positive and negative impacts in bird populations present in the river corridors. In response to this, GWRC's Environmental Code of Practice (included as Annexure 1) has committed to a bird monitoring programme that involves carrying out annual surveys on a three year on, five year off cycle on most of the major rivers affected by river management activities. The first three-year series of annual bird surveys on the western sector rivers, including the Waikanae River, commenced in late 2012, with three consecutive annual surveys having being completed in the summers of 2012/13, 2013/14 and 2014/15. The results these surveys are reported by (McArthur N. S., 2015) and are summarised in (Cameron, D, 2015) – Appendix E.

The river bird surveys are specifically designed to provide estimates of the local population sizes of four shorebird species that are known to breed on the open gravels of rivers subject to river management activities, and that are considered to be at relatively high risk of being adversely impacted by these activities (the banded dotterel, black-billed gull, and pied stilt, and black-fronted dotterel). The first three of these four species are of relatively high national conservation concern. Aside from these breeding birds, number of additional shorebird and waterfowl species make use of the lower reaches of the river and estuary during certain stages of their life cycle, and these are also included in the survey. The majority of the remaining bird species recorded in the river corridor are terrestrial species that are common and widespread in the surrounding landscape.

3.11.1.2 Survey findings

(McArthur N. S., 2015) reported that no shorebirds were observed breeding on the exposed gravel beaches of the Waikanae River during the 2012-2015 surveys. The morphology of the Waikanae River between the SH 1 bridge and the Waikanae Estuary, particularly the narrow channel width and relatively small areas of open, dry gravel habitat, means that there is very little (if any) suitable habitat to support riverbed nesting shorebirds upstream of the Estuary.

A total of 45 bird species were recorded during this period, including 27 native species and 18 introduced species. Of the native species, nine species are ranked as Nationally Threatened or 'At Risk' under the New Zealand Threat Classification System. In addition to the 45 species recorded during the 2012-2015 surveys, a further 45 species (42 native and three introduced) have been recorded on the Waikanae River (the majority at the Waikanae Estuary) since 1927, bringing the total number of bird species so far recorded on the Waikanae River to 90. Both the total number of species and the ratio of native to introduced species encountered within each 1 km survey section varied little upstream of XS155. However, the total number of species, the proportion of native species, and the proportion of Nationally Threatened and 'At Risk' species encountered gradually

increased downstream from this point, with the highest number of species being detected at the Waikanae River mouth.

3.11.2 Waikanae Estuary

The birds of Waikanae River have been described above. The Waikanae Estuary, and its associated wetlands and ponds, are identified by (McArthur N. R., 2015) as a site of significance for indigenous birds. It supports one of only two known populations of North Island fernbird in the Wellington Region, and one of the largest nesting colonies of pied shags in the region. At least twelve threatened or at risk species are known to be resident or regular visitors to this site. These are the banded dotterel, North Island fernbird, NZ dabchick, South Island pied oyster catcher, variable oyster catcher, bar tailed godwit, pied stilt, blag shag, pied shag, red-billed gull, white fronted tern and Caspian tern. Species such as the variable oyster catcher occupy the sand-spit where the river affords some protection from cats, ferrets, dogs and trail bikes on the other side of the reserve.

The critical period for this site in terms of the potential for negative effects extends all year round: (important summer site for Arctic-breeding shorebird; important winter site for NZ breeding shorebirds; all-year habitat for North Island fernbird).

3.11.3 Waimeha Stream

(McArthur N. R., 2015) described the bird values of the Waimeha Stream based on a site visit and desktop analysis, together with systematic bird data collected from the nearby Waikanae River. Sixteen species of birds have been recorded at the mouth of the Waimeha Stream, including 12 native species and four introduced species. Of the native species, six are ranked as 'At Risk' or Threatened under the New Zealand Threat Classification System.

(McArthur N. R., 2015) observed that:

"with the exception of the stream mouth, no suitable shorebird habitat exists along the length of this stream due to the narrow channel width and lack of open gravel beaches. The riparian habitat on either side of the Waimeha Stream appears to be extremely similar to that found along the nearby Waikanae River (a mixture of suburban, parkland and semi-rural habitats), so I believe it would be reasonable to assume that the Waimeha Stream supports a very similar bird community to that found along the Waikanae River… With the exception of those shorebird species recorded at the mouth of the Waikanae River, the remaining bird species detected are all relatively common and widespread in the surrounding landscape and are ranked as either "Not Threatened" or "Introduced and Naturalised" under the New Zealand Threat Classification System (Robertson et al, 2013). As a consequence, it's my view that the activities described in this consent application are likely to have a negligible impact on the bird species known or likely to be present along the Waimeha Stream."

3.11.4 Waimeha Estuary

The bird fauna of Waimeha Stream has been described above. Sixteen species of birds have been recorded at the stream mouth, including 12 native species and four introduced species. Of the native species, six are ranked as 'At Risk' or Threatened under the New Zealand Threat Classification System. (McArthur N. R., 2015) observed that the area of habitat at the Waimeha Stream mouth is very small and that the bird populations using this small area are transitory. The Waimeha Estuary has not been listed by (McArthur N. R., 2015) as a habitat of significance for indigneous birds.

3.12 Herpetofauna

A desktop search for lizard and frog records was undertaken for a corridor extending 1km either side of the Waikanae River and Waimeha Stream channels and running the length of the application area (Cameron, D, 2015). Only one lizard species is recorded within this area: the northern grass skink. Its

likely presence within the corridor is indicated as 'moderate' where rank grassland and scrubland occurs in areas infrequently inundated by the river. The likelihood of lizard presence is low in those areas frequently flooded by the river.

A field search for terrestrial and arboreal lizards was conducted alongside the Waikanae River at Jim Cooke Memorial Park on 26 July 2015 (day/night survey) as part of a separate consent application by GWRC for stopbank improvements. That search, conducted in optimal conditions, failed to detect any lizards or their sign (Wildland Consultants, 2015). The authors concluded that "*Overall, the habitat availability at the site is considered to be of low significance for lizards*".

It is noted that the likelihood of lizard presence in those areas frequently flooded by the river is low, and that the majority of river management activities occur in areas frequently affected by flood waters.

3.13 Natural character

The natural character of a river reach is a reflection of the river's physical morphology, hydrological regime, riparian and in stream ecology and the complex interactions among these parameters over time.

Quantification of such variables enables the development of a 'natural character index', which can then be used as a practical tool to establish the existing condition of specific river reaches and monitor changes from this baseline into the future.

This approach has been used in Australia, with the most comprehensive application being the Tasmanian River Condition Index (TRCI). In New Zealand a similar general characterisation has been undertaken for the plains (and scheme) reach of the Waingawa River. There have not, however, been any well-defined and documented assessments of natural character for waterways specifically for the purpose of reach characterisation, as it is relatively new science.

As part of investigations to support GWRC's applications for resource consents in the Hutt, Waikanae and Otaki Rivers, GWRC consultant Gary Williams has undertaken a basic assessment of natural character in these rivers, using a Natural Character Index (NCI) that has been determined by Massey University researchers (Death et al). The results are reported in Williams (2013), which is included in Appendix F. An NCI has been determined for six reaches in the Waikanae River covering the application area. The NCI uses a combination of individual indices that have been determined for a number of physical features of the channel including:

- the width of the actively worked channel
- the bankfull width before the river overflows to the floodplain
- the width of floodplain available to floodwater (permitted floodplain width)
- channel sinuosity, from flow length and direct valley length; and
- the number of pools per km

These features were determined from aerial photography and contour information produced from LiDAR imagery surveying. The earliest available (complete) aerial photography was used to set up a baseline index; for the Waikanae River, the reference photography was taken in 1952. This was then compared with measurements taken from the latest imagery.

The results of the NCI determination for the Waikanae River are given in Table 13.

Table 13: Natural Character Index for the Waikanae River

REACH (Cross Sections)	OVERALL NCI
XS 550 –XS 430	1.06
XS 420 – XS 350	1.08
XS 345 – XS 310	1.05
XS 300 – XS 240	0.64
XS 230 – XS 175	0.70
XS 155 – XS 80	0.88
Average	0.90

Source: Williams (2013)

The NCI values are the ratios of the present to historic measurements, where a value of 1 means no change over the assessment time period. The lower the ratio value the greater the change away from natural character. The NCI index varies from 0.64 to 1.08 for the six individual reaches, reflecting the fact that there has been varying degrees of modification over time. Where the index is greater than 1, there has been an improvement over the baseline condition – this has occurred in three of the reaches. The overall averaged index for the Waikanae River reaches is 0.90. Williams concluded that there has been relatively little modification of the river channel, and river management work has given rise to a more defined and consistent channel shape and condition overall.

Since determination of the NCI for a reach can be repeated from updated aerial photography/LiDAR survey data over time, it provides a potentially useful tool for monitoring trends in river condition over time.

3.14 Recreation

3.14.1 Waikanae River

An assessment of recreation and tourism in Wellington rivers has been undertaken by consultants TRC Tourism Ltd for GWRC, to support GWRC's application for resource consents in the Hutt, Waikanae and Otaki Rivers. The results are reported in (TRC Tourism, 2013). According to this report the Waikanae River is a popular recreational resource for local residents and visitors, particularly in the area downstream of SH1. Summary details are given below, and the full report is included in Appendix G.

Fishing

The Waikanae River supports a trout fishery which attracts anglers from the Wellington and Horowhenua Regions. The river is very accessible in the reaches downstream of SH1. The fishing season extends from October to April, with the busiest time pre-Christmas. Data taken from the NIWA National Anglers Survey indicates a generally upward trend in use: from 750 fishing visits in 1994/5, 420 in 2001/2 and 1420 (+/- 450) in 2007/8.

(TRC Tourism, 2013) also reports that the river is also popular for whitebaiting, with up to 50 nets on the river at any one time. Whitebaiting is most concentrated at the river mouth, and is also permitted within the Waikanae Estuary Scientific Reserve, during the season from 15 August – 30 November.

There is also some netting for flounder and fishing for kahawai and mullet in the lower reaches and at the river mouth.

In-river recreation

The lower reaches of the Waikanae River and the Waimanu Lagoon areas provide safe and sheltered reaches for entry level and children's water-based activities: principally kayaking, canoeing, rowing and swimming. There is limited yachting and wind-surfing, and radio-controlled boat use.

The Otaihanga Boating Club is located on Makora Rd. This building provides a community facility for meetings and functions. According to its website, the Club also holds the rights to a boat ramp located just downstream of the Boat Shed building; this can accommodate small boats.

Tracks

There is a well-formed track running either side of the Waikanae River between SH 1 and the coast. There are two footbridges across the river which enhance access and walking/biking/horse riding opportunities; the first is the Te Arawai bridge approximately 2 km downstream of SH 1, and the second is a further 3 km downstream at Otaihanga Domain.

(TRC Tourism, 2013) reports that the Te Arawai bridge receives up to 1,200 crossings per day in summer and around 700 per day in winter.

The river trail downstream of SH 1 is included in *Te Araroa - The Long Pathway;* this national walkway officially opened in 2011. In addition, the Kapiti Coast District Coastal Cycleway between Paraparaumu and Peka Peka crosses the Waikanae River at the Otaihanga footbridge and includes the gravel track on the true right of the river downstream of the bridge. This track joins to Tutere St in the Waikanae Beach settlement.

Waikanae Estuary Scientific Reserve

The reserve is linked to the Otaihanga Domain and the coast via a network of tracks. Popular activities in the reserve include bird watching, white-baiting, walking and picnicking.

El Rancho Holiday Camp

The Waikanae Christian Holiday Park ('El Rancho') is located beside the river at the end of Kauri Rd. Covering 70 acres (28 ha), it receives 12,000 guests annually, including numerous families. The main services offered include holiday accommodation, conferencing, ministry programmes and recreation. Use of the Waikanae River, particularly kayaking, is a prominent feature of the recreation programme.

3.14.2 Waimeha Stream

The Waimeha Stream is a popular whitebaiting and surf-casting area (TRC Tourism, 2013). The Waikanae Golf Course borders the eastern side of the stream upstream of the confluence with Ngarara Stream. This club has approximately 630 members and hosts approximately 30, 000 rounds of golf annually.

3.15 Tourism

Although Waikanae is a popular holiday destination and weekend beach destination for Wellingtonians, there is limited tourism activity directly associated with the Waikanae River itself.

Currently the main tourism operator on the river is Waikanae Estuary Tours, which operates 2 hour guided bird-watching tours to the estuary. El Rancho, noted above is also a significant tourist operator in the vicinity.

3.16 Neighbouring community

3.16.1 Residential areas

The settlements of Waikanae and Waikanae Beach lie immediately to the north of the Waikanae River, while Otaihanga lies upstream of the mouth on the south side of the river. Residences at the northeastern end of Paraparaumu Beach lie at the western edge of the Waikanae River estuary. Much of Waimeha Stream flows through residential areas.

The usually-resident population of these settlements and the number of occupied dwellings in each (as recorded in the 2006 NZ Census) is shown in Table 14, along with totals for the Kapiti Coast District and Wellington Region.

The data show that all areas are experiencing population growth, particularly Waikanae Beach, Waikanae East and Otaihanga. The high percentage of the total population over 65 years in Waikanae as a whole (Waikanae East, Waikanae West and Waikanae Park) and the Kapiti Coast generally reflects the popularity of these areas as a retirement destination.

Table 14: Population data

Area	No of occupied dwellings	Population	Population Increase since 2001	% over 65 years old	% under 15 years old
Waikanae Beach	1224	2895	18%	12.2	22.2
Waikanae East[17]	828	1986	10.7%	28.4	16.9
Waikanae West[18]	1689	3453	4.4.%	46.3	12.3
Waikanae Park[19]	846	1899	4.3%	42.7	12.5
Otaihanga	408	1110	11.8%	12.2	22.2
Kapiti Coast District	19368	46200	8.8%	23.3	19.4
Wellington Region		448956	5.9%	11.4	20.6

Source: NZ Census 2006

3.16.2 Infrastructure and services

In addition to the flood protection works already described in Section 3.3, the principal infrastructure and services within the river corridor include:

- The Waikanae Water Treatment Plant, located on the true right bank of the Waikanae River approximately 1200 m upstream of the SH 1 bridge, and accessed via Reikorangi Rd. Operated by the KCDC since 1977, the plant supplies water to Waikanae, Paraparaumu and Raumati. According to the KCDC website, the plant primarily sources water from the Waikanae River, but can also source supplementary water from groundwater bores when river levels are low
- The North Island Main Trunk railway bridge, approximately 50 m long

[17] Waikanae East covers the settlement lying east of SH1

[18] Waikanae West covers the block of land extending northeast from the river, between SH1 and Leybourne Avenue (approximately); see map on Census 2006 website for further details.

[19] Waikanae Park covers the block of land extending northeast from the river, between Leybourne Avenue and the end of Kauri Rd; see map on Census 2006 website for further details.

- The SH1 bridge, approximately 30 m downstream of the rail bridge, which is two lanes wide and approximately 70 m long
- The Dricon concrete plant and Gold Coast Removals Ltd house storage site, on the south bank immediately west of the SH1 bridge
- Two sets of Transpower high voltage transmission lines cross the river between Nimmo Avenue East and Nimmo Avenue West. The distance to the river of the closest pylon is approximately 35 m (on the north bank)
- The Te Arawai footbridge, downstream of Jim Cooke Memorial Park, constructed in 2009
- The Otaihanga footbridge over the river, providing access between Otaihanga Domain and the Oxbow on the northern bank
- Underground services at:
- XS 070 – power, sewer and telecommunications
- XS 110 to XS 120 – telecommunications
- XS 155 gas & telecommunications

The MacKays to Peka Peka Expressway (M2PP), which is a 4 lane, 16 km long motorway extending from just south of Poplar Ave, Raumati to just north of Peka Peka Rd, will cross the Waikanae River east of Otaihanga Road. This road is part of the Wellington Northern Corridor, which is identified as a 'road of national significance'. Resource consents were granted in early 2013; construction work commenced in late 2013 and is scheduled for completion in mid 2017. Further details are included in Appendix H.

3.17 Tangata whenua

The collective hapu of the Te Atiawa ki Whakarongotai holds mana whenua over the entire catchment of the Waikanae River. This mana whenua status involves comprehensive kaitiaki responsibilities for safeguarding the values of the river system.

According to The Te Puni Kokiri Directory of Iwi and Maori Organisations, the rohe (or tribal area) of Te Atiawa ki Whakarongotai is described as follows: 'From Kukutauaki to Whareroa (seaward) inland to Pukemore and to Maunganui northward to Kapakapanui and Pukeatua to Ngawhakangutu then westward to Kukutauaki'[20], as is shown in Figure 11.

The iwi is represented by two organisations: Runanga o Atiawa ki Whakarongotai Inc, which is an iwi authority for the purposes of the RMA, and Atiawa ki Whakarongotai Charitable Trust. The Whakarongotai Marae, located in the centre of Waikanae township, is the focus for the tangata whenua.

The Te Puni Kokiri Directory also shows that the rohe of two other iwi: Ngati Toa Rangatira and Rangitane, also extend over the lower western parts of the North Island, including the Waikanae River catchment. Ngati Toa Rangatira is represented by Te Runanga o Toa Rangatira, which is an iwi authority for the purposes of the RMA. Rangitane (North Island) is represented by six organisations, most of which are iwi authorities for RMA purposes.

Further information on the historic settlement of Waikanae by Te Atiawa ki Whakarongotai, sites of cultural and historic significance and the significance and value of the area to the iwi are included in the updated Waikanae Environmental Strategy (Greater Wellington Regional Council & Kapiti Coast District Council, 2014).

[20] Te Puni Kokiri website: http://www.tkm.govt.nz/iwi/te-atiawa-ki-whakarongotai/

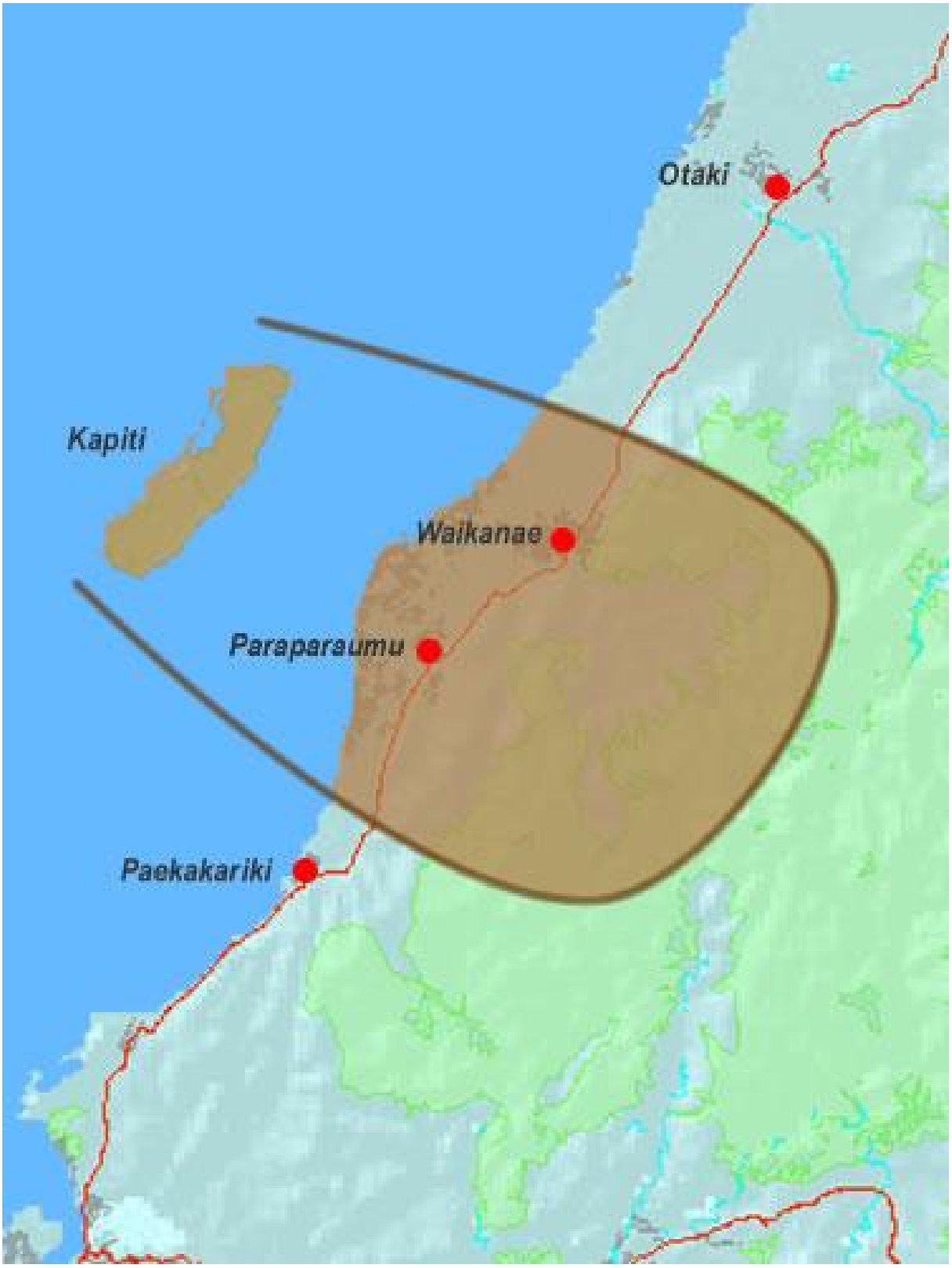

Figure 11: Rohe (tribal area) of Te Ati Awa ki Whakarongotai. Source: Te Puni Kokiri website

3.18 Archaeological sites

The New Zealand Archaeological Association online database does not record any archaeological sites within the application area.

The closest recorded site is Site R26/241, located at Waimea Pa adjacent to (and above) the river corridor near the river mouth. It is described as a midden site of early Maori origin, exposed by bulldozing for a subdivision on sand dunes between the Waikanae River, Hicks Crescent and Sunset Terrace. The records note 'contents included tuatua, triangle shell (*Spisula aequilateralis*), *Dosina anus*, cats eye, ostrich foot shells, charred wood and fishbone'. It is also noted as a 'findspot for a piece of obsidian and a pecked argillite stone'.

4 Proposed Activities

4.1 Purpose and intended outcomes

The main aims of the river operation and maintenance work programme are to:

- maintain the Waikanae River channel on its design channel alignment as defined in the WFMP
- maintain the flood capacity of the existing channels in the Waikanae River and Waimeha Stream by removal of obstructions and gravel build-ups (in the Waikanae only) as necessary
- maintain the integrity and security of the existing flood defences (including stopbanks and bank protection works)
- manage the outlets of the Waikanae River and Waimeha Stream in response to pre-determined triggers relating to channel morphology and/or upstream water levels

In addition, the work programme also aims to:

- maintain, or (where possible) improve, the in-river and adjacent riparian environment

These aims are discussed further below.

4.1.1 Maintenance of channel alignment

Without active management the river would erode its berms and develop meanders in a similar way to how it would have behaved in pre-European times. However the need to protect the private properties, urban infrastructure, utility services, bridges and floodway assets that are now located adjacent to the river today means that the river must be actively managed within its existing alignment.

Channel alignment is maintained using a combination of:

- Hard edge protection works such as rock rip-rap linings or groynes
- Soft edge protection such as planted, or layered and tethered, willows
- Mechanical shaping of the beaches and channel – either by 'ripping' (dragging a tine through the gravels), or by recontouring (more extensive movement and redistribution of the gravels)
- Channel diversion cuts

Hard edge protection works provide a high degree of bank protection but are expensive and can only be justified at points on the river which are particularly vulnerable to erosion and/or where strategic assets are at an unacceptable level of risk.

In contrast, soft edge protection works are less expensive and provide a moderate degree of berm security during flood events. They are suitable where there is a wide berm and they contribute to the relatively 'natural' appearance of the river. Often soft edge protection will need to be supported by channel shaping (e.g. beach and bed recontouring) particularly if they are located on the outside of a bend or other vulnerable points.

Diversion cuts may need to be undertaken to realign the low flow channel where it has moved too far from its design alignment, or to resolve a bank erosion problem. Typically diversion cuts are formed through beach areas, away from the flowing channel.

4.1.2 Maintenance of channel capacity

The tools used to maintain channel capacity may include:

- Clearance of vegetation from gravel beaches ('scalping')

- Removal of unwanted willows
- Clearance of flood debris
- Removal of weed and sediment
- Removal of sediment and gravel deposited on berms by flood events
- Gravel extraction from aggradation zones

In the Waikanae River, removal of beach vegetation and unwanted willows is important because of the tendency of these features to encourage gravel aggradation and debris accumulation. Gravel extraction has been identified as an essential tool if bed levels are to be managed effectively. Recent analysis has also shown that berm levels are increasing due to deposition of flood-borne gravel, and lowering of the berms in the future may also be necessary.

In the Waimeha Stream, removal of weed and sediment from the channel are the main channel management tools.

4.1.3 Maintenance of existing flood defences

This includes all of the works necessary to maintain the existing in-river structures, and repairs to flood defence structures outside the river bed – principally the stopbanks.

4.1.4 Management of river outlets

The outlets of the Waikanae River and Waimeha Stream can migrate both to the north and south of their upstream channels. From a flood protection perspective the optimum alignment is the shortest route to the sea. As the outlet migrates from this alignment, hydraulic efficiency of the channel reduces with consequent increase in flood levels upstream and erosion of the buffer areas protecting nearby housing development.

For this reason, new outlets at the river mouths are to be cut when upstream water levels reach a certain point or when the mouth has migrated beyond certain pre-set trigger points that are identified in Table 7.1 of the Regional Coastal Plan for the Wellington Region (RCP) (see below).

Regional Coastal Plan for the Wellington Region: Table 7.1 Trigger levels for river and stream mouth cutting in accordance with Rules 30 and 34		
River	Reason	Trigger
Waimeha Stream	Erosion	When the channel outlet within the coastal marine area migrates either 250 metres south or 150 metres north of a centre line determined by the training wall adjacent to Field way or the channel outlet creates a vertical scarp in the sand dunes which exceeds 2 metres in height.
	Flooding	When the water level increases 300 millimetres or more above normal river levels as measured at the Field Way road bridge.

Regional Coastal Plan for the Wellington Region: Table 7.1 Trigger levels for river and stream mouth cutting in accordance with Rules 30 and 34		
River	Reason	Trigger
Waikanae River	Erosion	When the channel outlet within the coastal marine area migrates either 500 metres south or 200 metres north of a projected line parallel to the centre line of the groyne on the south bank of the river.
	Flooding	When the water level increases 300 millimetres or more above normal river levels at the Otaihanga footbridge.

The Waikanae River mouth has been known to have been cut eleven times (1930, c. 1938, 1947, c. 1955, 1960, 1971, 1976, 1984, 1989, 1995 and 2001). At the time of application for the current resource consent (WGN 980256) it was estimated that mouth cutting would need to be undertaken every 5 to 6 years on average, however to date there has only been one occasion under the current consent when this has occurred (10 December 2001).

In contrast, the Waimeha Stream mouth has been cut 24 times since March 2000.

4.1.5 Environmental improvement

Environmental improvement within the river corridor is on-going, and includes development of the pathways and trails, footbridges and other community infrastructure, as well as restoration and planting of selected sites. This work is undertaken by GWRC in conjunction with KCDC and community groups. Ecological sites within and adjacent to the river corridor, and areas identified in the Waikanae River Environmental Strategy for restoration with native planting are included in Appendix I and are marked on the aerial photographs in Appendix D. GWRC has programmed $114,000 of works related specifically to implementation of the Waikanae Environmental Strategy between 2013 and 2016 (see Section 10.2.2).

Improvement of the in-river environment is also achieved by the on-going development of good practice by GWRC through better understanding of the effects of works and maintenance activities. In Section 3.12 it is noted that river works and maintenance activities have led to an overall measured increase in the natural character of several reaches of the Waikanae River channel over time.

4.2 Description of activities

4.2.1 Overview

More details of the operations and maintenance activities identified in Section 4.1 above are given in:

- Table 15: Summary of operations and maintenance activities
- Table 16: Description of construction activities
- Table 17: Description of activities involving demolition or maintenance of structures
- Table 18: Description of other works outside the CMA

Photographs of these activities are included in Appendix J.

Further specific details are also discussed in:

- Section 4.2.2 Diversion of water
- Section 4.2.3 Gravel extraction

As noted in Section 1.5, the activities have been assessed overall as having Discretionary Activity status according to the principle of bundling to the highest activity status. It is important to note however that some elements of the activities for which consent are sought are provided for as permitted or controlled activities (either in whole or in part, depending on the scale of the activity) within the regional plans, for example:

- Maintenance and repair of structures
- Extensions of rock rip-rap
- Disturbance of a river bed associated with clearance of flood debris
- Beach recontouring
- Trimming and removal of vegetation including any associated disturbance of the river bed or temporary diversion

It is important to note that the identified methods form the current 'tool box' for GWRC's operations and maintenance works but it is possible that different, more suitable methods are developed in the future. Accordingly, GWRC seeks to ensure as part of this application that the new resource consents that are granted do not restrict the methods to those listed here, but allow for new methods to be used provided that they are first incorporated into the COP via the agreed review process. This may include an initial trial period in selected areas

Table 15: Summary of operations and maintenance activities

Type of Activity	General Description	Typical Individual Components
Construction of "Impermeable" Erosion Protection Structures on & in the river bed	Erosion protection structures are classified as both 'impermeable' and 'permeable' because of the way current rules in the Regional Freshwater Plan for the Wellington Region (RFP) are written, but this is largely arbitrary because some so-called "impermeable" structures are not impermeable in the true sense of the word. 'Impermeable' structures are constructed of hard materials and are generally designed to give long-term protection to the river banks. Structural works involve activities that disturb the river bed (including movement of material, and may involve placement of additional gravel and removal of vegetation associated with formation of access) – all of which require approval under s 13 of the RMA. They may also involve disturbance of the bank edges and berms, and removal of vegetation which requires approval under s 9 RMA. Structural works may also involve temporary diversion of the river channel, and this requires approval under s 14 RMA. Any discharges of sediment from disturbed areas or discharges of water from temporarily bunded zones back to the river require approval under s 15 RMA.	Groynes constructed of rock and/or concrete block and/or gravel Rock linings (rip-rap and toe rock) Gabion baskets Driven rail and mesh gabion walls Reno mattresses Rock or concrete grade control structures

Type of Activity	General Description	Typical Individual Components
	Details of structural works in or on the river bed, including the specific activities that are included in this application are given in Table 16.	
Construction of "Permeable" Erosion Protection Structures on & in the river bed	Permeable structures are of lower structural strength than the 'impermeable' works, and can be semi-permanent in nature or designed as temporary measures giving protection to willow plantings while they are established. Details are included in Table 16. Construction of these structures requires the same RMA approvals as those noted above.	Debris fences Debris arrester Permeable groynes
Construction of other works outside the river bed (on berms and stopbanks within the river corridor)	The construction of new stopbanks or the driving of new culverts under the stopbanks are not included in this application. Works outside the river bed are mostly associated with the development of the paths and trails within the river corridor. New structural works outside the river bed may include new stormwater culverts under trails, small floodwalls, and drainage channels constructed across the river berms to carry stormwater to the river. Minor works associated with management or improvement of the riparian margins are also included, e.g. erection of footbridges and boundary fences. All these activities involve uses of land that require approval under s 9 RMA. Works involving diversion and discharge of water may also require approval under s 14 and s 15 RMA respectively. Details of structural works outside the river bed, including the specific activities that are included in this application are given in Table 16.	Cycleway/walkway construction and associated new stormwater drainage, culverts, footbridges and access ways Fences Floodwalls Shaping of river banks and berms
Demolition and removal of existing structures on & in the river bed	This refers to the permanent removal of erosion protection structures that have served their purpose. The partial demolition of a structure in order to effect its repair or upgrade is covered under maintenance, which is discussed below. Demolition work assumes removal of all material (other than that derived from bed material) from the river bed. Demolition works involve disturbance of the river bed, demolition and removal of material from the bed which all require approval under s 13 of the RMA (shaping of the river banks, vegetation removal, and placement of gravel associated with the formation of access may also be involved). If temporary diversion of the river channel is necessary then approval under s 14 RMA is also required. Any discharges of sediment from disturbed areas or discharges of water from	Demolition by mechanical and/or hand methods Removal of demolition material from river bed

Type of Activity	General Description	Typical Individual Components
	temporarily bunded zones back to the river require approval under s 15 RMA. Details of demolition works in or on the river bed, including the specific activities that are included in this application are given in Table 17.	
Maintenance of existing structures on & in the river bed	This includes the maintenance, repair, replacement, extension, addition to, or alteration of, any existing bank protection structures and outlet structures. Such activities, that disturb the river bed and may involve removal of vegetation and formation of access, require approval under s 13 of the RMA. Any temporary diversion of the river channel requires approval under s 14 RMA. Any discharges of sediment from disturbed areas or discharges of water from temporarily bunded zones back to the river require approval under s 15 RMA. The specific activities included in this application are given in Table 17. (Note that the control of vegetation associated with any structure by the application of herbicide is not included in this application).	Structural repairs and maintenance to: · Existing erosion protection structures in the river bed · Existing culverts and outlet structures that discharge directly to the Waikanae River (including clearance of debris)
Structural maintenance work outside the river bed	This may include intermittent repairs of damage to structural works such as stopbanks that has been caused by flood events, stormwater runoff or vandalism. It also may include repairs, enhancements or extensions to walking tracks and cycleway, and upgrade or repair of any stormwater culverts and drainage channels on the berms. Additionally, excavation of berms to remove silt and gravel deposited by floods and restore the design capacity of the floodway is included. These activities are uses of land requiring approval under s 9 RMA. The specific activities covered by this application, are given in Table 17.	Structural repairs and maintenance to: · Stopbanks & training banks · Flood walls · Stormwater culverts (including clearance of debris) · Stormwater drainage channels · Footbridges located on the river berms · Fences located on the river berms · Banks and berms
Development of vegetative bank protection	Willows are used extensively on the banks alongside the Waikanae River to stabilise and bind the banks and also afford additional protection to structural works. The introduction of any plant material onto a river bed, together with the disturbance of the bed associated with planting works (including the formation of access where necessary) requires approval under s 13 RMA. Works may also involve temporary diversion of the river channel, and this requires approval under s 14 RMA. Any discharges of sediment from disturbed areas or discharges of water from temporarily bunded zones back to the river require approval under s 15 RMA.	Tree Planting Willow layering, cabling & tethering

Type of Activity	General Description	Typical Individual Components
	The specific activities included in this application are given in Table 18.	
Maintenance of vegetative works	This may include trimming, removal, repair and re-cabling of layered or tethered willows, or trimming and additional planting to established willow stands. As noted above, the introduction of any plant material onto a river bed, together with the disturbance of the bed associated with planting works, or mechanical trimming and mulching of vegetation (and including the formation of access where necessary) requires approval under s 13 RMA. Any temporary diversion of the river channel requires approval under s 14 RMA. Any discharges of sediment from disturbed areas or discharges of water from temporarily bunded zones back to the river require approval under s 15 RMA. The specific activities included in this application are given in Table 18. (Note that the control of vegetation by the application of herbicide is not included in this application).	Trimming and mulching of trees (from the river bed) Removal of old trees Removal of damaged structures Additional planting New layering of trees Re-cabling of tethered willows
Channel shaping or realignment	This includes movement of the river bed material by mechanical means – both beach recontouring and bed recontouring (which used to be referred to as "cross-blading"). Machinery used in these operations can include bulldozers, excavators, tractors and dump trucks. It also includes shaping or contouring banks to improve channel profile (as opposed to shaping work associated with construction of specific structures) and reshaping/re-filling of bank edges that have been eroded or damaged. These works involve disturbance of the river bed and possibly removal of vegetation and disturbance of plant and animal habitat, all of which require approval under s 13 RMA. In addition, any temporary diversion of the river channel requires approval under s 14 RMA, and any discharges of sediment from disturbed areas or discharges of water from temporarily bunded zones back to the river require approval under s 15 RMA. The specific activities included in this application are given in Table 18.	Mechanical: · Beach recontouring and ripping · Channel diversion cut · Ripping of the bed in the flowing channel · Bed recontouring · Shaping/recontouring of bank edges
Channel maintenance	This covers activities that remove obstructions (such as vegetation or flood debris) from the channel and bank edges, as well as periodic removal of gravel from the bed. These works involve disturbance of the river bed and possibly removal of vegetation and disturbance of plant and animal habitat, all of which require approval under s 13 RMA. In addition, any discharges of sediment from disturbed areas require approval under s 15 RMA. The specific	Removal of vegetation & sediment Beach scalping Clearance of flood debris Gravel extraction

Type of Activity	General Description	Typical Individual Components
	activities included in this application are given in Table 18.	
Non-structural maintenance works outside the river bed	This includes regular maintenance works on berms or stopbanks such as mowing, and other activities such as riparian planting (with willows or native vegetation). The control of vegetation by the application of herbicide is not included in this application. These activities are uses of land requiring approval under s 9 RMA. The specific activities included in this application are given in Table 18.	Mowing stopbanks & berms (not involving machinery in river bed) Drain maintenance Water blasting Trimming and mulching of vegetation Planting & landscaping
Excavation, disturbance of, and deposition on, beach areas above MHWS water level	During river mouth realignment/erosion control activities, beach areas adjacent to the river channel that lie above mean high water springs sea level may be excavated as part of mouth cutting; such areas may also be disturbed by machinery tracking over them, or by deposition of sand that has been excavated from the foreshore. Because such areas lie above mean high water springs sea level and the active river channel, they may be regarded as lying outside the CMA. This means such activity requires approval under s 9 of the RMA.	Mechanical excavation, disturbance of sand, and deposition of sand and sediment
Urgent works	Any of the above activities that are undertaken in response to a flood or emergency situation and may need to be undertaken under regular methodologies or operating conditions.	
Works in the Coastal Marine Area	This includes: · mouth alignment activities including periodic cutting of a new opening (excavation and redistribution of sand) on the foreshore for the Waikanae River and Waimeha Stream mouths (in response to defined 'trigger points), and · maintenance of existing structures in the CMA. Details are included in Table 19. These activities require approval under s 12 of the RMA. In addition, any associated discharges of sediment from disturbed areas require approval under s 15 RMA.	Excavation of foreshore Movement and re-deposition of excavated material onto the foreshore Maintenance of existing structures (including groynes, training walls, debris arrester)

Table 16: Description of construction activities outside the CMA

Activity	Description	Historical and Likely Quantum	Typical Activity Components
Impermeable Groyne Construction	Groynes are structures that extend from the bank into the river bed and deflect the direction of the flow of water- see photographs in Appendix J. They are designed to slow flow velocities and gravel bed movement in the immediate vicinity of the river bank and hence prevent bank erosion. Impermeable groynes are constructed from impermeable material, such as rock or concrete blocks, and/or gravel. An impermeable groyne may be constructed entirely from rock boulders, or have a gravel or concrete block core. Concrete blocks are typically 1.6 x 0.8 x 1 m and weigh approximately 3 tonnes each. They have no exposed reinforcing steel and have a cast-in lifting eye to allow them to be cabled together. Groynes are typically constructed using a hydraulic excavator to excavate a trench typically 1.0 -3.0 m deep. Rocks (and/or concrete blocks) are placed in the trench and keyed into the adjacent bank to form the base of the groyne. Additional rock is then placed as a capping to shape the groyne. Generally an area of less than 100 m² of river bed would be disturbed in the construction of a groyne.	Sets of groynes are located adjacent to or near: · Sunny Glen (approximately 200 m downstream of SH 1) · Maple Lane (approximately 1 km downstream of SH 1) · Jim Cooke Memorial Park. Typically groynes vary from 350 to 750 tonnes of rock, but smaller groynes (approximately 150 tonnes) may also be constructed.	Remove vegetation if required Formation of access onto river bed (if required). Use excavator to batter bank to specified slope, prepare/contour bed or construct trench. Bulldozer may also be used to form a building platform. Excavate to foundation level Place hard material & filter cloth if required Rock stockpiling on bed River crossings Diversion of water Discharge of sediment
Rock Rip-rap Lining Construction	Rock rip-rap consists of rock boulders placed against a section of river bank to form a longitudinal wall - see Appendix J.	According to GWRC records, approximately 0.4 km (6%) of the right bank and 1.2 km (18%) of the left bank of the Waikanae River within the application area is rock lined. This equates to approximately	Extension of rock rip-rap (and associated disturbance, deposition on bed, diversion of water) – applies to small works.

Activity	Description	Historical and Likely Quantum	Typical Activity Components
	Constructed using hydraulic excavators shaping a section of river bank to a specified slope and excavating a trench in the river bed to a design scour depth. (This may necessitate temporary diversion of the river away from the works area by forming a low bund in front of the work area and dewatering the working area with a pump). Filter cloth or a filter material (usually gravel sourced in-situ) can be placed on the prepared slope prior to placement of the rock in the trench and up the slope batter. A full rock wall typically extends up to a height equivalent to a 2 year return period flood. Toe rock linings are constructed in a similar way but generally are not as deeply founded in the river bed and do not extend higher than approximately 1 m above low flow water levels.	11% of the total bank length within the application area. GWRC records also show that since 1999 only a small amount - approximately 260 m - of new rock rip-rap lining has been constructed (equating to approximately 3,000 tonnes of rock) – see Appendix K for details.	Remove vegetation if required
			Formation of access onto river bed (if required). Use machine to batter bank to specified slope, prepare/contour bed or construct trench. Bulldozer may also be used to form a building platform.
			Excavate to foundation level
			Place rock & filter cloth/gravel if required
			Rock stockpiling
			River crossings
			Diversion of water
			Discharge of water and/or sediment
Gabion basket/ Reno mattress Construction	Gabions are wire mesh baskets (typically 2m x 1m x 1m) filled with rock (either quarry rock or locally sourced riverbed material). They are generally used to provide isolated protection for banks and services such	There are currently no gabion baskets or reno mattresses in the Waikanae River or Waimeha Stream beds; however they are a useful tool in the right situation and as such, could be employed intermittently or occasionally in the future.	Remove vegetation if required
			Formation of access onto river bed (if required).

Activity	Description	Historical and Likely Quantum	Typical Activity Components
	as stormwater outlets, service crossings, bridge abutments or access tracks. Reno mattresses are wire mesh baskets that have wider and thinner dimensions than the more blocky gabions. They are filled with stones or pebbles generally derived from the in-situ bed material but quarry rock may also be used; they can be used for both bank protection and channel linings. Construction involves excavation of a trench at the toe of the bank to a depth of one basket. Baskets are lowered into the trench, and filled with rock, then empty baskets are placed on top laced together and filled to form the required protection structure. Sometimes the baskets are anchored to driven railway irons concealed in the bank. Construction is undertaken in the dry and may thus require temporary diversion of the river away from the works area by forming a low bund in front of the work area; generally dewatering of the working area (with a pump) is not required.		Use machine to contour bank to specified slope, prepare/contour bed or construct trench. Bulldozer may also be used to form a building platform. Place baskets and fill with rock and lace together Diversion of water Discharge of water and/or sediment
Driven Rail & Mesh Gabion Walls Construction	This is a continuous rail-iron founded gabion structure used to protect and stabilise bank edges. Willows are normally planted behind the back irons and over time the willow roots extend through the structure and assist in binding it together, while the willows grow over the works and hide the irons and basket work. Construction involves driving of railway iron piles at 1 m spacings along the inner (river-side) edge of the structure, and typically an iron is also driven 1 – 1.5 m behind these irons at 3 m spacings (to provide a back anchor). Piles normally only extend 1 -1.5 m above low flow level. Longitudinal cables are strung along the	There are currently no gabion walls in the Waikanae River or Waimeha Stream beds; however they are a useful tool in the right situation and as such, could be employed intermittently or occasionally in the future.	Remove vegetation if required Formation of access onto river bed (if required). Prepare/contour bed Form building platform if required Drive piles/posts Place mesh & fill with gravel

Activity	Description	Historical and Likely Quantum	Typical Activity Components
	piles to create a 'fence'. Gabion or chain link mesh is then laid behind the irons and wired to the longitudinal cables. A flap is left at the base to form the bottom of the basket work. Gravels are then placed in the baskets and mesh is usually placed to cap the structure. The main limitation of the work is the difficulty in founding to an adequate depth to avoid scour.		
			Plant willows
			Diversion of water
			Discharge of water and/or sediment
Grade control structure Construction	Grade control structures (either rock or concrete block) are constructed across the width of a watercourse to control gravel deposition with the goal of maintain the river bed level or to protect bridge piles.	There is a rock grade control weir (Kebbells Weir) located in the vicinity of Edgewater Park. There is also a grade control weir located immediately downstream of the SH1 bridge (this is maintained by NZTA). Grade control structures are a useful tool in the right situation and as such, could be employed intermittently or occasionally in the future.	As for Impermeable Groynes
Debris Fence Construction	Debris fences are iron and cable fences that extend from the bank into the river channel. They are used to create or re-establish a willow buffer zone along the edge of the river channel, and so maintain channel alignment. They are are interplanted with willows and afford protection to these by trapping flood debris and slowing flows (and gravel movement). Willows planted in a river bed without debris fences are very vulnerable to flood damage and are much less likely to establish than those planted with fences. Fences are constructed by driving railway iron posts (or similar) 3 -5 metres apart into the river bed in a series of discrete lines generally at a 45º angle from the	Debris fences have been constructed as part of flood protection works at Sunny Glen and Maple Lane on the Waikanae River. They have limited use in the Waikanae River and Waimeha Stream beds, however they are a useful tool in the right situation and as such, could be employed intermittently or occasionally in the future.	Remove vegetation if required
			Prepare/contour bed Form building platform if required
			Drive piles/posts into riverbed
			String cables
			Diversion of water
			Discharge of water and/or sediment

Activity	Description	Historical and Likely Quantum	Typical Activity Components
	channel alignment. The posts stand approximately 1.2 m above the bed. Three to four steel cables are strung through the posts to form the fence - see Appendix XX. It is usually necessary to contour the site with a bulldozer to create a smooth construction platform and also to divert the flowing channel away from the works site. The irons are driven with a hydraulic hammer mounted on a large excavator.		
Debris Arrester Construction	A debris arrester is generally constructed from railway irons, steel beams or pipe that is driven into the bed and tied together with horizontal irons. More robust than a debris fence, it is designed to catch flood debris and prevent it from travelling downstream where it may cause damage to bridges or other structures.	Currently there is a debris arrester on the Waimeha Stream, located immediately downstream of the Field Way bridge (see Appendix J). There are no debris arresters in the Waikanae River. Although used infrequently, debris arresters are a useful tool in the right situation and their suitability for future erosion control will be considered on a case-by-case basis.	Remove vegetation if required Prepare/contour bed Drive steel/timber piles into riverbed Attach horizontal iron rails Diversion of water Discharge of water and/or sediment
Permeable Groyne Construction	Permeable groynes act in a similar way to debris fences but are more robust and give greater control of flow direction. They are used to establish or maintain willow buffer zones. A variety of construction methods have been used in the past; generally timber groynes have been constructed in the Waikanae River. See Appendix J.	Timber groynes are located either side of the rock groynes at Sunny Glen and Maple Lane. There are no immediate plans for any new structures, but they remain a useful tool in the right situation and their suitability for future erosion control will be considered on a case-by-case basis.	As for Debris Fence
Construction works outside of the river bed	These works are mostly associated with development of the river trails and implementation of the Waikanae River Environmental Strategy.		Formation of new drainage channels Construction of cycle ways or walkways, and access ways.

Activity	Description	Historical and Likely Quantum	Typical Activity Components
	Minor works associated with management or improvement of the riparian margins are also included, e.g. erection of footbridges and boundary fences. All these activities involve uses of land that require approval under s 9 RMA. Associated with this work there may be a requirement for new stormwater culverts under trails, and drainage channels constructed across the river berms to carry stormwater to the river. These works also involve diversion and discharge of water requiring approval under s 14 and s 15 RMA respectively.		Construction of flood walls Erection of boundary fences Removal of vegetation Diversion of stormwater drains Discharge of stormwater

Table 17: Description of activities involving demolition or maintenance of structures outside the CMA

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Demolition & Removal of Structures	Structures on the Waikanae River are most likely to be removed following partial or total failure, and a decision being taken not to reconstruct. Removal is necessary to prevent creation or aggravation of erosion of the adjacent river banks, to remove danger to river users, and for visual reasons.	Removal or demolition of structures is not a major activity on the Waikanae River. It is undertaken on an as-required basis. Typically, it might involve one excavator for a few days per year.	Machinery on bed; bed disturbance; demolition & removal of structure from river bed; deposition of material on river bed; disturbance of plant & animal habitat.
Maintenance of 'impermeable' structures (in the river bed)	This work includes repair and maintenance of all existing 'impermeable' erosion protection structures in the river bed noted above. It also includes repair and maintenance of existing head walls, wingwalls, culverts, and steel grilles, flap gates etc. associated with outlet structures.	GWRC records show that since 1998 approximately 3,700 tonnes of rock has been used in maintaining groynes (either in repairing flood damage, or in topping up the rock in the structure); this equates to an average of 263 tonnes of rock utilised in groyne maintenance per year. Between 2000 and 2008 a total of 1745 tonnes of rock has been used to maintain the Kebbells Weir grade control structure. Maintenance of rock lining since 2000 has used a total of 660 tonnes of rock (equating to an average of 47 tonnes per year). See Appendix K for further details. GWRC also maintains (clearing, water-blasting) a few flood flap gates on outlets through the (Left bank) stopbanks at Greenaway Road and Jim Cooke Memorial Park.	Remove vegetation if required Add rock/concrete Rebuild River crossings Diversion of water Discharge of water and/or sediment Water blasting

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Maintenance of debris fence/ debris arrester/permeable groynes	This includes repairs to any damage, and clearance of flood debris build-up as required.	GWRC records show that the Field Way debris arrester (Waimeha Stream) is cleared once or twice a year, on average. Clearance is done either by hand, or with the assistance of a hydraulic excavator as necessary.	Remove debris
			Disturbance of bed associated with removal of debris
			Rebuild
Maintenance of structural works outside the bed	This covers repair and maintenance of all structures within the river corridor that lie outside the river bed, including stopbanks, cycle ways & paths, fences, floodwalls etc. It may include intermittent repairs to structural works (stopbanks, floodwalls, culverts, drainage channels, paths and trails) caused by floods, stormwater runoff or vandalism and enhancements or extensions to such structures.		Repair of stopbanks and berms, floodwalls etc. – recontouring, re-establishment of vegetation.
			Repair of stormwater drainage channels and culverts,
			Repair/upgrade of cycle ways or walkways
			Repair of boundary fences
			Removal of vegetation (i.e. outside of the river bed)
			Diversion of stormwater drains
			Discharge of stormwater
Urgent Works	This covers repair of any bank or bed protection works damaged by a flood event when an immediate response is necessary to protect existing permanent dwellings, network utility structures or flood mitigation structures from imminent threat of erosion. Such work may necessitate working outside normal operating conditions, such as outside usual hours of operation, working in the channel during fish spawning periods etc.	Varies in response to need; driven by flood occurrences. The actual type of work undertaken in response to a flood event will depend on the flood damage that has been sustained; it may include temporary or permanent repairs to structures or banks.	

Table 18: Description of other works outside the CMA

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Establishment bank protection plantings	This involves planting vegetation along the edges of river banks generally within the design buffer zone, in order to bind and support the bank edge and so maintain a stable river alignment. Branch growth also reduces water velocities at the bank edge which assists in erosion protection. Trees may be used to further reinforce structural works. Willow trees are the species considered most suitable for front-line flood protection (i.e. in the design alignment buffer zone). Native species are more suitable for planting outside of the buffer zone. Planting is generally carried out between June and September. Four planting methods are used: By hand, using a crow bar. Willow stakes are cuttings 1 – 1.5 m long and approximately 2.5 cm in diameter. Stakes or poles (i.e. large cuttings more than 3 m long) are usually cut from existing stands. 'Rip planting' using an excavator or planting tine. The tine is dragged through the soil at up to 1 m depth and the stakes/poles or rooted stock planted behind the moving tine. The movable arm of the excavator allows planting to be undertaken on quite steep banks and amongst established trees. This is most commonly used where large areas of planting are required. 'Trench planting' using a digger. Willow poles are planted in a trench dug and backfilled by the excavator. This method is used where willows are planted in very dry areas or immediately adjacent to fast flowing water. Planting using a mechanical auger to prepare holes for stakes or poles. See Appendix J for photographs of these activities.	Currently approximately 3.9 km (55%) of the Waikanae River right bank and 3.6 km (51%) km of the left bank within the application area is willow-lined; this equates to approximately 53% of the total bank length. GWRC records show that between 1998 and 2011 a total of 3071 willow poles and 1230 willow stakes were planted. This equates to an annual average of 219 poles and 88 stakes. See Appendix K for details. Willows are an important and necessary tool for stabilisation and protection of banks will need to continue to be used on the Waikanae River until such time as a more suitable alternative method is developed. It is not currently envisaged that there will be the need for significant areas of new willow plantings. Most planting work is associated with the rejuvenation of existing willow stands.	Cut stakes or poles from existing willows as required. Remove vegetation if required Prepare/contour bed Hand planted poles Rip planted using an excavator Trench planted Re-tethering, cabling, layering Re-planting of willows

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	Tethering (or cabling) involves cutting large willow or poplar trees and laying them in a shallow trench excavated along the bank to be protected. The trees are bundled with wire rope and securely fixed to driven railway irons and/or buried concrete block weights. The base of the trees are covered with gravel to encourage root growth, and willow poles are planted behind the tethered layer. The structure has sometimes been referred to as fascine. Layering is similar, except that in-situ willows are felled (or bent and snapped using a digger) obliquely, generally towards the river in a downstream direction. The intent is to allow the willows to sucker from branches on the ground once they are covered in silt and gravel. The tree is wired to its stump to prevent it breaking off in a flood. Layering is normally completed in the August – September period following completion of planting work.	GWRC records show that between 1998 and 2011 a total of 728 m of layered and tethered willow structures was established in the Waikanae River. This equates to an average of 52 m per year. See Appendix K for details.	Tethered, cabled, layered
Maintenance of vegetative plantings & structures	Maintenance of willow plantings on the river edge would generally involve removal of unstable trees, replanting with new poles, or layering and tethering of mature trees. Mulching is used to rejuvenate old trees; preventing them from getting too large or unstable while maintaining bank stability. Maintenance of existing layered and tethered trees usually involves strengthening by cabling-in additional tree material, and inter-planting with additional poles. If existing vegetative structures (cabled willows & tree groynes) start to show signs of failure a decision may be made to remove them to reduce the potential for them to create a hazard during future floods. This would involve excavation using a hydraulic excavator, and removal from the river bed. Periodic trimming of willows is also required to clear survey sight lines and to maintain access to the river. Clearance may be done by excavator and/or by hand.		Remove, thin, mulch trees using excavator. Re-tethering, cabling, layering Re-planting of willows

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Channel shaping or realignment	Beach recontouring is undertaken in the dry bed, away from the flowing channel. Carried out as a discrete activity, its purpose is to streamline the beaches to avoid any future obstructions to flow. It can also be undertaken as part of site preparation associated with establishment of structures, or in conjunction with bed recontouring. Beach ripping involves dragging a tine behind a bulldozer to loosen the upper surface layer (armour) of the beach; this encourages gravel movement and thus helps to prevent channel distortions and bank erosion.	Beach recontouring and beach ripping are undertaken very occasionally in the Waikanae River. However it is a useful tool in the right situation and will be undertaken on an as-required basis.	Beach recontouring Beach ripping
	Channel diversion cuts are typically undertaken through beach areas, away from flowing water, to create a new low flow channel within the design alignment. Undertaken either as a discrete activity or in conjunction with other works, a diversion cut assists in the establishment and maintenance of a more uniform and better aligned channel form.	Diversion cuts would be undertaken very occasionally in the Waikanae River. However it is a useful tool in the right situation, as it potentially offers a lower impact alternative to bed recontouring, and thus will be undertaken on an as-required basis.	Excavation of new channel across beach
	Ripping in the wet channel involves dragging a tine mounted on a bulldozer through riffle sections of the low flow channel, in order to encourage mobility of the gravels and thus encourage a more uniform channel form.	This activity has not been undertaken in the Waikanae River to date, but forms a new method that in the right circumstances may offer an alternative to, or reduce the need for, more extensive and invasive bed recontouring.	Ripping with a tine in the flowing channel
	Bed recontouring (formerly referred to as 'cross-blading') is mechanical shaping of the active channel to realign the low flow channel so as to reduce erosion (typically at the outside of a bend) or to prepare the bed for construction or planting works. Straightening of the channels increases the hydraulic efficiency of a reach and thereby reduces flood levels. Bed recontouring is done by cutting a new channel through the dry beach on the inside of a bend, leaving a bund at both ends to minimise silt discharges. Excavated material is placed at the outside edge of the new channel. When the new channel is completed, the	To date bed recontouring in the Waikanae has been undertaken as a relatively short-term solution to protect bank edges from further erosion. The channel alignment created by bed recontouring will often remain effective for up to 2 years; however a large flood can reduce the effectiveness at any stage. Hence the quantity of bed recontouring undertaken in any year is very dependent on the occurrence of flood events and	Bed recontouring

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	end bunds are removed, and the excavated material pushed across the old channel alignment to the required finished profile.	the effectiveness of other control measures such as gravel extraction. The largest requirement for bed recontouring will be after flood events. GWRC records show that a total of 2580 lineal metres of bed recontouring ('cross-blading') has been undertaken in the Waikanae River since 1998. This equates to an average amount of 184 lineal metres per year, although the actual amount has varied between 0 m and 500 m per year. See Appendix K for further details. The records show that several of the reaches involved have been worked more than once (i.e. the work tends to be focused in particular areas of interest).	
	Shaping or reconstruction of berm edges will normally occur following flood damage. The river is diverted away from the affected bank, and the bank edge is then rebuilt by placing fill in layers. Fill is generally sourced from a suitable adjacent beach where available; otherwise weathered overburden sourced from a quarry would be used. The intention is to reconstruct the berm to a similar height and alignment prior to erosion. Following reconstruction, the new bank edge will be stabilised by construction of one or more appropriate bank protection works.		Batter/shape banks Repair scalloped areas
Channel Maintenance	Removal of vegetation involves removal of excessive or unwanted willows or other tree species from the channel, so as to minimise potential for blockages during floods, or to prevent dislodged willows re-growing in the channel. Trimming of willows is also required to clear survey sight lines and to maintain recreational access to the river.	Removal of willows is not a major activity on the Waikanae River, and is usually done when machines are present for other works. Typically may involve a machine for a few days once or twice a year.	Removal of vegetation

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	Clearance may be done by excavator and/or by hand. See Appendix J.		
	Beach scalping involves mechanical clearance of woody and herbaceous weeds and grasses from gravel beaches. This is necessary to prevent reduction in flood flow velocities and gravel aggradation. Mechanical clearance is typically performed using a bulldozer, large excavator or front end loader to strip the vegetation and loosen the armouring layer. The vegetation is crushed and left to break down or become light flood debris. The activity involves excavation or disturbance of bed material but does not typically result in a discharge of sediment to the flowing channel.	Removal of vegetation from beaches is done throughout the application area every year, on an as-required basis. Typically this would involve the use of a machine for 3 to 5 days. Other minor areas of vegetation build-up would be removed using an excavator while other work was taking place, e.g. willow planting.	Beach scalping (clearance of vegetation)
	Flood debris is defined in the RFP as 'material deposited on the river bed as a result of wreckage or destruction resulting from flooding', and it can include trees, slip debris, collapsed banks, the remains of structures, and other foreign material including abandoned vehicles, but does not include the normal fluvial build-up of gravel. Removal of flood debris is necessary because blockages reduce channel cross-sectional area which result in higher flood levels. In addition, if allowed to occur, build-up of obstacles may deflect flood flows into banks, causing lateral erosion. Removal of flood debris covers only the minimal amount of work needed to clear the bed or structures within the bed of flood debris; any beach or bed contouring completed at a location where debris removal occurs is accounted for as beach or bed recontouring.	Uprooted trees, large logs and car bodies etc. are removed using an excavator. Smaller debris items and general rubbish are often removed by hand or with the assistance of a 4WD utility vehicle or tractor. This activity is normally undertaken after each significant flood event.	Clearance of flood debris
	Clearance of debris and vegetation from the Waimeha Stream channel. See photograph in Appendix J.	GWRC records show that the upper 'residential' section of the Waimeha Stream is generally hand-cleared, a few times per year. The lower sections of the stream are cleared less frequently (once a year) by hydraulic excavator located on the river	

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
		bank. Debris is loaded onto trucks for disposal away from the river. See Appendix K for details.	
	Gravel bed material is currently extracted from the Waikanae River to maintain bed levels to a design profile within an envelope of maximum and minimum levels. The aim is to maintain a balance between flood capacity (reduced by higher bed levels) and the threat of undermining bank protection works (increased by lower bed levels). Material is excavated from the beaches (i.e. above the active channel) where possible, and from the active channel using the methods discussed in Section 4.2.3.	The amount of gravel to be extracted will be determined in response to the movements in bed material throughout the river system; in particular gravel extraction policy will be determined principally by bed survey data which is collected on a regular basis, as discussed more fully in Section 4.2.3.	Gravel extraction Temporary stockpiling of excavated material on river bed
Maintenance of non-structural works outside the bed	This may include any works required to maintain the stability of the river berms, and general maintenance such as mowing of the river berms. Non-structural maintenance works, such as cleaning /water-blasting of any flood protection structures lying outside the bed, are also included.	GWRC mow river berms between SH1 and El Rancho (both banks) and stopbanks. Mowing is undertaken from the river banks. No mowing is undertaken on the Waimeha Stream banks and berms.	Repair of berms Mowing of berms Water blasting
Disturbance of beach areas above MHWS water level	Any disturbance that takes place above mean high water springs sea level is, by definition, outside the CMA (and the river bed). Disturbance of such areas may occur in association with river mouth cutting/outlet alignment activities. Material excavated from the foreshore may be placed against areas of eroded beach/dunes to assist with the realignment of the river/stream channel and to provide additional erosion buffering. Such activity may necessitate some tracking over the beach by the machinery involved.	See Table 19.	
Urgent Works	This covers repair of any non-structural bank protection works and any bed recontouring after a major flood event where immediate action is required to protect existing permanent dwellings, network	Varies in response to need; driven by flood occurrences, level of damage and the level of risk posed to adjacent assets.	

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	utility structures or flood mitigation structures from imminent threat of erosion. Such work may necessitate working outside normal operating conditions, such as outside usual hours of operation, working in the channel during fish spawning periods etc.		

Table 19: Activities in the CMA

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Excavation of diversion cut through foreshore (and associated deposition on sea bed & diversion of water)	New outlet channels for the Waimeha Stream and the Waikanae River are cut when upstream water levels reach a certain pre-determined trigger level, or when the mouths have migrated beyond pre-determined trigger levels, or (in the case of the Waimeha Stream) the channel creates a vertical scarp > 2m high in the dunes. See photographs in Appendix J. The new alignment is positioned directly downstream of the main river channel. A trench is excavated to form a pilot channel, and the excavated sand is used to block off the active channel. The pilot channel is not connected to the main channel at this stage. This work is undertaken a low tide when the sand is firmer and the machinery does not need to work in water. Water ponds in the upstream channel until the following low tide, when the block in the pilot channel is removed, releasing the ponded water upstream into the new channel. The new channel is then deepened and widened naturally by the river flow. Generally the work would be undertaken with the use of rubber- tired hydraulic excavators, loaders and a dump truck. It would usually be undertaken during low flows and at spring tides when tidal variation is largest. The operation would normally be completed over 24 hours. The methodology is similar for both the Waikanae River and the Waimeha Stream; the scale of works are larger on the former.	The Waikanae River has been cut eleven times historically; one of those occasions (December 2001) was during the term of the current consent. The Waimeha Stream has been cut 24 times since March 2000. It is expected that the frequency with which the rivers will need to be realigned in future will be similar.	Excavation of foreshore Deposition of sand on foreshore Diversion of river channel

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Deposition in intertidal zone of sand	The material excavated during the cutting of a new channel is spread on the foreshore to assist in the realignment of the river outlet and /or erosion control at the outlet.		
Maintenance of existing structures	Maintenance of the mouth groyne(s) in the Waikanae River involves: · Repair to the earth core: topping up with suitable fill and compacting · Repair to erosion of rip-rap armouring by topping up with similar material. Maintenance of the training wall on the right bank of the Waimeha Stream	GWRC work records (see Appendix J) show that maintenance of the mouth groyne is required relatively infrequently; the last work was undertaken to repair flood damage in May 2005. Access to this area is gained via the access road through the Waikanae Estuary Scientific Reserve. In contrast, the rubble mound training wall on the right bank at the Waimeha Stream mouth requires relatively frequent maintenance.	Top-up and repair to groyne (Waikanae River) and training wall (Waimeha Stream) at river mouth Clearance of debris arrester (Waimeha Stream).

4.2.2 Diversion of water

Several of the activities noted in Table 16, Table 17 and Table 18 require diversion of part of the Waikanae River flow. This includes permanent diversion of normal low flows as a result of:

- Construction of new structural works or bank reconstruction
- Bed recontouring
- Gravel extraction

It also may include temporary diversion of normal low flows to allow construction of new works, demolition of obsolete or damaged works and repairs to banks.

4.2.3 Gravel extraction

4.2.3.1 Background

River gravels have been extracted from the Waikanae River bed for over 60 years, and records held by GWRC indicate that extraction undertaken between the 1950's and 1970's in particular caused considerable lowering of the bed. Since development of the WFMP, the aim of GWRC's gravel extraction programme has been to maintain the existing channel capacity of the river at or about the volumes determined by the 1991 bed level survey. GWRC records show that between 1998 and 2012 approximately 65,000 m³ of gravel has been removed from the river channel, principally in the reaches downstream of Jim Cooke Memorial Park (which lies adjacent to XS 260 - XS 300 approximately). To date this has not been sufficient to achieve the objective of returning the river bed to the desired profile.

Since 1998, gravel extraction has been undertaken under two resource consents: WGN 980256(01) which has only permitted extraction from beaches (i.e. from above normal water levels); and WGN 020106 which was obtained to allow additional extraction from the lower Waikanae River over a 5 year period between 2002-2007, to remove the gravel build-up that occurred following the 1998 floods. This extraction was permitted from the active (i.e. 'wet') channel, and was undertaken mainly in the Pukekawa reach – see Appendix D for location. No extraction was undertaken within the Waikanae Estuary Scientific Reserve. The total amount extracted during the 5 year 'wet extraction' consent amounted to 33, 998 m³, while the total extracted under the 'dry extraction' consent to date has amounted to 30,885 m³ (see Appendix K for details).

The amount of gravel to be extracted has been determined from regular bed level surveys and gravel volume analyses, and hence it changes over time. For example; the 1995 gravel analysis resulted in a recommendation to extract 3,000 m³ of gravel annually under consent WGN 980256. Following the 1999 survey it was determined that additional extraction was required, which as noted above, led to GWRC seeking consent WGN 020106 for extraction of a total of 35,000 m³ of material from the active channel in the lower reaches of the river over the next 5 years; this amount was over and above the extraction that was to be undertaken under consent WGN 980256 from the gravel beaches. The 2004 survey results showed that gravel aggradation below Jim Cooke Memorial Park had continued to increase, despite the extraction undertaken, which resulted in extraction volumes undertaken under consent WGN 980256 being increased from 3,000 m³ to 9, 000 m³. Following the 2009/10 survey, recommended extraction volumes under this consent for the following 5 year period have again increased - to 12, 9000 m³ per year.

4.2.3.2 Proposed extraction volumes

The results of the latest GWRC 2009/10 bed survey and gravel analysis have been used to determine the proposed extraction amounts and methodology for the next five year period.

Every year an estimated 6000 m³ of material enters the river system below Jim Cooke Memorial Park, on average; in addition, an estimated 43, 700 m³ of material has built up in this area since 1991. Table 20 gives a breakdown of how this latter gravel accumulation is distributed.

Table 20: Waikanae River – accumulated gravel volumes

Reach	Reach Description	Estimated accumulated gravel volume (m³)
XS 50 – XS 80	CMA boundary to Kokako Rd	11,500
XS 80 – XS 130	Kokako Rd to El Rancho	14,000
XS 130 – XS 300	El Rancho to Jim Cooke Memorial Park	18, 200
Total		43, 700

To return these reaches to 1991 bed levels, all of the accumulated gravel together with the annual input needs to be removed. This would require a one-off extraction operation (referred to as the 'initial gravel extraction operation') in these lower reaches, and then on-going annual 'maintenance' extraction of the gravel entering the upstream end of the zone (particularly between Greenaway Rd XS 200 and Edgewater St XS 380) each year.

To achieve this extraction a range of extraction methods will be needed over the term of the new resource consent, as described below. All works will be undertaken in accordance with the COP; more detail is provided below.

4.2.3.3 Extraction of accumulated gravel (XS 50 to XS 80)

This section describes the proposed methodology for removal of the accumulated gravel that will be applied to the lowest 300 metre tidal reach, upstream from the CMA boundary. This reach is under water for the majority of the time, and so extraction must occur in the 'wet' by necessity. There is a channel form (albeit submerged) that will be maintained through the extraction operation.

Preparatory works

Prior to works commencing, a Monitoring Plan for the initial gravel extraction will be developed to quantify the effects of the proposed works and assess their impacts. It is anticipated that this would involve a comprehensive before/after/control/impact (BACI) survey design, and would include the collection of data relating to water quality (suspended sediment, water clarity, nutrients), deposited sediment (sediment cover and substrate size), habitat quality, and the recolonization of invertebrates and fish.

The most recent cross section surveys will be compared with the design profile and cross sections to determine cut and fill depths and to accurately calculate available gravel volumes.

A detailed Excavation Plan will be prepared for use by the operator(s); it will identify specific actions that will be undertaken to minimise the time that operations in the active channel will occur, and to avoid other adverse effects as far as practicable. It will include directions covering items such as:

- The specific extent of the works for each operational stage. This will include preparation of working plans showing the active channel centre line (thalweg) and an indicative active channel width;

- The extraction methods to be used;
- The machinery to be used;
- Operation timing, taking account of any requirements to manage noise and effect on recreational use, and of the timing constraints shown in Table 6 of the Code of Practice (refer Annex 1);
- Access routes to be used;
- Requirements around plant condition;
- Requirements around repairs and refuelling of machinery;
- Health and safety requirements, including management of public health and safety; and
- A complaints procedure.

In-channel works and gravel removal

This reach of the river is the most difficult to extract from because of fluctuating water levels. For this reason extraction operations will need to be undertaken in the two hours either side of low tide (i.e. generally within a four hour working window on any day).

Waratahs will be used to mark the intended final position of the low flow channel that will remain after the completion of works (where possible).

The material will be pushed from the bed to the channel edges against the bank by one or more D8 or D9 bulldozers. The windrowed material will then be placed directly into a temporary stockpile on the adjacent bank by a long-reach excavator (where location allows), or loaded onto an off-road dumper truck for transport to the stockpile. Figure 12 and Figure 13 show how this operation was undertaken during 2002-2007.

GWRC intends to use the area of adjacent bank immediately upstream of the Otaihanga boat ramp (located at the mouth of Mazengarb Stream) as a temporary stockpile area. Stockpiled material will be left to dry for a minimum of one day before being transported off site via the existing formed access road from the boat ramp that passes through the Waikanae Estuary Scientific Reserve to Makora Road. Any damage caused to this track will be reinstated.

Figure 12: River channel, showing gravel windrowed against bank edges

Figure 13: Extraction of gravel from the tidal reach (XS 60 approximately)
(Note that with reference to Figure 13, the currently proposed methodology does not involve placement of bunds in the river channel as shown, as this method has proved less than optimal in restoring the river channel to a suitable profile).

4.2.3.4 Extraction of accumulated gravel (XS 80 to XS 130)

This section describes the proposed methodology for removal of the accumulated gravel that will be applied to the 500 m reach extending from Kokako Rd upstream to El Rancho.

Extraction from the active channel ('wet' extraction) will also be required in this reach. Works will be undertaken according to a plan that provides for the new low flow channel to be formed beach by beach, to a meander pattern with a pool and riffle form, as extraction proceeds. This method has been used in the Hutt River since 2006, with the intention being to maintain a well-defined low flow channel form that has a 'natural' slope to adjacent beach areas, and well-formed pools and riffles, all of which provide good quality habitat for invertebrates and fish.

Preparatory works

Preparatory works will be generally as described in Section 4.2.3.3 above.

In-channel works and gravel removal

The relatively narrow channel width and limited access in the reach mean that extraction operation will need to be done entirely in the active channel. Entry and exit to the riverbed will be at on the left bank at XS 110.

The works will be undertaken using one or more excavators and off-road dumper trucks. The low flow channel will be deepened by the excavator(s) and material loaded onto the truck(s) for transport to a stockpile area in Otaihanga Domain in the vicinity of the access point at XS 110. Stockpiled material will be left to dry for a minimum of one day before being transported off site via the already formed access road through the Domain to Makora Road (refer to Figure 10 in Appendix D).

4.2.3.5 Extraction of accumulated gravel (XS 130 to XS 300)

This section describes the proposed methodology for removal of accumulated gravel within the 1.7 km reach extending from El Rancho to the upper (eastern) end of Jim Cooke Memorial Park.

Preparatory works

Preparatory works will be generally as described in Section 4.2.3.3 above.

In-channel works and gravel removal

In this reach, a combination of excavator(s) and off road dumper(s) will also be used to remove gravel from the river bed. As with the downstream reach, the low flow channel will be deepened by an excavator and material temporarily stockpiled on the adjacent beach(es) for a minimum of one day. An excavator(s) or front end loader(s) will then be used to load the gravel onto either road truck(s) or off road dumper(s) for transport offsite. During this latter part of the operation the works will take place above normal water levels (except for any river crossings for access or for transport of extracted gravel that may be necessary) and no further re-working of the low flow channel will be required (this is referred to as 'dry extraction' – see Figure 14) . The gravel will be extracted in strips parallel to the river flow, working from the front of the beach to the rear. Small stockpiles of the extracted gravel may be formed on a daily basis, but would not normally be left in the floodway for longer than the working day.

As operations proceed, the beach will be re-contoured to give a smooth finished profile, with a central rise, a downward slope to the low flow channel, and a well-defined water edge (where possible).

Figure 14: 'Dry' extraction from beach above active channel

The extracted gravel will be transported away from site using existing access tracks and/or public roads wherever possible. It is intended that existing entry and exit points to the riverbed at XS 130 and XS 175 will be used. However, in places where direct access to the working area from the bank edge is not available, there may be a requirement for new access points to be formed from the bank edge. If no access is possible from the bank edge, there may be a requirement for river crossing points to be formed and for off road dumper(s) to track within the river bed (see Figure 15). Such crossings will be kept to a minimum, and restricted to a single point of entry and exit.

Likely connections from the haul road to the public road network are located at Greenaway Road and Nimmo Ave. GWRC is also currently negotiating a third access over the Howarth block, which is owned by KCDC and located opposite Jim Cooke Memorial Park.

Figure 15: River crossing with an off road dumper on the Hutt River

4.2.3.6 Extraction of on-going annual gravel input

Removal of the 6,000 m³ of gravel that is estimated, on average, to be transported down the river system and deposited into the aggradational reaches of the river below SH1 will require a combination of 'wet' and 'dry' extraction methods depending on the location and patterns of gravel deposition.

If the gravel is removed from the upper parts of the aggradational zone (i.e. above XS 130 approximately) on an on-going annual basis, then under normal circumstances this should be sufficient to prevent gravel accumulation in the lower tidal reaches of the river. Note however, that large floods may still carry gravel further downstream into the tidal reach on occasions.

4.2.3.7 Timing and duration of extraction works

GWRC currently proposes to undertake the initial extraction operation between XS 50 and XS 300 to remove the gravel build-up in this area as a 'one-off' operation which may need to be

undertaken over a period of up to three years to allow for mitigation of effects on aquatic ecology. Extraction will commence at the upstream end of the area, as this will interrupt the sediment supply to the tidal reach of the river (below El Rancho), and will proceed progressively downstream in stages.

An opportunity exists for this operation to be done at the same time that GWRC is upgrading the Jim Cooke Memorial Park stopbank in the 2016/17 financial year. A further opportunity also exists for the extraction to also be done in conjunction with the New Zealand Transport Agency (NZTA) in the construction of the Mackays to Peka Peka Expressway, which has commenced.

It is assumed that the machinery described in the preceding Sections 4.2.3.3 to 4.2.3.5 would be able to move approximately 400m^3 per day (over a four hour period) in the lowest tidal reach, and approximately 600 m^3 per day (over an eight hour period) in the more upstream reaches. An indicative estimate of the time taken to complete the proposed extraction operation on this basis is shown in Table 21.

Table 21: Indicative time to complete initial gravel extraction operations

Reach	Volume to be removed (m^3)	Approximate extraction volume per day (m^3)	Hours per day	No. of days/weeks (based on 5 working day week)
XS 50 –XS 80	11,500	400	4	29 days; 6 weeks
XS 80 – XS 130	14,000	600	8	23 days; 5 weeks
XS 130 –XS 300	18,200	600	8	30 days; 6 weeks
			Total time for 'one-off' extraction	82 days; 16 weeks
Above XS 130	6,000 per year (average)	600	8	10 days; 2 weeks per year (average)

The figures show that the 'one-off' extraction of the gravel build-up could take up to 82 days, or approximately 16 weeks to complete, if it were assumed operations were undertaken on week days only and there were no delays. On-going annual extraction would require an average of 2 weeks per year; however the rates of inflow of gravel depend on the size and frequency of flood events meaning that it would be possible that in some years no extraction might be undertaken, while in others extraction might take longer than 2 weeks.

Unfavourable weather conditions, tidal conditions (in the lowest reach), and delays due to unavailability of personnel, machinery or other operational factors would all increase extraction times. If additional machinery were utilised, and/or hours of operation extended, then the estimated extraction times could be decreased. If the gravel were to be used for one of the projects identified above, it is likely that the extraction period would be shortened.

It should also be noted that the times in Table 21 apply to the shifting of bed material within the river bed to the channel sides and removing the gravel from the bed to stockpiles on the river bank. This means that the total amount of time that machinery would operate in the active channel would be less that the times indicated. In addition, removal of material from stockpiles on the river banks or elsewhere outside the river corridor could be undertaken over a longer time-frame.

4.3 Design of work programmes

4.3.1 Gravel extraction programmes

Following each five yearly riverbed survey, GWRC produces a detailed gravel analysis report that includes recommendations for:

- Management objectives specific to each river reach
- Available volumes, which are determined by comparing the actual mean bed levels (MBL) with the OBL
- Priority reaches
- The appropriate extraction methodology

These recommendations then form the basis of the gravel extraction programmes for the subsequent years until the next riverbed survey.

Gravel extraction is generally undertaken by contractors. In recent times, GWRC has extracted gravel for its own purposes where there is a defined need (e.g. construction of new stopbanks), however the council relies heavily on gravel contractors to extract material from the river in order to minimise costs. The availability of contractors wishing to remove and process the gravel material, and limited access arrangements are further factors which determine the volume of material that is actually extracted for flood management purposes.

Contractors who have undertaken extraction in the past, and are likely to continue to do so in future include Garry Holland Earthmoving Ltd and Mills Albert Ltd.

4.3.2 Other works programmes

The specific type of work chosen will depend on the nature of the problem at a site and river engineering design criteria such as channel width, flow velocities and channel alignment, the width of berm to critical assets including stopbanks and services, cost versus benefit, available budget and environmental considerations.

Soft-edge works are cheaper than hard-edge works but afford a lower level of protection and require time to establish before being effective. Construction of structural works at an early stage may avoid the necessity of more extensive works at a later stage, or reduce the requirement for repeat in-channel works with consequential reductions in overall cost and environmental impact.

Costs of permanent works can vary from $5/m^2$ for willows, $7,000 to $11,000 for a typical debris fence[21] and from $1,500 to $3,000 for rip-rap lining[22]. New structural works will typically be constructed where existing willow protection is repeatedly failing, or where existing structural works have failed and repair is neither adequate nor appropriate.

A range of structural options is required to ensure the optimal option (based on consideration of the factors above) is used at each particular site.

GWRC undertakes a formal annual inspection of all infrastructural assets and assign a condition rating of 1 to 5 to each asset (1 being highest). From this inspection, the annual work programme is derived; the work programme notes ongoing maintenance activities (mowing etc.) and the work required to improve those assets with low condition ratings.

[21] Based on 2013 GWRC rates of $366/m and a typical length of 20-30 m.
[22] Based on 2013 GWRC rates of $123/tonne and a volume of between 12 - 25t/m.

5 Consideration of Alternatives

5.1 General

Alternatives to the proposed activities can be considered at a number of levels. On a broad scale, the consequences and unacceptability of doing nothing, and the consideration of the extent and type of flood protection works that should be adopted in the Waikanae River and Waimeha Stream are issues that have already been addressed by the community through the development of the WFMP. It is not proposed to re-consider these issues further in this application.

In addressing the more specific issue of alternatives to the individual activities that are proposed, it is relevant to note that the types of activities undertaken in the river have changed, and will continue to change, over time in response to different management philosophies, available technology, experience of what does and does not work at a practical level, and increasing understanding of the river system and the effects of activities. The evolution of the current flood protection scheme as a whole also influences the types and the relative amounts of works that are required on an on-going basis.

The works and activities proposed in this application form a suite, or 'tool-box', of techniques to address and implement the objectives of the WFMP, and are based on current good engineering and environmental practice. This has been formalised into an updated COP (which is still under development). The Code provides specific details of the methods of undertaking each of the identified activities, together with agreed restrictions around their use.

The availability of a 'toolbox' of methods enables river managers to select the most suitable method or methods to address a particular issue, taking into account:

- the urgency of the work and consequences of not undertaking it
- the degree of digression of the channel from its design alignment and/or desired plan form
- the values associated with the specific site and the river as a whole
- the environmental effects of the work and available alternatives to achieving the desired outcomes

River managers undertake such assessment, and consideration of alternative methods, in the development of all work plans.

5.2 Specific matters

Two matters that have been specifically questioned as to their need or otherwise are the use of willows for river protection work, and the need for gravel extraction.

Willow planting

Willow planting forms an essential part of current river protection work nationwide. Willows are easy to establish, grow rapidly and form an intricate root system that is ideal for binding and strengthening river banks and structural measures such as permeable groynes and debris fences. Generally, the same results cannot be achieved using native species. This means the most realistic alternatives to willows are likely to be structural works (e.g. rock lining), which involves higher costs and arguably increased environmental impact.

It should be noted that GWRC uses sterile cultivars in all willow planting so that the issue of wilding plants becoming established in the river bed is minimised (although willow debris is still able to re-establish vegetatively on exposed beaches if left unchecked).

Once established, the presence of willows along a river bank contributes to the available aquatic habitat, by the provision of sheltered habitat within the tangle of roots binding the banks, the provision of shade by overhanging branches and by the input of leaf matter into the water.

This report has noted that the willow plantings along the Waikanae River are now relatively well established, and work involving willows by GWRC into the future is expected to be largely focused on maintenance and renewal of these plantings. In addition, on-going plantings of native trees and other restoration of ecological areas within the river corridor will add to and enhance the natural biodiversity of the area over time.

Gravel extraction

Gravel needs to be extracted from the Waikanae River because of the continuous supply that is carried from the bed and banks of the upper catchment and deposited in the lower reaches of the river, leading to aggradation of the river bed in these reaches. Although fine sediment is carried by the river into the lower reaches and deposited in the estuary, and then scoured and washed out to sea by flood flows on a relatively regular cycle, it is thought that even large flood flows may be insufficient to carry gravel material through the estuary area and out to sea. This is despite such flood flows (10 to 20 year return period) being capable of naturally eroding a new channel to the sea at the river mouth.

At present the limit of the gravel deposition zone is located at or about XS 50. Without any further gravel extraction, river bed levels within the depositional zone of the river (i.e. mostly downstream of XS 380) could be expected to continue to rise, and gravel is likely to continue to migrate slowly downstream into the estuary area. The effects of rising bed levels would include:

- Reduction of channel capacity for flood flows
- Increasing amounts and frequency of material deposited on berms
- Increase in the risk of berm and bank edge damage and channel avulsion23

The effect of continued gravel migration into the estuary is less certain, but GWRC considers that it could result in a wider, less stable river channel at the river mouth and possibly higher water levels during floods (which would affect both neighbouring residential areas and the wetlands of the Waikanae Estuary Scientific Reserve). It would also be likely to armour the finer sediments currently within the estuary, which would have a large impact on the type of habitats currently available for estuarine biota.

In addition, the increased flood risk arising from the reduced channel capacity would require that either the community accepted a diminishing standard of flood protection over time, or committed to on-going costs of increasing the size and extent of structural flood defences (such as stopbanks). Dealing with the effects of increased deposition on berms and increased berm and bank damage would require a more intensive annual river management regime, which again would involve higher costs to the community. It should also be noted that adoption of such an approach would be unsustainable in the long term, as eventually the river bed would end up elevated above the surrounding floodplain. This could result in a catastrophic flood in the surrounding area if the stopbanks were breached.

[23] Avulsion refers to the sudden abandonment of a channel by the river and formation of a new channel.

6 Assessment of Environmental Effects

The proposed works give rise to a range of actual and potential effects (both positive and negative) on the community and the established natural ecology of the river environment. Some effects will be relatively short-lived while others have longer term consequences.

Positive effects are discussed in Section 6.1. Adverse effects are identified and summarised with reference to individual activities in Sections 6.3 to 6.15.

6.1 Positive effects

The principal positive effects of the proposed works as a whole include increased security from the risks of flooding and flood damage for the Waikanae community. This includes increased personal safety, lowered risk of property damage or loss, lowered risk of insurance claims and costs and lowered risk of disruption to lives and economic activity. This is a very significant and important positive effect and without it the long term economic well-being of communities living in the Waikanae River floodplain would be seriously jeopardised.

In relation to positive effects on the natural environment, the Department of Conservation has noted (in the Wellington Conservation Management Strategy) that river management works help to retain the natural elements of the Waikanae estuary and adjacent wetland. For example, periodic cutting of the Waikanae River mouth help to reduce erosion at the southern end of the reserve, and reduce flood levels in the surrounding land. In addition, extraction of gravel from the upstream river channel prevents gravel deposition over the fine sediment habitats favoured by wading birds in the estuary. In-river works such as bed recontouring and gravel extraction may be undertaken in a manner that results in a more 'natural' river meander pattern with associated pools and riffles that provide improved habitat complexity and quality for aquatic ecology over time.

6.2 Discharge of sediment

6.2.1 In-river works

Activities that involve the movement or excavation of river bed material within flowing water (including, but not limited to, bed recontouring and wet gravel extraction) will cause discharge of natural fine bed sediments into the water column. The sediments are the same or very similar to those that occur naturally in the water column during natural flood events. The main difference is that the discharge from works activities is likely to occur at times of low flow when the suspended solid load of the water is also low and the ability to quickly transport sediments through the river systems is reduced..

The nature of the sediment discharge will depend on whether the sediment is derived from recently reworked gravels (i.e. gravels that have been disturbed and re-deposited by flood events in the channel), or from disturbance of older alluvial bank materials comprising gravels with a silt/clay matrix.

Measurements of turbidity and suspended solids were taken in association with the GWRC 2012 Hutt River gravel extraction programme upstream of Kennedy-Good Bridge (which was undertaken from 26 November 2012 to 19 December 2012). Approximately 16,000m^3 of gravel was extracted from a river length of approximately 300m (XS 720 – 750), (which was less than the 1400 m river length between XS 720 and 860 as originally planned). The activity was undertaken by two bulldozers which pushed the gravel up onto a beach for later removal by off road dumper or road truck. The truck crossed the river at several locations. The results of the water quality monitoring are summarised in Table 22. They show that maximum turbidity and suspended solids

values of 306 NTU and 207 mg/L respectively, were recorded in the river during bulldozer operation.

Table 22: Turbidity and suspended solids (SS) monitoring results for the Hutt River during gravel excavation by bulldozer in flowing water 500m Upstream of Kennedy Good Bridge on 28 November 2012

Time*	Bulldozer activity	Upstream		100m Downstream		500m Downstream	
		Turbidity (NTU)	SS (mg/L)	Turbidity (NTU)	SS (mg/L)	Turbidity (NTU)	SS (mg/L)
16:10	Excavating gravel from river	6	1	175	90	47	29
16:35	Excavating gravel from river	5	2	306	207	102	51
17:00	No activity (work ceased at 17:00)	6	1	52	180	84	100
17:35	No activity	4	1	13	72	64	17
18:00	No activity	5	1	7	1	8	1

*Sampling commenced at the upstream site followed by 100m and 500m downstream over a 15 minute period.

Source data from Geotechnics Ltd

Table 23 summarises the results of turbidity and suspended solids monitoring undertaken during repeated truck crossings of the Hutt River at the same location. Truck crossing activity was shown to cause turbidity and suspended solids increases of up to 16 NTU and 2 mg/L respectively.

Table 23: Turbidity and suspended solids monitoring results for the Hutt River during truck crossings of the river 500m Upstream of Kennedy Good Bridge on 28 November 2012

Time	Truck activity	Upstream		100m Downstream	
		Turbidity (NTU)	Suspended solids (mg/L)	Turbidity (NTU)	Suspended solids (mg/L)
15:40	Prior to crossing river	1	1	6	2
15:48	Truck crossing river (1)	-	-	17	4
15:52	Truck crossing river (2)	-	-	5	2
15:54	Truck crossing river (3)	-	-	8	3
15:56	Truck crossing river (4)	-	-	12	2
15:58	Truck crossing river (5)	-	-	4	2
16:00	Truck crossing river (6)	-	-	7	2
16:02	Post crossing river	1	1	7	3

Source data from Geotechnics Ltd

The results confirm earlier observations that water clarity returns to near ambient levels rapidly, often within 1 hour of the activity ceasing. This is an important result because it indicates that even during an intense period of in-stream channel works the aquatic biota downstream would have the benefit of normal water quality for at least half of each 24 hour period.

These latest results indicate lower values than those previously recorded by GWRC for the Hutt and Waikanae Rivers (see Table 24 which indicates that bulldozer channel shaping could generate suspended solids concentrations as high as 690 mg/L). Cameron (2015) notes that suspended solids concentrations as high as 780 mg/l also occur during a one year return period flood (in the Hutt River). For smaller more frequent flood events, i.e., those occurring three to four times each year, suspended solids concentrations typically fall in the range 100 to 400 mg/l.

Table 24: Suspended solids concentrations in Waikanae River below works

River	Activity	Suspended solids concentration in river (mg/L)		
		Background	Downstream (100m)	Downstream (300m)
Hutt	Channel shaping	2	480	-
	Bulldozer crossing river	2	130	-
	High river flow event (410m³/s @ Birchville on 19/11/96)	780	-	-
	High river flow event (160m³/s @ Birchville on 8/10/2007)	397	-	-
	High river flow event (80m³/s @ Birchville on 5/2/2013)	65	-	
Waikanae	Placement of rip-rap	<2	98	68
	Truck crossing	<2	<2	11
	Thalweg cutting by bulldozer	<2	690	160

Source: GWRC 1998 data.

Recent monitoring of water quality variables during channel realignment in the Hutt River at Belmont showed that, in addition to elevated levels of suspended solids, the discharge plume contained elevated levels of total nitrogen and total phosphorus. There was, however, no corresponding increase in dissolved nutrients in the water column indicating that the nutrients were bound to particulate matter (Cameron, D, 2015). The river bed disturbance is therefore unlikely to have stimulated periphyton growth because the nutrients were not present in a form that could be readily taken up by aquatic plants. The particulate material in the discharge plume may also harbour microbiological contaminants, but the results of the Hutt River study indicate that any increase in indicator bacteria in the water column is likely to be intermittent and localised (Cameron, 2015).

In summary, the available data indicate that:

- River crossings by dumper trucks generate relatively low suspended solids concentrations, from 2 to 10 mg/l above background; this would apply to all machinery (other than bulldozers) required to do river crossings
- River crossings by bulldozer can increase river suspended solids concentrations by 130 mg/l
- Channel shaping by bulldozer can increase suspended solids concentrations by nearly 700 mg/l
- Suspended solids and turbidity levels return close to ambient levels rapidly, typically within 1 hour of the activity ceasing
- The discharge plume may also contain elevated levels of total nitrogen and total phosphorus, but monitoring undertaken in the Hutt River indicates that these nutrients are bound to particulate material and that there is no associated increase in water column concentrations of dissolved nutrients (and therefore little risk of stimulating excessive algae growth)
- A moderate fresh (with no river works) can increase river suspended solids by over 700 mg/l

6.2.2 Drain Clearance

The clearance of silt and debris from drains and culverts has the potential to generate minor amounts of suspended sediments. This is expected to occur over a relatively short period of time.

6.2.3 Earthworks outside the river bed

Earthworks undertaken on the banks and berms, such as repairs to stopbanks or trails, and excavations associated with lowering of berms also have the potential to generate stormwater runoff containing suspended sediment.

6.3 Construction of impermeable erosion protection structures

6.3.1 Groynes

Sets of groynes are located upstream of Sunny Glen (XS 410 approximately), and near Maple Lane (XS 345 approximately) and Jim Cooke Memorial Park. GWRC records (see Appendix K) show that although some of these groynes have been re-built since 1998, no new groynes have been constructed since this time. This indicates that construction of groynes can be regarded as an infrequently occurring activity on the Waikanae River. There are no groynes on the Waimeha Stream.

Short term effects

Construction requires excavation and disturbance of the bed material and creates a localised temporary increase in suspended solids concentrations, possibly by as much as 100 mg/L immediately downstream of the works area. Cameron (2015) notes that a suspended solids concentration of this order would cause a sharp reduction in water clarity and would be clearly visible from the bank. It would, however, be less than that generated by a moderate fresh in the river, as discussed in Section 6.2. Monitoring that has been undertaken recently in gravel bedded rivers has confirmed that suspended solids concentrations return rapidly to ambient levels once the in-stream activity ceases. Therefore, the maximum continuous duration of a discharge plume generated by in-stream channel works would be little more that the length of a working day; the aquatic biota would have the benefit of normal water quality for at least half of each 24 hour period. Mechanical disturbance of the bed would disrupt the macroinvertebrate community within the immediate works area and may cause some mortality of smaller fish which seek shelter within the substrate, but these effects are likely to be relatively minor. Trout and other large fish are more likely to move away from the disturbance and so are less likely to be harmed. It considered that these conclusions can be applied to the Waikanae River as well.

Other potential short term effects of groyne construction such as disruption of nesting birds inconvenience to recreational users of the river or river banks and noise intrusion in the neighbouring community are anticipated to be less than minor, and can be adequately avoided or mitigated through adoption of appropriate practice and timing of works. This is outlined further in the COP.

Long term effects

The purpose of rock groynes is to alter the river flow pattern to protect the river banks at that location from erosion. To ensure that further erosion problems are not generated downstream of the new structures in the long term, comprehensive engineering design is undertaken prior to construction.

Cameron (2015) notes that rock groynes may increase the morphological complexity of the river particularly if they are constructed against what was previously an eroding bank. This often results in deep pools associated with the toe of the structure, and water sheltered from the current downstream of the structure. The combination of fast water, sheltered water, deep pools and large crevices amongst the boulders can potentially provide a variety of habitat for both native fish and trout. Perrie (unpublished draft) recently recorded seven native fish species, brown trout and shrimp in deep water habitat associated with groynes on the Hutt River near Kennedy Good

Bridge. A recent Fish & Game NZ survey shows that trout numbers through the same reach were relatively high, and that many were located in deep holes associated with the rock groynes. Taking this into account, it was concluded that rock groynes have the potential to enhance some forms of fish habitat and that the overall effect of such structures on native fish and trout populations in Wellington's western rivers is likely to range from neutral to positive.

6.3.2 Rock lining

GWRC records for the Waikanae River indicate that approximately 11% of the total bank length within the application area is rock lined, with the majority of this occurring on the left bank. Of this, only a small amount, approximately 260 m has been constructed since 1999 (see Appendix K). This indicates that construction of rock lining can be regarded as an infrequently occurring activity on the Waikanae River. There are no rock lined banks on the Waimeha Stream.

Short term effects

Construction of a trench and placement of rock would include disturbance of bed materials and a localised increase in suspended solids concentrations. (Cameron, D, 2015) notes that short term effects on water quality and habitat quality are likely to be similar to those described for the construction of rock groynes in the previous section.

Similarly, mechanical disturbance of the bed will disrupt invertebrate habitat and may cause some mortality of smaller fish which seek shelter within the substrate. The extent of this disturbance would depend on the quantum of rip-rap to be constructed and the type of habitat which is being replaced. The overall significance of this effect needs to be considered in the context of the total area in which it occurs, which is relatively small.

Other potential short term effects of rock lining construction such as disruption of nesting birds inconvenience to recreational users of the river or river banks and noise intrusion in the neighbouring community are anticipated to be less than minor, and can be adequately avoided or mitigated through adoption of appropriate practice. This is outlined further in the COP.

Long term effects

Cameron (2015) notes that the longer term effects of rock rip-rap lining are likely to be site specific. Bank contouring could destroy valuable fish habitat beneath undercut banks or overhanging vegetation, and placement of boulders against the bank may reduce the availability of deep water habitat for larger fish. However, in other instances, where deep water is maintained against the toe of the rock rip-rap lining, protruding boulders and those which have worked free might potentially provide feeding lies for trout and shelter for other fish species. Crevices between boulders may provide shelter for small and in some cases larger fish. The establishment of vegetation amongst the rock lining has the potential to provide overhanging cover, which may improve fish habitat, although GWRC staff have advised it may also generate potential terrestrial weed management issues.

Cameron (2015) considers that overall this activity would appear to have a neutral to negative impact on aquatic ecology at any specific location, depending on the extent of undercut banks and/or the net loss of overhanging vegetation. It is important to note in this context that recent surveys of native fish and trout numbers in the Hutt River at Belmont where river banks are extensively lined with rip-rap indicate a relatively diverse and abundant fish fauna exists despite the potential for such adverse effect. (No comparable data is available for the Waikanae River but it is expected the effects might be similar).

Rock lining does alter the visual appearance of the river channel, and can make it appear less 'natural'. This can be mitigated to a reasonable extent by the choice of appropriate rock material

compatible with the existing river bed material, and by establishment of appropriate vegetation behind the rocklines.

6.3.3 Other structures

Construction of other impermeable erosion protection structures including gabion baskets, reno mattresses and driven rail and mesh gabion walls involves the same basic components and similar types of effects as outlined above for rock linings. Some excavation or disturbance of riverbed material is required in preparation for construction, and the finished structure will generally result in some loss of channel complexity. This may include some loss of fish habitat, particularly if the structure is replacing an undercut bank or dense overhanging vegetation. However, in other instances erosion protection structures may enhance channel complexity and create new habitat for fish. Given the relative infrequency with which these works are undertaken in comparison to rock lining, the overall impact of these works in terms of the total affected area is considered to be much less than those associated with rock lining.

Construction of rock or concrete grade control structures would also include minor, localised riverbed disturbance, and in the longer term could have the potential to impede fish passage and present an obstacle to recreational users. This can be avoided or mitigated by making suitable provision for these matters in the design of the structure. This is outlined further in the COP.

6.4 Construction of permeable erosion protection structures

This category of structure includes debris fences, debris arresters and timber groynes. These structures are used relatively infrequently in the Waikanae River (see Table 16 for details). There is one sole debris arrester at the Waimeha Stream mouth.

Short term effects

Construction would involve localised diversion of the river and disturbance of the river bed by mechanical shaping and preparation of the site. The initial diversion of the river flow away from the works area would result in the discharge of suspended sediment into the flowing river, causing elevated turbidity and suspended solids levels, probably in the upper end of the range as discussed in Section 6.2. However the diversion would typically be completed quickly, usually within a matter of hours, after which the works are undertaken mostly in the dry, with minimal effects on river water quality.

Mechanical disturbance of riverbed materials would disrupt invertebrate habitat and may cause some mortality of smaller fish which seek shelter within the substrate. The extent of this disturbance would depend on the size of the structure and the type of habitat that is affected. Based on the total amount of river bed that would be affected the overall potential impact would generally be expected to be relatively minor.

Long term effects

The maintenance of debris arresters may cause a temporary release of sediment and other material into the stream, but any discharge is likely to be of short duration and is unlikely to have any lasting adverse effect on downstream aquatic biota.

Over time these structures work to trap flood-borne debris, which can provide sheltered habitat for juvenile and larger fish. However, as periodic clearance of debris is required to maintain the structure and prevent the accumulation of large obstacles in the flood channel, this may counter this positive effect to an extent. (Cameron, D, 2015) notes that on balance these structures would appear to have a positive to neutral effect on aquatic habitat and fish.

Other potential adverse effects on recreational users and the amenity values of the river arising from these structures are considered to be less than minor.

6.5 Construction of works outside the river bed

The construction of cycle ways, walkways, fences, drainage channels and other minor works outside of the river bed (on berms and stop banks within the river corridor) are unlikely to have any direct effect on water quality or the aquatic ecology of the rivers, provided that appropriate control of stormwater runoff from any areas of earthworks is undertaken. This would include undertaking works in accord with the Erosion and Sediment Control Guidelines for the Wellington Region (Greater Wellington Regional Council, 2006). All other short-term effects associated with this type of construction work are expected to be less than minor. In the long-term, these works contribute to the development of the river corridor as described in the Waikanae River Environmental Strategy, which will have overall positive benefits for the local and wider community.

6.6 Demolition and removal of existing structures

Cameron (2015) notes that the effects of demolition and removal of an existing structure on water quality aquatic ecology will be site specific, depending on the type of structure and its location, and that the magnitude of these effects could be expected to fall within a range up to and including those described above for the construction of those structures. Generally structures are only removed if they have been damaged and/or have become redundant because of changes in the river channel. The removal of such structures reduces the health and safety risk to river users, as well as reducing adverse visual impacts.

6.7 Maintenance of structures on the river bed

Any potential adverse effects associated with the repair, replacement, extension or alteration of existing structures on or in the river bed will depend on the type of structure, its location and the extent of the works required. The magnitude of these effects could be expected to fall within a range from less than minor, up to and including those described above for the construction of those structures.

6.8 Maintenance of works outside the river bed

Since these works occur outside the bed of the river there is little potential for them to have an adverse effect on the river water quality or aquatic ecology, provided that appropriate control of stormwater runoff from any areas of earthworks is undertaken.

Potential short-term adverse effects on recreational users and the neighbouring community of these activities are expected to be less than minor, and the long-term effect is to contribute to the development and maintenance of the river corridor, which will have overall positive benefits for the local and wider community.

6.9 Establishment of vegetative bank protection

6.9.1 Willow planting

Currently over half of both the left and right banks (51 % and 55% respectively) of the Waikanae River within the application area are willow-lined. It is not envisaged that there will be a need for significant new plantings; future work will largely be focused on maintenance and renewal of current plantings.

Short term effects

As willow planting works are undertaken in the dry, the effects of construction on water quality and aquatic habitat are expected to be negligible, as noted by (Cameron, D, 2015).

No significant river bird nesting habitat or breeding pairs of river nesting birds have been identified in the Waikanae River, so the potential for adverse effects on these is less than minor. Potential short term effects on any other species of roosting birds are also expected to be less than minor.

Similarly, effects on recreational users and the neighbouring community are expected to be less than minor, and can be easily mitigated by the adoption of appropriate good practice (such as communication with affected parties prior to commencement of works, and confinement of operations to agreed working hours). This is outlined further in the COP.

Long term effects

According to Cameron (2015), planting and layering for edge protection can benefit the aquatic ecology of the river due to the creation of shade, cover and the supply of woody debris. He notes that on the other hand, it is also recognised that use of willow plantings and other bank protection methods to train and hold the river channel in a design alignment could result in restriction or reduction of habitat diversity unless the design alignment also provides for preservation of habitat diversity through a number of deliberate measures.. He concludes that on balance vegetative bank edge protection is expected to enhance some forms of fish habitat and the overall effect on native fish and trout populations is likely to be positive.

Willows may provide roosting habitat for river birds such as shags, however (McArthur N. P., 2013) notes that planting of poles on previously open gravel beaches may lead to the loss of potential river bird roosting and nesting habitat. This is not expected to be an issue of significance in the Waikanae River, as significant new plantings are not anticipated.

The historical introduction of willows (a non-native species) along the river margins has reduced the natural biodiversity of the river ecosystem. This issue is difficult to avoid since the erosion protection results that can be achieved via the use of willows as front-line river bank protection cannot be replicated with the use of native species. However, the reduction in biodiversity is offset by two important factors:

a GWRC does not plan to significantly extend the total area of willow plantings in the river corridor in future.

b GWRC also undertakes planting of native trees and restoration of selected natural areas in the river corridor in accordance with the objectives of the Waikanae River Environmental Strategy. This contributes significantly to the increase in biodiversity values of the river corridor.

6.9.2 Maintenance of vegetative works

Maintenance of willow plantings include removal of old trees, replanting, or layering and tethering of existing trees. It also includes periodic trimming of willows to clear survey sight lines for channel maintenance or realignment work, and to maintain recreational access and visual connection to the river (in accordance with the Waikanae River Environmental Strategy). Records in Appendix K show that an average of 219 willow ‘poles’ and 88 ‘stakes’ have been planted annually since 1998, and approximately 52 lineal m per year of tethered willows/tree groyne construction has been undertaken on average over the same time.

Short term effects

The short term effects of maintenance work is expected to be negligible, however the removal of old trees may result in the immediate loss of fish habitat.

Long term effects

Cameron (2015) notes that willow layering for edge protection can benefit the aquatic ecology due to the creation of shade, cover and the supply of woody debris to the river. Willow trunks layered over the bank into the channel may provide many opportunities for cover for eels and other fish species. On the other hand the removal of trees may result in the loss of good quality fish habitat. While re-planting would normally be undertaken following tree removal, there may be a delay of 10 to 15 years before the full benefits of riparian planting on aquatic ecology are realised. In practice however new willow lines are often established behind existing willows several years before front line willows are removed. This allows for newer willows to become established before removing old trees, thus reducing potential adverse effects.

Massey University students, supervised by Dr Mike Joy, have been monitoring fish numbers in a reach of the Waitohu Stream where willow removal was undertaken, and follow up monitoring after the event is proposed. The monitoring results, when available, might provide useful information on potential effects of this activity and/or provide guidance for future monitoring.

In relation to other long term effects, maintenance and rejuvenation of willow plantings contributes to the implementation of the Waikanae River Environmental Strategy by enhancing and maintaining the visual amenity values of the river corridor.

6.10 Channel maintenance

6.10.1 Removal of woody vegetation

Willows or other tree species may be removed from the channel, so as to minimise potential for blockages during floods, or to prevent dislodged willows re-growing in the channel. Short and long term effects are as described for willow maintenance work (Section 6.9.2). They may include reduced habitat heterogeneity, and the addition of wood and carbon sources to the river.

6.10.2 Removal of aquatic vegetation and silt

GWRC undertakes regular clearance of aquatic macrophytes (aquatic weeds) and silt from the Waimeha Stream to maintain channel capacity. High densities of these plants can increase sediment deposition, reduce channel capacity and increase the risk of flooding of the surrounding land. The 'residential' upper reaches of the stream are usually hand cleared approximately three times a year, while the lower reaches are cleared by hydraulic excavator around once each year. Excavated vegetation is either placed on the bank to drain or held in the bucket to drain before being dumped into a truck for transport to a disposal area. A free draining "weed bucket" is used to minimise the extraction of stream sediment, fish and other non-target material.

Short term effects

Hand clearance is the least disruptive method but may not be viable in the wider lower reaches of stream. Mechanical excavation is more disruptive and can result in the immediate loss of a high proportion of the available plant cover. Potential adverse effects of vegetation removal include the following:

- Loss of fish spawning habitat such as inanga;
- Stranding of fish and removal of invertebrates during digger operation;

- Suspended sediment causing fish mortality from oxygen depletion, and non-lethal effects on macroinvertebrates and fish;
- Fish and invertebrate populations affected by changes in habitat structure;
- Changes in channel morphology and hydrology

Cameron (2015) notes the disturbance associated with aquatic weed removal is likely to be short lived provided the works program incorporates a site specific mitigation strategy including the maintenance of beneficial plant refuges, procedures for returning stranded fish to the waterway, and timing of works to avoid disruption of inanga spawning. . These provisions have been included in the COP.

Long term effects

Cameron concluded that despite the disruption for the fish population associated with regular machine clearance, it is evident that the Waimeha Stream continues to support an abundant and diverse fish fauna.

6.10.3 Removal of beach vegetation

The removal of vegetation from stream beaches (also known as beach scalping) would be undertaken on a very infrequent basis in the Waikanae River (and not at all in the Waimeha Stream).

Cameron (2015) notes that there is evidence that removing weeds from river beaches has considerable value for those birds which roost and breed on open river beds. This is not likely to be significant in the Waikanae River because of the lack of such birds and the infrequency of the activity.

6.10.4 Clearance of flood debris

Clearance of flood debris may involve operation of machinery on both gravel beaches and in the active channel. In the latter situation, there is likely to be localised short-term disturbance of the river bed and generation of elevated suspended sediments in the water column. The effects on water quality will depend on the machinery involved and the time spent in the channel. Overall, these effects are expected to be similar or less than those described for the maintenance of structures.

Cameron (2015) considers that overall, there is little doubt that flood debris can increase the range of water depth and velocities which in turn provide for a variety of habitat preferences for fish, although he notes that Jowett (1995) suggested that flood debris are not sufficiently abundant to influence fish distribution to any great extent. Where there is opportunity to leave flood debris that presents no apparent risk to structures or public safety, (Cameron, D, 2015) concludes this would be beneficial to enhancement of available fish habitat.

6.11 Channel shaping and realignment

6.11.1 Beach ripping

Cameron (2015) considers that ripping of beaches is unlikely to have any immediate downstream effects on water quality or aquatic habitat, since it is undertaken on the dry beaches rather than in the active channel. The effects are to loosen the beach gravels so that in the next flood, the bed material will be more readily mobilised, possibly causing additional siltation and gravel accumulation in the reach downstream. These processes already occur during floods and consequently river biota is well adapted to a dynamic, mobile bed environment. In this context the additional silt and gravel entrained from lengths of ripped beaches is unlikely to be important.

6.11.2 Beach recontouring

Short term effects

Beach recontouring work is undertaken in the dry bed away from the active channel, and consequently there is little risk of short term construction impacts on water quality or aquatic ecology.

The activity may have implications for river birds although as noted above, there are currently no known populations of such birds in the Waikanae River. When done in conjunction with clearing of vegetation from beaches, the activity may improve the quality and/or quantum of potential river bird roosting and breeding habitat. The possibility that such birds may become established in such habitat in future is provided for in the COP, which proposes sets of three annual bird surveys on a regular cycle with 5 yearly intervals between them (i.e. 2012, 2013, 2014; 2020, 2021, 2022; etc.).

Other potential adverse effects such as the generation of noise and dust can be managed by appropriate practice (as included in the COP) and are expected to be less than minor.

Long term effects

Cameron (2015) states there is no evidence of negative impacts in the long term.

6.11.3 Channel diversion cut

Establishment of the diversion cut involves mechanical excavation of a new channel on the desired new alignment; generally this is through a beach area, away from the flowing channel. The excavated material may be placed between the side of the new channel and the flowing channel which is to be realigned or it may be removed to another location in the river bed.

The excavation cut is bunded at the upstream end and a flow restriction barrier placed at the downstream end while excavation work proceeds to minimise silt discharges. When the new channel is completed, the end bunds are removed to allow diversion of the active channel into the newly formed channel (this may either be done immediately by mechanical means or may be done naturally by the river over time). Some bed recontouring, to push excavated material across the old channel alignment (if it is not to be retained as a backwater habitat area) may also be required to achieve the finished profile.

Potential adverse effects of this activity during construction involve disturbance of dry river bed habitat (which has the potential to affect river birds) and disturbance or restriction of recreational use. Provided works are undertaken in accordance with the Code of Practice, these effects are expected to be minor.

Once the diversion cut becomes operational, and water is diverted into the new channel, there is likely to be an initial release of suspended sediment to the river from the disturbed river gravels in the bed of the new channel. This may result in some deposition of sediment downstream. The effects of this would not be as significant as those associated with bed recontouring or gravel extraction, and are expected to be short-lived.

6.11.4 Bed ripping in the flowing channel

Mechanical ripping of the bed in the wet channel is a technique used in some rivers to improve the low flow channel form and alignment through the riffle zones in particular. Wet ripping involves aquatic habitat disturbance and release of sediment to the water column, however the activity is generally less extensive and can be completed more quickly than bed recontouring and thus the scale of effects is relatively less than with bed recontouring.

These works cause some disruption to periphyton, invertebrate and fish communities. Nevertheless, as described above for bed-recontouring, re-colonisation is rapid and the impact is generally short lived.

6.11.5 Bed recontouring

Bed recontouring (formerly referred to as 'cross-blading') can be undertaken as a discrete exercise to address erosion of bank edges, or in association with gravel extraction. The records in Appendix K relate to the latter activity. They show that on average, just less than 200 lineal metres of bed recontouring has been undertaken annually in the Waikanae River since 1998.

Short term effects

Bed recontouring involves mechanical working in the active channel and entails extensive disturbance of bed material and significant temporary release of suspended sediment into the water column. The short term construction effects on water quality, macroinvertebrate and fish populations are likely to be similar to those associated with 'wet' gravel extraction because the two processes are very similar in terms of bed disturbance, although the extent and duration of works in the active channel may be less than required for wet gravel extraction (days rather than weeks) because much of the work can be completed in the dry and generally bend realignment affects a lesser extent of the riverbed than extraction works.

Long term effects

Cameron (2015) considers that bed recontouring, where it is used to straighten the channel, is likely to result in loss of channel complexity and a consequent overall reduction in aquatic habitat diversity. Mitchell (1997) observed that major channel alignment involves the direct loss of habitat and offers few direct ecological benefits apart from greater channel stability. Mitchell concluded that channel realignment was the flood protection practice most likely to have significant impacts on the environment (but noted that, overall, the river management approaches used on Wairarapa Rivers should result in an enhancement of biological activity).

Perrie (2009) observed that channel realignment on the Waingawa River resulted in significant straightening of the river channel in the study reach and had a clear impact on the diversity of habitat types. In particular deep runs were reduced in overall extent and pools were completely removed, while the proportion of shallow run and riffle habitats increased. Perrie considered this to be a net reduction in the overall diversity of habitat in this reach because of the relative scarcity of deep water habitat and because of the higher complexity of that habitat type relative to shallow water habitats.

In summary, (Cameron, D, 2015) concludes that the medium to long term effects on the aquatic ecology of bed recontouring, where it is used to merely straighten the channel, are mostly negative, and the significance of those effects for the river ecology at the reach scale will depend on the quantum of bed recontouring undertaken over time and any new suitable ecological habitat that is created to replace or offset the negative effects on the existing habitat. He notes, however, that it may be possible that this activity could be undertaken at a rate that balances the destabilising effects of floods, without on-going loss of habitat complexity, provided measures are in place to ensure the number of pools and riffles within a specified reach are not reduced below an agreed optimum level.

There is also an opportunity to mitigate many of these adverse effects in the Waikanae River by applying the principles developed for the Hutt River gravel extraction programme, whereby the works are designed to form a well-defined low flow channel with a 'natural' slope to the beach and well-formed pools and riffles, which provide good quality habitat for invertebrates and fish. The addition of other design elements, such as the maintenance or creation of backwaters as part

of these works, could also be considered to assist in the retention of habitat diversity. This methodology has been included in the COP.

6.12 Gravel extraction

Two distinct phases of gravel extraction are planned:

- An intensive, one-off removal of approximately 43,700 m³ of accumulated gravel from the known limit of gravel deposition in the lower reaches at or about XS 50 (i.e. upstream of the CMA), to the upper reaches of the gravel depositional zone at about XS 300. This work could require between 3 to 5 months of work, over two to three years, in the active channel (as described in Section 4.2.3.7).
- Extraction of the annual inputs of gravel into the upper reaches of the depositional zone on an on-going, annual basis in order to maintain the desired bed levels. Currently the average amount that would need to be removed annually is estimated to be 6,000 m³. This work would involve approximately 2 weeks per year on average.

6.12.1 Potential aquatic ecology effects in Waikanae River

6.12.1.1 Birds

Gravel extraction from beaches above the active channel (in the dry) may have implications for river bird roosting and breeding habitat. However, based on the recorded bird use of the river (discussed in Section 3.11 above), Cameron (2015) concludes that there are no birds within the river corridor likely to be at risk from gravel extraction activities.

6.12.1.2 Herpetofauna

Only one lizard species, the northern grass skink, has been recorded within the vicinity of the Waikanae River, and the likelihood of this lizard being present in those areas frequently flooded by the river is considered to be low. Accordingly, Cameron (2015) assesses the risk of negative effects on herpetofauna to be negligible and no specific mitigation measures are considered to be necessary in respect of herpetofauna.

6.12.1.3 Fine sediment mobilisation and deposition

Gravel extraction from the dry is likely to have minimal effects on water quality of the Waikanae River, although in those cases where trucks are required to cross the river there is potential for minor temporary discharge of suspended sediment and disturbance of bed material. This can be managed by requiring vehicles to use designated crossing points. Cameron (2015) also considers it unlikely that the gravel extraction will result in fine sediment accumulating on the river bank due to the hard sedimentary geology of the Waikanae catchment.

Gravel extraction is also proposed from the w wetted channel of the Waikanae River, which entails extensive disturbance of bed material and significant release of suspended sediment into the water column. Cameron (2015) considers suspended solids concentrations in the river immediately downstream of the works would be about the same order as an annual flood, that concentrations would decrease fairly rapidly with distance downstream, and would return to near ambient levels within an hour of the completion of works. Consequently, if works in the actively flowing channel are limited to no more than 12 hours each day the aquatic biota downstream of the works would have the benefit of normal water quality for half of each 24 hour period, including night time when much of the native fish feeding activity occurs. Gravel extraction will increase rates of sediment deposit in downstream habitats but based on studies conducted on

Wairarapa rivers, this effect is short lived, with a return to ambient levels after the first fresh (refer Death & Death,2013).

6.12.1.4 Benthic habitats

Gravel extraction can cause a major change in the relative areas of in-stream habitat types, often resulting in a reduction of pool and swift riffle habitat and an increase in run habitat; and nearly always with an associated loss in hydraulic complexity. In some instances rivers quickly revert to a more natural form after the first fresh in the river, but this is not always the case. In some instances the re-establishment of specific habitat types may require a series of high flow events over several months. The time required for recovery can be reduced by incorporation of an engineered channel design, with a well-defined low flow channel with a 'natural' slope to the beach, and creation of well-formed pools and riffles as part of the works.

6.12.1.5 Macroinvertebrate communities

The Waikanae is a relatively small river with moderately high water clarity, and with high ecological values within the affected gravel extraction reaches. The proposed gravel extraction will cause a physical disturbance over a sustained period. Difficult access, especially in the reach upstream of Otaihanga Domain, is likely to result in heavy machinery tracking for some distance within the riverbed.

Cameron (2015) reports that there is strong evidence that macroinvertebrate re-colonisation of shallow riffle areas disturbed by in-stream works is rapid and that any impacts are likely to be short lived. Clear impacts on macroinvertebrate communities can be expected immediately after works, but recovery to the pre-works condition is likely to be rapid (within seven or eight weeks, and typically after the first significant fresh has passed through and re-worked the river gravels). This is likely to be the case in the Waikanae River where a healthy and diverse benthic community in the river upstream of the works area would be available to assist in the re-colonisation of disturbed reaches (as already occurs after major floods). It is noted however, that where the area of mechanical disturbance involves multiple riffles over a longer river length, the overall productivity of that reach is likely to be reduced, potential reducing food supplies for fish.

6.12.1.6 Fish communities

Cameron (2015) summarises some relevant studies on the effect of gravel extraction on fish communities, which had variable findings for the effect of gravel extraction on fish communities. For example, fish populations at the site of extraction may reduce or have no discernible change, and some species may increase in abundance downstream of the works.

Where there is a potential for loss of important habitat due to river engineering works, the COP requires that consideration be given to options for avoiding or mitigating any such loss, for instance by incorporating a design meander pattern into the works, with a focus on creation of alternative or replacement riffle and pool habitat. For large scale works affecting a long length of river and multiple riffles, consideration should also be given to leaving some riffles (perhaps every second riffle) untouched so as to maintain sufficient reserves in the local fish population to enable the efficient recolonization of the engineered reaches.

6.12.1.7 Fish spawning and/or migration

As described in Cameron (2015), the Waikanae River application area provides spawning habitat for a variety of fish, including:

- Inanga spawning habit is located in tidal estuary edge vegetation, and is discussed below in relation to the Waikanae Estuary.

- Other galaxiid species including koaro, banded kokopu and giant kokopu, spawn in vegetation or cobbles at the riparian margin between April and August. Spawning habitat is generally thought to occur near typical adult habitats, which for most of these species will be in minor watercourses outside (upstream) of the application area.
- Bullies spawn in riverbed substrate, often under large rocks, between August and February. Some spawning habitat is expected to occur within the application area.
- Torrentfish spawn in riverbed substrate, probably in the lower river near the coast (within the application area), mostly between January and April.
- Trout move into headwater tributaries, or suitable areas on the main-stem, to spawn during May and June. Trout spawning occurs throughout much of the Waikanae catchment, including parts of the main-stem of the river, potentially including some reaches within the application area.

6.12.1.8 General comments on aquatic ecology effects in Waikanae River

It is clear that the proposed gravel extraction programme has the potential to cause significant adverse effects on the river ecology, at least in the short term. Potentially disturbance of the bed could be expected to occur over a period of many weeks over a 2.8km reach of river. Consequently the bed disturbance and discharge plume would have the potential to interfere with juvenile fish migration and to disrupt spawning of inanga, bullies, torrentfish and brown trout. Potential adverse effects on juvenile native fish migration and spawning could, however, be addressed by limiting the amount of bed disturbance that can occur during period of peak upstream migration and spawning, as summarised in Table 25.

Table 25: Recommended constraints of works in the wetted river channel – Waikanae River

<table>
<tr><th></th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Waikanae River main-stem</td><td></td><td></td><td></td><td></td><td colspan="3">No works in trout spawning reaches</td><td></td><td colspan="4" rowspan="2">No more than 3 day's work per site or 15 days in the application area</td></tr>
<tr><td>Waikanae River Estuary</td><td></td><td></td><td colspan="3">No works at inanga spawning habitat</td><td></td><td></td><td></td></tr>
</table>

Given these constraints, and to minimise adverse effects on river ecology, the Ecology Report in Appendix E identifies that it would be desirable to spread the bed lowering gravel extraction over two of three years. For instance gravel extraction could be undertaken in the upper reach (XS 300 to XS 130) in year one, the middle reach (XS130 to XS80) in year two, and the tidal reach (XS 80 to XS 50) in year three. Subsequent maintenance extraction from the Greenaway Road reach (XS300 to XS200), to maintain the bed levels, should also observe these exclusion periods.

6.12.2 Potential aquatic ecology effects in Waikanae Estuary

6.12.2.1 Birds

The Waikanae Estuary and its associated wetlands and ponds are identified as a site of value for indigenous birds. The proposed gravel extraction reach extends from XS 80 downstream to XS50, well within the estuarine reach, raising the possibility of adverse effects on valuable bird habitat, including the nesting habits of the North Island fernbird and the pied shag.

6.12.2.2 Sediment deposition

Estuaries are a sink for sediments; their natural cycle is to slowly infill with fine muds and clays. However, sedimentation rates have increased since European settlement, and monitoring over the period 2010 to 2014 in the Waikanae Estuary indicates rapid sediment deposition (Cameron, D, 2015).

The proposed gravel extraction activity would not add to the total fine sediment load in the river (in fact it would reduce it slightly), but may accelerate the rate of sediment transport to the estuary and deposition within the estuary in the short term. The main settlement zone for fine sediment is currently the upper estuary flats, at the downstream end of the application area, where soft mud overlays firm muddy sands. In the short term, while the gravel extraction programme is underway it is likely that deposition rates would increase further in the upper estuary, potentially worsening the risk of sediment related impacts such as poor water clarity and muddy intertidal substrates, which favour mud tolerant invertebrate taxa and may have implications for resident and migrating fish.

However, it is anticipated that a proportion of fine sediment in upper estuary flats will be removed during the last phase of the gravel extraction programme. It is expected also that the lowering of the river bed level will halt the current tendency or aggrading bed levels, and facilitate the transport of sediment out through the mouth during flood events, which may have the effect of reducing sedimentation rates in the estuary in the medium term.

6.12.2.3 Inanga spawning

Inanga spawning habit is located in tidal estuary edge vegetation and occurs during March, April and May. Suitable areas of inanga spawning habitat have been observed on the Waikanae River within and downstream of Otaihanga Reserve, predominantly on the true left (south) bank.

Potential adverse effects on juvenile native fish migration and spawning could be addressed by limiting the amount of bed disturbance that can occur during period of peak upstream migration & spawning, as summarised in Table 25 above. Initial extraction phase??

6.12.3 Recreation effects

The initial extraction phase is likely to create disruptions to recreational use of the river and river corridor which are likely to be significant, given that by necessity the work will be undertaken over the peak summertime recreational use period. As the works progress, public access to sections of the river bed and adjacent banks will need to be restricted for safety reasons. The duration and sequencing of the works will be planned to ensure that the area of river bed removed from public use at any one time is minimised as much as possible.

The sediment plume generated by the in-stream works is likely to reduce water quality in the river downstream of the works, which may also adversely affect in-stream recreational use. Although this cannot be completely avoided, the staging and timing of works (as far as practicable) can offer some opportunities for reduction of the impacts.

The disruption of recreational use may have a short-term flow-on effect to commercial and tourism operators who rely on the river environment for part or all of their business (Waikanae Estuary Tours and El Rancho have been identified as such parties in (TRC Tourism, 2013)). GWRC proposes to conduct further consultation with any such affected parties throughout the application process, and will use the feedback from such consultation together with on-going discussions to develop work programmes that minimise the extent of any effects as much as is practicable.

6.12.4 Traffic and noise effects

Transport of excavated gravel to stockpiles on the river bank and from stockpiles to offsite destinations is likely to involve several movements by large dumper trucks daily, over a period of several months. This has the potential to generate both dust and noise which could adversely affect the residents living in areas adjacent to haul roads during this time. It could also adversely affect recreational use in parts of the river corridor, and particularly the Otaihanga Domain (where a stockpile is proposed to be located). GWRC proposes that these effects could be managed as far as practicable by appropriate routing and timing of vehicle movements, the use of dust control measures such as water spraying on roads (if necessary), and by further consultation with immediately affected community to identify any further specific issues.

6.13 Activities in the CMA

6.13.1 Waikanae River mouth realignment

This work would be undertaken infrequently, in response to the defined triggers (as outlined in the RCP). The operation would be expected to take a maximum of 24 hours to complete and involves the use of several earth moving machines.

Short term effects

The excavation cut will disturb the beach and foreshore immediately in front of the river channel; this area can develop into a sand-spit extending up to 700m to the southwest. The area is naturally unstable, being periodically affected by flood flows and frequently eroded or submerged by wave action during high tides and storm surges. When the formed pilot channel is opened, the ponded water in the river channel is released and this scours a channel through to the sea, mobilising large quantities of sand in the process. This will creates a visible discharge plume in near-shore coastal waters similar to that generated by a large flood event. Much of the scoured material will be deposited within the surf zone and then gradually dispersed by wave action and tidal currents, predominantly in a southerly direction. Finer material is likely to remain in suspension causing a temporary reduction in visual clarity in coastal water in the vicinity of the cut, especially during the first few hours of the breach, but is likely to have little effect on the biota of the surf zone.

Long term effects

Bird species such as the variable oystercatcher occupy the sand-spit where the river affords some protection from predators such and cats, dogs and ferrets. The excavation cut will initially convert the sand-spit into an island as the old river channel to the south will be maintained as a back-water. The effect of this will be to maintain and possibly enhance the quality of available safe roosting habitat at such times, although the total area may be reduced. However, aerial photographs taken between 2005 and 2013 (currently available on Google Earth), indicate that this is a dynamic situation and that at times the island disappears or is submerged at high tide, possibly following major storm events.

Robertson and Stevens (2012) considered that the artificial opening of the channel to the sea effectively causes the loss of the lower part of the estuary and reduces the ecological values of the area because there is limited potential for long term estuarine communities to develop. Cameron (2015) notes in relation to this that the instability of this area is a natural feature of a dynamic river system and that the breaching of the sand-spit would occur from time to time, without mechanical intervention. In this context the additional adverse effects resulting from mechanical opening are probably minimal. It is also noted that DOC considers that the river management works including mouth realignment may have a generally positive effect on the

maintenance of habitat in the wetland areas of the Waikanae Estuary Scientific Reserve by preventing erosion at the southern end of the reserve and reduction of flood levels.

6.13.2 Waimeha Stream mouth realignment

The short term effects are likely to be of a similar nature, but much lesser scale to those described above for the Waikanae River mouth. Adverse effects on aquatic and benthic ecology are expected to be negligible, and there will be significant long term benefits to local residents due to the prevention of erosion of adjacent dunes which buffer the adjoining properties.

6.13.3 Maintenance of existing structures

6.13.3.1 Maintenance of rock groyne and rip-rap lining at Waikanae River mouth

Maintenance of the rock groyne and rock rip-rap lining at the mouth of the Waikanae River on the true left bank is likely to be undertaken relatively infrequently; the most recent occurrence was in May 2005 to repair flood damage. Rock will be hauled by truck along an existing road through the Waikanae Estuary Scientific Reserve and placed by hydraulic excavator. No adverse effects are anticipated or likely to arise from this work.

6.13.3.2 Maintenance of training wall at Waimeha Stream mouth

Maintenance of the rubble mound training wall on the right bank of the Waimeha Stream mouth will be undertaken as required, on an infrequent basis. The work typically involves topping up rock that has been eroded by sea action or flooding. Again, it is not anticipated that any adverse effects are likely.

6.13.3.3 Clearance of debris arrester on Waimeha Stream

A debris arrester consisting of a row of 8 timber poles across the width of the stream at the Field Way Bridge prevents logs and other large debris from being washed upstream by the incoming tide and wind. Accumulated material is periodically removed by hydraulic excavator and/or hand clearance, typically once each year. Debris from the arrester is buried on the beach above the high tide mark near the stream mouth. Any adverse effects arising from this work are expected to be less than minor.

6.14 Cultural effects

The Waikanae River has important historical and cultural value for Te Atiawa ki Whakarongotai, who are tangata whenua in the area covered by this application.

The following extracts have been taken from the updated Waikanae Environmental Strategy (Greater Wellington Regional Council & Kapiti Coast District Council, 2014).

‘Te Atiawa ki Whakarongotai sees the river from its origins in the tears of Ranginui and in the formation of streams in the Tararua Mountains. Management of the river should include consideration of the wider catchment, including the river’s natural floodplain, its sister tributary, the Waimeha, as well as its flow into the Tasman Sea (Te Tai o Rehua).

As well as being connected to the wider environment, the Waikanae River has complex and ancient associations with tipuna of its many occupying hapu. The health and wellbeing of the river is seen as being connected to the health and wellbeing of the people of Te Atiawa ki Whakarongotai.’

‘There are a range of mahinga kai areas in the Waikanae River environment as the river has been a key source of traditional food historically, and is still an important area within which to source

kai and other natural resources. Te Atiawa ki Whakarongotai are seeking to develop an Iwi Environmental Management Plan that documents all the mahinga kai sites and species of significance.'

'There a number of known Wahi Tapu sites located in or near the Waikanae River Corridor, especially in the lower reaches of the river. These include urupa (grave sites) as well as historic pa sites and flood cultivation areas.'

These mahinga kai and waahi tapu sites and any other site specific information will be incorporated into GWRC's database of important values and sites, as it becomes available. It should be noted that GWRC are providing assistance to Atiawa ki Whakarongotai with initial development of their Iwi Management Plan. This database of information will be taken into consideration in the planning of all flood protection works, as outlined in the COP.

In addition, 'the status of Te Atiawa ki Whakarongotai as mana whenua of the Waikanae River catchment gives them the rights and responsibilities to practice kaitiakitanga over the River environment and corridor. Kaitiakitanga is the practice of guardianship in accordance with tikanga Maori. Kaitiakitanga seeks to integrate the management of the ecological health of the river system with the social, cultural, and economic outcomes of the community.'

The following is a list of key values which the practice of kaitiakitanga seeks to uphold and how they are relevant to the Waikanae River environment. This should not be considered an exhaustive list but instead should provide guidance as to what outcomes may be important from kaitiaki perspective:

- Mauri: Life, health, vitality, and energy. This pertains to both the whole river system and all that which exists within it including inanimate objects such as soil and rock. This can be measured by a variety of variables including biodiversity, water quality, forest composition etc.
- Maramatanga: Knowledge, analysis, creativity. This can be measured by the degree of protection and respect for knowledge and intellectual property connected to the river system, and the generation of new knowledge and research that enables the community to better protect and improve the river system.
- Mana: Autonomy, security, self-determination. This can be measured by the degree to which tangata whenua have access to decision-making on the river system and the degree to which local people can gain sustenance and social cohesion through a relationship with the river system.
- Wairua: Spiritual well-being, peace, reverence. This can be measured by the protection offered both to the waahi tapu within the river system and to the natural character of the River Corridor.
- Whakapapa: The natural connections and genealogy. This can be measured by the degree to which ecological and ethnobiological relationships that exist within the river system are protected and enhanced.'

Many of the measures to avoid or mitigate adverse effects of the environment, and particularly those affecting fish and aquatic habitat, which GWRC have included in the COP, will also achieve positive outcomes in terms of one or more of these cultural values. However, GWRC also acknowledges that there are some cultural and spiritual values that are more problematic to make provision for within the current river management paradigm.

As explained further in Section 8, GWRC is working with the iwi to ensure that understanding of cultural issues of importance and appropriate responses to them continue to be developed, and are incorporated into the Code. To this end, a member of the iwi has been invited to join the Science Group, which will have a key role in the on-going review and development of the Code.

6.15 Urgent works

Works undertaken in response to the mitigation of immediate risks of flooding to the safety of people, property or the community's existing investment in flood protection works may include any one or more of the activities and their associated effects described above; however, the immediacy of the need for the works may require them to be undertaken in a manner outside the usual methodologies and practices described in this application. The COP will include a protocol for Urgent Works.

6.16 Cumulative effects

The potential for the effects of GWRC operations and maintenance activities to be increased by other similar activities undertaken in the catchment by other parties is low. KCDC has conducted some erosion protection works in the vicinity of their Water Treatment Plant weir from time to time, but the cumulative effect of this on the river is expected to be negligible, given the small scale of the works and the ability of the river ecology to recover rapidly from any negative effects of disruption.

Available evidence suggests that although works and maintenance operations have been undertaken over a long period of time, the Waikanae River supports a relatively diverse range of fish and aquatic biota. This suggests that major cumulative adverse effects on aquatic ecology do not occur.

The new bridge across the Waikanae River associated with the Mackays to Peka Peka Expressway works will involve some in river work associated with construction of the bridge piers on the river banks between XS 150 and XS 155 (see Appendix D). The work is likely to involve some short term disruption to the river bed ecology in the immediate vicinity, which is likely to be of a similar scale and nature as that described for construction of other structures. The resource consents for this work have been granted, and the effects of the work were considered under that process. Any long term cumulative effects of the work are expected to be negligible.

The monitoring programme outlined in Section 8 of Cameron (2015) – Appendix E and detailed in the COP is intended to establish a long term monitoring framework covering both geomorphological and biological measures of river health. It includes the development of a natural character index (NCI) which, it is expected, will provide a measure of the cumulative effects of river-channel activities on river morphology, and by inference on habitat quality. Further investigations will need to be undertaken to better establish the link between NCI scores and ecological condition, and is noted that the applicability of this approach has yet to be tested.

7 Consultation

Consultation on flood protection work affecting the Waikanae River is an integral part of GWRC activities. River management activities have a high profile in the Waikanae community. This is due, in part, to the regularity of floods and the on-going consultation undertaken by GWRC. GWRC works within the river are well reported in local newspapers, further reflecting the interest shown by the community.

The most recent phase of public consultation for undertaking flood protection works in the Waikanae River and Waimeha Stream began in 1996, as part of the WFMP. The Friends of the Waikanae River Group (FWR) was set up as a direct outcome of the WFMP process. The FMP was reviewed during 2011-12 and further consultation has been undertaken as part of the review process.

GWRC has consulted with a number of external and internal parties in relation to this application, and in the preparation of the COP. This consultation will be on-going throughout the processing of the consent applications, and beyond. Further details are provided below, and in the draft COP (Annex 1).

7.1 Parties consulted on this application

The consultation process to date has involved:

- The 'Science Group' described in Section 1 of this report
- Ati Awa ki Whakarongotai Charitable Trust
- Kapiti Coast District Council
- Department of Conservation
- Fish & Game NZ
- Friends of the Waikanae River
- Infrastructure Providers (Transpower, Telstra Clear, NZTA, Wellington Electricity Lines Ltd, PowerCo, KiwiRail, Electra Ltd, Vector Ltd, Chorus Ltd)
- Winstone Aggregates
- Recreation groups

The extent of consultation, comments received and, where appropriate, the GWRC response are summarised below. It is important to note that the draft application sent out was incomplete as it did not contain a full description of the proposed works – particularly as it relates to gravel extraction. Hence the consulted parties have not had the opportunity as yet to consider the full assessment of effects or comment on them. To address this, GWRC intends to conduct further consultation with affected and interested parties as the application process proceeds.

7.2 Feedback received to date

7.2.1 Science Group

As outlined above, one of the key consultation components has been the establishment by GWRC of a 'Science Group' to provide advice to assist the consent application process and in particular the environmental monitoring that has been undertaken as part of preparing this application and the wider consenting process. This group has met routinely since June 2012, and their involvement is anticipated to continue throughout the processing of this application and beyond. The group includes a cross section of scientists from within GWRC and external parties including

Fish & Game NZ, DOC and Massey University, together with a consultant ecologist and consultant river management engineer.

The group has been instrumental in guiding the design of environmental monitoring in the Hutt River and rivers in the Wairarapa. This has included recognition of the potential value of the Natural Character Index that is under development in the New Zealand context by researchers from Massey University (namely Amanda Death, Dr Russell Death and Dr Ian Fuller). The Group's input has also contributed significantly to development of the COP.

The Science Group meeting in March 2013 discussed the draft Hutt River application (which was subsequently lodged in early April) specifically, including the proposed approach, conditions, and the new COP. The Group was provided with a draft of the resource consent application for the Waikanae River and Waimeha Stream (which is based on the same approach as the Hutt River application) in April 2013.

Subsequent to this, the Science Group has given further consideration to the specific matters and effects arising from the proposed works in the Waikanae River and Waimeha Stream as part of the ongoing drafting of the COP and monitoring process. This is an iterative process which is on-going and is extremely valuable to the project. It should be noted that the statements in this report do not necessarily reflect the opinions of individual members of the Science Group.

7.2.2 Ati Awa ki Whakarongotai Charitable Trust

Iwi representatives from the Ati Awa ki Whakarongotai Charitable Trust were part of the Kapiti Floodplain Management Plan Advisory Committee and they were also involved in the 1998 resource consent application. Representatives from the Trust were contacted by GWRC's Iwi liaison group to advise them of the consent process and a copy of the draft application was sent to the Chair of the Trust.

Since the application was lodged in April 2013, GWRC has meet with Ati Awa ki Whakarongotai Charitable Trust, initially to discuss the wider Flood Protection relationship between GWRC and the Trust. More recently the Trust has nominated a representative to attend the Science Group meetings. Te Atiawa ki Whakarongotai have also provided comments and made recommendations on the updated Waikanae Environmental Strategy (Greater Wellington Regional Council & Kapiti Coast District Council, 2014), which are included in that document and provide further guidance.

Relationships will continue to develop with Ati Awa ki Whakarongotai and their comments and concerns will be discussed as they are received. GWRC and the iwi are both continuing to explore ways to assist each other in understanding the way forward with the resource consent process, and the wider cultural values associated with the river.

7.2.3 Kapiti Coast District Council

Consultation with KCDC has been ongoing since 1996 when work started on the WFMP. GWRC officers met with KCDC officers prior to preparation of this resource consent application, and the draft application was sent KCDC in April 2013.

No specific concerns have been raised to date, and in general officers are supportive of the work undertaken by GWRC in the Waikanae River and Waimeha Stream.

Further discussion, particularly in relation to gravel extraction, will be undertaken and comments addressed as they are received.

7.2.4 Friends of the Waikanae River (FWR)

FWR is independent, does not represent GWRC, and is not a sub-committee of any committee of the GWRC. Its role is to act as a channel of communication between the community and the statutory bodies responsible for managing the river. The relationship with GWRC is defined in a formal Memorandum of Understanding. GWRC works to ensure that the Friends provide an ongoing consultative input from the community represented by the Friends into its activities. The draft resource consent application was sent to FWR in March 2013.

Because the draft was provided at an early stage, it did not include all the relevant background information or impact assessment. FWR provided some useful feedback on background detail to assist the development of the application document.

FWR comments were noted and suggested changes have been incorporated into the application document. GWRC will continue to work with FWR through the course of this application.

7.2.5 Recreational Users Groups

These include Kapiti Fly Fishing, Otaihanga Boating Club, Waikanae Golf Course and El Rancho.

Recreation and tourism consultant TRC Tourism met with, or contacted, the groups listed above in 2012 as part of the recreation and tourism assessment commissioned by GWRC. The feedback and comments have been incorporated into the TRC report in Appendix G. TRC provides recommendations and suggestions for mitigation in section 5 of their report.

No additional comments have been received to date.

GWRC response to the TRC recommendations are as follows:

- In respect of the recommendation to 'consider recreational users in future design, planning and construction', it is noted that this is already part of current practice and has been included in the updated COP.
- In respect of the recommendation to undertake 'information sessions to present maintenance plans and explain rationale and processes as part of ongoing education and communication with user groups, especially fishermen and kayakers': GWRC notes that this may be a useful approach, and is open to undertaking such consultation if the demand for it is established.
- Further discussion will be undertaken as comments are received through the application process.

7.2.6 Infrastructure Providers

GWRC sent a letter to Transpower, Telstra Clear, NZTA, Wellington Electricity Lines Ltd, PowerCo, KiwiRail, Electra Ltd, Vector Ltd, Chorus Ltd in January 2013.

No relevant comments have been received to date.

Further discussion will be undertaken as comments are received through the application process.

8 Continuous improvement and management

Consideration of mitigation needs to be undertaken in the context of the assessment of the significance of overall effects and the absolute need for river management to occur. It is important that any mitigation of river management activities achieves an overall net positive benefit for both the community and the environment. It is important that any constraints applied to river management activities do not negate the positive benefits to the community of the flood protection system or impose unrealistic costs on the community.

8.1 Proposed management and mitigation measures

8.1.1 Operational Management Plans

Operational Management Plans are a key tool for how river management operators plan and execute their work. The Plans manage work on a reach by reach basis, provide for identifying and managing reach specific values, and reflect the high-level direction provided in any Floodplain Management Plans.

The Operational Management Plans will also:

- describe the management objectives;
- describe the channel type and key morphological characteristics;
- contain the design channel and river corridor;
- describe minimum and maximum bed levels;
- describe any buffer zone;
- describe any areas with significant indigenous ecosystems or significant indigenous biodiversity values;
- describe any recreational values and areas of safety concern;
- identify and describe the cultural values of kaitiaki sites, established by the Māori Consultative Group;
- describe the range of management methods which may be implemented, taking into account:
  - effects on ecological and other significant environmental values; and
  - any recommendations from the Māori Consultative Group ; and
- include any other matters to comply with the COP

The implementation of Operational Management Plans will enable the efficient and effect management of river management activities over time.

8.1.2 Site Specific Management

River management activities have the potential for short term adverse effects as addressed in Section 6 above. Wellington Regional Council proposes specific management procedures in the event that significant activities in identified sensitive locations and seasons are required. Significant activities are set out in the COP, and are generally related to one or more of the following:

- wet gravel extraction;
- bed recontouring;
- ripping in the active channel; or

- channel diversion cuts.

When site specific management is required, a Site Specific Environmental Management plan (SSEMP) will be prepared to demonstrate how the proposed river management activities will be limited to the extent necessary to undertake the activities in a manner that remedies or mitigates adverse effects on the environment. More specifically, an SSEMP will describe:

- the works proposed, including methodology and timing;
- the reasons why the proposed activities must be undertaken during that period and within that habitat, as applicable, and specific measures to remedy or mitigate effects;
- the site specific environmental monitoring;
- requirements of communication with key stakeholders;
- how the design channel and bed levels will be maintained;
- how any reach specific values identified by the Māori Consultative Group have been taken into account; and
- a suitably trained or qualified expert's opinion that appropriate steps will be taken to remedy or mitigate adverse effects or, if not, why an expert opinion was not required.

8.1.3 Ecological Enhancement Fund

In response to increasing the knowledge of river management activities and their effects on the Waikanae River, feedback from the Science Group, and feedback from key stakeholders such as mana whenua and DoC, Wellington Regional Council proposes to establish an Ecological Enhancement Fund (EEF). The EEF will implement recommendations identified in the Annual Report to maintain or enhance:

- the space available for the river (for example, by acquiring adjacent land);
- areas of vegetation with high biodiversity values (including the planting of native species) in the river corridor;
- in-stream values; or
- any other area of important habitat.

8.1.4 Environmental Monitoring Plan

GWRC propose to prepare an Environmental Monitoring Plan which will sit alongside the COP. It will provide a programme of environmental monitoring, involving collection of a range of physical parameters that reflect aspects of river natural character and processes, and which can be used as indicators of the effects of river management activities on selected environmental values. The EMP will consist of:

- the baseline monitoring parameters;
- survey methodologies;
- event monitoring; and
- procedures and methods for baseline reporting.

8.1.5 Existing mitigation

Mitigation that GWRC currently undertakes in conjunction with management of the river environment includes:

- Funding of the annual drift dive surveys undertaken by Fish & Game NZ. This has been undertaken since 1999, and has built up a valuable database of fish numbers and trends since that time.
- Contribution to native plantings in the river corridor and development of the river corridor in accordance with the Waikanae River Environmental Strategy. This strategy forms an important part of the WFMP, and provides a framework for enhancing the river environment. It guides management of the Waikanae River (particularly in respect of capital works and developments outside the river bed) to provide a structure for enhancing the environmental values of the river corridor downstream of the Water Treatment Plant.
- shows that GWRC has committed $114,000 over the three year period from 2013/14 to 2015/16 to implementation of the Waikanae River Environmental Strategy.
- Partial funding of the FWR
- Funding of a part-time contractor employed by the FWR to assist in maintenance works.

GWRC intends to continue all of this mitigation.

9 Proposed conditions of consent

A proposed set of conditions of consent are appended to this application which seek to manage the potential adverse effects on the environment (Appendix L). River management activities have the potential for short term adverse effects, and cumulative effects as the river changes over time. The proposed conditions enable site specific management procedures for significant activities or activities in identified sensitive locations and seasons, and comprehensive monitoring and reporting methods to identify changes in the river system if it occurs.

Additionally, GWRC does not intend that any conditions of consent will impose quantum limits, as it needs to be able to undertake its operation and maintenance activities using its 'toolbox' as required, guided as necessary by limits established in the COP via the consideration of the outcomes of the environmental monitoring, rather than through the imposition of arbitrary limits.

The proposed conditions require that all river management works and maintenance activities are undertaken in accordance with good practice guidelines in the COP, which incorporate the extensive technical learnings on river management practices.

10 Statutory assessment

10.1 RMA Assessment

Section 104 of the RMA sets out the matters to which a consent authority must have regard to, subject to Part 2 of the RMA, when considering an application for resource consent. These are:

- Any actual and potential effects on the environment of allowing the activity (refer to Section 6 above)
- Any relevant provisions of:
  - a national environmental standard
  - other regulations
  - a national policy statement
  - a New Zealand coastal policy statement
  - a regional policy statement or proposed regional policy statement
  - a plan or proposed plan; and
- Any other matter the consent authority considers relevant and reasonably necessary to determine the application.

10.1.1 Part 2 of the RMA

Part 2 of the RMA sets out the purpose and principles of the Act. The purpose of the RMA is to promote the sustainable management of natural and physical resources.

The operations and maintenance activities undertaken by GWRC on the Waikanae River and Waimeha Stream are imperative to protecting the social and economic wellbeing and health and safety of the people and assets of the Waikanae floodplain and wider Kapiti Coast area.

The COP, along with any necessary ongoing monitoring and the ability to review the Code where desirable, will ensure that the life-supporting capacity of the rivers and their ecosystems are safeguarded and adverse effects are avoided, remedied or mitigated.

Additionally the works are proposed to be undertaken in a manner that preserves the natural character of the waterways and their margins in the long term and maintains public access to and along the waterways. Amenity values will also be maintained and enhanced, and the habitat of trout will also be protected over time.

GWRC seeks to ensure that the relationship of Maori and their culture and traditions with the river are provided for.

In summary, the rivers will be managed in a way which enables people and communities to provide for their social, economic and cultural wellbeing and their health and safety, while ensuring that the life-supporting capacity of the rivers themselves are safeguarded and adverse effects upon them avoided and mitigated. The proposed works are therefore in keeping with the purpose of the Act.

10.1.2 National Environmental Standards

There are currently five national environmental standards in effect as regulations under the RMA, for:

- Air quality
- Sources of human drinking water

- Telecommunications facilities
- Electricity transmission
- Assessing and managing contaminants in soil to protect human health

None of the provisions of these standards are relevant to this application.

10.1.3 National Policy Statements

Currently there are four national policy statements in force under the RMA:

- the New Zealand Coastal Policy Statement 2010
- the National Policy Statement on Electricity Transmission 2008
- the National Policy Statement for Renewable Electricity Generation 2011
- the National Policy Statement for Freshwater Management 2011

Of these, the New Zealand Coastal Policy Statement and the National Policy Statement on Freshwater Management are of potential relevance to this application.

New Zealand Coastal Policy Statement

The purpose of the NZCPS is to state policies to achieve the purpose of the RMA in relation to the coastal environment. Local authorities are required to give effect to these policies in their regional policy statements, regional and district plans.

The NZCPS contains seven objectives, summarised below.

NZCPS Objective	
1	To safeguard the integrity, form functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land...
2	To preserve the natural character of the coastal environment and protect natural features and landscape values ...
3	To take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in management of the coastal environment...
4	To maintain and enhance the public oppen space qualities and recreation opportunities of the coastal environment ..
5	To ensure that coastal hazard risks taking account of climate change, are managed ..
6	To enable people and communities to provide for their social, economic and cultural wellbeing and their health and safety, through subdivision, use and development ...
7	To ensure the mangement of the coastal environment recognises and provides for New Zealand's international obligations regarding the coastal environment, including the coastal marine area.

The NZCPS also includes 29 policies designed to achieve these broad objectives. Those most relevant to this application are briefly discussed below.

Policy 2 – The Treaty of Waitangi, tangata whenua and Maori heritage

> *(c) With the consent of tangata whenua and as far as practicable in accordance with tikang Maori, incorporate matauranga Maori ... in the consideration of applications for resource consents ....*

GWRC recognises the statutory and kaitiaki roles of iwi in relation to the Waikanae River and Waimeha Stream and seeks an outcome that is agreeable to iwi which is in keeping with these

objectives and policies. Engagement with tangata whenua is underway and will continue through the period of processing and consideration of the consent and the on-going development of the COP. Engagement will then continue through the life of the consent as the COP and monitoring are kept up to date.

Policy 3 - Precautionary approach

> *(1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse.*

The proposed initial gravel extraction from the lower reaches of the Waikanae River is the activity most likely to have potentially adverse effects on the estuarine/coastal environment (at least in the short term). GWRC will adopt a precautionary approach to management of these effects by careful planning to minimize the time that machinery will operate in the river channel as far as is practicable, and will undertake a monitoring programmme throughout the planned operation to ensure effects are identified and the programme can be altered to take account of the resultant findings as works proceed.

Policy 6 – Activities in the coastal environment

> *(1) In relation to the coastal environment:*
>
> > *(j) where appropriate, buffer areas and sites of significant indigenous biological diversity, or historic heritage value.*
>
> *(2) Additionally, in relation to the coastal marine area:*
>
> > *(c) recognise there are activities that have a functional need to be located in the coastal marine area, and provide for those activities in appropriate places.*

GWRC's proposed activities within the CMA are limited and only include activities that have a functional need to be located there. There are significant natural values associated with the wetland areas of the Waikanae Estuary Scientific Reserve, but it is considered that these will be adequately bufferred from any direct effects from the proposed works (principally short-term gravel extraction).

Policy 11 – Indigenous biological diversity/biodiversity

To protect indigenous biological diversity in the coastal environment:

(a) avoid adverse effects of activities on:

(i) indigenous taxa[4] that are listed as threatened[5] or at risk in the New Zealand Threat Classification System lists;

(ii) taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened;

(iii) indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare[6];

(iv) habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare;

(v) areas containing nationally significant examples of indigenous community types; and

(vi) areas set aside for full or partial protection of indigenous biological diversity under other legislation; and

(b) avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on:

(i) areas of predominantly indigenous vegetation in the coastal environment;

(ii) habitats in the coastal environment that are important during the vulnerable life stages of indigenous species;

(iii) indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh;

(iv) habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes;

(v) habitats, including areas and routes, important to migratory species; and

(vi) ecological corridors, and areas important for linking or maintaining biological values identified under this policy.

There are at least two known threatened plants in the Waikanae Estuary Scientific Reserve; nine threatened species of fish have been identified in the Waikanae River and five in the Waimeha Stream. The proposed works will not be undertaken in locations where the threatened plants are known to be located and so effects on them will be avoided. While there may be some short term adverse effects on native fish due to release of sediment into the areas of the estuary downstream of the CMA boundary these will be avoided as far as possible by appropriate timing of the works and design of work programmes to minimise the disruption; the long term effects on native fish are not expected to be significant. The proposed works are expected to have a positive effect on the maintenance of wading bird habitat in the estuary.

Policy 13 – Preservation of natural character

(1) To preserve the natural charcter of the coastal environment and protect it from inappropriate subdivision, use and development:

(a) Avoid adverse effects of activities on natural character in areas of the coastal environment with outstanding natural character; and

(b) Avoid significant adverse effects and avoid, remedy or mitigate other adverse effects on natural character in all other areas of the coastal environment.

The coastal environment at the Waikanae River mouth is not an area that has been identified as having outstanding natural character. The proposed works are not expected to have any significant adverse effect on the natural character of the coastal environment.

Policy 19 – Walking access

> *(3) Only impose a restriction on public walking access to, along or adjacent to the coastal marine area where such a restriction is necessary: ...*
>
> *(e) to protect public health or safety; ...*

GWRC's works in the lower reaches of the Waikanae River and Waimeha Stream will only restrict public access temporarily where necessary for public health and safety.

Policy 20 – Vehicle access

Control use of vehicles, apart from emergency vehicles, on beaches, foreshore, seabed and adjacent public land where:

(a) Damage to dune or other geological systems and processes; or

(b) Harm to ecological systems or to indigenous flora nad fauna, for example marine mammal and bird habitats or breeding areas and shellfish beds; or

(c) Danger to other beach uses; or

(d) Disturbance of the peaceful enjoyment of the beach environment; or

(e) Damage to historic heritage ; or

(f) Damage to the habitats of fisheries resources of significance to customary, commercial or recreational users, or

(g) Damage to sites of significance to tangata whenua;

might result.

GWRC only proposes to use vehicles on the foreshore and beaches in conjunction with mouth realignment work . This work is intermittent and short-lived and is not expected to have any significant adverse effects.

Policy 22 – Sedimentation

> *(1) Assess and monitor sedimentation levels and impacts on the coastal environment.*
>
> *(2) Require that subdivision, use or development will not result in a significant increase in sedimentation in the coastal marine area, or other coastal water...*

It is possible that the proposed initial gravel extraction operation will temporarily increase sedimentation rates in the Waikanae Estuary, however on balance the works will reduce the overall amount of sediment that would eventually be released into the estuary. It is expected that in the longer term the sediment will be flushed naturally from the estuary by freshes and floods. GWRC proposes to undertake monitoring in conjunction with the proposed extraction to ensure that the effects can be identified and addressed as work proceeds.

Policy 23 – Discharge of contaminants

> *(1) In managing discharges to water in the coastal environment, have particular regard to:*
>
> *(a) the sensitivity of the receiving environment;*

(b) the nature of the contaminant to be discharged, the particular concentration of contaminants needed to achieve the required water quality in the receiving environment, and the risks if that concentration is exceeded; and

(c) the capacity of the receiving environment to assimilate the contaminants; and

(d) avoid significant adverse effects on ecosysytems and habitats after reasonable mixing;

(e) use the smallest mixing zone necessary to achieve the desired water quality in the receiving environment; and

(f) minimise adverse effects on the life-supporting capacity of water within a mixing zone

The settling of sediment in the estuary area occurs naturally during times of low flow, and the sediment is mobilised and flushed out to sea during flood times on a cyclic basis. The receiving environment thus has the capacity to assimmilate temporary increased inflows of sediment. GWRC will minimise the effects of this by planning works with the objective of minimising the time that operational works are conducted in the active channel (and thus the length of time sediment will be released to the water column).

Policy 26 – Natural defences against coastal hazards

(1) Provide where appropriate for the protection, restoration or enhancement of natural defences that protect coastal land uses, or sites of significant biodiversity, cultural or historic heritage or geological value, from coastal hazards.

(2) Recognise that such natural defences include beaches, estuaries, wetlands, intertidal areas, coastal vegetation, dunes and barrier islands.

The Wellington Conservation Management Strategy (Department of Conservation, 1996) notes that continued river management works (including mouth cutting) helps to retain the natural elements of the Waikanae Estuary. Mouth realignment work also assists in the protection of the beaches and dune systems to the north and south of the Waikanae and Waimeha estuaries.

National Policy Statement for Freshwater Management 2011

This national policy statement sets out objectives and policies that direct local government to manage water in an integrated and sustainable way. Setting enforceable quality and quantity limits is a key purpose of the policy statement. Only the policies relating to water quality have relevance to this application (since there is no proposal to take water from the rivers), and in particular, Policy A4. This policy is an interim provision, requiring all regional councils to amend their regional plans to include the following requirements until changes made under Schedule 1 of the Act giving effect to Policies A1 and Policy A2 (dealing with freshwater quality limits and targets) become operative:

> *"1. When considering any application for a discharge the consent authority must have regard to the following matters:*
>
> *a) the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water and*
>
> *b) the extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with fresh water, resulting from the discharge would be avoided.*
>
> *2. This policy applies to the following discharges (including a diffuse discharge by any person or animal):*
>
> *a) a new discharge or*
>
> *b) a change or increase in any discharge –*
>
> *of any contaminant into fresh water, or onto or into land in circumstances that may result in that contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering fresh water.*

The discharges of natural silts and sediments that result from the operations and maintenance works is not a new discharge in the sense that this application is for a continuation of the works that are already undertaken on these waterways. In any event, the assessment of effects in this report illustrates that the manner in which the works will be undertaken to avoid adverse effects on the life-supporting capacity of the waterways.

10.1.4 Regulations

The following regulations are of relevance to the application:

Freshwater Fisheries Regulations 1983

Clause 70 of these regulations states:

> *"(1) No person shall in any water intentionally kill or destroy indigenous fish.*
> *(2) No person, having taken indigenous fish from any water, shall leave the fish upon the bank or shore of any stream or lake, except where such indigenous fish is used in accordance with any provisions of a District Anglers Notice relating to lures".*

The proposed works are in accordance with these requirements. No indigenous fish are or will be killed intentionally as the result of any of GWRC's works and maintenance activities, although there may be some inadvertent mortality of small fish or larvae living in the crevices of the river

bed as a result of river bed disturbance associated with construction works, gravel extraction or bed re-contouring. Overall, the significance of this effect is expected to be less than minor due to the limited extent of any such effects. No large fish are expected to be affected as they are generally able to swim away from the affected areas. It is proposed that any eels or other fish found in drains affected by drain clearing activities could be returned to the stream.

10.1.5 Regional Policy Statement

The second generation RPS became operative on 24 April 2013. The proposed works are in keeping with this RPS. The relevant objectives and policies that GWRC is required to have regard to in consideration of this application are identified in Appendix K.

An analysis of the proposal against the relevant objectives and policies is outlined below.

Coastal Environment

Objectives 3, 4, 6, 7 and 8 and Policies 35, 36, 37, 38, 40, 53 and 64

The effects of GWRC's proposed activities on the natural character and health of the ecosystems and access in the coastal environment have the potential to have adverse effects over a very limited time in the short term. However in the longer term the works are expected to have no significant adverse effect and potential positive effects that may contribute to enhancement of the character and values of this area.

Fresh water

Objectives 8 and 13 and Policies 43, 53 and 64.

Although the Waikanae River is a highly modified waterway, evidence shows that it supports a relatively healthy aquatic ecosystem that includes a diverse range of native fish, as well as a significant brown trout fishery. The proposal provides for the protection and possible enhancement of these values through the adoption of good practice at all times will continue to collect information on the effects of activities on aquatic and other ecological values and modify practices over time in response to the findings.

One of the objectives of the Waikanae River Environmental Strategy is the on-going improvement of access along the river corridor, and GWRC is committed to giving effect to this through its on-going works and activities in the river corridor.

Indigenous ecosystems

Objective 16 and Policies 47 and 64.

The approach proposed by GWRC is that the ecosystems and habitats within the application area will be maintained and in some cases enhanced. Although habitats with significant biodiversity values (such as the Waikanae Estuary Scientific Reserve) may potentially be adversely affected in the short term (e.g. by increased sedimentation in the estuary which affects the type of habitat and assemblage of aquatic fauna) such effects are within the range of effects that occur naturally from time to time in this dynamic environment. In the long term, the proposed works are expected to have no significant effect on this environment, and may contribute to maintain and enhance its values.

Natural hazards

Objectives 19 and 20, and Policies 51 and 52.

The proposed works and activities are in accord with the WFMP which has an overall key objective of minimising the risks and consequences of the effects of the flood hazard. They thus give effect to these objectives and policies. Adoption of good engineering and environmental

practice, together with on-going monitoring will provide certainty that proposed works and activities are appropriate and will not increase hazard risks.

Tangata whenua

Objectives 23 to 28 and Policies 48, 49 and 66.

As noted in relation to the NZCPS policies above, GWRC recognises the kaitiaki roles of iwi in relation to the Waikanae River and seeks an outcome that is agreeable to them which is in keeping with these objectives and policies. Initial engagement with tangata whenua is underway and will continue through the period of processing and consideration of the consent and the on-going development of the COP. Engagement will then continue through the life of the consent as the COP and monitoring are kept up to date.

10.1.6 Regional Freshwater Plan

The proposal is in accordance with the requirements of the Regional Freshwater Plan for the Wellington Region (RFP). The relevant objectives and policies that GWRC is required to have regard to in consideration of this application are identified in Appendix K.

An analysis of the proposal against the relevant objectives and policies is provided below.

For ease of reference, the following list identifies which appendices of the RFP include (or do not include) the water bodies which are the subject of this application.

RFP Appendix	Appendix Title	Are the water bodies the subject of this application included in the Appendix?	Relevant RFP policies
Appendix 2	Wetlands, lakes and rivers and their margins, with a high degree of natural character	No	
Appendix 3	Water bodies with nationally threatened indigenous fish recorded in the catchment (Part A) and nationally threatened indigenous aquatic plants (Part B)	Yes – the Waikanae River above the CMA boundary (and several tributaries in the upper catchment outside the application area) are identified in Part A (namely short-jawed kokopu and koaro). *Leptinella dioca var. monoica* (button daisy), found in the Waikanae Estuary Scientific Reserve, is included in Part B of Appendix 3.	4.2.13
Appendix 4	Water bodies with important trout habitat (including spawning areas) – water quality to be managed for fishery and fish spawning purposes	Yes – the Waikanae River, upstream of grid reference R26 807 347 (which lies approximately at XS 140 adjacent to El Rancho) is identified in Appendix 4.	4.2.14, 5.2.3

RFP Appendix	Appendix Title	Are the water bodies the subject of this application included in the Appendix?	Relevant RFP policies
Appendix 5	Water bodies with regionally important amenity and recreational values – water quality to be managed for contact recreation purposes	Yes - the Waikanae River from SH1 to the river mouth (which lies within the application area) is identified in Appendix 5, specifically for 'swimming and angling'.	4.2.15, 5.2.4 5.2.10
Appendix 6	Water bodies with water quality to be managed for water supply purposes	No (Appendix includes Waikanae River above the Water Treatment Plant only)	
Appendix 7	Water bodies with water quality identified as needing enhancement	Yes – the Mazengarb Drain upstream from its confluence with the Waikanae River (true left bank, XS 55 approximately) is included.	5.2.9

The relationship of tangata whenua with fresh water

Objectives 4.1.1 – 4.1.3 and Policies 4.2.1 – 4.2.8

GWRC seeks an outcome that is agreeable to iwi and is in keeping with these objectives and policies. It seeks to ensure that the relationship of tangata whenua with the Waikanae River is recognised and provided for. Consultation with tangata whenua is underway and will continue through the period of processing and consideration of the consent and the development of the COP.

Natural values

Objectives 4.1.4 – 4.1.6 and Policies 4.2.9 – 4.2.14

The application area is not included in Appendix 2 of the RFP, being those waterbodies that have a high degree of natural character.

One threatened plant, *Leptinella dioca var. monoica* (button daisy), found in the Waikanae Estuary Scientific Reserve, is included in Part B of Appendix 3 of the RFP. Section 3.8 notes that the reserve is also known to contain two regionally rare *Carex* species, Creeping sneezeweed (*Centipeda minima subsp. Minima*) which has the highest threat status of 'Nationally Critical', and swamp buttercup (*Ranunculus macropus*) which is in decline nationally. The proposed works will be confined to the river channel and an existing formed access road within the reserve and are not expected to have any adverse effect on the threatened (or any other) plants.

The Waikanae River upstream of grid reference R26 807 347 (which lies approximately at XS 140 adjacent to El Rancho) is identified in Appendix 4 of the RFP as a water body with important trout habitat. GWRC's method of operation, the monitoring undertaken to date and their commitment to ongoing monitoring that might be necessary to further understand and avoid or mitigate any effect of its activities on trout reflect its commitment to avoiding, remedying and mitigating any adverse effects on important trout habitat.

The practices proposed by GWRC are to be undertaken in a manner that preserves the natural character of the Waikanae River and its margins as far as practicable. Similarly the approach seeks to safeguard the life-supporting capacity of the river and its ecosystems over the long term.

The work undertaken by Massey University and Gary Williams on the natural character of the Waikanae River further reinforces GWRC's desire to further understand the natural values of the river and to ensure that they are not degraded.

Amenity value and access

Objectives 4.1.7 – 4.1.8 and Policies 4.2.15 – 4.2.17

The Waikanae River downstream of SH1 (which lies entirely within the application area) is identified in Appendix 5 of the RFP as having regionally important amenity and recreational values for swimming and angling.

GWRC's operations will be undertaken in a manner to avoid adverse effects on recreation, amenity and access. GWRC has historically avoided working in periods of peak recreational use and times works so that adverse effects on amenity and recreational use are minimised. GWRC is actively engaging with recreational groups with a view to accommodating their needs as much as is practicable.

Public access is only restricted by the applicant within defined areas for the duration of particular works for public health and safety reasons. Otherwise, the applicant does not restrict public access.

- As well as avoiding adverse effects on recreation, amenity and access, GWRC actively facilitates the use of the Waikanae River and its margins for active and passive recreation, through the development and implementation of the Waikanae Environmental Strategy.
- GWRC assists in the funding of a part-time contractor who helps FWR with maintenance works.

Flood Mitigation

Objectives 4.1.9 – 4.1.10 and Policies 4.2.18 – 4.2.22

The operations and maintenance works that GWRC undertakes and seeks to continue undertaking are essential to meeting the outcomes sought by these objectives and policies.

The activities proposed to be consented by this proposal are undertaken to contain the risk of flooding to human life, health and property to an acceptable level, in accordance with the WFMP.

The development of the WFMP represented the culmination of a significant amount of work and gathering of information to define the flood hazard associated with the Waikanae River, and to develop a programme of flood mitigation works and activities that was acceptable to the local community. The activities proposed in this application are to be undertaken in this context.

In addition to the objectives and policies, the methods (other than rules) described in Section 8.3 of the RFP require that GWRC maintains and enhances flood mitigation in river beds of the region.

Water Quality and Discharges to Fresh Water

Objectives 5.1.1 – 5.1.3 and Policies 5.2.1, 5.2.3 – 5.2.16

These objectives and policies require that the area of the Waikanae River that is the subject of this application be managed for aquatic ecosystem purposes; from the mouth to SH1 it is to be managed for swimming and angling, and upstream of El Rancho it is also to be managed as a trout fishery/for trout spawning. The area covered by the application is not listed in Appendix 2 of the RFP as requiring water quality to be managed in its natural state, nor in Appendix 6, for water

supply purposes. Nor are the rivers to be managed so that water quality is enhanced (Policy 5.2.9). Section 3.7 notes that the effects of discharges from the Maze garb Drain on the water quality in the Waikanae River have largely been addressed; although the final reach of this tributary lies within the Waikanae River corridor this application does not seek to undertake any specific works in the Maze garb Drain.

The discharges associated with the proposed works are of natural silts and sediments only. The works will be undertaken in a manner that manages the water body for its intended purpose. The COP will ensure that methodologies and times of works are developed so as to achieve this.

Water Quantity and the Taking, Use, Damming or Diversion of Fresh Water
Objectives 6.1.1 and 6.1.4 and Policies 6.2.14 – 6.2.15

Some of the works proposed require the temporary or permanent minor diversion of the watercourse for the purposes of undertaking the works. Any diversions required will be undertaken in a manner to avoid adverse effects.

Use of the Beds of Rivers and Lakes and Development of the Floodplain
Objectives 7.1.1 – 7.1.4 and Polices 7.2.1 – 7.2.15

These objectives and policies stress and illustrate the importance of GWRC's river management activities including flood protection; the ability of GWRC to continue to undertake them and to maintain existing flood protection infrastructure. The application is entirely consistent with, and gives effect to, them.

Conclusion on RFP objectives and policies

GWRC's proposal, is in keeping with the objectives and policies of the RFP and will achieve the environmental results anticipated.

The works proposed are essential to the wellbeing of the people of the Waikanae area as they protect them to an agreed level of flood protection. The objectives, policies and methods require that this occurs in a manner that provides for the avoidance or mitigation of adverse effects on the recreational and natural values of the water bodies. GWRC is committed to doing this and has proposed specific measures (outlined in this application) to be undertaken in conjunction with the proposed works to ensure this is achieved.

10.1.7 Regional Soil Plan

The proposal is in accordance with the requirements of the Regional Soil Plan for the Wellington Region (RSP).

The majority of the land in the river corridor, including the stopbanks and berms, falls outside the scope of the RSP.

The key objectives of the RSP of relevance to the proposal are:

- General - to ensure that land use practices reflect the inherent susceptibility of some landforms to erosion,
- Vegetation Cover - that vegetation cover is used wherever practical as a method of avoiding, remedying or mitigating erosion ,and
- Soil Disturbance - that sediment runoff is effectively managed.

The need to address the inherent susceptibility of river banks to erosion is an integral part of all the flood protection works that GWRC undertakes, and the reason that many of the works are undertaken. Protection of the banks from erosion is primarily effected by the use of rock protection structures, riparian planting in conjunction with bed recontouring and other channel

management practices. The use of vegetative cover to manage river bank erosion has been extensively employed in the Waikanae River, in conjunction with other methods where this is not practicable.

Generally the amount of soil disturbance associated with works out of the river bed will be limited. GWRC is committed to adopting good practice in such situations to ensure sediment runoff into the waterways is avoided as far as is possible.

10.1.8 Regional Coastal Plan

The proposal is in accordance with the requirements of the Regional Coastal Plan for the Wellington Region (RFP). The relevant objectives and policies that the Regional Council is required to have regard to in consideration of this application are identified in Appendix L.

An analysis of the proposal against the relevant objectives and policies is provided below.

General matters – Environmental

Objectives 4.1.1, 4.1.2, 4.1.5 -4.1.9, 4.1.11, 4.1.12 and Policies 4.2.1 – 4.2.4, 4.2.8 -4.2.11, 4.2.14, 4.2.18, 4.2.19 and 4.2.21

These policies and objectives seek to ensure that activities and uses in the CMA are appropriate, that adverse effects on public access, health, amenity values and important ecosystems are avoided and that land managed by DOC and included in a Conservation Management Strategy is taken into account in the consideration of resource consent applications.

GWRC's proposed activities within the CMA are limited to maintenance of existing structures at the mouths of the Waikanae River and Waimeha Stream, and realignment works at the mouths of both watercourses. These activities are appropriate in these areas, and they do not have adverse effects on access, public health or the amenity values of the area. They contribute to the reduction of a natural hazard (flooding) in the surrounding area, and they do not create any irreversible adverse effects on the natural values of the areas. The Wellington Conservation Management Strategy specifically notes that continued river management works will probably be necessary to help retain the natural elements of the Waikanae Estuary.

General matters – Tangata whenua

Objectives 4.1.13, 4.1.14 and 4.1.16 and Policies 4.4.25 and 4.2.27

GWRC seeks an outcome that is agreeable to iwi and is in keeping with these objectives and policies. It seeks to ensure that the relationship of tangata whenua with the Waikanae River is recognised and provided for. Initial consultation with tangata whenua is underway and will continue through the period of processing and consideration of the consent and the development of the COP.

General matters – Management

Objectives 4.1.18, 4.1.19, 4.1.21 – 4.1.23 and Policies 4.2.34 – 4.2.39

These objectives and policies seek to ensure there is sufficient information available on which to base resource management decisions in the CMA, that there is good communication between agencies with responsibility for management in the coastal environment and conditions on resource consents are used to avoid, mitigate or remedy adverse effects.

The activities that GWRC undertakes directly within the CMA are limited, and are unlikely to have any significant adverse effect. There is potential for the proposed initial gravel extraction operation to generate short term effects downstream of the works which may affect aquatic habitat in the CMA, within the Waikanae Estuary area. GWRC proposes to undertake a monitoring programme in association with these works to ensure sufficient information is available to

quantify and assess effects, and plans to prepare detailed excavation plans which will have minimisation of the operation of machinery in the water and consequent generation of elevated turbidity as their primary aim. GWRC is committed to on-going consultation with other agencies with responsibility for management in the coastal environment, including DOC and KCDC.

Structures – Environmental

Objectives 6.1.1 – 6.1.4 and Policies 6.2.1 -6.2.3, 6.2.7, 6.2.8 and 6.2.16

These policies and objectives aim to ensure, among other things, that structures in the CMA are appropriate, are adequately maintained and are removed if no longer necessary. GWRC maintains one groyne at the mouth of the Waikanae River, and a training wall and debris arrester at the mouth of the Waimeha Stream – all of which are necessary and appropriate for the flood and erosion protection they provide. Maintenance of these structures is in accordance with, and gives effect to, these policies. GWRC does not seek consent to construct any new structures in the CMA.

Destruction, Damage or Disturbance of Foreshore and Seabed – Environmental

Objectives 7.1.2 and 7.1.3 and Policies 7.2.1 and 7.2.2

Cutting of a new channel at the mouths of the Waikanae River and Waimeha Stream creates a temporary disturbance of the foreshore and seabed in these locations. The activity occurs in a highly dynamic environment and the effects on the morphology and habitat of the affected areas are temporary, minor and reversible. The release of water through the newly cut channel may result in elevated sediment levels immediately downstream but this effect is short-lived and minor. The proposed mouth realignment activity in the Waikanae River takes place in an Area of Significant Conservation Value (i.e. the Waikanae Estuary Scientific Reserve) but it does not adversely affect the values of this area; in fact the Wellington Conservation Management Strategy notes that river management works (which include mouth cutting) may help to maintain the natural vales of this area.

Destruction, Damage or Disturbance of Foreshore and Seabed – Management

Objective 7.1.4 and Policy 7.2.9

This objective and policy seek to ensure that activities undertaken for the well-being of the community and activities with minor adverse effects are allowed in the CMA. GWRC's proposed mouth realignment activities are entirely consistent with this.

Deposition of Substances on the Foreshore or Seabed

Objective 8.1.3 and Policies 8.2.1 – 8.2.3

These allow deposition of sand, shell, shingle and other natural material if the purpose of the deposition is to combat erosion, and the deposition does not cause any adverse effect on marine fauna or flora or human uses of the area.

River mouth realignment work involves excavation of a new channel and movement (deposition) of the excavated material to an adjacent location on the foreshore to create a bund in the old channel. There are no adverse effects on marine life or human use. This activity is entirely consistent with these policies.

Taking, Use Damming and Diversion of Water – Environmental

Objectives 12.1.1 – 12.1.3 and Policies12.2.1 -12.2.5

These objectives and policies allow take, use, damming or diverting of water in the CMA where there are no discernible effects on natural and physical values. They also recognise that positive benefits arise from diversions of rivers in the CMA for flood protection purposes.

Policy 12.2.4 seeks to ensure that any adverse effects on native fish spawning or migration in relation to such activity are avoided or remedied.

GWRCs river mouth alignment works are consistent with and in keeping with these objectives and policies. River mouth realignment work is not expected to create any adverse effects on native fish spawning or migration.

Policy 12.2.5 requires consideration to be given to the effects of any diversion in the CMA on the mauri of the coast. In relation to this, it is noted that mouth realignment works have been undertaken intermittently over a long period of time and GWRC seeks to continue this activity in a similar manner. To date no issues of note have been raised with respect to any adverse effects on the mauri of the coast. Iin keeping with these objectives and policies, consultation with tangata whenua is important and all endeavours will continue to be made to engage with iwi through the period of processing and consideration of the consent and the development of the COP.

10.1.9 Proposed Natural Resources Plan

The PNRP is the new generation combined regional plan for Wellington. The PNRP was publicly notified on 31 July 2015 and Council hearings will commence in April 2017. Until the conclusion of the necessary Hearings and any subsequent appeals, there is significant uncertainty as to the final rule provisions and objectives and policies that may be included in a Natural Resources Plan.

Therefore out of an abundance of caution, this application seeks resource consent under the Rules set out in Table 10.2 below. An assessment of the application under the themes of relevant objectives and policies is provided in Table 10.1 below. We note that confirmation of the relevance and applicability of these rules as the PNRP progresses will be discussed in conjunction with GWRC's regulatory team.

Table 10.1: PNRP Objectives and Policies

Objectives and policies theme	Objective/Policy	Comment
Mana whenua and relationships with air, land and water	Objectives 14 - 16	GWRC has established working relationships with mana whenua which recognises their connection to the air, land and water. Consultation with mana whenua has also been focussed on how the principals of kaitiakitanga can be realised through ongoing input into river management activities and cultural health monitoring.
Risk from natural hazards	Objective O20	GWRC's application relating to river management activities is focused on the Council's ability to manage risk from natural hazards and climate change in the form of flooding. This will mitigate the potential adverse effects of flooding on people, communities and infrastructure.
	Policy P29	GWRC's river management activities directly give regard to climate change and its ability to cause or exacerbate river flooding and erosion.
Riparian margins	Objective O27	GWRC's activities in relation to river management will involve establishing riparian vegetation. Other activities focused on improving flood resilience will maintain existing riparian vegetation.
	Objective O44	GWRC may be required to carry out land use activities such as earthworks as part of its river management activities. GWRC will implement appropriate measures to minimise adverse effects on

Objectives and policies theme	Objective/Policy	Comment
Earthworks and vegetation clearance		soil and water from these activities in accordance with the Good Practice guidelines set out in the COP (Annex 1).
	Policy P97	Earthworks and other land use activities will be managed to minimise discharges of sediments.
Minimising adverse effects	Policy P4	In this application, GWRC is proposing the use of good management practices during its river management activities, including timing activities appropriately and, where possible, locating the activities away from Scheduled sites.
Flood protection activities	Policy P15, P16	GWRC's river management activities are expressly provided for in policies P15 and P16. Both existing and new flood activities are recognised as being beneficial and generally appropriate.
	Policy P7	The proposed gravel extraction for flood protection and control purposes, are recognised as a form of beneficial use and development.
Managing gravel extraction	Policy P103	Gravel extraction activities will be carried out for the purpose of managing flooding and erosion and risk, and taking into account natural processes (including coastal processes).

Rules identified as relevant to the activities proposed have been identified as including (but not limited to) the following.

10.2 Proposed Rules in the PNRP

Rule	Rule wording	Activity Status
Rule R67	Discharges inside sites of significance	Non-complying
Rule R101	Earthworks and vegetation clearance	Discretionary
Rule R108	Activities in natural wetlands and significant natural wetlands	Non-complying
Rule R127	Reclamation of the beds of rivers or lakes	Non-complying
Rule R129	All other activities in river and lake beds	Discretionary
Rule R153	Removal or demolition of a structure or part of a structure	Restricted discretionary
Rule R195	Disturbance or damage inside sites of significance	Non-complying
Rule R201	Dredging for flood protection purposes or erosion mitigation inside sites of significance	Discretionary
Rule R205	Destruction, damage or disturbance inside sites of significance	non-complying

10.1.10 Section 104D

The application was lodged in April 2013. As described above, the activity status for the river management activities is discretionary under the operative plans. Therefore these consents continue to be considered, processed and decided on as discretionary activities. However out of an abundance of caution, if s104D applied the proposal will not be contrary to the objectives and policies of relevant plans and therefore meets the test of section 104D (1)(b).

10.2 Other matters

10.2.1 Waikanae Floodplain Management Plan

The role of the WFMP has been discussed in Section 2.1.

10.2.2 GWRC Long Term Plan

GWRC's Long Term Plan is a requirement of the Local Government Act 2002, and contains information about the range of activities and services the council intends to provide to meet the region's needs, along with an explanation of expenditure and funding associated with them. The LTP for 2012 -2022 was adopted by Council on 27 June 2012.

Flood protection and control works to be undertaken over the next 10 years are outlined in Part 3 of the LTP. This reflects the strategy outlined in the WFMP and provides more specific detail around scheduling and funding of the works. The capital expenditure programme for the Waikanae River is included in Table 26, while the level of funding for the overall works and maintenance programme (for all rivers in the Wellington Region, including the Waikanae River) is shown in Table 27.

From these tables it can be seen that on average, over $15M is programmed to be spent annually in the next ten years on maintenance and operational activities in Wellington rivers, while more than $2 M of capital works and upgrades, and $114,000 of works related to the Waikanae Environmental Strategy are programmed for the Waikanae River alone between 2013 and 2016.

In particular, it is of particular relevance to note also that $229,000 has been identified in the LTP for development of the new COP over the next two financial years.

The detail in the LTP provides the direction and basis for development of GWRC's annual operational works programmes.

Table 26: GWRC flood protection and control works capital expenditure programme 2012/13 to 2021/22 -Waikanae River ($)

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	Total
Kāpiti											
Jim Cook Park Stopbank	-	413,000	852,000	991,000	-	-	-	-	-	-	2,256,000
Waikanae Environmental strategy implementation	-	21,000	43,000	50,000	-	-	-	-	-	-	114,000
Kāpiti area total	1,305,000	1,832,000	1,409,000	1,561,000	1,040,000	1,013,000	497,000	394,000	407,000	421,000	9,879,000
Western area total	6,168,000	3,968,000	2,498,000	3,588,000	7,513,000	7,583,000	6,409,000	9,078,000	7,659,000	6,266,000	60,730,000

Source: (Greater Wellington Regional Council, 2012)

Table 27: GWRC flood protection works annual operating expenditure 2012/13 to 20121/22 - all Wellington Rivers ($000)

	2012/13 Plan $000s	2013/14 Plan $000s	2014/15 Plan $000s	2015/16 Plan $000s	2016/17 Plan $000s	2017/18 Plan $000s	2018/19 Plan $000s	2019/20 Plan $000s	2020/21 Plan $000s	2021/22 Plan $000s
Applications of operating funding										
Understanding flood risk	1,347	1,449	1,500	1,634	1,707	1,731	1,793	1,815	1,791	1,810
Maintaining flood protection and control works and improving flood security	10,610	11,171	11,688	12,137	13,005	13,713	14,773	15,132	16,132	16,872
Total applications of operating funding	**11,957**	**12,620**	**13,188**	**13,771**	**14,712**	**15,444**	**16,566**	**16,947**	**17,923**	**18,682**

Source: (Greater Wellington Regional Council, 2012)

10.2.3 GWRC Asset Management Plan

The GWRC Asset Management Plan (AMP) contains further detail of the level of maintenance and anticipated expenditure relating to the assets (including flood protection infrastructure) managed by GWRC on behalf of the community. The requirements of the AMP are an important input to the development of GWRC's annual maintenance works programme.

10.3 Notification

The persons considered to be affected by the proposal are iwi, KCDC, Department of Conservation, Fish & Game NZ, commercial operators (including El Rancho) and recreational users of the Waikanae River corridor. In accordance with s95A (2) (b) of the RMA, GWRC requests that the application be publicly notified so as ensure that any other persons who may be interested in the proposal can become involved and have their comments and opinions considered.

11 Summary and Conclusions

GWRC is seeking resource consents to enable the continuance of the suite of flood protection works and maintenance activities that it undertakes in the Waikanae River and Waimeha Stream. This work is undertaken to fulfil GWRC's statutory obligations in respect of flood protection and management of flood hazard, and also give effect to the requirements of the community of the Waikanae area, as outlined in the WFMP (which includes the Waikanae River Environmental Strategy). Consent is also sought for gravel extraction from the active ('wet') channel in the Waikanae River (an activity undertaken previously between 2002 and 2007), and the ability to employ other channel management methods including diversion cuts through beach areas, and ripping of riffle sections of the flowing channel.

The Waikanae River and Waimeha Stream within the application area have been managed and modified since the early 20th century. Today these watercourses flow beside significant areas of urban development and infrastructure. Despite this, the Waikanae River has generally high water quality and supports a relatively diverse fish population. It is regarded as a significant recreational resource for the region. Water quality is not routinely monitored in the Waimeha Stream, but it might be expected to be of lesser quality than that in the Waikanae River. Nevertheless, it is known to also support a range of native fish species and contain inanga spawning habitat.

The range of activities undertaken by GWRC in the Waikanae River is comprehensive, covering the construction and maintenance of structures, establishment and maintenance of vegetative plantings and river bank protection, a variety of channel management and maintenance activities including bed recontouring and gravel extraction, and mouth realignment. Activities are undertaken both in the river bed and on public land within the river corridor. In comparison, activities in the Waimeha Stream are generally limited to removal of accumulated sediment and aquatic weeds, maintenance of structures at the river mouth and mouth realignment. Many of the activities are undertaken on a relatively infrequent basis, but all of the activities identified are deemed to be necessary for the work, even if they have not been undertaken frequently in recent years.

The most extensive flood protection works in the Waikanae River are willow protection plantings, which line approximately 53% of the banks within the application area, followed by rock lining, which affects approximately 11% of the total river bank length. The activities having the most potential for environmental impact are gravel extraction and bed recontouring. Generally these occur in limited areas of the river on an intermittent, short term basis.

However as part of this application GWRC proposes an initial gravel extraction operation to remove approximately 43, 700 m^3 of gravel that has accumulated between the CMA boundary and the upstream end of Jim Cooke Memorial Park at XS 300 since 1991 (despite on-going gravel extraction over this time). The presence of this gravel has raised river bed levels and reduced the flood carrying capacity of the river channel, which in turn has increased flood risks and the frequency of works to address flood damage. GWRC considers it is preferable to undertake the initial extraction in the proposed manner rather than over a longer time to limit the impacts in terms of time and to maximise the length of time that the advantages and benefits flowing from the work will be available over the life of the new consent. This operation has the potential to create relatively short term adverse effects of some significance on the aquatic ecology of the river and on recreational and possibly commercial tourism activity over one summer period if not properly managed. GWRC proposes to manage and mitigate these effects as much as is practicable through the development of detailed extraction plans which will aim to minimise the amount of time necessary for operation of machinery in the active channel, and through on-going consultation with the affected community which will inform the optimisation of sequencing and timing of the extraction operation. A detailed monitoring programme will be undertaken in

association with these works to quantify and assess the impacts of the short term gravel extraction programme, in accordance with the requirements of the. The benefits of the proposed gravel extraction work will include lowered flood risk, and less need for works in the lower reaches of the river (meaning less disturbance of the aquatic ecology and recreational use).

The main potential adverse effects of the proposed activities (other than the initial gravel extraction programme) can be grouped into seven categories, described below.

11.1 Water quality

Adverse effects on water quality can be generated by the deliberate movement of river bed material associated with activities such as the construction of structures, bed recontouring and gravel extraction. The release of suspended sediment into the water lasts for as long as the activities are occurring, and typically gravel extraction, which may take place over a few weeks per year, is likely to have the greatest effect in this regard. Investigations have found that at their most extreme the levels of suspended sediments generated are similar to those that occur naturally during floods. Typically the effects on water quality are short lived, with the river rapidly returning to ambient turbidity levels upon the cessation of the disturbance. These effects can be avoided as far as is practicable by the adoption of good practice (as described in the COP), which involves design and planning of works prior to any on the ground activity, to ensure works are undertaken in the most effective and efficient manner.

Operation of machinery in the bed of the river has the potential for adverse effects on water quality arising from accidental fuel or oil spills. This can be avoided by the adoption of good practice that prohibits all re-fuelling and any other maintenance work involving oils, hydraulic fluid etc. from occurring on the river bed. These provisions are included in the COP.

Finally, there is potential for earthworks undertaken on the banks and river berms to generate suspended sediments in stormwater runoff from such areas. This could affect water quality in the rivers. Such effects can be avoided by the adoption of good practice, including adherence to GWRC's erosion and sediment control guidelines (Greater Wellington Regional Council, 2006) to ensure stormwater discharges from earthwork areas are appropriately managed. These provisions are included in the Code.

11.2 Aquatic ecology

The ecological effects of each activity will be site specific, depending on interactions between river channel morphology and the composition and distribution of riparian and aquatic communities in the affected reach. Some practices such as the establishment of vegetative buffer zones, willow planting and layering, and construction of rock groynes, will have mostly positive effects on river ecology, while other activities such as channel realignment by bed recontouring will have mostly negative effects (at least in the short term). (Cameron, D, 2015) notes that vegetative bank protection is by far the most widespread activity in the Waikanae River, and its effect on riverine ecology is likely to be mostly positive. Other activities with higher potential for adverse effects are undertaken on a relatively smaller proportion of the river. He concludes that when viewed as an overall package, it seems likely that net effect of all these activities on native fish and trout populations is likely to be close to neutral and that existing values will be maintained.

GWRC mitigation of bed recontouring is currently focused on incorporating final shaping of affected reaches to provide for more complexity of habitat to assist recovery. GWRC is also committed to continued investigations into the impacts of in-river works on aquatic ecology which will ultimately help to improve practice and enhance mitigation. This is reflected in the COP, which proposes on-going baseline environmental monitoring of several key ecological

variables and event monitoring for works that involve significant disturbance of the river bed in the flowing channel, such as wet gravel extraction and bed recontouring. The methodology to be used in this monitoring work is still under development. This includes the identification of thresholds and 'triggers' which if exceeded, would result in further detailed investigation or a review of the flood protection activity being monitored. The findings of such a review would determine if any changes to the Code were required.

11.3 Birds

Adverse effects on river birds are likely to be relatively minor, largely due to the absence of threatened or vulnerable species in the Waikanae River. Nevertheless, GWRC is committed to the adoption of good practice, such as provision for the possibility that threatened species may become established in future. Monitoring surveys as proposed in the COP will ensure that if any future change in bird populations occurs, this can be identified and appropriate mitigation developed.

11.4 Recreation

In the short term any adverse effects of GWRC's river management activities are most likely to be relatively minor, involving restriction of access to sections of the river or river berms. These can be avoided as far as is practicable by restrictions on the most disruptive activities (such as wet gravel extraction or bed recontouring) at times of peak recreational use at those locations. These provisions have been included in the COP.

In the longer term, the impacts on off-river recreational users are likely to be positive, as the development of the river corridor in accordance with the Waikanae River Environmental Strategy progresses.

11.5 Neighbouring community

Based on past experience and the sole recorded complaint that has been received over the past fifteen years in relation to GWRC's river works and maintenance activities, the overall adverse effects on the neighbouring community are anticipated to be less than minor overall.

Any effects are most likely to be associated with noise, and are most likely to occur in areas where residences are closest to the river corridor.

The potential for such effects can be adequately avoided by such things as:

- The restriction of activities to reasonable working hours
- Management of traffic movements
- Good communication with affected residents
- Ensuring that a readily accessible system for making complaints exists, so that any complaints can be conveyed to the appropriate staff and addressed promptly

These provisions have been included in the COP.

11.6 Cultural

Local iwi have traditionally valued the Waikanae River as a source of food and other resources; the iwi also have a wider cultural role as kaitiaki of the river, with a focus on the maintenance of its spiritual, cultural and physical values. Many of the provisions that have been incorporated in the COP to protect ecological values, such as works exclusion periods, requirements to include provision for fish passage, measures to avoid accidental fish mortality, and mitigation of adverse effects on aquatic habitat will also achieve positive outcomes in terms of cultural values.

However, GWRC also acknowledges that there are some cultural and spiritual values that are more problematic to make provision for within the current river management paradigm.

GWRC is working with the iwi to ensure that understanding of cultural issues of importance and appropriate responses to them continue to be developed, and are incorporated into the COP. This process is iterative and on-going.

11.7 Other effects

Other potential adverse effects of the works on the landscape and visual amenity values of the river corridor are considered to be less than minor, particularly in the context of the other landscape enhancement work associated with implementation of the Waikanae River Environmental Strategy that GWRC undertakes.

Overall, the long term positive effects of the suite of proposed works when viewed as a whole are significant: the direct reduction of the flood hazard and risks to life, property and the economy of the Waikanae community. They are a key component of the continued economic and social well-being of the Kapiti Coast District in particular and the Wellington Region as a whole. GWRC river management works are noted as being beneficial to maintenance of the habitat and ecological values of the Waikanae Estuary Scientific Reserve through which the river flows before reaching the coast, and to date DOC has been generally supportive of GWRC's river works programme.

GWRC is seeking a 35 year term for the new consents, and is proposing to have much of the specific detail relating to works, including work quantums, excluded from the consent conditions.

Central to this proposal is the idea that a comprehensive COP will sit alongside the WFMP, annual works programmes (and associated detailed work plans) to guide and direct GWRC's works and maintenance activities. The COP, rather than consent conditions, will provide specific detail and direction on the methodology to be adopted for individual activities. It will be a living document that reflects current good practice.

GWRC also proposes an on-going programme of research and monitoring of the key environmental effects of activities (such as gravel extraction). The outcomes of this monitoring will be subject to evaluation and review which in turn will lead to adjustments to the COP, through an agreed process. Iwi and stakeholders are and will continue to be engaged in this process.

This approach allows for informed environmental decision making through-out the life of the consent, on the best information available. The approach avoids the need to seek changes to the consent conditions at unnecessary cost to the ratepayer but provides a robust system of ensuring that the activities and methodologies used are environmentally appropriate over the 35 year life sought for the consent.

A draft COP has been prepared and is included with this application as Annex 1. Development of this document will be on-going through the application process, and beyond.

Consultation with affected parties and interested groups has been commenced in the preparation of this application, although it should be noted that the proposed scope of the gravel extraction programme has been expanded since this initial consultation. GWRC will consult further with affected parties and interested groups throughout the processing of the application as appropriate.

The proposed suite of activities has overall status as a Discretionary Activity (based on the principle of bundling activities to the highest activity status). GWRC has requested that the application be notified to ensure any other affected or interested parties have the opportunity to have input to the consideration of the application.

This application has illustrated that the proposal is in keeping with the purposes of the RMA and the objectives and policies of the regional policy statement and plans and will deliver the anticipated environmental results that the policies of the regional plans are expected to achieve. For this reason we consider that the consents should be granted.

12 Applicability

This report has been prepared for the exclusive use of our client Greater Wellington Regional Council (Flood Protection) (Flood Protection Department), with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:

.....

Pip Lee

Environmental Consultant

Authorised for Tonkin & Taylor Ltd by:

.....

Jenny Clafferty

Project Manager

Report prepared by:

.....

Ed Breese

Project Director

p:\85484\85484.001\issueddocuments\waikanae river 2016\waikanae_river_application.finaldocx.docx

References

Boffa Miskell Partners. (1992). *Waikanae River Floodplain Managment Plan: Environmental Investigations. Report prepared for Wellington Regional Council Report No WRC/R1-T-06/92.*

Cameron, D. (2015). *Effects of Flood Protection Activities on Aquatic and Riparian Ecology in the Waikanae River. Prepared for Greater Wellington Regional Council (Flood Protection).*

Death, R. & Death, F. (2013). *Ecological effects of flood management activities in Wairarapa Rivers.*

Death, R. & Death, F. (2013). *Ecological effects of flood management activities in Wairarapa Rivers. Prepared for Greater Wellington Regional Council.*

Department of Conservation. (1996). *Wellington Conservation Management Strategy.*

Greater Wellington Regional Council & Kapiti Coast District Council. (2014). *Waikanae River Environmental Strategy: An outcome of the Waikanae Floodplain Management Plan.*

Greater Wellington Regional Council. (2006). *Erosion and Sediment Control Guidelines for the Wellington Region.*

Greater Wellington Regional Council. (2010). *Waikanae Floodplain Management Plan - 10 Year Review.*

Greater Wellington Regional Council. (2012). *Long Term Plan 2012 -2022 (incorporating the Annual Plan 2012/13).*

Greater Wellington Regional Council. (2012). *Waikanae River Environmental Strategy: An outcome of the Waikanae Floodplain Management Plan.*

Heath, M. P. (2014). *Rivers State of the Environment monitoring programme. Annual data report, 2013/14. Greater Wellington Regional Council GW/ESCI-T-14/118.*

Leathwick, J. R., West, D., Gerbeaux, P., Kelly, D., Robertson, H., Brown, D., . . . Ausseil, A. G. (2010). *Freshwater Ecosystems of New Zealand (FENZ) Geodatabase - User Guide.*

McArthur, N. P. (2013). *Diversity, abundance and distribution of birds on selected rivers in the Wellington Region. GWRC Draft report.*

McArthur, N. R. (2015). *A review of coastal and freshwater habitats of significance for indigenous birds in the Welington region. Environmental Science Department, Greater Wellington Regional Council.*

McArthur, N. S. (2015). *Baseline monitoring of the birds of the Otaki, Waikanae and Hutt Rivers, 2012-2015. GWRC, Environmental Science Department.*

Miskelly, C. M. (2008). *Conservation status of New Zealand birds, 2008. Notornis 2008 Vol 55: 117-135.*

Montgomery Watson. (1998). *Resource Consent Applications for Operations and Maintenance Activities on the Waikanae River. Report prepared for Wellington Regional Council Flood Protection (Operations).*

Opus International Consultants Ltd. (2010). *Hutt River Sediment Transport - source to beach.*

Opus International Consultants Ltd. (2012). *Waikanae River Sediment Transport Phase 2A: Sediment Budget.*

Perrie A, Morar S, Milne JR, Greenfield S. (2012). *River and stream water quality and ecology in the Wellington region. State and trends. Greater Wellington Regional Council Report No GW/EMI-T-12/143.*

Perrie, A. (2013a). *Effects of gravel extraction from the wetted channel on the aquatic ecosystem of the Hutt River: a summary of macroinvertebrate data collected before and after gravel extraction. GWRC internal memo July 2013.*

Perrie, A. (2013b). *Effects of gravel extraction from the wetted channel on the aquatic ecosystem of the Hutt River: a summary of two Environmental Science Department investigations undertaken in 2012/13. GWRC internal memo July 2013.*

Pilkington, S. (2014). *Hutt and Waikanae Rivers: Sportsfish Monitoring Results 1999 - 2014. Report prepared on behalf of the Flood Protection Group, Greater Wellington Regional Council and Fish and Game NZ.*

Pilkington, S. (2011). *Hutt and Waikanae Rivers: Sportsfish Monitoring Results 1999 - 2011. Report prepared on behalf of Wellington Regional Council and Fish & Game NZ, Wellington Region.*

Pilkington, S. (2012). *Hutt and Waikanae Rivers Sportsfish Monitoring Results 1999 -2012. Report prepared on behalf of the Flood Protection Group, Wellington Regional Council and Fish and Game NZ, Wellington Region.*

TRC Tourism. (2013). *Wellington Rivers Recreational and Tourism Assessment. Report prepared for Greater Wellington Regional Council.*

Wellington Regional Council. (1997). *Waikanae Floodplain Management Plan: The Community's Plan for the Waikanae River and its environment.*

Wildland Consultants. (2015). *Fauna Survey and Mitigation of Potential Effects of Proposed Stopbank Improvements at Jim Cooke Memorial Park, Waikanae, Kaptiti Coast. Report prepared for Greater Wellington Regional Council.*

Williams, G. (1992). *Waikanae River Floodplain Management Plan: Waikanae River characteristics and sedimentation.*

Williams, G. (2013). *Western River Schemes Natural Character. Report on the Natural Character of the Rivers and an assessment of Natural Character for Scheme Monitoring. Prepared for Greater Wellington Regional Council.*

Appendix A: Consent application forms

Appendix B: Application Area & land ownership

Appendix C: Certificates of Title

Appendix D: Aerial photographs & maps

Appendix E: Cameron (2015)

Effects of Flood Protection Activities on Aquatic and Riparian Ecology in the Waikanae River. Prepared for Greater Wellington Regional Council (Flood Protection) - FINAL REPORT

Appendix F: Williams (2013)

Western River Schemes Natural Character. Report on the Natural Character of the Rivers and an assessment of Natural Character for Scheme Monitoring. Prepared for Greater Wellington Regional Council

Appendix G: TRC Tourism (2013)

Wellington Rivers Recreational and Tourism Assessment. Report prepared for Greater Wellington Regional Council.

Appendix H: MacKays to Peka Peka Expressway Project

- Figure 1.2 from the NZTA (March 2012) Assessment of Environmental Effects: Non-Technical Summary
- NZTA McKays to Peka Peka Expressway

Appendix I: Ecological Areas and Restoration Planting Areas

Source: Waikanae River Environmental Strategy 2012

Appendix J: Activity Photographs

Appendix K: GWRC works and maintenance records

- Construction of groynes (tonnage, number and location) 1999-2013
- Maintenance of groynes (tonnage and location) 1999 -2013
- Construction of rock lining (tonnage, length and location) 1999-2013
- Maintenance of rock lining (tonnage and location) 1999 -2013
- Construction/maintenance/removal of debris fence
- Construction/maintenance/removal of timber groyne
- Willow and native planting
- Tree groyne construction
- Bed recontouring ('cross-blading') – location and length 1998 – 2011

Appendix L: Draft Conditions of Consent

Appendix M: Relevant regional objectives and policies

- Regional Policy Statement
- Regional Freshwater Plan
- Regional Coastal Plan

ANNEX 1: Code of Practice (working draf

www.tonkintaylor.co.nz