REPORT

Resource Consent Applications

River Management Activities in the Otaki River, Waimanu, Rangiuru & Ngatoko Streams, Katihiku & Pahiko Drains

Prepared for
Greater Wellington Regional Council

Prepared by
Tonkin & Taylor Ltd

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Context

River management activities (including flood protection) have been undertaken in the Otaki River for over 80 years, and today the floodplain is protected by flood protection infrastructure that is valued at approximately $20M . The settlement and growth of adjacent urban areas and the development of the surrounding agricultural and rural land is dependent on an expectation that the risk of flooding is maintained at a known and acceptable level. To achieve this, management of the Otaki River together with two of its tributaries which join the river near its mouth (the Rangiuru and Ngatoko Streams), the Katihiku and Pahiko Drains on the southern side of the river, and the Waimanu Stream and Chrystalls Lagoon upstream of SH1, will continue to be required 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 made up 6% (or nearly $28 M) of the council's expenditure for the 2015/16 financial year .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.

Central to this is the idea that the new COP will sit alongside the Otaki 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 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 COP will be a living document that drives good practice while remaining flexible and responsive to the dynamic nature of the river environment.

Proposed activities

The range of activities undertaken by GWRC in the Otaki 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 river mouth realignment. Activities are undertaken both in the river bed and on land and within the river corridor. Works in the minor watercourses and drains are generally limited to removal of accumulated sediment and aquatic weeds and maintenance of outlet structures. 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.

As part of this application, GWRC proposes to extract gravel from the bed of the Otaki River, using a combination of wet and dry extraction methodologies. The amounts of gravel to be removed will be determined via regular and on-going surveys and analyses of river bed levels and sediment transport patterns; thus they are expected to vary over time. Currently it is proposed that an average of 53,500 m^3 of gravel is to be extracted annually from the areas of the river bed downstream of Chrystalls Bend. In addition, a one-off extraction of approximately 35, 000 m^3 from Mangahanene Island near the Otaki River mouth, is also proposed. Some of this latter gravel extraction will occur on a beach adjacent to the CMA, and the works may affect the edge of the CMA to a minor extent in order to form an appropriate final profile for the beach following the extraction works. GWRC does not have any existing structures in the CMA and does not seek in this application to construct any new structures in the CMA. Apart from this, works in the CMA will be limited to removal of flood debris and periodic mouth realignment.

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 currently being 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 Otaki 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 gives 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 increased occasional increases in 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 ripping and 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 incorporating final shaping of affected reaches to provide for a more natural meander form and more complexity of habitat within the river channel 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. These can largely be avoided through adoption of appropriate practice, which has been incorporated into the COP.
- **Recreation**. Adverse impacts on recreational activities are most likely to be relatively infrequent and minor, 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 Otaki River Environmental Strategy progresses. Measures such as avoidance of key recreational periods, and attention to the safety of river users have been incorporated into the COP.
- **Neighbouring community**. Based on past experience, the adverse effects on the neighbouring community are anticipated to be less than minor overall. Mitigation measures such as communication with affected residents, restrictions on operating hours and management of traffic have been incorporated into the COP.
- **Cultural**. GWRC has an established relationship with iwi and will continue to work with them to better understand their concerns, share knowledge and make provision for recognition of cultural values within the COP. This is an iterative process that is greatly assisted by the participation of an iwi representative in the Science Group. A cultural impact assessment has been requested from the local iwi but is not yet available.

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 Otaki River Environmental Strategy that GWRC undertakes in conjunction with Kapiti Coast District Council (KCDC) and community groups including Friends of the Otaki River (FOTOR).

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 Otaki River. 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.

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 Need for river management activities

River management activities (including flood protection) have been undertaken in the Otaki River for over 80 years, and today the floodplain is protected by flood protection infrastructure that is valued at approximately $20M[1]. The settlement and growth of adjacent urban areas and the development of the surrounding agricultural and rural land is dependent on an expectation that the risk of flooding is maintained at a known and acceptable level. To achieve this, management of the Otaki River together with two of its tributaries which join the river near its mouth (the Rangiuru and Ngatoko Streams), the Katihiku and Pahiko Drains on the southern side of the river, and the Waimanu Stream and Chrystalls Lagoon upstream of SH1, will continue to be required 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 made up 6% (or nearly $28 M) of the council's expenditure for the 2015/16 financial year.

The overarching vision and strategy for flood protection work in the Otaki River is contained in the Otaki Floodplain Management Plan (OFMP)[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 regional council'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 Otaki River Environmental Strategy[4] forms an important part of the OFMP and 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 and other ecological factors, access, visual amenity and recreational opportunities.

1.2 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:

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

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[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, 1998). See Section 2.2 for further details.
[4] (Wellington Regional Council, 1999)

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 Otaki River application. The work of the Science Group has resulted in the initiation of a number of new environmental investigations focused on flood protection 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 Hutt and Waikanae Rivers 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 COP 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 draft COP 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 COP 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, 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 Existing consents held and new consents sought

GWRC employs a variety of structural and non-structural methods, outlined in the OFMP, to manage the flood hazard from the Otaki River. The GWRC's Flood Protection Department (Flood Protection) has particular responsibility for management of the Otaki River bed, berms and banks[5], over an 11.4 km (approximately) reach from the river mouth upstream to the Pukehinau water level recorder, within this framework. The Council also actively manages a number of other smaller watercourses on the Kapiti Coast, including the Rangiuru and Ngatoko Streams and the Katihiku and Pahiko Drains (all of which join the Otaki River just upstream of its mouth) and the Waimanu Stream and Chrystalls Lagoon (at Chrystalls Bend upstream of SH1), for the purposes of flood protection.

GWRC currently holds resource consents WGN 980254 (01), (02), (03), (04) (05) & (06) for works and maintenance activities in the bed, and on the berms and stopbanks outside the bed, of the Otaki River downstream of the Pukehinau river recorder, and also in the bed of the Otaki River within the Coastal Marine Area (CMA). These consents expired on 22 February 2014 but have been afforded continuance pursuant to s 124 of the RMA.

This application is for resource consents to allow continuance of GWRC's operational and maintenance activities in these areas, with the addition of some new best practice methods, such as ripping of the bed in the wet channel. The consent also seeks the ability to undertake wet gravel extraction from the Otaki River. The application also covers limited works in three small tributaries (Waimanu, Rangiuru and Ngatoko Streams), Chrystalls Lagoon, and two drains (Katihiku and Pahiko Drains) that discharge to the Otaki River estuary.

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.

[5] For an explanation of these terms refer to Section 1.7.

1.5 Applicant and area covered by application

Key details are summarised below and the required forms for this application are included in Appendix A.

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, berms and stopbanks of the Otaki River, between the Pukehinau water level recorder, located approximately 300 m downstream from the Waihoanga suspension bridge (at NZTM grid reference 1785582.8 E, 5478685.0 N (approximately) and the actual position of the Otaki River mouth. Bed and banks of Waimanu Stream from the confluence with the Otaki River, approximately 1 km upstream to NZTM grid reference 1783386.42 E, 5483640.60 N (including the bed and banks of Chrystalls Lagoon). Bed and banks of Rangiuru Stream between NZTM grid references 1779855.38 E, 5487282.18 N and the mouth at NZTM grid reference 1777768.93 E, 5486245.13 N (approximately). Bed and banks of an un-named tributary of Rangiuru Stream, between NTM grid references 1778982.84 E, 5486779.97N and 1778615.94E, 5486750.00N (approximately). Bed and banks of an un-named tributary of Rangiuru Stream, between NTM grid references 1779352.58 E, 5486965.96 N and 1779797.50 E, 5487047.37 N (approximately). Bed and banks of Ngatoko Stream, between the eastern side of the Riverbank Road Extension culvert at NZTM grid reference1779297.82 E, 5486405.34 N (approximately) and the confluence with Rangiuru Stream at the Rangiuru outlet structure (NZTM grid reference 1777885.88 E, 5486263.51 N approximately). Bed and banks of Katihiku Drain, between NZTM grid reference 1777018.84 E, 5483476.14 N (approximately) and the confluence with the Otaki River. Bed and banks of Pahiko Drain, between Swamp Rd at NZTM grid reference 1778422.59 E, 5482966.57 N (approximately) and the confluence with Katihiku Drain at NZTM grid reference 1778027.41 E, 5485457.07 N (approximately).
Address for service and invoicing	Greater Wellington Regional Council Flood Protection Department Attention: Tracy Berghan

Specifically the application covers:

- Land in the Otaki River corridor downstream of the Pukehinau water level recorder;

[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.

- The bed and banks of the lowest 1 km reach of Waimanu Stream, including where the stream widens into the area known as Chrystalls Lagoon;
- The bed and adjacent banks of the Rangiuru Stream, including two of its un-named branches;
- The bed and adjacent banks of the Ngatoko Stream, downstream of the culvert under Riverbank Road Extension;
- Katihiku Drain;
- Pahiko Drain; and
- The parts of those rivers and streams lying within the CMA.

Aerial photographs showing details of the application area and land ownership are provided in Appendix B. Further details are included below.

1.5.1 Otaki River corridor

The Otaki River corridor comprises the river bed and adjacent land. The river corridor extends from the Pukehinau water level recorder downstream to the CMA boundary. Chrystalls Lagoon and the majority of the sections of Waimanu Stream included in the application also lie within the Otaki River corridor. In addition, GWRC maintains the bed of Waimanu Stream for approximately 100 m outside of the river corridor.

Figure 2 (below) gives an indication of publicly and privately owned land within the river corridor; further details are shown on the maps in Appendix B. The majority of the land in the river corridor is in public ownership, and is administered by Greater Wellington Regional Council and Kapiti Coast District Council. However, significant areas upstream of SH 1 are privately owned, and there is also one area in private ownership on the left bank upstream of the river mouth. Certificates of Title relating to the Otaki River are included in Appendix C.

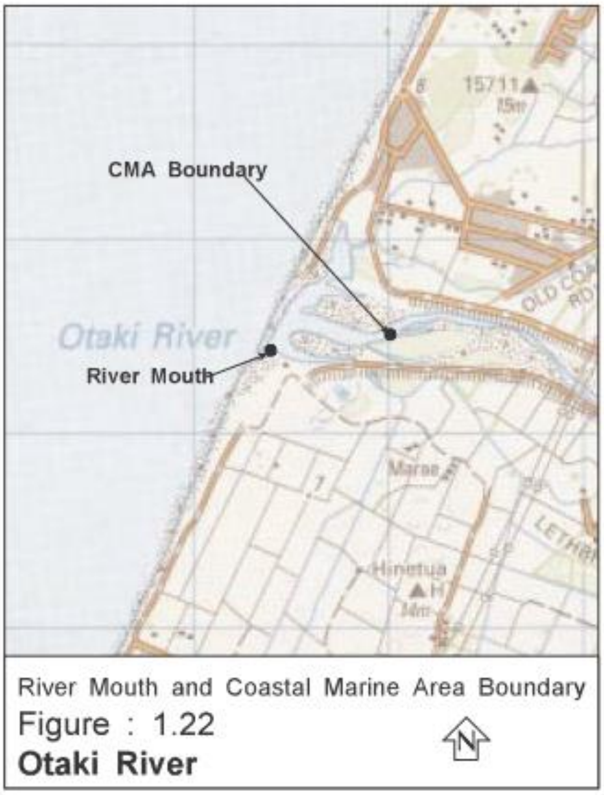
1.5.2 Minor watercourses

The application covers the bed and banks of Rangiuru and Ngatoko Streams and Katihiku and Pahiko Drains, which principally flow through private land lying outside the river corridor. Titles for this private land are also included in Appendix C.

1.5.3 Otaki River mouth

The mouth of the Otaki River forms the downstream extent of the application area.

Appendix 1 (River Mouths) of the Regional Coastal Plan for the Wellington Region (RCP) defines the position of the Otaki River mouth at grid reference NZMS 260 R25 875 776, which is incorrect as this point lies several kilometres off the coast to the north. The position of the river mouth is also depicted in Figure 1.22 of the same RCP Appendix 1, as shown in Figure 1 below. Changes in the position of the river mouth since the publication of the RCP means that the actual position of the river mouth does not correspond with this point. This application seeks to recognise the dynamic nature of the position of the river mouth by avoidance of a fixed definition for this point.



Topographic Information is Copyright LINZ

Figure 1: Location of Otaki River mouth and the CMA boundary as defined in the RCP

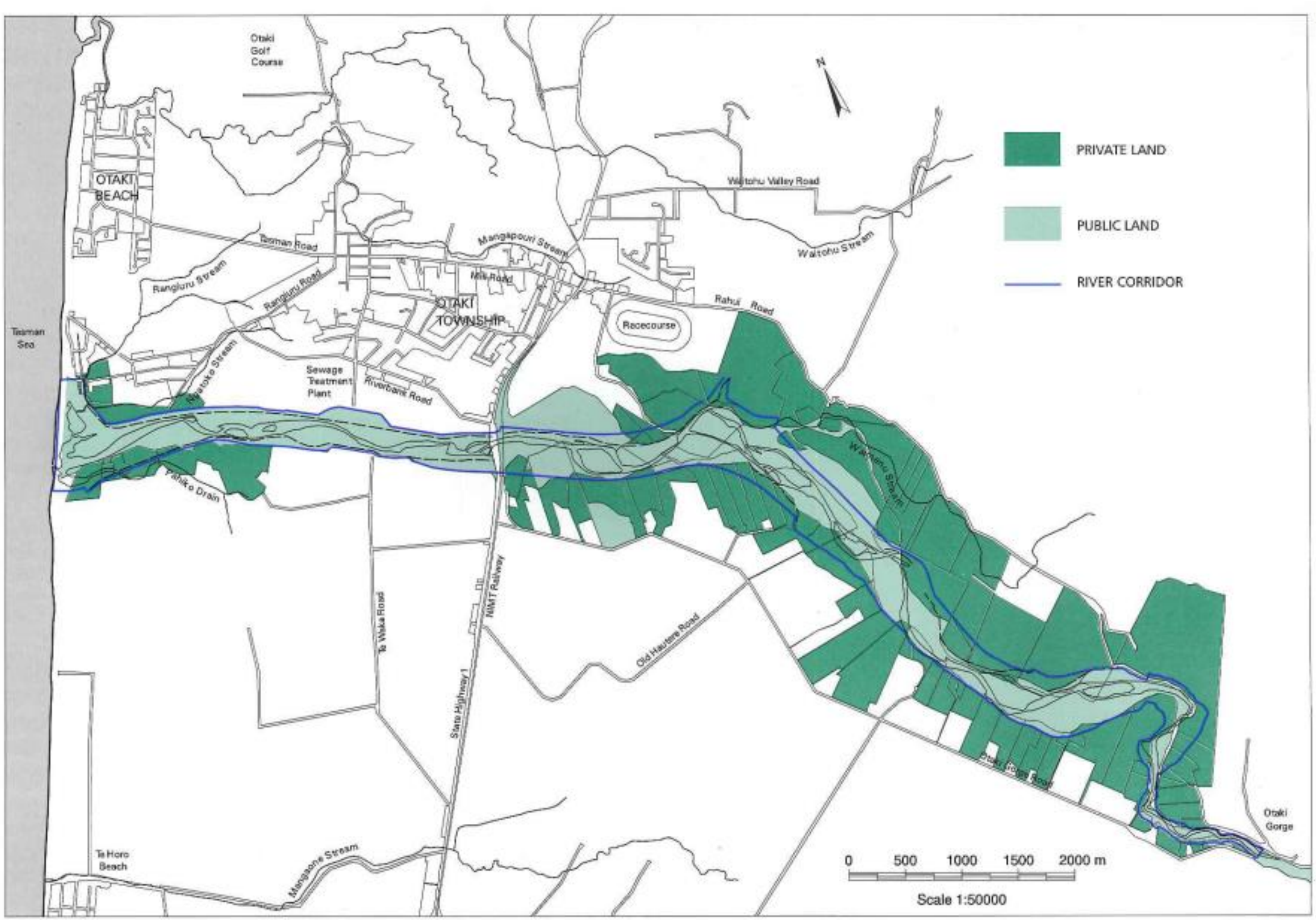


Figure 2: Land ownership in the Otaki river corridor. Source: Figure 9 in Otaki Floodplain Management Plan

1.5.4 Rangiuru Stream mouth

Reference to the aerial photographs in Appendix D shows that the Rangiuru and Ngatoko Streams converge at the outlet structure located under the road extending south from the end of Kapiti Lane. After passing through the structure, the stream (known as Rangiuru Stream) flows for a further 130 m to discharge to the northern part of the Otaki River estuary. The mouth of the stream is considered to lie at this point.

1.5.5 Coastal marine area

The CMA boundary within the Otaki River is defined in the RCP at a point at grid reference NZMS 260 R25 880.475, which corresponds to NZTM 1777982.5E, 5485785.7 N. This point is depicted in Figure 1.22 of Appendix 1 of the RCP – see shown in Figure 1 above. It lies approximately 500 m upstream of the current river mouth position.

The CMA boundary in relation to the Rangiuru Stream lies at a point approximately 50 m upstream of the mouth[8], which is approximately 80 m downstream of the Rangiuru outlet structure.

1.6 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.

The prescribed activity status for each activity varies 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 consents sought

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 Rule 44 – Removal or demolition of structures Rule 48 – Placement of impermeable erosion protection structures Rule 49 – All Remaining Uses of River Beds	Construction in/on the river bed of: • impermeable erosion protection structures • rock/concrete grade control structures • drainage channels and minor culverts associated with walkway developments Construction in/on the river bed of: • permeable erosion protection structures: • debris fences • debris arresters Planting of willows in the river bed Layering, tethering and cabling of willows in the river bed Recontouring of the river bed Mechanical loosening (ripping) of river bed Excavation of channel diversions in the river bed Shaping and repair of bank edges Trimming or removal of vegetation from the river beds

[8] This point is calculated according to the manner prescribed in section 2 of the RMA, namely the lesser of 5 times the width of the river mouth or 1 km. The width of the Rangiuru Stream mouth is approximately 10 m.

Type of Consent	Relevant Plan & Rule	Activities
		Clearance of flood debris from the river beds, stream culverts and Chrystalls Lagoon Extraction and removal of silts and gravel from the river bed and Chrystalls Lagoon Maintenance, repair, replacement, extension, addition, alteration of structures on the river bed Demolition and removal of structures from the river bed Construction of footbridges Undertaking of urgent works in the river bed 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 Disturbance of vegetation on berms, including mowing Excavation, disturbance of, and deposition of material on the land (beach) above mean high water springs sea level adjacent to the CMA in the Otaki River
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 Discharge of stormwater into surface water associated with works outside the river bed
Coastal Permit	RCP Rule 40	Any activity involving destruction, damage or disturbance of foreshore & seabed associated with: • removal of flood debris • gravel extraction on beaches adjacent to the CMA • urgent works • mouth cutting
	RCP Rule 48	Deposition of sand, shingle, shell or other natural material on foreshore or seabed associated with activities noted in RCP Rule 40 above

Type of Consent	Relevant Plan & Rule	Activities
	RCP Rule 61	Discharge of a contaminant or water into water in the CMA, outside any Area of Significant Conservation Value associated with activities noted in RCP Rule 40 above
	RCP Rule 76	Take, use, damming or **diversion** of water outside any Areas of Significant Conservation Value associated with activities noted in RCP Rule 40 above

Consent is sought for GWRC's complete suite of flood protection operations and maintenance activities, as outlined in Table 2 above. It should be noted that some of these activities are classed as permitted activities to a certain threshold. For information purposes these are listed in Table 3 below.

Table 3: Permitted activities in the current regional plans

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 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	Recontouring of beaches in the river bed Removal of vegetation/ 'scalping' of beaches in the river bed
RFP Rule 39	Maintenance of drains
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
RCP Rule 6	Maintenance, repair, replacement, extension, addition or alteration to or of structures including associated disturbance of foreshore or seabed
RCP Rule 7	Removal or demolition of structures including associated disturbance of foreshore or seabed
RCP Rule 28	Clearance of piped stormwater outfalls in the CMA

Relevant Plan & Rules	Permitted Activities
RCP Rule 29	Beach grooming and recontouring
RCP 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 the Otaki River mouth, in accordance with triggers defined in Table 7.1 of the RCP and provided the foreshore is not disturbed to a depth greater than 1 m below the natural water table or to a width > 5m
RCP Rule 53	Discharge of stormwater from any structure in the CMA

1.7 Interpretation

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

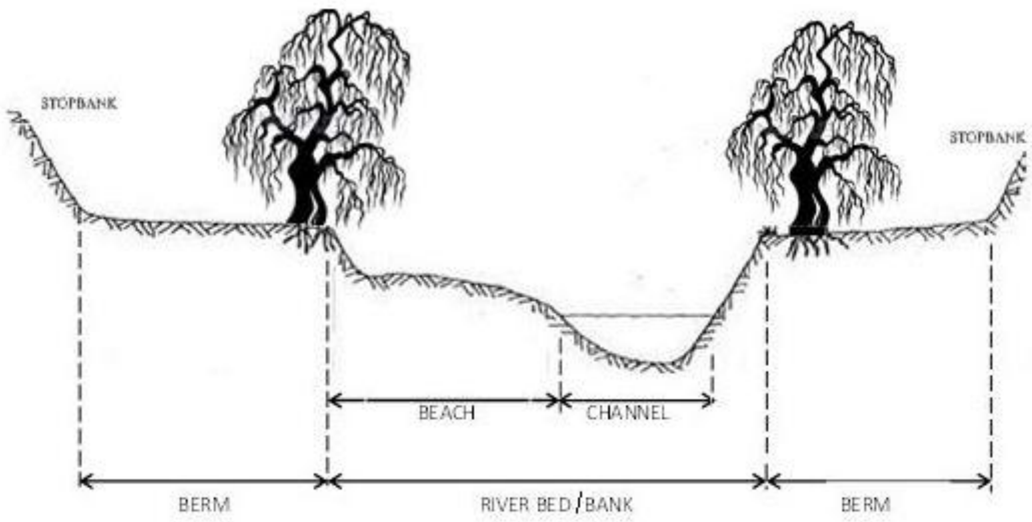


Figure 3: Explanation of terms

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 3 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 3 for a visual representation.
Beach ripping	Neither the RMA nor the RFP define this. For the purposes of this application it is defined as **'mechanical disturbance of beaches above the active channel for the purpose of loosening the gravel material to enable its mobilisation during flood events'**.
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 3 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 Historical perspective

Until approximately 100 years ago, the form of the Otaki River was determined by the interplay between climate, hydrology and the geology and form of the surrounding landscape; as such it was free to meander across its floodplain in response to changes in these factors over time. Over this time, tangata whenua and early European settlers had no choice but to adapt their patterns of settlement and use of the river and adjacent land in accordance with, and in response to, the behaviour of the river. Later, increased settlement of the Otaki floodplain in the late 19th and early 20th centuries was associated with rapid clearance of the original lowland forest and drainage of wetland areas. In turn this led to increased runoff and subsequent increased river bank erosion. Significant flood events were recorded in 1854, 1904, 1906, 1920, 1925, 1926, and 1931 (4 separate events). Attempts to manage the flood hazard from the Otaki River date from 1923, and response to the 1931 flood events saw major stopbank construction and groyne works being carried out in the upper part of the river, between the railway and Otaki Gorge.

The failure of these works subsequently led to construction of a more comprehensive flood control scheme by the Manawatu Catchment Board, between 1945 and 1955. This scheme comprised stopbanks, drainage works and channel alignments, with a focus on confinement of the river channel, which required continual and costly maintenance. In 1946 the Tower Dredge was used to excavate thousands of cubic metres of gravel from the river in the reach downstream of SH1, lowering the river bed by 2 m and narrowing and straightening the former braided river channel, from 600m across to 250 m across, in the process. The excavated material was used to construct the stopbank on the true right of the river. River control work was extended upstream of SH1 in late 1948. By 1992 it is reported that a total of $17.4M (in 1992 dollar terms) had been spent on the Otaki Flood Protection Scheme (Montgomery Watson, 1998). Of that, $1.5M had been spent on stopbanks, $2M on drainage works and $13.9M on erosion control and channel alignment. Much of this expenditure was funded by government subsidies, which were eventually terminated in 1990.

Despite this investment, the scheme did not provide secure protection from flooding; for example, in 1955 the Chrystalls Bend stopbank was over-topped by a medium sized flood (approximately 3% annual return probability), and in March 1990 Rangiuru was inundated by a comparatively minor flood. In addition, there was constant concern over the ability of stopbanks to withstand erosion from the river and the risk of their structural failure during a major flood.

Gravel extraction was the principal tool used by the Manawatu Catchment Board to maintain channel alignment between 1960 and 1980, and became closely associated with a commercial extraction industry. In the mid 1970's it became clear that the extraction rate far exceeded the replenishment rate and was leading to degradation of the river bed and contributing to failure of protection works. By 1984 the Manawatu Catchment Board reached an agreement with commercial operators to gradually reduce their annual gravel take. Between 1967 and 1991, a total of 3,113,000 m^3 of gravel was extracted, with approximately 32% taken from below the SH1 bridge, and the remainder from upstream of the bridge (G & E Williams Consultants Ltd, 1992).

By the late 1970's the Manawatu Catchment Board had also come to the realisation that it was not feasible to try to train the river to a confined single-thread channel. A review in 1978 recommended abandonment of this approach, and allowing the river to meander naturally within as wide a corridor as possible. This approach was adopted and has been maintained subsequently.

2.2 The Otaki Floodplain Management Plan

In 1991 GWRC initiated studies and consultation to develop a Floodplain Management Plan, in response to the continuing high cost of river management works, concerns over their effectiveness and an increasing understanding by local authorities that new methods were required to address ever increasing demand for security from flooding.

The Otaki Floodplain Management Plan (OFMP) was published in June 1998, and was the result of a collaborative effort by GWRC, Kapiti Coast District Council, the Otaki community and Ngati Raukawa. The Plan is intended to be a living document, providing a blueprint for management of the Otaki River and floodplain (and the Waitohu and Mangapouri Streams to the north) over a 40 year timeframe (i.e. to 2037). It was intended that the Plan would be reviewed every 10 years; at this stage this is scheduled for 2014/15.

The OFMP proposes three principal methods to reduce the flood hazard from the Otaki 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 Otaki floodplain and have been included in the Kapiti Coast District Plan, to ensure new development is appropriate to the level of flood hazard. In addition, the OFMP ultimately aims to have all land in the river corridor in public ownership.
- Structural methods, required to provide an agreed level of protection (based on a 1 in 100 year flood) to existing development on the Otaki floodplain, including:
  - Stopbanks
  - Outlet structures
  - House raising
  - Bridge raising (Waitohu Stream only).
- 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 OFMP also proposed preparation of an Environmental Strategy, which was subsequently published in 1999, to provide an overall framework for environmental outcomes to guide all agencies and individuals undertaking activities in the river corridor. The Otaki River Environmental Strategy (Wellington Regional Council, 1999) defines a vision for development of the Otaki River corridor as a greenbelt which will function as a visual link and ecological corridor from the Tararua Ranges to the coast. Its sets out a plan for planting and other work that will, over time increase the volume and diversity of indigenous species and natural ecological processes and systems, as well as improving public access and recreational opportunities in the river corridor. This work is undertaken by GWRC in conjunction with KCDC, DOC and community groups, particularly FOTOR.

2.2.1 Design Standard

The OFMP identifies the 100 year event as the design standard for structures within the Otaki floodplain. New stopbanks are designed to this standard, and are a minimum of 4 m wide at the top, with batters of 3.5:1, and a 5 m wide access strip on either side.

The design standard makes an allowance for a 5 mm/year rise in sea level.

2.2.2 Preferred channel alignment

The OFMP defines a preferred channel alignment for the Otaki River, which has been developed based on the dominant flow regime and an assessment of the river's natural meander patterns. This provides an appropriately wide channel to convey flood flows, and also to allow the major and minor channels to meander within it.

The preferred alignment is shown in Figure 4, and is described as follows:

- River mouth to rail bridge: dominant flow channel 150 m wide, with 40 m berms;
- Rail bridge to Chrystalls Bend: modified dominant flow channel 180 m wide with 80 m berms; and
- Chrystalls Bend to Otaki Gorge: fairway channel 255 m wide with 80 m berms.

The preferred channel alignment (design channel) is also marked on the aerial photographs in Appendix D, which shows it in more detail. It can be seen that in some places the river does not currently sit on the design alignment.

It is GWRC's intention to use a combination of both structural and non-structural methods to establish and hold the Otaki River on its design alignment. If the river meanders outside this in response to flood events, channel maintenance activities will be used to restore it to the preferred course.

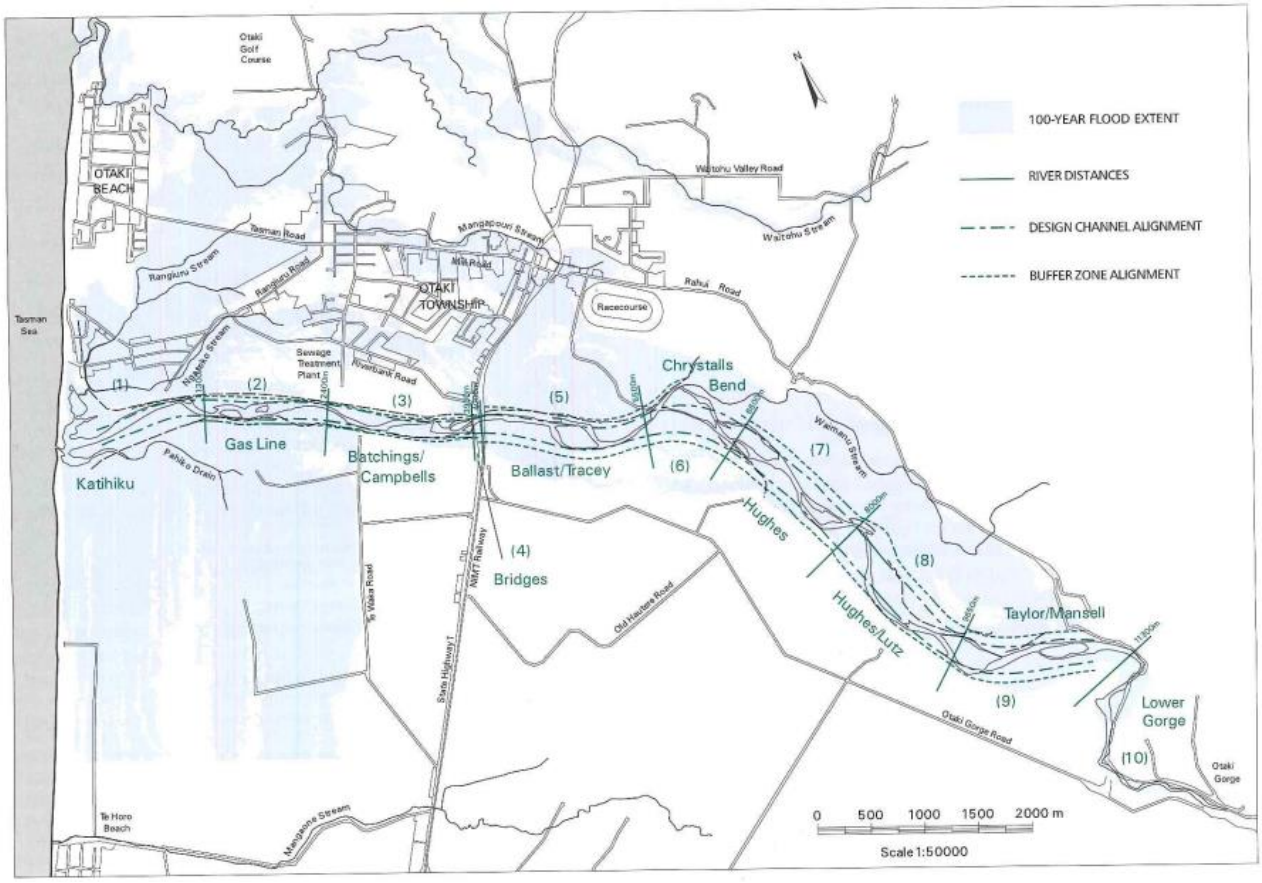


Figure 4: Preferred channel alignment. Source: Otaki Floodplain Management Plan

2.2.3 Design meander

A preferred design for the river channel meander patterns and associated beaches, within the overall preferred channel alignment noted above, has been developed for GWRC by consultant Gary Williams. These are shown in Figures 2A to 2C in Appendix E.

This design is based on the natural form of the low flow channels and beaches that can be observed forming on the recession of flood events, and aims to maintain reasonably well-formed and consistent channels to minimise the erosive forces on the banks during floods. The design can be used to guide the location and type of structural and in-channel works that are needed to maintain the prescribed channel form, and reduce areas of erosion pressure. At the same time, establishment of the design meander offers an opportunity for improvement of the natural character of the river form and an enhancement of the pool and riffle sequences within the river.

Williams' work has determined that in the reaches downstream of SH1, a consistent meander pattern can be achieved and the existing river edge protection works generally fit with this meandering channel. The one exception is the long rock lining along the right bank (XS 120 to XS 180), which is not on the preferred channel alignment. A relatively consistent meander pattern also exists from SH1 upstream to where the river is deflected by the high terraces on the left bank (Mansell property – XS 1020) although the wider fairway channel in this section of the river allows for greater flexibility in the channel form, with some tendency for channel splitting and meander migration. The highest area of channel instability exists at the cliffs lying between where the river exits the gorge (XS 1040 approximately) and Mansells Bend (XS 990 approximately).

2.2.4 Optimum bed levels

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

The OBLs take into account factors such as:

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

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

- 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 Otaki River will be managed, and future decisions relating to gravel extraction (volumes, locations and extraction rates) 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. Accordingly, it is expected that the volumes of gravel and the locations from which extraction takes place will also be adjusted over time.

2.2.5 Survey cross sections

GWRC conducts five-yearly cross-sectional surveys of the Otaki River at locations approximately 100 m apart along the reaches downstream of the Pukehinau water level recorder. These are marked (as XS nn) on the aerial 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 latest available data is from the survey undertaken in 2010/11; the next survey is scheduled for the 2015/16 financial year.

The application area extends between XS 00 (at the river mouth) and XS 1140 – i.e. over a distance of 11.4 km (approximately).

2.3 Scale and impacts of flood hazard

The OFMP contains maps showing the likely extent of flooding associated with a 1 in 100 year flood event and for a flood 50% larger than a 1 in 100 year event[10]. At the time of publication (1998), the Plan estimated a figure of $1.9M for annualised flood damages[11]; the figure is likely to be much higher today.

In addition to financial costs, the risks to life and property from flooding in the Otaki 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 Otaki River has been identified in the OFMP 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.

[10] Figures 1 and 8 in (Wellington Regional Council, 1998)
[11] An economic technique for estimating the average annual cost of flood damage, or annual economic losses caused by floods.

2.4 Existing consents

Resource consents currently held by GWRC for operations and maintenance works are listed below.

Table 4: Existing resource consents

Consent No WGN 980254	Purpose	Granted	Expiry
(01) Land Use	To undertake routine operations and maintenance in the bed of the Otaki River, including construction, repair and maintenance of bank protection works, maintenance and extension of existing structures, repair of river berms and stopbanks, removal or demolition of obsolete structures, bed contouring, flood relief cuts, gravel extraction, tree planting, layering and tethering, beach scalping, clearance of flood debris, vegetation removal, beach contouring and contingency works.	22 February 1999	22 February 2014
(02) Land Use	To undertake routine operations and maintenance activities on berms and stopbanks outside the bed of the Otaki River and the coastal marine area, including repairs, reconstruction and maintenance of stopbanks and berms, and contingency works.		
(03) Water Permit	To temporarily and permanently divert the normal flow of the Otaki River during, and as a result of undertaking river operation and maintenance activities.		
(04) Discharge Permit	To discharge silt and natural stream bed sediments into the Otaki River during, and as a result of, 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 the river beaches.		
(06) Coastal Permit	To undertake routine operations and maintenance in the bed of the Otaki River located in the coastal marine area, including clearance of flood debris, bed recontouring, flood relief cuts, gravel extraction, river mouth realignment, maintenance of existing structures, and contingency works.		

Compliance reports held by GWRC for consent WGN 980254 show that, apart from two late submissions of the annual report (in 1999/2000 and 2010/2011) there has been full compliance with the consent conditions.

3 Existing Environment

This section describes the various components that make up the existing environment. The available information generally only covers the Otaki River. Information on the Waimanu, Rangiuru and Ngatoko Streams, and the Katihiku and Pahiko Drains is scant, and this appears to be a function of their highly modified nature, small size, and limited access (as they mostly lie on private land).

3.1 Tangata whenua

The iwi of Ngati Raukawa ki te Tonga hold mana whenua over the land within which the application area lies (see Figure 5). There are five hapu with a direct interest in the river, and they are collectively referred to as Nga Hapu o Otaki.

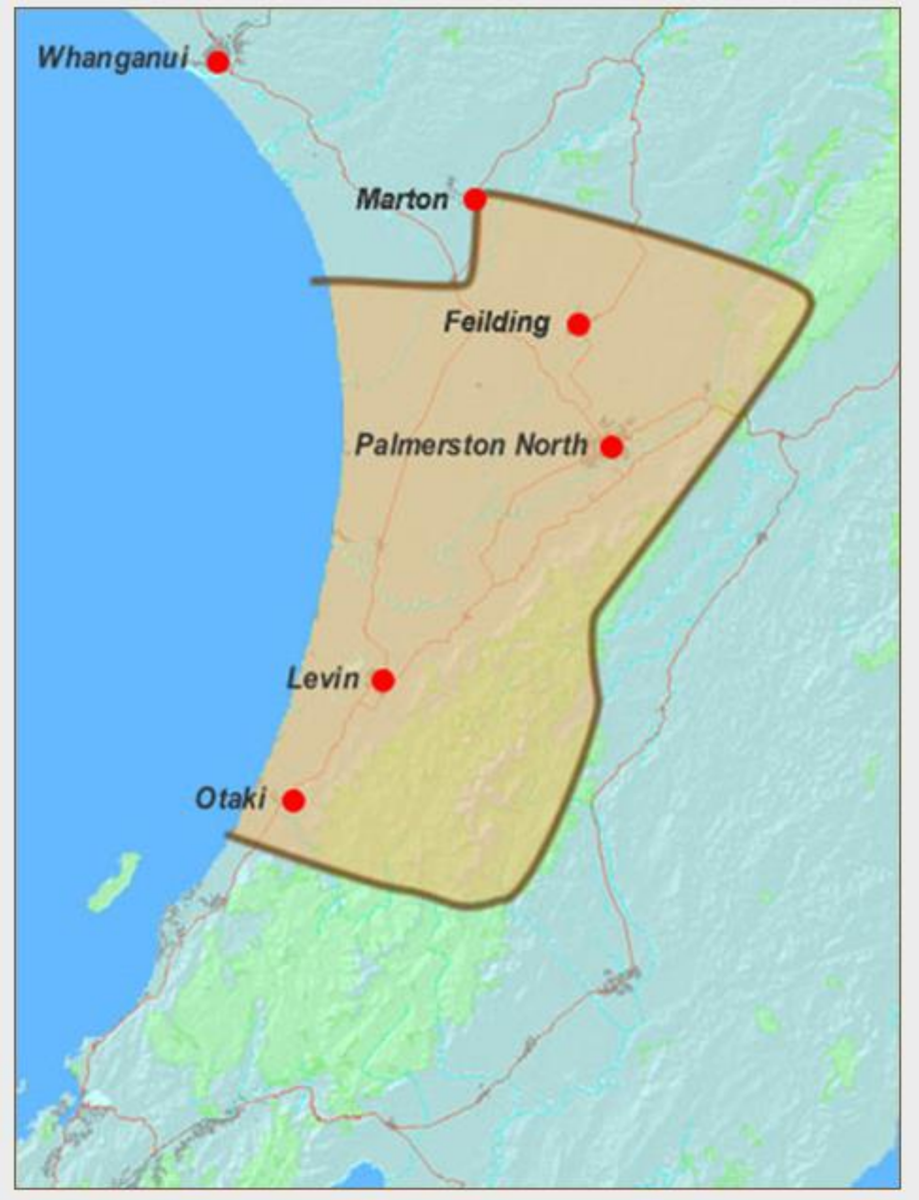


Figure 5: Rohe of Ngati Raukawa ki te Tonga. Source: www.tkm.govt.nz

The directory on the website of Te Puni Kokiri 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 Otaki 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 the purposes of the RMA.

3.2 Catchment overview

The Otaki River is the largest of the rivers in the western part of the Wellington Region. It arises in the south-western foothills of the Tararua Range, and emerges from the upper catchment via a series of gorges and flows westwards across the coastal plain before discharging via an estuary to the Tasman Sea. The river is approximately 57 km long, and the extent of the catchment, covering a total area of 345 km², is shown in Figure 6. The catchment is the largest of all catchments draining the western side of the Tararua Range, and is approximately three times the size of the neighbouring Waikanae River catchment. Almost 90% of the catchment is mountainous or steep hill country, with the remaining 10% covering the low lying coastal plain and estuary.

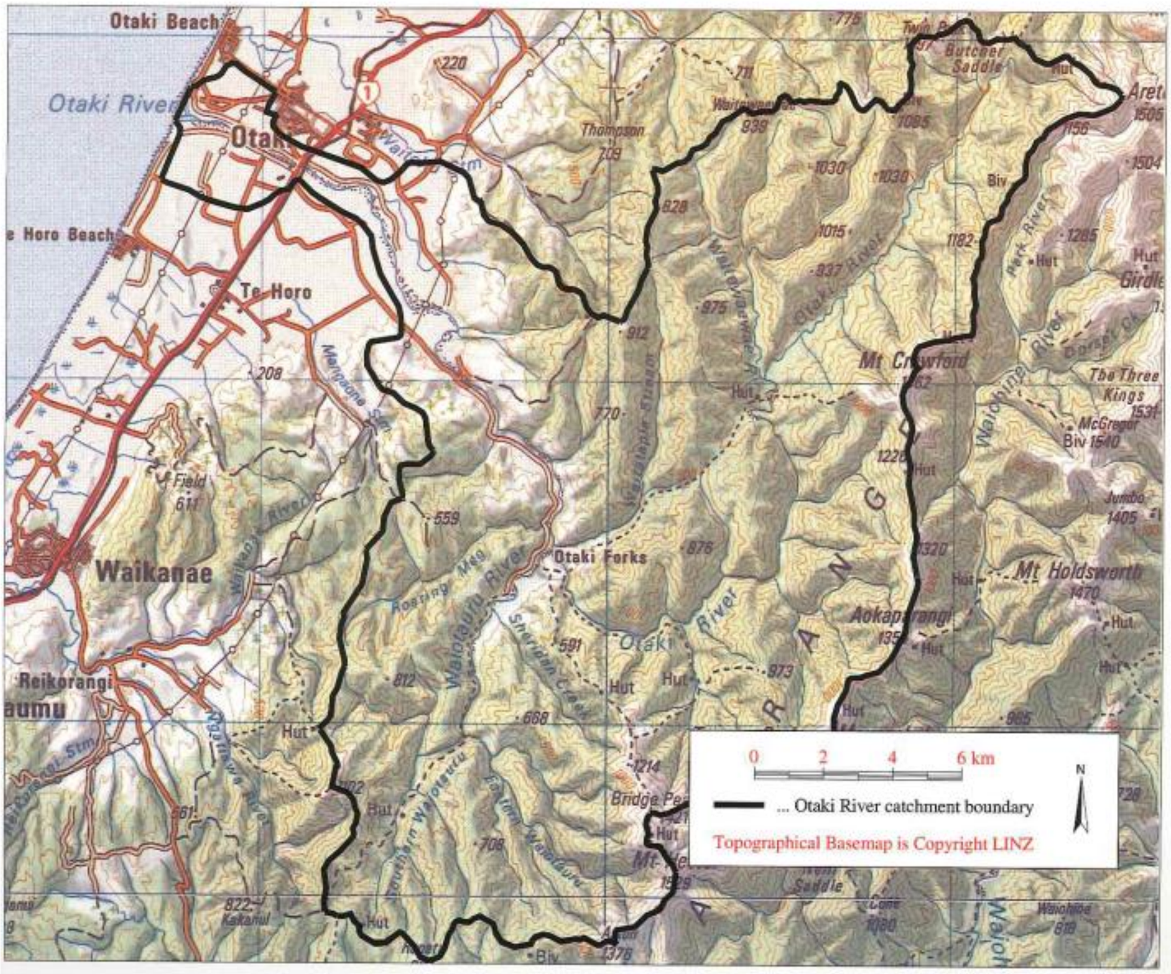


Figure 6: Otaki Catchment. Source: (Wellington Regional Council, 1998)

The application area covers the lower section of the river across the coastal plain, a distance of 11.4 km approximately.

The main tributaries of the Otaki River are the Waitewaewae River, Kahiwiroa Stream, Whatiuru Creek, Penn Creek, Waiotauru River, Waitatapia River, Pukeatua Stream (Roaring Meg) and Pukehinau Stream, which all lie upstream of the application area.

On the coastal plain, within the application area, there are some minor spring-fed channels that join the main river within 1-2 km of the gorge, but the only tributaries of note are the Waimanu (Rahui) Stream, which joins the river on its true right bank approximately 2 km upstream of SH 1, and the Ngatoko and Rangiuru Streams, which flow to the river just upstream of its mouth. The river also has numerous other un-named minor tributaries.

3.2.1 Waimanu Stream

Waimanu Stream drains an area of foothills and river terrace lying in the vicinity of Rahui Rd, on the eastern side of the Otaki River upstream of SH 1. In its lower reaches the stream flows through Chrystalls Lagoon on the true right bank of the river within the floodplain in an area known as Chrystalls Bend. This lagoon is a man-made structure formed during construction of the flood protection works at Chystalls Bend. Waimanu Stream flows for a further 200 m (approximately) after exiting the lagoon before entering the main channel of the Otaki River at the downstream end of the bend.

3.2.2 Rangiuru Stream

Rangiuru Stream is a small branched stream, flowing in a well-defined, entrenched (and highly modified) channel across the lower part of the coastal plain lying to the west of Otaki township. Its longest (northern) branch is approximately 2.5 km in length, and the stream flows in a generally south-westwards direction, passing under Rangiuru Rd (between the residential areas of Rangiuru and Otaki Beach before flowing southwards for a short distance to join with the Ngatoko Stream.

The combined streams then flow via a controlled outlet fitted with floodgates under Kapiti Lane (see photograph in Appendix I), for a further 130 m through the coastal dune to the part of the Otaki estuary located on the northern side of the main channel of the Otaki River. The floodgates have been modified to slow the rate of closing on the incoming tide to give more time for fish to move from the sea into the Rangiuru catchment.

3.2.3 Ngatoko Stream

Ngatoko Stream is a small stream approximately 2 km long, which flows across the plain immediately to the north of the Otaki River. It skirts around the southern side of the settlement of Rangiuru, passing under Riverbank Road Extension, and Old Coach Rd, before joining with Rangiuru Stream, on the eastern side of Kapiti Lane (as noted in Section 3.2.2 above).

3.2.4 Katihiku and Pahiko Drains

The Katihiku and Pahiko Drains form part of a drainage system constructed across the coastal plain to the south of the Otaki River, including an area known as the Whakapawaewae wetland. The ecological assessment report that supports this application (Cameron, 2015), which is included in Appendix G, notes that this wetland is an ecologically important remnant of a once more extensive wetland which stretched across the coastal plain between the Otaki and Waikanae Rivers. Both drains are deep and steep-sided (see photograph in Appendix I). The more westerly, Katihiku Drain is approximately 2.5 km long, and the Pahiko Drain, which joins the Katihiku approximately 200m upstream of the Otaki River southern stopbank is approximately 3.3 km long. The Katihiku Drain exit is controlled via a floodgate through the stopbank (see Appendix I).

3.3 Otaki River character

The earliest plan records dating from the 1870's show that the Otaki River had multiple highly mobile channels particularly near the river mouth and in the area of high terraces upstream of Chrystalls Bend. Since that time the river has been highly modified. Downstream of the SH1 bridge, a straight channel was cut to the sea in the 1940's, with large amounts of gravel extracted from the bed to form stopbanks. Between these stopbanks the river has been confined within an imposed channel that has been maintained by rock lining, debris fences, groynes and vegetation establishment on the channel edges and other management methods such as in-channel shaping and gravel extraction. Initially, the reaches upstream of SH1 were also confined by scheme works to a relatively narrow channel, but later changes in policy allowed a wider channel to develop, and vegetated islands within the channel were cleared. A major realignment at Chrystalls Bend was part of this development.

The meander pattern of the channel is a mix of minor and major meanders, which continue to form regardless of imposed channel constraints, but which are distorted by them (G & E Williams Consultants Ltd, 1992). At moderate flows the river has a semi-braided form, and at low flows, it is a single thread channel with alternating gravel beaches.

The river flows to an estuary at its mouth, and has a direct opening to the sea through a sand and gravel spit formation. The mouth is enlarged by flood flows, and then reduced by coastal longshore movement of sediment. The tidal influence in the river extends a few hundred metres upstream from the coast, and not as far as the GWRC monitoring site located 650 m upstream of the river mouth (Cameron, *pers. comm.).*

The gradient of the river bed flattens over the short reach where it goes through the 'S' bend (at Mansells) after leaving the gorge, and then steepens again to a relatively uniform 5 m/km across the coastal plain. It flattens out again over the final 500 – 800 m reach through the estuarine zone.

The Otaki River can be described in five broad landscape character reaches, identified in (Montgomery Watson, 1998) and (Wellington Regional Council, 1999), and summarised below.

3.3.1 Lower Otaki gorge reach

This area extends from the Pukehinau water level recorder on the true right bank of the river (located approximately 2.5 km downstream of the Pukehinau River confluence), approximately 1 km downstream to the NIWA cableway across the river. In this reach the river flows through a deeply incised valley with exposed greywacke bedrock. The cliffs are topped with a mix of exotic and native vegetation.

3.3.2 Rahui reach

This reach covers an approximately 2 km length of the river where it emerges from the narrow gorge and bends 90^{o} westwards around the Mansell property on the true left bank. Cliffs enclose the river on both sides at the bend, and these cliffs (Hautere cliffs) continue along the south bank, whereas the land on the north bank opens to an outwash plain. Over this reach the river broadens, and begins to form a braided pattern.

3.3.3 Upper Otaki reach

Covering almost 6 km, this reach extends from the bend downstream of the Mansell property to the railway bridge. The Hautere cliffs at the upstream end of the south bank are a distinctive landscape feature which is accentuated by remnants of totara on the terraces above. These cliffs become gradually lower in height and merge with the floodplain with progression downstream.

Significant areas on the terraces to the south of the river are used for horticulture. In contrast, the north bank consists of a low lying plain in open pasture, much of which is used for dairying or horse breeding.

Features of note include Chrystalls Bend, lying approximately 1.5 km upstream of the bridge, where significant realignment and protection work has been undertaken, along with restoration work and planting particularly on the northern bank. The Winstone Aggregates shingle extraction and processing plant and Stresscrete precast concrete plant lie on the northern bank of the river immediately upstream of the rail bridge.

3.3.4 Lower Otaki reach

Extending from the railway bridge downstream to a point where the river commences opening out to its estuary, this reach of the river has been considerably straightened, narrowed and confined within stopbanks on both sides. Approximately 1 km downstream of the SH1 bridge, there is a gravel extraction plant operated by Winstone Aggregates, with an adjoining refuse station and oxidation ponds. The remaining land on the north bank and also on the south bank is in either pasture, or horticultural use.

In the downstream part of this reach the river meanders across a wide shingle bed, and a reduction in gradient results in large pools of still water.

3.3.5 Estuary/river mouth reach

Over this final reach the river widens to a low-lying estuarine landscape. (Cameron, 2015) notes that the Otaki Estuary is a shallow, medium sized “tidal river mouth” estuary that is nearly always open to the sea through a gravel spit formation; flood flows periodically enlarge this opening and in the intervening times it is reduced by longshore movement of sand and sediment. (River mouth alignment is also undertaken mechanically from time to time by GWRC in response to defined trigger points, as explained in Section 4.1.4).

As noted above, the estuary is associated with the Pahiko and Katihiku Drains and Whakapawaewae wetland remnant to the south, and the Rangiuru and Ngatoko Streams to the north. The estuary is dominated by river flows and is well-flushed. Ecologically, productivity and biodiversity is low due to the coarse nature of the bed, low habitat diversity (absence of salt march or intertidal flats), strong fluctuations in salinity and water currents (Robertson & Stevens, 2007).

3.4 Existing structural works

This section gives a brief overview of the existing structural works on the Otaki River and minor tributaries included in this application; river mouth management and gravel extraction are discussed in Section 4.1.4 and Section 4.5 respectively.

3.4.1 Stopbanks and outlet structures

Prior to development of the OFMP, stopbanks existed on both the north and south banks downstream of SH1, and on the north bank upstream of SH1 at Chrystalls and Chrystalls Extended. The OFMP proposed upgrade of the Chrystalls and Chrystalls Extended stopbanks and construction of new stopbanks at Harpers, lower and upper Hughes and Lutz. Figure 7, taken from the OFMP, indicates the location of these stopbanks.

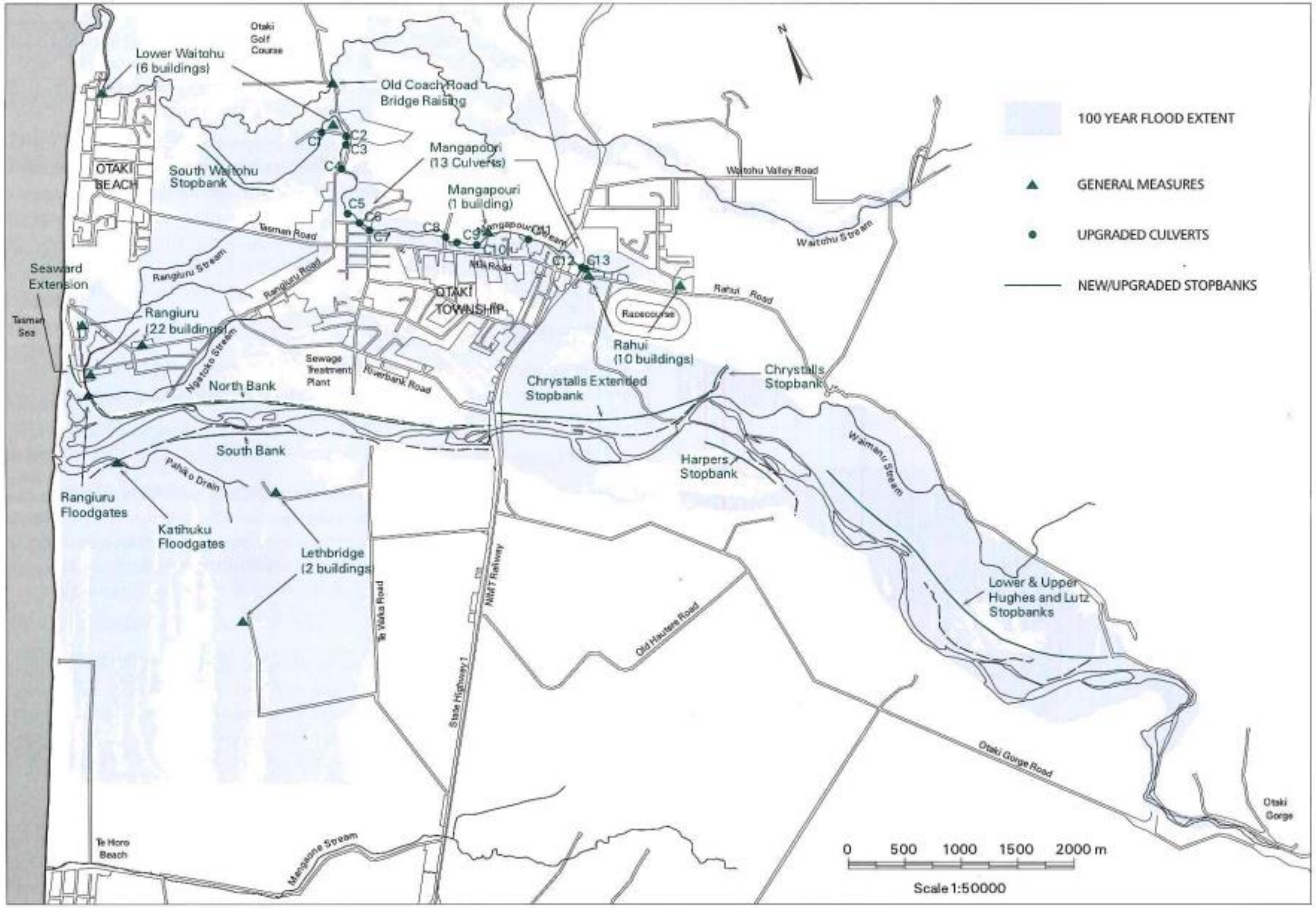


Figure 7: Location of structural works. Source: Otaki Floodplain Management Plan

Figure 7 also shows floodgates were proposed at the confluence of Ngatoko and Rangiuru Streams which are designed to protect the Rangiuru residential area from high seas or storm conditions. Upgrade of the two floodgates at the outlet of the Pahiko/Katihiku Drain system on the south bank, designed to prevent floodwaters entering the drain system, was also proposed. These floodgates are mounted on a culvert that runs through the stopbank.

Progress to date is as follows:

- Chrystalls Stopbank – completed 2000;
- Chrystalls Extended Stopbank – Construction and associated land purchase completed 2012;
- Harpers Stopbank – not yet undertaken;
- Lutz Upper & Lower Stopbank – Completed 1999;
- Rangiuru Floodgates – completed in 2002;
- Katihiku Floodgates upgrade – not yet undertaken;
- Minor repairs to North Bank stopbank; and
- South bank stopbank – concept options investigated. Proposed to commence 2016/17.

In addition to the structures named above, GWRC also maintains:

- A penstock through Chrystalls Stopbank
- A floodgate through Chrystalls Stopbank
- The Railway Line floodwall floodgate

3.4.2 Other structural protection works

The OFMP also identified over $5M of other protection works and planting over the 10 reaches shown in Figure 4, and briefly described below, along with progress to date.

Katihiku (mouth to XS 130):

- Extraction of Mangahanene Island to reduce erosion pressure on adjacent banks (not yet undertaken);
- Placement of rock linings on right bank (progressing); and
- Protection plantings for most of right bank (progressing).

Gas Line and Batchings/Campbells (XS 130 to XS 390):

- Maintain river between existing stopbanks;
- Rock riprap placement on right bank;
- Toe rock placement on left bank;
- Clearance and recovery of berms & protection planting on both banks; and
- (Concept designs for this work were completed in 2012, and works are progressing).

Bridges (XS 390 to 398):

- Toe rock placement on right bank;
- Protection planting south banks; and

(These works were completed in 2009/10).

Ballast/Tracey (XS 398 to XS 550):

- Protect stopbank on north bank with toe rock, rail iron groynes and planted buffer zones; and
- Rock groynes completed 2013/14.

Chrystalls Bend (XS 550 to XS 660):

- Realignment and additional rock riprap and protection plantings for the right and left banks to increase security.

(The works were completed in 1994, and included formation of Chrystalls Lagoon).

Hughes (XS 660 – 800), Hughes/Lutz (XS 800 – 965) & Taylor/Mansell (XS 965 -1130):

- Implement the fairway channel (Completed)
- Rail iron groynes and planting on both banks (Partly completed)

Work on the north bank and some on the south bank has been completed. Concept design options for further work the south bank (XS 790-930) were completed in 2012, and are due to be reviewed in 2016-17 as part of review of the Otaki Floodplain Management Plan.

Lower Gorge (XS 1130 – XS 1350):

No major structural works were identified as being required in this area.

3.4.3 Rangiuru and Ngatoko Streams

GWRC does not own or maintain any structures on these streams, apart from the outlet structure near the Rangiuru Stream mouth noted above.

3.4.4 Katihiku and Pahiko Drains

GWRC does not own or maintain any structures on these streams, apart from the outlet structure through the stopbank noted above.

3.4.5 Waimanu Stream and Chrystalls Lagoon

GWRC maintains one debris arrester on Waimanu Stream, located immediately upstream of the culvert under the haul road. The structure consists of four driven railway irons at 1 m spacings across the stream.

3.5 Geology

The basement rocks, exposed in the upper catchment, are alternating greywackes and argillites of the Torlesse Supergroup, which were laid down as sands and muds in a marine environment in the Triassic period. These rocks were uplifted during the Pleistocene period to form the Tararua Ranges, and were subject to much deformation, shearing and faulting during this time. A number of faults trending in a generally northeast-southwest direction cross the Otaki catchment, and the upper reaches of the Otaki River are in part controlled by one of these faults, the Otaki Forks Fault.

Erosion of the hillsides during the Pleistocene glacial periods of the last 2 million years led to deposition of deep gravel deposits in the catchment valleys and along the coastal plain beyond the foothills. During intervening interglacial periods the river and its tributaries would rework these deposits. At the same time, higher sea levels led to marine incursions over the outwash plain and alluvial deposits, with deposition of marine sands and silts over them.

Terraces formed of sands and gravels associated with the last two glacial periods (and the interglacial phases that preceded each) flank the Otaki River downstream of Pukehinau Stream. These terraces decrease in height towards the coast. They extend approximately to SH 1 on the north side of the river, and as far west as Te Waka Rd, beyond SH 1 on the south side of the river.

Dust blown from the exposed un-vegetated surfaces during glacial periods accumulated as loess, and significant deposits remain on the slopes of the foothills and some higher areas of terrace land.

The coastal plain has been built from outwash fan and alluvial gravels, shallow marine deposits, and wind-blown dune sands. Over the present interglacial period (Holocene) 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, wetlands and associated peat deposits have formed in places behind new dunes.

The Otaki River has degraded into the outwash terraces and deposits of the coastal plain, and it transports the gravel bed material from the upper catchment downstream to the coast. River alignment is affected by movement along an active fault at Chrystalls Bend. The river maintains a direct opening to the sea and can pass its bed load to the coastal system (G & E Williams Consultants Ltd, 1992).

3.6 Hydrology

The Otaki River is a large watercourse, with mean annual flow of 30,790 l/s (as measured at the Pukehinau water level recorder). Its headwaters lie in the Tararua Range, which receives a mean annual rainfall of over 5,000 mm that is relatively evenly distributed throughout the year. This, together with the large catchment area, means that the Otaki River is generally not subject to prolonged extreme low flows; its 7 day mean annual low flow (MALF) at Pukehinau is more than $1/20^{th}$ of the mean flow and occurs, on average, less than 4% of the time. It also equates to a specific flow of 17.1 $l/s/km^2$, which is one of the highest specific discharges in the Wellington Region, and is similar to the other major rivers emerging from the Tararua Ranges, such as the Waiohine and the Waingawa Rivers (Thompson, 2011).

River levels have been continuously monitored at the 'Otaki River at Pukehinau' site, operated by NIWA, since July 1980. GWRC undertakes regular spot flow gauging at this site to maintain an accurate stage to flow rating.

The maximum recorded flow to date is 1549 m^3/s, which occurred on 6 Jan 2005. This event had an estimated return period of 34 years. Estimated high flow frequencies for the Otaki River at Pukehinau, based on site data from 1980-2006 and historic annual maxima for 1958 – 1980 are given in Table 5. Low flow estimates are given in Table 6.

Table 5: Flood frequencies Otaki River at Pukehinau

Return Period (yrs)	Flow (m^3/s)
2	918
5	1145
10	1295
20	1439

Return Period (yrs)	Flow (m^3/s)
34	1549 (maximum recorded)
50	1626
100	1766

Source: GWRC

Table 6: Low flow frequencies Otaki River at Pukehinau

Return Period (yrs)	Flow (l/s)			
	1 Day	7 Day	14 Day	28 day
MALF	4693	5183	5891	8094
5	3944	4246	4690	6276
10	3649	3901	4250	5627
20	3432	3648	3926	5150
50	3212	3391	3597	4666
100	3078	3234	3396	4370

Source: GWRC

3.7 Sediment transport

Gravel bed material is moved intermittently by flood events down the river channel via the normal processes of erosion and deposition, until it reaches the coast. According to (Williams, 2013) – see Appendix F – the river transports around 50,000 to 100,000 m³ of gravel per year, with a substantial proportion reaching the coast.

Williams also notes that the gravel bed material of the river is relatively coarse: the medium size for the whole of bed material varies from 50 to 80 mm, and for the surface armouring layer it varies from 50 to 200 mm. The size of the armouring layer reduces significantly downstream of SH 1, which Williams surmises may be due to a combination of the confinement of the river by flood protection works, gravel extraction and the lesser grade of the river bed.

An indication of the frequency of flood events causing gravel movement is given in Table 7. In this regard it should be noted that a flow of 175 m^3/s represents the lower threshold of motion (i.e. the point at which some of the smaller sized bed gravels begin to move), while a flow of 350 m^3/s represents an upper threshold of motion, based on based on consideration of the median (or D_{50}) particle size. More discussion of this concept can be found in a report by Gary Williams that was prepared for GWRC (G & E Williams Consultants Ltd, 1992).

Table 7: Otaki River peak flood flow distribution 1991-2011, for flows above the threshold of motion for gravel transport

Flow (m3/s)	1991 - 1996	1996 - 2001	2001 - 2006	2006 - 2011	Average annual 1991-2011
175 – 300	67	50	43	48	52

Flow (m3/s)	1991 - 1996	1996 - 2001	2001 - 2006	2006 - 2011	Average annual 1991-2011
300 – 425	29	17	23	16	21
425 – 565	7	17	13	13	13
565 – 710	7	3	4	6	5
710 – 850	2	7	1	3	3
850 – 1130	2	4	4	4	4
1130 – 1415	2	2	0	0	1
>1415	0	0	1	0	0
Total	116	100	89	90	99

Source: (Gardner, 2011)

The table shows that, on average, there are 99 flood events per year during which gravel movement in the Otaki River will occur, which gives an indication of the mobility of the river bed. The data in the table also show that the number of small and medium sized events has been reasonably consistent over the 10 year period shown. Such events transport gravel through the river system with resultant changes in river bed levels and the position of meander channels, but they do not generally result in major morphological changes to the river bed form or position. Flood events over 1,130 m^3/s would be expected to cause more significant morphological changes in the bed form, and it can be seen that there have not been any of these lower return period, higher flood flow events over the past five years. Consequently, there has been a relatively smaller quantum of river works needed to manage the river form over the corresponding period. However, the new resource consents do need to allow for the works necessary to address the effects of larger flood flows which will inevitably occur in the longer term.

3.8 Vegetation

3.8.1 Vegetation in the Otaki catchment

Figure 8 shows that much of the upper Otaki River catchment remains in natural forest cover, which is a mix of alpine scrub, beech and broadleaf podocarp. The original forest cover of the coastal plain has been almost entirely cleared, and only small remnants remain.

The dominant land uses in the lower catchment are farming (dairying, sheep, beef and deer) and horticulture; additional uses include lifestyle blocks and urban settlements.

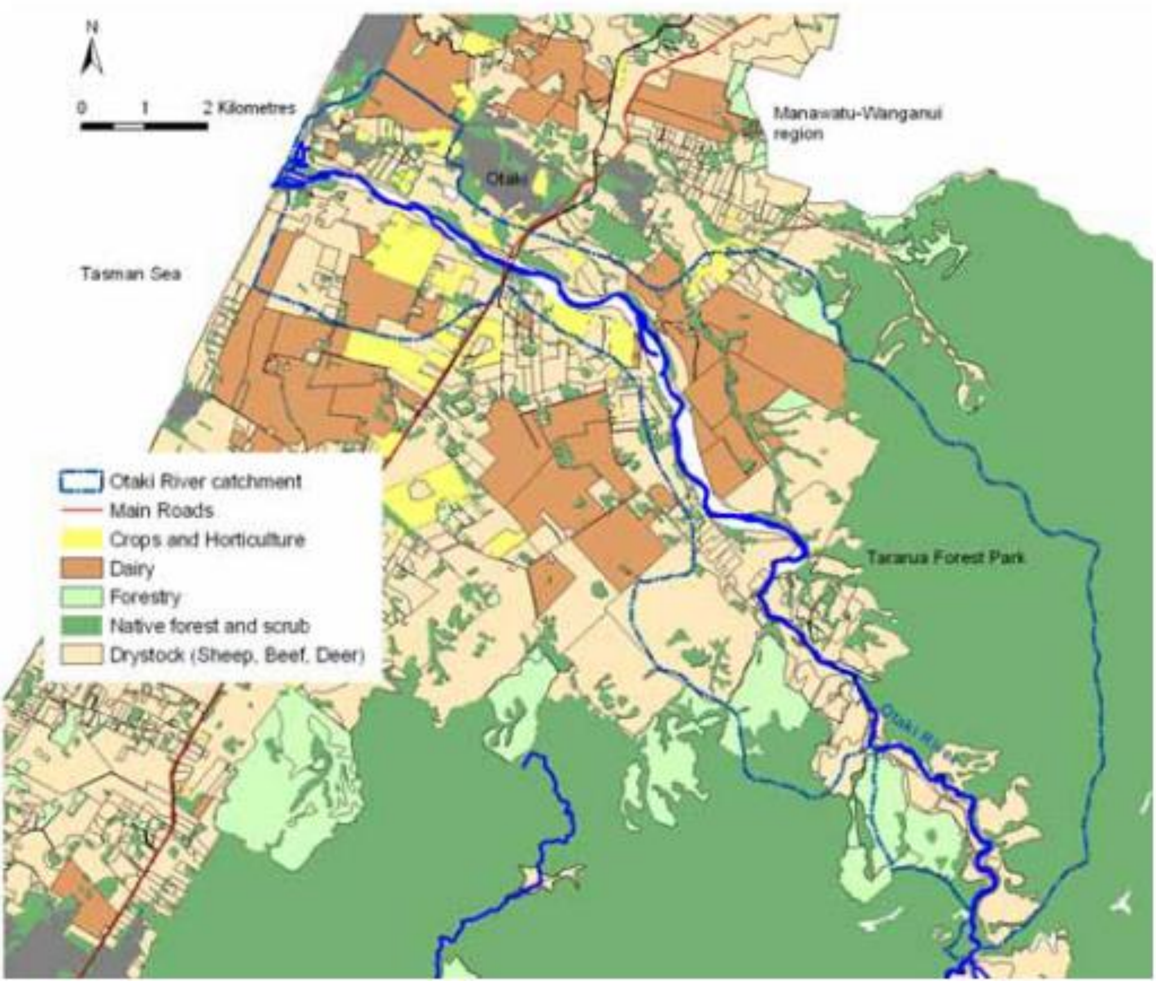


Figure 8: Land cover and use in the Otaki River catchment and surrounding coastal plain, compiled from Agribase (AgriQuality 2002) and Land Cover database 2 (Ministry for the Environment 2001). Source: (Thompson, 2011)

3.8.2 Riparian vegetation of Otaki River

While most native vegetation has disappeared from the river banks below SH1, (Cameron, 2015) reports that there are still some good forest remnants in the Otaki Gorge area (mostly upstream of the Otaki River application area). These remnants usually include kohekohe together with species such as mahoe, kaikomaiko (*Pennantia crymbosa*), rewarewa, titoki, tawa, and occasional totara and karaka trees. In an evaluation of rare terrestrial plants in the floodplain, Boffa Miskell (1992) describe a large hebe species with local distribution (*H. angutissima*) growing on steep riverside cliffs and is only known from the Otaki Gorge area, as well as the shrub daisy, *Olearia cheesemanii*, both of which has restricted distribution. However, the known distribution of these species is upstream of the application area and consequently will not be affected by flood protection activities.

Riparian vegetation within the application area is highly modified and has few indigenous elements. The great majority of riparian edge vegetation within the application area is planted willows. Of the 22.2km of total river bank length within the application area, it is estimated that 18.8km (85%) has been planted with willows as vegetative bank protection. Scattered bushes of shrubby weeds such as gorse, lupin and wattle are common. On the edges of the open gravel river bed and gravel bars lupin is common. There are many introduced weeds, grasses and scramblers of which the most ubiquitous are fennel, montbretia, yarrow, purple top, clover, cocksfoot, tall fescue, Yorkshire fog, blue morning glory and greater bindweed (Boffa Miskell, 2001).

3.8.3 Vegetation of the Otaki River Estuary

The northern tidal lagoon margins have a mixed vegetation of flax, taupata, cabbage trees, raupo, grasses, and rushes. Native salt meadow species reported by Boffa Miskell (1992) include glasswort (*Salicornia australis*), shore primrose (*Samolus repens*), *Selliera redicans* and Batchelor's button (*Cotula coronopifolia*). The total area of salt marsh habitat associated with the northern tidal lagoon is estimated at approximately 2 ha. This area is well outside of the design channel alignment and is unlikely to be disturbed by flood protection activities.

Semi sheltered estuarine habitat located on the south side of the river also contains some saltmarsh habitat. The strip along the stop bank contains the most significant vegetation community including *Selliera radicans*, *Samolus repens*, toetoe, quillwort, oioi, sharp spike sedge, *Isolepis cernua*, *Shoenoplectus tabernaemontani* and the regionally rare *Carex litorosa* (Groundtruth, 2013). Groundtruth (2013) notes that some of these species are very sparse and vulnerable to the encroachment of weeds such as tall fescue, sharp rush and pampas from around the margins. The majority of this habitat is outside of the design channel alignment and is unlikely to be disturbed by flood protection activities.

The flats at the western tip of the gravel bar are less diverse and much of the margin is covered with exotic species, however on an area of loose fine gravels the native *Carex pumila* is widespread (Groundtruth, 2013).

The part of the gravel bar located within the design channel alignment, which is likely to be affected by channel widening, is heavily covered in weeds. As recently as 2008 this area was relatively bare open gravel which would have provided valuable habitat for shorebirds, but has subsequently been colonised by exotic scrubs including pampas, gorse, lupin, Montpellier broom, and tree lucerne.

3.8.4 Riparian vegetation of Rangiuru and Ngatoko Streams

These watercourses lie within rural and urban landscapes. The stream margins are vegetated with flax, toetoe, grasses and a variety of exotic species to provide a moderately intact vegetation on at least one bank.

3.8.5 Riparian vegetation of Katihiku and Pahiko Drains

The bankside vegetation of Pahiko Drain is dominated by water celery (*Apium nodiflorum*), and tall fescue grass (Festuca arundinacea), with patches of native sedges (*Carex germinata* and *Isolepis prolifera*). The Katihiku drain is dominated by water celery and *Carex germinata.*

3.9 Water quality

Surface water quality has been routinely monitored in the western half of the Wellington Region by GWRC since 1987.

There are two RSoE[12] monitoring sites in the Otaki River catchment: one at the Pukehinau Water level recording site, and one approximately 700 m upstream of the river mouth. These sites correspond to the upstream and downstream extents of the application area - see Table 8 for details.

[12] 'Rivers State of the Environment'

Note that none of the minor watercourses included in the Otaki River application area (Rangiuru Stream, Ngatoko Stream, Waimanu Stream, Pahiko Drain, Katihuku Drain) are part of the GWRC RSoE monitoring programme, and routine water data are not available for these watercourses.

Table 8: RSoE Monitoring Site Details –Otaki River Catchment

Site no.	Site name	Site co-ordinates (NZTM)		Date started
		Northing	Easting	
RS 05	Otaki R at Pukehinau	5478749	1785426	Sep 1991
RS 06	Otaki R at mouth	5485886	1777983	Apr 1990

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; and
- Heavy metals (dissolved copper, lead, zinc).

Summary statistics for selected core water quality variables measured from 2010-2015 are given in Table 9.

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

Determinand	Otaki River@ Pukehinau (RS05) (within the application area)			Otaki River@ Mouth (RS06) (within application area)			Guideline value
	median	min	max	median	min	max	
Water temp. (°C)	10.3	3.9	17.1	12.4	5.26	20.3	≤19
DO (%saturation)	99.9	74.8	119	101	67.5	118.8	≥80
pH	7.46	6.19	8.07	7.45	6.3	8.54	6.5-9.0
Visual clarity (m)	4.03	0.120	11.54	2.97	0.08	9.07	≥1.6
Turbidity (NTU)	0.72	0.230	48	0.940	0.260	69	≤5.6
Suspended solids (mg/L)	<1	<1	60	<0.1	<1.0	72	--
Conductivity (µS/cm)	65.2	37	85	67.5	37	86	--
TOC (mg/L)	1.4	0.250	5.5	1.3	0.250	6.7	--

Determinand	Otaki-River @ Pukehinau (RS05) (within the application area)			Otaki River @ Mouth (RS06) (within application area)			Guideline value
NNN (mg/L)	0.032	0.001	0.073	0.042	0.001	0.116	≤0.444
Ammoniacal N (mg/L)	<0.005	<0.003	0.024	<0.005	<0.003	0.029	≤0.021
Total N (mg/L)	0.055	0.055	0.180	0.055	0.055	0.270	≤0.614
DRP (mg/L)	0.004	0.002	0.011	0.004	0.002	0.009	≤0.010
Total P (mg/L)	0.005	0.002	0.054	0.005	0.002	0.072	≤0.033
E. coli (cfu/100ml)	5	<1	130	30	2	600	≤550

GWRC's water quality index (WQI) for RSoE sites measures the median values of six key water quality variables against relevant guidelines and assigns an overall grade (poor, fair, good or excellent). Over the five year period that was measured, both Site RS 05 and Site RS 06 were rated as having "excellent" water quality each year, meeting all six guideline values. Although sites RS05 and RS06 are both located within the application area and are potentially affected by flood protection activities, these sites were ranked 3rd and 7th, respectively, out of the 55 RSoE sites monitored in the Wellington Region for the year to June 2014. (Thompson, 2011) notes that the Otaki River is one of the few rivers in the Wellington Region in which water quality is maintained throughout its length. This is attributed to a large proportion of the upper catchment remaining in unmodified indigenous vegetation, buffering of significant sections of the lowland section of the river by riparian vegetation and the absence of highly compromised lowland tributaries or point source discharges.

(Thompson, 2011) reports that water quality monitoring undertaken by GWRC at popular swimming sites at the SH1 road bridge and at "The Pots" (located in the gorge near Pukehinau) provides further evidence of the excellent water quality in the Otaki River, with only one significant exceedance of the Ministry for the Environment/Ministry of Health national microbiological guidelines having been recorded at each site since 2001. This report notes that although mat-forming algae growth that could present a nuisance and/or health hazard to swimmers has been observed in the lower river reaches during at least one recent summer, cyanobacteria growth is generally not an issue in the Otaki River.

3.10 Freshwater ecology

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 3.9; and
- 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.

3.10.1 Periphyton

Periphyton assessments are undertaken at 46 of the RSoE sites with hard substrates (gravel and cobbles), including the sites of relevance to this application (RS05 and RS06).

The results of periphyton biomass monitoring for the period 2010-2014 are summarised in

Table 10, and monthly observations of filamentous and mat forming periphyton covering for the same period are summarised in xx. For a detailed analysis of the results, refer to (Cameron, 2015).

Table 10: Summary of streambed peripyton biomass at RSoE sites in the Otaki River application area from 2009 to 2014

Site no.	Site name	Chlorophyll a (mg/m2)				
		2010	2011	2012	2013	2014
RS05	Otaki River@ Pukehinau	2.2	1.0	0.47	1.56	0.37
RS06	Otaki River@ Mouth	2.1	1.8	12.61	2.04	15.35

Source: after Perrie et al, 2011; Perrie and Conwell, 2013; Morar and Perrie, 2013; and Heath, Perrie, & Morar, 2014. Non-compliance with MfE (2000) guidelines is highlighted in bold type.

Table 11: Summary of monthly observations of visible streambed filamentous and mat-forming periphyton cover in relation to exceedances of the MfE (2000) guidelines at RSoE sites within the application area for the years to June 2010, 2011, 2012, 2013 and 2014[13]

Year	Site no.	Site name	*n*	Streambed cover (%)						
				Filamentous (>2 cm long)		Mats (>0.3 cm thick)		Cyanobacteria mats (>0.1cm thick)		
				Max	n>30% cover	Max	n>60% cover	Max	n 20-50 %	n>50%
2010	RS05	*Otaki River@ Pukehinau*	11	39	1	4	0	nt	nt	nt
	RS06	*Otaki River@ Mouth*	12	50	1	12	0	nt	nt	nt
2011	RS05	*Otaki River@ Pukehinau*	9	2.5	0	26.5	0	nt	nt	nt
	RS06	*Otaki River@ Mouth*	9	31	1	16	0	nt	nt	nt
2012	RS05	*Otaki River@ Pukehinau*	10	2	0	1	0	nt	nt	nt
	RS06	*Otaki River@ Mouth*	10	32	1	18	0	nt	nt	nt
2013	RS05	*Otaki River@ Pukehinau*	11	25	0	2	0	nt	nt	nt
	RS06	*Otaki River@ Mouth*	11	70	2	22	0	nt	nt	nt

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201 4	RS05	*Otaki River@ Pukehinau*	9	0	1	23	0	3	0	0
	RS06	*Otaki River@ Mouth*	9	33	0	0	0	11	0	0

Source: after Perrie and Conwell, 2013; Morar & Perrie, 2013; Heath, Perrie, & Morar, 2014.

Over the five year period from 2010 to 2014 inclusive, the Pukehinau and river mouth sites complied with the MfE guidelines for periphyton biomass on all sampling occasions. Over the same five year period the periphyton cover guideline for filamentous was achieved in 48 of 50 monthly surveys at Pukehinau and in 45 of 50 monthly surveys at the river mouth. The algae 'mat' guideline was achieved in all surveys at both sites. 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 Otaki River, which is consistent with the low proportion of agricultural or urban land-use in the catchment and the consistently low nutrient levels recorded in river water.

(Thompson, 2011) notes that the tendency for periodic nuisance periphyton growth observed in the lower reaches may be attributable to favourable growth conditions triggered by sluggish flow and elevated water temperatures in shallow unshaded sections of the river.

3.10.2 Macrophytes

3.10.2.1 Otaki River

No records of aquatic macrophytic vegetation for the Otaki River have been located, other than salt marsh species. Observations from bankside inspections of the river channel between the SH1 Bridge and the river mouth 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.).

3.10.2.2 Rangiuru and Ngatoko Streams

Aquatic macrophytes are an important feature of the Rangiuru/Ngatoko stream system. The bed substrate of Rangiuru Stream is predominantly sand and gravel. Water clarity is good under base-flow conditions allowing high light levels on the bed, producing a lush macrophyte growth covering 30 to 40 percent of the stream bed surface at the time of the site inspection (Cameron, 2015).

3.10.2.3 Katihiku and Pahiko Drains

The aquatic and bankside vegetation of Pahiko Drain is dominated by water celery, and tall fescue grass, with patches of native sedges. The grasses and sedge potentially provide inanga spawning habitat, however it is not clear to what extent the area upstream of the flap would be utilised when the flapgates are shut on the spring tides.

3.10.3 Macroinvertebrates

GWRC undertakes annual monitoring of macroinvertebrate communities at the Pukehinau and river mouth RSoE monitoring sites. Both sites are located within the Otaki River application area. The Macroinvertebrate Community Index (MCI) is used as a measure of instream habitat quality, plus three other measures: Quantitative MCI (QMCI), %Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa and %EPT individuals.

The results for the period 2010 to 2014 are summarised in. Further analysis of the data including commentary on the data limitations is included in (Cameron, 2015).

Table 12: Mean macroinvertebrate metric scores (and standard deviation) at the Otaki River and Rangiuru Stream RSoE sites, based on samples collected annually in 2010, 2011, 2012, 2013 and 2014. MCI & QMCI quality classes also indicated

Site no.	Site name	No.	MCI	QMCI	No. taxa	No. EPT taxa	%EPT individuals	%EPT individuals
RS1	Rangiuru Stream (MWH, 2015)	1	63.9 (poor)	3.2 (poor)	16	1	6	
RS 05	Otaki River @ Pukehinau	5	132.3 (4.95) (excellent)	7.37 (0.31) (excellent)	18.2 (3.70)	11.2 (2.17)	62.4 (8.99)	88.6 (2.34)
RS 06	Otaki River @ mouth	5	112.5 (13.7) (good)	6.87 (0.87) (excellent)	16.2 (2.49)	6.8 (1.64)	42.4 (11.43)	80.1 (11.8)

Source: (Perrie A, Morar S, Milne JR, Greenfield S, 2012). Note shaded sites are not in the application area and are included for comparative purposes only

The Otaki River at the upstream end of the application area (Site RS05) supports a macroinvertebrate fauna dominated by sensitive EPT taxa, which make up 87% of individuals and 62% of taxa recorded at this site. The mayfly *Deleatidium* is the dominant taxa and is often 10-fold more abundant than the next most abundant species, which typically include the caddisfly *Aoteapsyche*, Orthocladiinae midges and the riffle beetle Elmidae. 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.

Deleatidium remains the dominant taxa in the lower Otaki River at RS06 but the abundance of two winged flies (Diptera) is higher than at RS05, probably in response to slightly higher nitrogen levels and increased algae production in the lower river. These changes are reflected in small reductions in MCI and QMCI scores at RS06 compared with RS05. Nevertheless, the biotic index scores indicate good to excellent invertebrate quality classes in the Otaki River near the mouth.

Site RS05 is near the upstream extent of the application area and is characterised as a “reference” site with “excellent” habitat quality, 96% of the catchment in indigenous forest and 0.1% in production pasture. The lower site (RS06) near the downstream extent of the application area is characterised as “impacted” with “fair” habitat quality, 88% indigenous forest and 8.8% production pasture. The land use differences between the two sites result in a modest increase in nitrogen concentrations in the river, as well as a modest increase in algae productivity, and a small reduction in macroivertebrate index scores.

3.10.4 Fish

3.10.4.1 Otaki River

Records in the New Zealand Freshwater Fish Database (NZFFD) for the Otaki River and associated minor stream catchments are summarised in (Cameron, 2015).

Twelve species of fish have been recorded within the Otaki River and tributaries, including eleven native fish and the introduced brown trout. In addition, freshwater shrimp and freshwater crayfish (koura) are common in the lower catchment. . One species recorded in the Otaki River system, the shortjaw kokopu, is considered to be threatened (Nationally Vulnerable) while eight fish species are considered to be 'at risk' due to declining numbers nationally.

The core fish community of the Otaki River application area consists of longfin eel, torrentfish, inanga, koaro, and common bully. Other species such as banded kokopu are likely to be seasonally abundant but not necessarily resident within the application area.

The limited information that is available for the main-stem suggests that the abundance of fish in the lower river may be limited by a scarcity of good quality habitat.

- Most of the indigenous fish species recorded in the catchment, except dwarf galaxias, 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 upstream migrations from the sea into the lower river include the following:Peak periods of upstream migration of juvenile galaxiid species (whitebait), torrentfish and redfin bully occur between August and December;
- Peak periods of upstream migration for juvenile longfin eel, shortfin eel and common bully are later during the summer, from December through to February.

Sea run brown trout migrate from the sea into the river during the autumn, moving up through the river and into headwater tributaries to spawn in the winter, however trout are not obliged to spend time in the sea and most trout in the Otaki River system may simply move upstream from adult riverine habitat to spawning areas during May, June and July.

Downstream migration from the river into the sea occurs for most indigenous species during summer to late-winter and is undertaken by eels as adults and by galaxiids, and bullies as larvae. Downstream migratory activity is influenced by a number of environmental factors including rainfall, water temperature and phase of the moon but is generally assisted by increased river flows, which may make it less susceptible to disruption by in-channel river works.

Sensitive periods and locations for fish spawning are summarised in (Cameron, 2015) and include:

- Inanga spawning habitat is located in tidal estuary edge vegetation and occurs during March, April and May. Taylor and Kelly (2001) note that while the Otaki River main-stem, lacking riparian vegetation, is not suitable for inanga spawning, two spring fed tributaries in the lower reaches (the Rangiuru Stream and Pahiko/Katihiku Drain) offer good habitat for inanga spawning. Both of these systems drain low lying pastoral land, and probably as a consequence of this incorporate floodgates. Other galaxiid species including koaro, banded kokopu, shortjaw 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 (McDowell, 1990; Smith, 2015).
- Bullies spawn in riverbed substrate, often under large rocks, between August and February. Spawning habitat is thought to occur near or upstream of adult habitats.
- Torrentfish spawn in riverbed substrate, probably in the lower river near the coast, mostly between January and April.
- Trout move into headwater tributaries to spawn during May and June. Trout spawning habitat in the Otaki appears to be limited to upper tributaries and it is thought that the main-stem of the Otaki below the gorge does not provide important trout spawning habitat due to the generally coarse nature of the bed substrate

3.10.4.2 Tributary streams

Fish species recorded in the Waimanu Stream are listed in (Cameron, 2015). No fish records are available for Rangiuru/Ngatoko Stream or the Paiko/Katihiku drains, and so (Cameron, 2015) has used predictions from the FENZ database to identify the core fish community. Based on this information and observations of habitat quality, the predicted core fish communities are as follows:

- Waimanu Stream: longfin eel, shortfin eel, torrentfish, giant kokopu, common bully, redfin bully and brown trout.
- Rangiuru/Ngatoko Stream and Paiko/Katihiku drains: longfin eel, shortfin eel, inanga and common bully.

3.10.4.3 Comparison between the application area and upstream reaches

The application area in the Otaki River begins at the sea and extends 11km upstream through urban Otaki, and the agricultural area between Rahui Road and Otaki Gorge Road, terminating at the Waihoanga Suspension Bridge near the Otaki Gorge. The application area contains the urban reach of the river, and is affected by urban and agricultural development within that reach.

Based on the geographical and geomorphological differences between these areas, some difference in the fish community is to be expected. In particular, low elevation fish taxa such as inanga 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 (Cameron, 2015) are generally consistent with those predictions.

In addition to geographical changes, the transition from an indigenous forest catchment of upper catchment to the rural and urban areas of Otaki has caused a range of habitat changes associated with the reduced integrity of riparian vegetation, increased inputs of nutrients (especially nitrogen), and increased occurrence of pest species.

While it would be possible to compare the fish data from the application area with an upstream area unaffected by flood protection activities, such a comparison would not be useful in the context of this assessment because of the geographical, geomorphological, and land-use differences.

3.10.4.4 Otaki River Estuary

The fish community of the Otaki River and minor tributaries within the application area has been described above. Of the 25 NZFFD records available for the catchment none are located within the estuarine reach. However, Boffa Miskell (2001) carried out a limited fish survey by trapping (box net and fyke net) in the lower Otaki River including sites located in ‘upper estuary’ and ‘middle estuary’. That survey identified four freshwater species: inanga, longfin eel, torrentfish and common bully. Species such as shortfin eel, koaro, banded kokopu, giant kokopu, shortjaw kokopu, black flounder and redfin bully, although not recorded in the survey, would be expected to be either resident or transient in the estuarine reach.

The estuary is also known to provide spawning and/or rearing habitat for a number marine species including kahawai, snapper, dogfish, red cod, gurnard and yellow eyed mullet (DoC Database, referenced in Boffa Miskell, 2001).

Taylor and Kelly (2001) note that while the main-stem of the Otaki River, lacking riparian vegetation, is not suitable for inanga spawning, two spring fed tributaries in the lower reaches (the Rangiuru Stream and Pahiko/Katihiku Drain) offer good habitat for inanga spawning. Both of these systems drain low lying pastoral land and incorporate floodgates. The floodgates at the entrance to Rangiuru Stream have been modified to slow the closing on the incoming tide to give fish more time to move from the sea to the stream.

Trout

The RPS lists the Otaki River as having important trout habitat, particularly in the reaches from the headwaters to the SH1 bridge. NZ Fish & Game considers the river to be a regionally important trout fishing destination and in terms of "angler days" is in the top 25 % of recognised angling water bodies in the Wellington Region. (Cameron, 2015) notes that the trout fishery is highly variable due to the effects of floods which 'regularly turn over a relatively unstable bed'.

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[14]) 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-September). Egg development takes 4-6 weeks; 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. According to (Cameron, 2015) trout spawning habitat is expected to be scarce or absent in the main-stem of the river downstream of Otaki Gorge.

3.11 Macroalgae and phytoplankton in the Otaki Estuary

Macroalgae distribution in the Otaki Estuary has not been comprehensively mapped. Nevertheless Robertson & Stevens (2007) describe the estuary as having low risk of macroalgal blooms, low risk of phytoplankton blooms, low risk of dissolved oxygen depletion and low risk of anoxic sediments.

3.12 Birdlife

GWRC has recognised that there is potential for flood protection activities to have both positive and negative impacts in bird populations present in the river corridors. In response to this, the Code commits to a bird monitoring programme. The first three-year series of annual bird surveys on the western sector rivers, including the Otaki 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, Small, & Govella (2015).

3.12.1 Riverbed nesting shorebirds

McArthur, et al, (2015) reported that three species of shorebirds were observed using the exposed gravel beaches and islands of the Ōtaki River during the 2012-2015 surveys. The pied stilt, a species ranked as 'At Risk, Declining' under the New Zealand Threat Classification System was the most common shorebird species, followed by the banded dotterel (ranked as Nationally Vulnerable) and the black-fronted dotterel, a recent coloniser from Australia. Further discussion on these findings is given in (Cameron, 2015).

[14] 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.

3.12.2 Spatial patterns in bird species diversity

A total of 48 bird species were recorded on the Ōtaki River during the 2012-2015 bird surveys, including 30 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 (Robertson et al, 2013). In addition to the 48 species recorded during the 2012- 2015 surveys, a further 15 species (13 native and two introduced) have been recorded on the Ōtaki River since 1982 (McArthur, et al, 2015), bringing the total number of birds species so far recorded on the Ōtaki River to 63.

Both the total number of species and the ratio of native to introduced species encountered within each 1 km survey section varied little along the 11.6 km of the Ōtaki River that was covered during these surveys (Figure 3-14). A lower total number of species tended to be recorded upstream of XS890 and between XS350 and XS260 (from the SH 1 bridge to approximately one kilometre further downstream). In contrast, the Ōtaki Estuary supported a much higher total number of species, a higher ratio of native to introduced species and a higher number of Nationally Threatened and 'At Risk' species than any other reach of the Ōtaki River.

Four sites of value for native birds have been identified on the Ōtaki River based on the data collected during these surveys

3.12.3 Sites of value for indigenous birds on the Otaki River

Four sites of value for native birds have been identified on the Ōtaki River based on the data collected during these surveys – refer to (Cameron, 2015).

Virtually the entire length of the 11.6 km of the Ōtaki River surveyed provides breeding habitat for regionally significant populations of both banded and black-fronted dotterels, and for a relatively large local breeding population of pied stilts. Approximately 8% of the Wellington Region populations of both banded and black-fronted dotterels breed on the Ōtaki River (McArthur et al, 2015).

A nesting colony of black shags (*Phalacrocorax carbo;* a species ranked as 'At Risk, Naturally Uncommon') was discovered on the escarpment on the true right of the Ōtaki River. This colony is one of only eight black shag nesting colonies known to be active in the Wellington Region at the present time (Birds New Zealand, unpublished data).

The lower reach of the Ōtaki River between XS90 and XS170 appears to be utilized by banded dotterels as a post-breeding staging area prior to migration. In late summer (January), a relatively high number of non-territorial adult and juvenile dotterels roost in this downstream reach of the river before departing on migration.

The Ōtaki Estuary supports a relatively high total number of bird species, a relatively high number of Nationally Threatened and 'At Risk' species, and a higher ratio of native to introduced bird species than any other reach of the Ōtaki River.

3.12.4 Birds at the Otaki River Estuary

Bird species reported in and around the river mouth are summarised in (Cameron, 2015). The Otaki Estuary was found to support a relatively high number of bird species, a relatively high number of Nationally Threatened and 'At Risk' species, and a higher ratio of native to introduced bird species that any other reach of the Otaki River. The Otaki Estuary is identified as a "habitat of significance for indigenous birds". The Otaki Estuary has also been designated a "Key Native Ecosystem" by GWRC.

3.13 Herpetofauna

Bell (pers. com., 2015) searched the Department of Conservation BioWeb Herpetofauna database for lizard and frog records within a corridor extending 1km either side of the Otaki River channel centreline.

Only one lizard species is positively identified within the search area, the northern grass skink, which is recorded near the estuarine reach of the river. The database also holds one record of an unidentified skink and one record of unidentified frog, both located near the upstream end of the application area. The northern grass skink is assessed as having a moderate likelihood of presence within the Otaki River corridor where there is rank grassland and scrubland, however the likelihood of presence is low in those areas frequently flooded by the river. The record of a northern grass skink near the Otaki Estuary indicates the presence of a population in that area, and indicates some potential for other lizard species to be found in that vicinity. Elsewhere, however, the Otaki River corridor is highly developed and is assessed as containing little habitat of value for lizards.

3.14 Natural character

The natural character of a river is a reflection of physical morphology, geology and hydrological regime and the complex interactions among these parameters over time.

It has been proposed that if a number of such physical variables were to be quantified and combined into a 'natural character index' or NCI, then this index might be able to be used as a practical tool to measure the existing condition of specific river reaches and also to monitor changes from this baseline into the future. In turn, and based on research evidence that there is a link between physical morphology and ecology, the NCI could also then be used as a proxy measurement of the health of the riparian and in-stream ecology of the river reaches.

This approach has been used in Australia, with the most comprehensive application being the Tasmanian River Condition Index (TRCI). In New Zealand, Massey University researchers Dr Russell Death, Amanda Death and Dr Ian Fuller have been developing a similar general NCI characterisation.

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 limited version of the NCI under development by the Massey University researchers. The results are reported in Williams (2013), which is included in Appendix F. An NCI has been determined for six reaches in the Otaki River covering most of 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 Otaki River, the reference photography was taken in 1939. (Williams notes that the river was relatively unmodified at this time, although severe storms in the Tararua Ranges prior to this time had destabilised the catchment and led to a high gravel bed load supply to the river.) This was then compared with measurements taken from the latest imagery.

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

Table 13: Natural Character Index for the Otaki River

REACH (Cross Sections)	OVERALL NCI
XS 990 –XS 870	0.76
XS 860 – XS 780	0.62
XS 770 – XS 610	0.53
XS 600 – XS 490	0.71
XS 480 – XS 370	0.52
XS 360 – XS 220	0.55
XS 210 – XS 80	0.40
Average	0.58

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 the baseline natural character (i.e. as existed in 1939), while conversely an index greater than 1 indicates there has been an improvement over the baseline condition. The NCI index for the Otaki River was shown to vary from 0.40 to 0.76 for the seven individual reaches, with an average value of 0.58. Williams concluded that the data indicates that there has been a substantial decline in the physical condition of the river (with the exception of the sinuosity component of the index).

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. However, because this is relatively new method, more work needs to be undertaken to determine the optimum number and combination of parameters that best represent a river's 'natural character', and to determine the sensitivity of the index to changes in individual parameters. This information would be necessary to understand which parameters might be best manipulated (by river management works and activities) to produce an improvement in NCI for an individual reach, and the costs of doing so. Furthermore, the investigations by Death and Fuller to date (e.g. (Death, R. & Death, F., 2013)) have shown that more work is also needed to establish a clear relationship between NCI and measures of ecological health such as trout and native fish numbers, or macroinvertebrate assemblages. At this stage, it is too early to contemplate using the NCI as a river management tool or to formulate consent conditions based on NCI scores. GWRC is committed, however to contributing to the development of the NCI by supporting the Massey University researchers on the Science Group and proposing that NCI parameters form part of environmental monitoring work.

3.15 Recreation

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 Otaki River offers extensive opportunities for both in-river and off-river recreation. Summary details are given below, and the full report is included in Appendix H.

Fishing

The report authors advise that the Otaki River is a popular and challenging brown trout fishery that can be fished year round. The majority of fishing is undertaken downstream from Chrystalls Bend (i.e. within the application area). A key access point for fishing is the SH1 bridge area, and there is also good access from tracks on both sides of the river downstream of SH1. The number of fishing visits to the Otaki River (as recorded by the NIWA National Angling Survey) has remained relatively stable over the last decade: 690 (+/- 220) in 1994/95, 350 (+/-90) in 2001/02 and 700 (+/- 180) in 2007/08.

The river mouth is an important whitebaiting area, with up to 60 users present at times. Whitebaiting also occurs on the Rangiuru Stream but numbers of users are limited to a few at any one time by site constraints.

Surfcasting for kahawai and set-netting for flounder are undertaken at the river mouth, and children are known to fish in the estuary.

Paddling

The Otaki River is regionally significant for kayaking; with an estimated 2,000 kayaker visits per annum it is the most popular river in the region. The majority of paddling takes place in the upper reaches between Otaki Forks and the Waihoanga Suspension Bridge (which lies approximately 300 m upstream of the application area), although some kayaking occurs downstream to the SH1 bridge.

Swimming

The Otaki River is popular for swimming, with use focused around the SH1 bridge area and the mouth.

Walking & cycling

(TRC Tourism, 2013) reports that the development of tracks on both sides of the river since 2006 has led to a significant increase in walking and cycling opportunities. Some horse-riding along these trails is also undertaken. The trails include:

- the Otaki River Highway to Sea walk, extends approximately 4 km on the true right bank from SH 1 to the estuary
- a 4.5 km access track from SH1 to the coast on the true left bank
- the Chrystalls Bend walk from SH1 upstream for approximately 3km, to a large pond and picnic area

The Kapiti Coast Cycleway between Paekakariki and Peka Peka is planned to extend to Otaki in future; a new bridge was completed over the Rangiuru Stream in 2012 to provide a walking and cycling link from the south to Otaki Beach.

Hunting

Wildfowl hunting and duck shooting are undertaken during the permitted season on the Otaki River lagoons and at Chrystalls Bend, with maimai at these locations managed by NZ Fish & Game.

Other

Other activities occurring at the river mouth and beach include firewood and shellfish collecting and bird-watching. GWRC organises the 'Kapiti Great Gravel Grab'; a one-day event that has been held annually for the past six years and allows the public to collect stones and gravel from the river bed. This event attracted approximately 300 cars and trailers in 2012.

Development of a new lake 8 ha lake and amenities to the north of the Winstones Aggregates site on the northern bank of the Otaki River immediately upstream of SH1 will provide a further recreational resource in the vicinity of the river.

3.16 Tourism

Consultants TRC Tourism (TRC Tourism, 2013) report that that there is limited tourism activity in the Otaki River area. The report notes the Riverslea Lodge located in the Otaki Gorge, which offers retreat-style accommodation, and Captivate Adventures, also based in the Otaki Gorge, which offers outdoor recreation activities for individuals, groups and schools.

3.17 Neighbouring community

3.17.1 Residential areas

According to the OFMP the population of the Otaki floodplain was about 7,000 in 1996; the 2006 Census data indicates that there was little change in this number over the subsequent 10 year period. The majority of people living in the Otaki floodplain live in the Otaki Township and Otaki Beach settlements, with the remainder spread throughout the surrounding rural areas.

3.17.2 Infrastructure and services

In addition to the flood protection works already described in Section 3.4 the principal infrastructure and services within the application area include:

- the North Island Main Trunk railway bridge, approximately 300 m long;
- the SH1 bridge, approximately 60 m downstream of the rail bridge, which is two lanes wide and over 200 m long and also carries telecommunications and power cables;
- the Winstone Aggregates quarry and gravel processing plant on the true right bank immediately upstream of the railway bridge;
- the Stresscrete precast concrete plant on the true right bank immediately upstream of the railway bridge;
- the gravel processing plant on the true right bank approximately 1 km downstream of the SH1 bridge also operated by Winstone Aggregates;
- Transpower high voltage transmission lines which cross the river at XS 140 –XS 150 and XS 870 approximately (see Appendix D);
- An underground gas pipeline which crosses the river at XS 150 approximately; and
- A local distribution power line crossing at XS 250.

In March 2013, the New Zealand Transport Agency (NZTA) and KiwiRail applied to the Environmental Protection Authority (EPA) for two notices of requirement and forty-nine resource consent applications, relating to the construction, operation and maintenance of the Peka Peka to North Otaki Expressway (PP2O). This is one of seven sections of the Wellington Northern Corridor which has been identified by the Government as a ‘Road of National Significance’. A Board of Inquiry confirmed the requirements and granted the resources consents in February 2014. Detailed design is now underway. The proposal includes two parallel two-lane road bridges over the Otaki River, approximately 120 m upstream of the current rail bridge (see Figure 9 and Figure 10).

Figure 9: Map of Peka Peka to North Otaki Expressway. Source: EPA 0227 May 2013

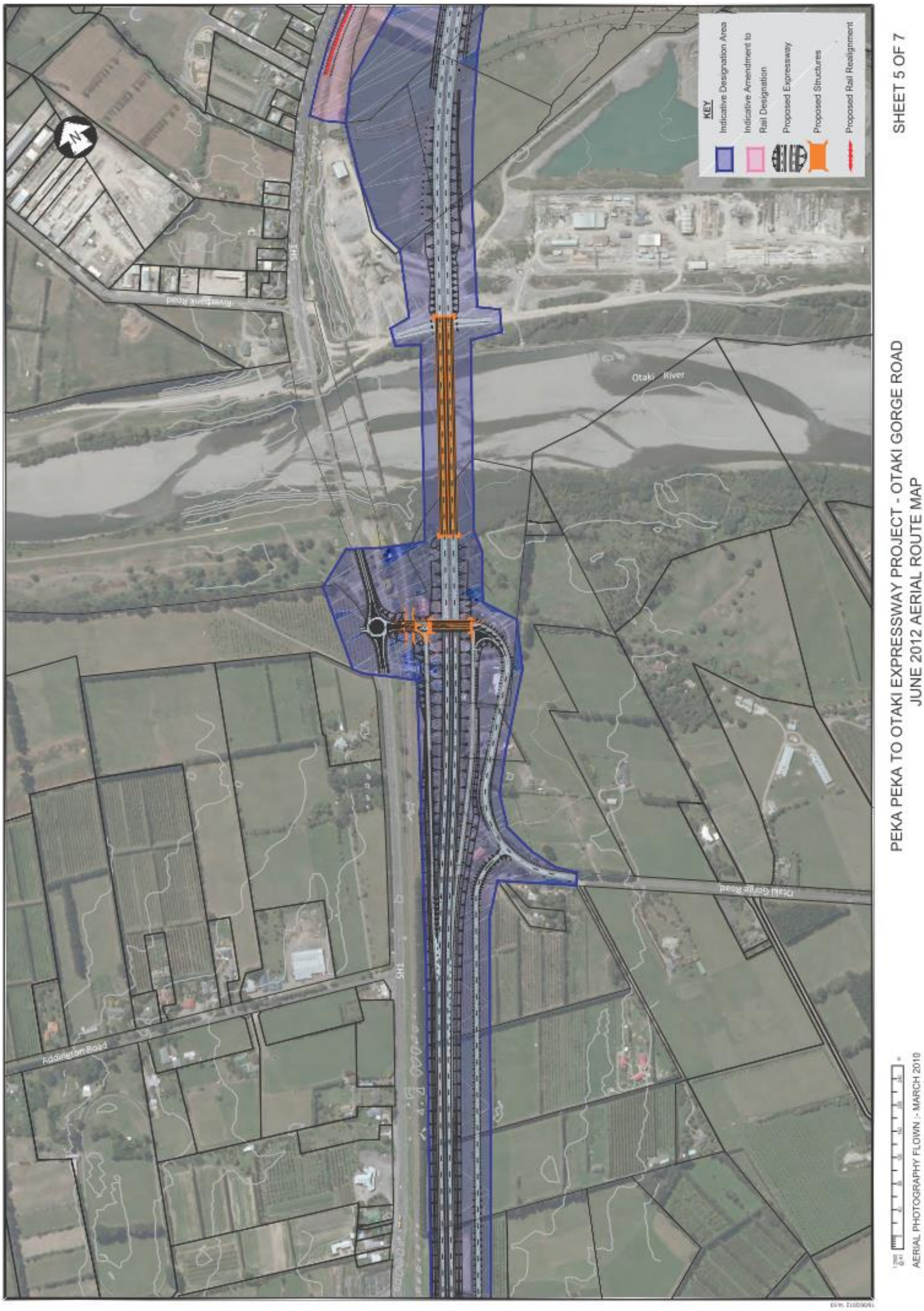

Figure 10: Detail of proposed expressway bridge over the Otaki River. Source: http://www.nzta.govt.nz/projects/peka-peka-to-otaki-application/docs/technical-report-22b-appendix-d-part-2.pdf

3.18 Archaeological sites

The New Zealand Archaeological Association online database identifies one site within the application area; details are included in Table 14.

Table 14: Details for identified archaeological site in application area

Site Reference	Name	Location	Recorded details
RS 25/11	Ferry Hotel	Approximately 200m from high water mark, on the true left bank of Otaki River within the Otaki estuary	'The area has been modified by river activity/flooding. There is a considerable amount of debris along the riverside banks; driftwood etc. undoubtedly concealing the hotel's brick foundations. A 19th century leather shoe (sole) was found during the site visit.'

Source: ArcSite online database of the NZ Archaeological Association

GWRC is aware from consultation with iwi to date that there are also waahi tapu associated with the Otaki River and its tributaries. No further details are available at present, but further knowledge may be made available (as appropriate) during further consultation and cultural impact reporting.

4 Proposed Activities

4.1 Purpose and intended outcomes

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

- align and maintain the Otaki River channel on the design alignment as defined in the OFMP on the more detailed meander pattern that has been developed for the river channel within the design alignment (see Section 2.2.3 for explanation)
- maintain the flood capacity of the existing channel by removal of obstructions and gravel build-ups as necessary
- maintain the integrity and security of the existing flood defences (including stopbanks and bank protection works – see Section 3.4 for details)
- manage the outlet of the Otaki River in response to pre-determined triggers relating to channel morphology and/or upstream water levels
- maintain the capacity of Rangiuru and Ngatoko Streams, and Katihiku and Pahiko Drains by clearance of obstructions and weed and maintenance of the outlet structure associated with them
- maintain the capacity of Waimanu Stream and Chrystalls Lagoon by clearance of flood debris and other obstructions and weed growth

In addition, the work programme also aims to:

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

4.1.1 Maintenance of channel alignment

Without active management the river would erode its berms and develop meanders in a similar way to that which existed in pre-European times. However the need to protect the private properties, urban infrastructure, utility services, bridges and floodway assets that are located adjacent to the river today means that the river must be actively controlled 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 and debris fences;
- Mechanical shaping of the beaches and channel – either by ‘ripping’ (i.e. dragging a tine through the gravels), or by recontouring (more extensive movement and redistribution of the gravels); and
- Channel diversion cuts.

Structural protection works are designed to be sufficiently robust to withstand flood events and do not require support with channel shaping. These works 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. Generally 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 are a means of realigning the low flow channel where it has moved too far from its design alignment, or a means of deflecting the channel where it is creating a bank erosion problem. They may provide a more effective and lower impact alternative to bed recontouring.

4.1.2 Maintenance of channel capacity

The tools currently used to maintain channel capacity are:

- Clearance of vegetation from gravel beaches ('scalping');
- Removal of unwanted willows;
- Clearance of flood debris;
- Clearance of silt & aquatic weed (from minor watercourses and Chrystalls Lagoon); and
- Gravel extraction from aggradation zones.

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 outlet of the Otaki River can migrate both to the north and south of its upstream channel. 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, a new outlet at the river mouths is 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 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**
Otaki River	Erosion	When the channel outlet in the coastal marine area migrates either 300 metres south or 300 metres north of the centre line of the river measured 700 m upstream.
	Flooding	When the river mouth closes or the Rangiuru flood gates are unable to effectively operate due to high water levels.

GWRC records show that the Otaki River mouth has been cut five times since 1998: twice in 2002, and once each in 2005, 2009 and 2011 - see Appendix J for full details.

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 including FOTOR. GWRC has programmed $351,000 of works related specifically to implementation of the Otaki Environmental Strategy between 2012 and 2022 (see Section 11.3.1). This includes an allocation for employment of a contractor to maintain riverside and estuary plantings and assist FOTOR with their on-going planting work.

Improvement of the in-river environment may also be achieved by the on-going development of good practice as outlined in the COP, which is enabled as GWRC further develops its understanding of the effects of works and maintenance activities through its environmental monitoring programme. The collection and analysis of relevant environmental information is an integral part of this process.

4.2 Description of activities

The operations and maintenance activities included in this application are summarised in Table 15: Summary of operations and maintenance activities. More details are given in:

- 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
- Table 19: Activities in the CMA
- Photographs of these activities are included in Appendix I.
- Relevant additional information is given in:
- Section 4.3 Formation of access
- Section 4.4 Diversion of water
- Section 4.5 Gravel extraction

While these methods form the 'tool box' for GWRC's operations and maintenance works, it may be that different, more suitable methods are developed in the future. Accordingly, GWRC is seeking to ensure that the new 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 process. This may include an initial trial period in selected areas.

As noted in Section 1.6, 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
- Mouth cutting and associated disturbance of the foreshore and seabed, and diversion of water in the CMA.

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. 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.	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
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 and 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.	Cycleway/walkway construction and associated new stormwater drainage, culverts, footbridges and access ways Fences Floodwalls Shaping of river banks and berms

Type of Activity	General Description	Typical Individual Components
	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.	
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 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.	Demolition by mechanical and/or hand methods Removal of demolition material from river bed
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.	Structural repairs and maintenance to: • Existing erosion protection structures in the river bed • Existing culverts and outlet structures that discharge to the Otaki 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 cycle ways, and upgrade or repair of any	Structural repairs and maintenance to: • Stopbanks & training banks • Flood and/or retaining walls

Type of Activity	General Description	Typical Individual Components
	stormwater culverts and drainage channels on the berms. These activities are uses of land requiring approval under s 9 RMA. The specific activities covered by this application, are given in Table 17.	• 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 Otaki 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. The specific activities included in this application are given in Table 18.	Tree Planting Willow layering, cabling & tethering
Maintenance of vegetative works	This may include trimming, removal, repair and re-cabling of layered or tethered willows, or trimming and additional planting to establish 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: recontouring of beaches above the active channel, and of the bed within the active channel (which used to be referred to as “cross-blading”). It also includes excavation of diversion cuts through beaches or bars for the	Mechanical: • Beach ripping • Beach recontouring • Channel diversion cuts

Type of Activity	General Description	Typical Individual Components
	purpose of realigning the channel. 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.	• Ripping in the wet channel • Bed recontouring • Recontouring (shaping and/or infilling) 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 silt and 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 activities included in this application are given in Table 18.	Removal of vegetation (both aquatic and terrestrial) Beach scalping Clearance of flood debris Gravel extraction from Otaki River bed Removal of silt, debris from drains and Chrystalls Lagoon
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 and the active river channel, they lie 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

Type of Activity	General Description	Typical Individual Components
Urgent works	Any of the above activities that are undertaken in response to a flood or emergency situation and may need to be undertaken outside regular methodologies or operating conditions.	
Works in the Coastal Marine Area	This includes: • clearance of flood debris • minor disturbance associated with gravel extraction • mouth alignment activities including periodic cutting of a new opening (excavation and redistribution of sand) on the foreshore for the Otaki River mouth (in response to defined ‘trigger points’) • urgent works 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.	Disturbance of foreshore and seabed Excavation of foreshore and seabed Movement and re-deposition of excavated material onto the foreshore

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 I. 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. Typically groynes vary from 350 to 750 tonnes of rock, but smaller groynes (approximately 150 tonnes) may also be constructed. Generally an area of less than 100 m² of river bed would be disturbed in the construction of a groyne.	GWRC records included in Appendix J show that 14 new rock groynes were constructed between December 2007 and January 2011.	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 H.	According to GWRC records, approximately 1.3 km (11%) of the right bank and 3 km (27%) of the left bank of the Otaki River within the application area is rock lined. This equates to approximately 19% of	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.	the total bank length overall within the application area. GWRC records also show that since 1998 a total of 1,361 m of new rock rip-rap lining has been constructed (equating to approximately 17,000 tonnes of rock) – see Appendix J 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 Otaki River or the minor watercourses; however they are a useful tool in	Remove vegetation 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.	the right situation and as such, could be employed intermittently or occasionally in the future.	Formation of access onto river bed (if 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 Otaki River or the minor watercourses; 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 are currently no grade control structures in the Otaki River or the minor watercourses; however they 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 45⁰ angle from the 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 I.	Debris fences have been used extensively on the Otaki River. GWRC records show that between 1998 and 2005 a total of 1130 m of debris fences were constructed at several locations. No further construction has been undertaken over the last seven years.	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
	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 (see Appendix I).	There is one debris arrester in the Waimanu Stream, upstream of Chrystalls Lagoon.	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.	Limited numbers of timber groynes have been constructed at Upper Taylors.	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 Otaki River Environmental Strategy. 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		Formation of new drainage channels Construction of cycle ways or walkways, and access ways. Construction of flood and/or retaining walls Erection of boundary fences Removal of vegetation

Activity	Description	Historical and Likely Quantum	Typical Activity Components
	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.		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 Otaki 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 and 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 between May 2004 and March 2010 approximately 1,140 tonnes of rock have been used in maintaining rock groynes in several locations (either in repairing flood damage, or in topping up the rock in the structure); this equates to an average of 81 tonnes of rock per year. See Appendix J for further details. GWRC also maintains (clearing, water-blasting etc. outlet structures on: • Rangiuru Stream • Katihiku Drain • Chrystalls stopbank	Remove vegetation if required Add rock/concrete Rebuild River crossings Diversion of water

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
		• Railway Line floodwall • Chrystalls Stopbank penstock.	
			Discharge of water and/or sediment
			Water blasting
Maintenance of debris fence/ debris arrester/permeable groynes	This includes repairs to any damage, and clearance of flood debris build-up as required.	GWRC work records in Appendix J show that since 1998 maintenance was undertaken on 1500 m of debris fences at a number of locations. This work occurred between 2001 and 2006, with no maintenance work being undertaken in the last 6 years.	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.	This work is undertaken as required.	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

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
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 dwellings, network utility structures or flood mitigation structures from imminent threat of erosion. Such work may necessitate working outside regular methodologies or operating conditions.	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. 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	Currently approximately 9 km (81%) of the right bank and 10 km (88%) km of the left bank within the application area is willow-lined; this equates to approximately 85% of the total bank length overall. GWRC records show that between 1998 and 2012 a total of 33,573 willow poles and 66,085 willow stakes were planted. This equates to an annual average of 2,398 poles and 4,720 stakes. See Appendix J for details. Willows are an important and necessary tool for stabilisation and protection of banks that will need to continue to be used on the Otaki River. 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
	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 I for photographs of these activities.		
	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 (Appendix J) show that an 80m section of tethered willows was constructed at the SH1 bridge in 1999/2000.	Tethered, cabled, layered
Maintenance of vegetative			Remove, thin, mulch trees using excavator.

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
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.		Re-tethering, cabling, layering Re-planting of willows
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 recontouring can include "ripping" of the beach surfaces to loosen gravels for the purpose of maintaining mobility of the bed material. 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 is undertaken infrequently in the Otaki River. However, it is a useful tool in the right situation and as such, could be employed intermittently or occasionally in the future.	Beach recontouring Beach ripping

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	Channel diversion cuts (formerly referred to a 'flood relief cuts') are a method that is used in the Otaki River to relieve the erosive pressure placed by the river flow on eroding bank edges or vulnerable river protection structures and plantings. The work is undertaken mostly in the 'dry', and involves excavation of a new channel across an existing beach. Ideally the new cut would be made up to 1 m below the existing water level. Bunds are placed at either end of the channel while the excavation work is undertaken to control the release of sediment to the water column, and opened once the cut has been completed. See Appendix I.	GWRC records show that a total of 25 channel diversion cuts have been made at various locations within the river bed since 1998. It is intended that channel diversion cuts under the new resource consents will be undertaken within the context of, and to support, the design meander pattern for the river as required.	Excavation of new channel across a 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 is 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. 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 end bunds are removed, and the excavated material pushed across the old channel alignment to the required finished profile.	GWRC records show that bed recontouring is undertaken over one or more sections, each of a few hundred metres long, on an annual basis. The total length of bed recontouring undertaken annually between 1999 and 2012 has varied from 400 m to 1200 m. See Appendix J for further details. In recent years the work has been concentrated in the part of the river upstream of SH 1. It is intended that bed recontouring under the new resource consents will be undertaken within the context of, and to support, the design meander pattern for the river as required.	Bed recontouring
	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		Batter/shape banks Repair scalloped areas

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	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 if this is considered necessary, and/or supported by other in-channel works.		
Channel Maintenance	Removal of vegetation involves removal of excessive or unwanted willows or other tree species from the Otaki River channel edge, 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. Clearance may be done by excavator and/or by hand. In addition, clearance of aquatic weeds and silt from the minor watercourses and Chrystalls Lagoon is also included. See Appendix I.	Removal of willows is not a major activity on the Otaki 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. Clearance of the minor watercourses is undertaken generally on an annual basis. Excavation of silt from Chrystalls Lagoon is undertaken approximately every 5 years.	Removal of vegetation from banks and channels Removal of silt from bed of minor watercourses
	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	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)

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
	not typically result in a discharge of sediment to the flowing channel.		
	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
	Gravel bed material is currently extracted from the Otaki River 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 4.5.	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 4.5.	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 and stopbanks along the Otaki River. Mowing is undertaken from the river banks rather than from the channel. No mowing along the minor watercourses is undertaken.	Repair of berms Mowing of berms Water blasting

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Disturbance of coastal beach areas above MHWS water level	Any disturbance of beaches that takes place **above** mean high water springs sea level is, by definition, outside the CMA. 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 dwellings, network utility structures or flood mitigation structures from imminent threat of erosion. Such work may necessitate working outside regular methodologies or operating conditions.	Varies in response to need; driven by flood occurrences, level of damage and the level of risk posed to adjacent assets.	

Table 19: Activities in the CMA

Activity	General Description	Historical and Likely Quantum	Typical Activity Components
Clearance of flood or other debris	This would involve the mechanical removal of large obstructions such as tree trunks, or other debris such as car bodies etc. where they are likely create hazards or channel deflections.	This activity is generally undertaken infrequently, on an as-required basis.	
Minor disturbance of beach edges associated with gravel extraction	Removal of gravel from parts of Mangahanene Island within the preferred design channel alignment will mostly occur above mean high water springs (i.e. not in the CMA), but there may be some minor disturbance of the river bed in the CMA adjacent to the beach associated with contouring of the beach to its finished profile.		
Excavation of diversion cut through foreshore (and associated deposition on sea bed & diversion of water)	A new outlet channels for the Otaki River is cut when upstream water levels reach a certain pre-determined trigger level, or when the mouths have migrated beyond pre-determined trigger levels. See photographs in Appendix I. 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 at 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.	The Otaki River has been cut 5 times over the last 14 years. It is expected that the frequency with which the river 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
	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.		
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.		
Urgent works	This covers any of the above activities where immediate action is required to protect existing dwellings or land from imminent threat of erosion. Such work may necessitate working outside regular methodologies or operating conditions.	Varies in response to need; driven by flood occurrences, level of damage and the level of risk posed to adjacent assets.	

4.3 Formation of access

Although existing access points will be used wherever possible, works to enable access may need to be undertaken as a precursor to many of the activities noted in Table 16 to Table 19. These works may involve trimming or clearance of small amounts of vegetation on the river banks, shaping or temporary placement of gravel in a localised area of the river bank and/or river bed to permit vehicle access to the river bed. All such disturbance (where required) would be confined to the minimum necessary to allow the proposed activities to be undertaken in a safe and effective manner. Reinstatement would be undertaken if appropriate.

4.4 Diversion of water

Several of the activities noted in Table 16 to Table 19 require diversion of part of the Otaki River flow. This includes permanent diversion of normal low flows as a result of:

- Construction of new structural works or bank reconstruction;
- Bed recontouring; and
- 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.

Excavation of weed and silts from Chrystalls Lagoon is also facilitated by temporary diversion of Waimanu Stream through a swale around the rear of the lagoon. This is achieved by placing large rocks in the stream channel (at approximately XS 530). The diversion is normally in place for three to four days while the clearance work is completed, and occurs approximately every five years.

4.5 Gravel extraction

4.5.1 Background

As noted in Section 3, the Otaki River is a large river which transports significant volumes of gravel from the upper catchment to the coast. This process leads to patterns of erosion and deposition in the river channel that can have a significant effect on the capacity of the channel. For this reason, management of this process by mechanical extraction of gravel in areas of deposition has been a vital part of flood protection operations in recent years. It is estimated that 837,300 m^3 of gravel has been removed from the Otaki River since 1991.

In 1998 the OFMP acknowledged the importance of gravel extraction in the management of the lower Otaki River. The Plan set initial guidelines for gravel extraction, which recognised that although there was a net overall increase in bed levels over the managed length of the river due to gravel deposition, degradation of the bed was also occurring in the zone above Chrystalls Bend. These included:

- To allow an average of 50,000 m^3 of gravel to be extracted annually until 2001/02 (under regional council consent), with extraction locations to be chosen to provide maximum benefits for river channel management. Extraction to be undertaken by private individuals or companies; and
- Extraction in the 1.5 km reach above Chrystalls Bend to be deferred until bed levels have recovered.

River bed management and gravel extraction policy is reviewed after every five-year river bed survey, as explained in Section 2.2. Analyses based on the latest survey data (which currently is the 2011 survey) set the direction until the next survey. Thus proposed gravel extraction volumes and locations for extraction will change in response to this process over time.

The latest review of gravel management in the Otaki River is reported in (Gardner, 2011); the report compiles and analyses data from the 2011 bed level survey and preceding five-yearly cross-sectional surveys (1991, 1996, 2001, 2006), together with records of gravel extraction.

Table 20 summarises the overall gravel volume changes in the river corridor, which takes losses and gains due to gravel transport and losses arising from mechanical extraction into account. It can be seen that overall there was a decrease of 365, 000 m³ indicating that more material was removed from the system (by extraction or transport to the sea) than was input from erosion. The figures also show that all of this net decrease occurred in the upper section of the river between Chrystalls Bend and Otaki Gorge, while the sections of the river below Chrystalls Bend experienced a net gain in gravel.

Table 20: Net changes in gravel volume 1991 -2010 in the Otaki River

Reach	Cross sections	Net change in gravel volume (m³)
Mouth to SH1	XS 0 – XS 340	+ 42,380
SH 1 to Chrystalls Bend	XS 350 – XS 490	+ 41,899
Chrystalls Bend to Lower Otaki Gorge	XS 501 – XS 1040	- 449,206
Total	XS 0 - XS 1040	- 364,927

Source: (Gardner, 2011)

4.5.2 Proposed extraction volumes

To determine the appropriate amounts of gravel extraction for the five year period following the 2011 bed level survey, the gravel balance for two sections of the river within the reaches where gravel extraction has historically occurred have been analysed. The results are shown in Table 21 and Table 22.

The figures in the tables show that approximately 42,380 m³ of gravel has built up in the river channel downstream of SH 1 since 1991, equating to an annual average increase of approximately 24,000 m³. In comparison, 32,907 m³ of gravel has built up in the river corridor between SH 1 and Chrystalls Bend over the same timeframe, with an average annual input of 14,600 m³.

Table 21: Gravel balance for Mouth to SH1 (XS 00 to XS 340)

	Volume (m³) **1991 -2010**
Total net change	42,380
Total extraction	442,289
Total deposition (+)/degradation (-)	+ 484,669
Annual average deposition	+ 24,233

Source: (Gardner, 2011)

Table 22: Gravel balance for SH 1 to Chrystalls (XS 350 to XS 560)

	Volume (m³) 1991 -2010
Total net change	32,907
Total extraction	258,680
Total deposition (+)/degradation (-)	+ 291,587
Annual average deposition	+ 14,579

Source: (Gardner, 2011)

In order to restore each reach to 1991 bed levels, it would be necessary to remove the total net build-up plus the annual increments to the system. Accounting for the five year period from 2011 to 2016, this would amount to:

Mouth to SH1: 42,380 + (5 x 24,000) = 162,380 m^3, or an annual average extraction rate of **approximately 32,500 m^3**

SH 1 to Chrystalls: 32, 907 + (5 x 14,600) = 105,500 m^3, or an annual average extraction rate of **approximately 21,000 m^3**

The total volume of gravel extraction required from these areas, on average, over the next five years is therefore currently calculated to be 32,500 + 21,000 m^3 = **53,500 m^3 per annum**. This recommendation will next be updated following analysis of the 2016 bed level survey data, and may change in response to this.

In addition, a one-off extraction operation to remove approximately **35, 000 m^3** of gravel from the area adjacent to the active channel near the Otaki River mouth, known as Mangahanene Island, is also proposed to be undertaken over the next five years. This is discussed further in Section 4.5.4 below.

4.5.3 Proposed methodology

To date, gravel extraction has been undertaken from beaches above the active channel – a method referred to as 'dry extraction'. GWRC proposes to continue with this method of gravel extraction in areas where it is appropriate to do so. Also, in order to undertake the work required to establish the Otaki River on its design alignment (see Section 2.2.2) it will be necessary to remove some beach areas altogether, which will necessitate the operation of machinery in flowing water at times. Similarly, as it is proposed to establish a design meander pattern within the river corridor (see Section 2.2.3), all gravel extraction under the new resource consent will be undertaken in accordance with this regime. Again, this will require operation of machinery in the active channel at times. Extraction of gravel from the active channel is referred to as 'wet extraction'. Further details on the two extraction methods are outlined below.

4.5.3.1 Dry Extraction

'Dry extraction' involves extraction of gravel from beaches above the normal low flow water level. All works are undertaken out of running water, except for any river crossings for access or for transport of extracted gravel that may be necessary.

Extraction is usually carried out using either hydraulic excavators or front end loaders which load onto trucks (either road trucks or off road dumpers). Extraction is undertaken in uniform strips parallel to the river channel, to a depth no lower than 0.2 m above the normal level of the adjacent flow – Figure 11.

Figure 11: 'Dry' extraction from beach above active channel (Waikanae River)

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. The extracted gravel is transported to the processing plant using existing access tracks and/or public roads wherever possible. For remote beaches trucks may need to travel along the dry river bed, and may need to cross the river. Such crossings will be kept to a minimum, and restricted to a single point of entry and exit.

At the end of extraction, beaches are left with a sloping even surface to ensure that there are no major discontinuities that could divert future floodwaters. The next fresh or flood will re-work the bed to a more natural form.

4.5.3.2 Wet extraction

<u>Preparatory works</u>

- The most recent cross section surveys are compared with the design profile and cross sections to determine cut and fill depths and calculate available gravel volumes.
- Construction plans are prepared, which detail the active channel centre line (thalweg), active channel width and beach offsets, and finished beach and river bed levels.
- The beach edge and active channel centre line are set out from reference points on the bank, and are marked with either a green waratah (beach edge) or red waratah (thalweg).

In-channel works

- The low flow channel is deepened by pushing gravel material up onto the existing beach to form a temporary stockpile. Over most of the extraction reach this work is carried out by one, or sometimes two, D9 bulldozers, with the machines working in the low flow channel. At some smaller beaches where the low flow channel is relatively deeper and well-defined (generally in the downstream end of the reach), an excavator is generally used. There may be times when this excavator may also need to work in the low flow channel. In some instances it may be necessary to cut a new channel through an existing beach to achieve the design meander pattern.
- Work commences at the downstream end of each beach with a lowering and re-shaping of the riffle; the machine will then continue shaping the low flow channel, moving in an upstream direction to create a lowered pool.
- Upon completion of the pool deepening some re-shaping of the riffle may be required to ensure the desired cross-over has been achieved.

Gravel removal

- The temporary gravel stockpiles are allowed to drain sufficiently (for at least 1 day) before gravel removal commences. The raised beach is then lowered progressively by the contractor.
- Work commences at the downstream end of the beach and proceeds upstream. Gravel is extracted in strips parallel to the river flow, working from the front of the beach to the rear. This stage of the operation takes place above normal water levels, and no further re-working of the low flow channel is required. The raised beach also remains largely intact during flood events.
- A front end loader is used to load the gravel onto either road trucks or dumpers, which then transport it offsite via existing haul roads for processing (Figure 12). 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; or if no access is possible from the bank edge, there may be a requirement for river crossing points to be formed, and for trucks to track within the river bed (Figure 13).

Figure 12: Gravel extraction: front-end loader loading an off-road dumper truck (Hutt River)

Figure 13: Gravel extraction: off-road dumper crossing river

Further re-contouring

- At the completion of the gravel extraction operation the remaining beach is re-contoured to give a smooth profile, with a central rise, downward slope to the low flow channel, and a well-defined water edge (where possible). Where the low flow channel is shaped with a bulldozer, there may be the need to further shape the beach edge with an excavator to achieve this. The purpose of this is to ensure a minimum of re-working by the river is required to re-establish a 'natural' channel form and shape.
- As the river reworks the altered meander pattern and lowered riverbed, any adjoining bank protection works and bank edges may become exposed and vulnerable to erosion; this is most likely to happen after a flood. This may require further re-shaping of riffles and beaches after such times, and it may also be necessary to use additional protection measures (e.g. willow layering, tree groynes, tethered willows and groynes or toe rock protection) to protect the most vulnerable willow stands and bank edges.

Timing of works

Generally the majority of in stream channel works have occurred between 10 November and 22 December, to comply with the following:

- 1 September – 9 November (inclusive) to avoid upstream migration of native fish[15]
- 23 December to 15 February (inclusive) to avoid peak angler use and recreational users

Removal of stockpiled gravel is undertaken throughout the year.

[15] Note that the COP extends this period to 1 September – 30 December

4.5.4 Extraction from Mangahanene Island

In recent years the Otaki River has become deeply channelized along the true right bank downstream of XS 60, in the reach lying within the CMA, and this places significant erosive pressure on the right bank in that location. The cause of the channelization is a build-up of gravel on the opposite beach on the left bank – an area that GWRC refers to as 'Mangahanene Island' (which reflects the fact that it was historically an island, although it is not any longer) – see Figure 14. Stabilisation of the gravel beach by dense scrub and weeds has interfered with the usual mobility of the river bed gravels and further exacerbated the problem. It should be noted that the area has significance to local iwi, lying on the fringes of the Whakapawaewae wetland (see Section 3.8).

GWRC proposes to remove the scrub, weeds and gravel from the parts of this area that lie in the design channel, between XS 30 and XS 80 – i.e. the area to the north of the dashed blue line in Figure 14, using the dry extraction methodology only. The land in the design channel is mostly in public ownership, but borders the properties to the south owned by the Katihiku X Trust, and encroaches into them in places.

This action will relieve some of the erosive pressure on the right bank, by allowing the river to spread over a wider area on the southern side of the channel at times of high flow. Gravel will be skimmed from the area by the dry extraction method and removed off site.

It should be noted that the edges of the 'island' downstream of XS 50 (approximately) lie adjacent to the CMA boundary. While most of the proposed gravel extraction will occur above mean high water springs and thus outside the CMA, some operation of machinery and/or recontouring along the wetted margin of the channel may occur to facilitate formation of a desirable finished profile for the works area.

Figure 14: Location of the area known as 'Mangahanene Island' (circled in red) with approximate position of design channel on left bank shown in blue

The total estimated volume of gravel to be removed is approximately 35, 000 m^3.

The material will be removed entirely by the dry extraction method.

Discussions with the adjacent landowners will be undertaken prior to any works being undertaken, to identify any concerns or questions they may have and to explore arrangements around access to the site.

GWRC would also expect, prior to undertaking any works, to prepare a detailed Excavation Plan that would identify such things as:

- Detailed gravel volume calculations;
- Details of the specific location and extent of the proposed works;
- Specific actions that will be undertaken to avoid, mitigate or remedy adverse effects;
- The machinery to be used;
- 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.

4.6 Design of work programmes

4.6.1 Gravel extraction programmes

GWRC will formulate its annual gravel extraction programmes on the basis of the recommendations of the latest gravel analysis report (which is produced after each five yearly bed level survey), together with the recommendations for establishment of the design channel and design meander pattern (see Section 2.2).

Gravel extraction is generally undertaken by contractors (Winstone Aggregates).

4.6.2 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 such as tree planting etc. 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/m² for willows, \$7,000 to \$11,000 for a typical debris fence[16] and from \$1,500 to \$3,000 for rip-rap lining[17]. 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.

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

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.

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 Otaki River and the minor watercourses covered by this application are issues that have already been addressed by the community through the development of the OFMP. 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 OFMP, and are based on current good engineering and environmental practice. This has been formalised further into an updated COP that 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; and
- 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 considerations

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.

5.2.1 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, experience to date has shown that the same results cannot be achieved using native species.

GWRC established a trial at three sites on the Hutt River in 2001 to investigate the use of native planting for river edge protection. The results of this work are reported in (Phillips et al, 2009). In summary, the report concluded that while native plants could be used to stabilise smaller order streams, there were limitations to the use of native planting for edge protection in larger rivers. In particular, natives are:

- slower to establish;
- have shallower root systems; and
- have higher maintenance costs.

The native species with the most potential for river edge protection are toetoe (*Cortaderia fulvida*), flax (*Phormium tenax*) and some grasses (*Carex sp*.). However it was also noted that in flood events there is potential for erosion of these clump-type plants to channel cause blockages.

In light of the trial outcomes, native planting cannot be regarded as a comprehensive or comparable alternative to willows; the most realistic alternative at this stage is likely to be structural work (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 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 application has noted that the willow plantings along the Otaki 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 ecological restoration and enhancement within the river corridor will extend the amount and range the natural biodiversity values of the area over time.

5.2.2 Gravel extraction

The continuous supply of gravel that is carried from the bed and banks of the upper catchment and deposited in the lower reaches of the river leads to aggradation of the river bed and berms, and consequent reduction of the channel capacity to convey floodwaters. In turn, this leads to increases in the risk of flooding unless the gravel is continuously removed.

Should gravel extraction not be undertaken, the consequences would require that either the community accepted a diminishing standard of flood protection from the existing scheme over time, or alternatively was prepared to commit 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.

6 Assessment of Environmental Effects

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 Otaki communities. 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 – including the use of productive agricultural and horticultural land in the Otaki River floodplain. It also lowers the risk of negative flow-on effects of flood events on the economy of the wider region.

6.2 Other effects

The potential and likely actual adverse effects of the proposed works are identified and summarised with reference to individual activities in Sections 6.4 to 6.22. The assessment is made within the context of the Otaki River and associated minor tributaries being highly modified and managed waterways, which nevertheless have important natural characteristics and values and significant cultural value. Cumulative effects arising from interaction with other consented works in the river are addressed in Section 6.23.

6.3 Discharge of sediment

6.3.1 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.

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 recently 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 that was 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 23. 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 23: 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: Geotechnics Ltd

Table 24 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 24: 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: 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 25 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. The channel shaping results listed above are therefore not outside of the normal range for a mobile gravel bedded river.

Table 25: 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 (410m^3/s @ Birchville on 19/11/96)	-	780	-
	High river flow event (160m^3/s @ Birchville on 8/10/2007)	-	397	-
	High river flow event (80m^3/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

Mechanical disturbance during low flows is likely to result in some settlement of fine sediment on the riverbed downstream of the works area, however this effect is relatively short lived in run and riffle habitat as water velocities during subsequent minor flood flows are generally sufficient to remove most of the fine sediment from the affected reach (Cameron, 2015).

In summary, the available data indicate that:

- River crossings by off-road 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
- Channel shaping may result in a temporary increase in fine sediment deposition on the riverbed downstream of the works
- A moderate fresh (with no river works) can increase river suspended solids by over 700 mg/l
- The discharge plume may also contain elevated levels of total nitrogen and total phosphorus but monitoring in the Hutt River indicates that these contaminants are typically bound to particulate material and not likely to stimulate algae growth

6.3.2 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.

6.4 Construction of impermeable erosion protection structures

6.4.1 Groynes

The location of groynes on the Otaki River can be seen on the aerial photographs in Appendix D.

Records for the Otaki River show that 14 rock groynes have been constructed between 2007 and 2013. There are no groynes on the Waimanu, Rangiuru or Ngatoko Streams or in the Katihiku and Pahiko Drains. Sets of groynes are one tool that could be used to hold the river in its design meander pattern. The number of groynes that may be needed in future will depend on the balance of bank protection measures that is considered to be most effective and affordable in establishing and holding the design meander.

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 an increase in suspended solids 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 6.3.1. Monitoring in gravel river beds 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 of 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 Otaki 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, since they 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, care is taken to ensure the design is appropriate and construction is overseen by appropriately qualified personnel.

(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 sheltered water in its lee. 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. Work undertaken by Alton Perrie of GWRC Environmental Science Department (Perrie, 2013) 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 (including the Otaki River) is likely to range from neutral to positive.

Four sites of value for native birds have been identified on the Otaki River based on the 2012 to 2015 surveys (refer to Section 3.12). None of these sites are likely to be at risk from groyne construction, although consideration should be given to the locations of these sites as part of the pre-works planning prior to any construction in the Otaki River.

6.4.2 Rock lining

GWRC records for the Otaki River indicate that approximately 19% of the total bank length within the application area is rock lined, with over twice as much on the left bank as on the right. Of this, approximately 1300 m has been constructed since 1999 (see Appendix J). The location of the most significant rock lining can be seen from the aerial photographs in Appendix D:

- XS 130 - 180 (right bank)
- XS 220 – 240 (left bank)
- XS 480 – XS 511 (Waimanu Stream outlet, right bank)
- XS 521 – 560 (Chrystalls Bend – right bank)

The proportion of rock lining in the Otaki is less than that in the Hutt River (25%) and more than in the Waikanae River (11%). There is no rock lining on the minor tributaries of the Otaki River. There is no rock lining on the Rangiuru or Ngatoko Streams or in the Katihiku and Pahiko Drains.

Rock lining is an effective tool for holding the river channel in a design meander (either in conjunction with rock groynes or as an alternative to them). The amount of rock lining that will be needed under the new resource consents will depend on the balance of bank protection measures that is considered to be most effective and affordable in establishing and holding the design meander.

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, 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. Although no construction in the CMA is proposed, any rock lining in tidally influenced reaches above the CMA boundary could have the potential to destroy inanga spawning habitat. As yet, such areas have not been clearly identified, but it is proposed that this would be addressed by a survey in the lower Otaki River and associated tributaries as part of the Monitoring Plan that is proposed to be undertaken as part of the new resource consents. Once any such areas have been identified, it will be possible to ensure that river works either avoid such areas or make suitable provision for mitigation of effects.

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. Hence it would be erroneous to attribute the relative paucity of fish fauna in the Otaki River solely to the presence of rock lining in the river.

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.

Four sites of value for native birds have been identified on the Otaki River based on the 2012 to 2015 surveys (refer to Section 3.12). None of these sites are likely to be at risk from rock rip-rap construction, although consideration should be given to the locations of these sites as part of the pre-works planning prior to any construction in the Otaki River.

6.4.3 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 infrequency with which these works are undertaken in comparison to rock lining, the overall actual 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 during construction, 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.

6.5 Construction of permeable erosion protection structures

This category of structure includes debris fences, debris arresters and timber groynes. Debris fences have been employed relatively extensively in the Otaki River (see Appendix J for details), although not in the past few years. There is one debris arrester on the Waimanu Stream upstream of Chrystalls Lagoon.

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 likely 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 6.3. 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.

As with other structures, the potential short term effects of debris 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.

Long term effects

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, 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.

6.6 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 Otaki River Environmental Strategy, which will have overall positive benefits for the local and wider community.

6.7 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 can reduce the health and safety risk to river users, as well as reducing adverse visual impacts. This is not a major activity and is undertaken on an as required basis, typically for no more than one or two days per year in the Otaki River. It is unlikely to have a significant impact on invertebrate or fish habitat.

6.8 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.

6.9 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 and sediment 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.

6.10 Establishment of vegetative bank protection

6.10.1 Willow planting

Currently approximately 85% of the Otaki River banks within the application area are willow-lined, with roughly equal areas of planting on the right and left banks. 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 in the Otaki River corridor. No planting of willows is undertaken by GWRC on private land adjacent to the minor watercourses.

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, 2015).

Other potential short term effects on any roosting birds, recreational users and the neighbouring community are also expected to be less than minor, and can be easily mitigated by the adoption of appropriate good practice (such as the inspection of the proposed works area for any birds prior to commencement of works, and confinement of operations to agreed working hours). These provisions have been included 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 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 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 also provide roosting habitat for river birds such as shags, however (McArthur, 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 Otaki 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 the fact that GWRC also undertakes significant planting of native trees and restoration of selected natural areas in the river corridor in accordance with the objectives of the Otaki River Environmental Strategy. This latter planting contributes significantly to the increase in biodiversity values of the river corridor, and (Cameron, 2015) suggests that this is a reasonable compromise to the overall willow management issue.

6.10.2 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 Otaki River Environmental Strategy). Records in Appendix J show that an average of 2400 willow 'poles' and 4700 'stakes' have been planted annually since 1998, with only one minor instance of tethered willow construction in the same time.

Short term effects

The short term effects of maintenance work is expected to be negligible, however any removal of old trees may result in the immediate loss of fish habitat and possibility a temporary and localised increased sediment inputs to the stream via stormwater runoff.

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 (particularly large sections along the river bank) might 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.

Overall, maintenance of vegetative works is not expected to have significant impacts.

6.11 Channel maintenance

6.11.1 Removal of woody vegetation

This activity covers the 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. Short and long term effects are as described for willow maintenance work (Section 6.10.2).

6.11.2 Removal of beach vegetation

(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 (provided, of course that the activity is not undertaken at the same time as breeding is occurring).

6.11.3 Removal of aquatic vegetation and silt

GWRC undertakes regular clearance of aquatic macrophytes (aquatic plants) and silt from Rangiuru and Ngatoko Streams, Chrystalls Lagoon, and Katihiku and Pahiko Drains. This is necessary to maintain channel capacity and manage the risk of flooding of the surrounding land.

Maintenance activities may include the removal of vegetation and silts by mechanical excavation, clearance of flood debris, maintenance of existing culverts and floodgates, as well as planting and landscaping (see photograph in Appendix I of mechanical drain clearance). Access to the drains is across private land, and is arranged with the relevant landowners. Excavated material is placed on the bank.

Chrystalls Lagoon is mechanically cleared of weed and silt approximately every five years. To date, an excavator has been used, but GWRC is currently trialling the use of a cutting boat, on loan from Hawkes Bay Regional Council. With the latter method, the cut weed floats downstream to the lagoon outlet, where it is removed by an excavator. To facilitate the lagoon clearance work the Waimanu Stream is diverted into a swale that runs around the rear of the lagoon.

Short and long term effects

There is a lack of information on the ecology of the minor watercourses noted above, and in particular, the presence and abundance of fish fauna in them. (Cameron, 2015) considers that the core fish community in the Rangiuru and Ngatoko Streams is likely to include longfin eel, shortfin eel, common bully and inanga, and other galaxiid species such as giant kokopu, shortjaw kokopu, banded kokopu and koaro may also be present where suitable habitat is available. The Katihiku and Pahiko Drains are deep, steep sided waterways with soft sediment substrate, and macroinvertebrate habitat is largely limited to macrophytes. Fish habitat is limited in both quality and abundance in the straight sided channels, although prolific macrophytes provide cover. Although no fish records are available it is expected that the core fish community will consist of longfin eel, shortfin eel, inanga and common bully.

(Cameron, 2015) considers that hand clearance of weed is the least disruptive method but may not be viable for large reaches of stream. Mechanical excavation is more disruptive and can result in the immediate loss of a high proportion of the available plant cover, and of the substrate when silts are excavated as well.

Potential adverse effects of vegetation removal include:

- Loss of fish spawning habitat;
- Stranding of fish and removal of invertebrates during digger operation;
- Suspended sediment causing fish mortality;
- Non-lethal effects of suspended sediment impacting fauna;
- Fish and invertebrate populations affected by changes in habitat structure; and
- Changes in channel morphology and hydrology.

As parts of the Rangiuru Stream and Katihiku Drain are known to provide inanga spawning habitat, the timing of any works will be undertaken to avoid disturbance of these areas from March to May, inclusive. In addition the period from 15 August to 30 November when the whitebait return from the sea to run up the river (the whitebait season) will also be avoided.

6.11.4 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 & Richardson (1995) suggested that flood debris are not sufficiently abundant to influence fish distribution to any great extent. He concludes that where there is opportunity to leave flood debris that presents no apparent risk to structures of public safety, it would be beneficial to enhancement of available habitat for fish.

6.12 Channel shaping and realignment

6.12.1 Beach ripping and scalping

Beach ripping will be undertaken on an infrequent basis in the Otaki River (and not at all in the minor watercourses), while removal of vegetation from beaches (scalping) is done more frequently.

(Cameron, 2015) considers that these activities are unlikely to have any immediate downstream effects on water quality or aquatic habitat, since they are 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, and will continue to pass down the river system. The effect of this might possibly cause additional siltation and gravel accumulation in the reach downstream. However, 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.

There is evidence that removing weeds has considerable value for those birds which roost and breed on open riverbeds. McArthur, et al (2015) identified that virtually the entire length of the application area provides breeding habitat for regionally-significant populations of both banded and black-fronted dotterels and for a relatively large local breeding population of pied stilts, and the lower reach of the Ōtaki River appears to be utilized by banded dotterels as a post-breeding staging area prior to migration. In light of this information McAthur made a number of recommendations for the protection of breeding colonies on the Otaki River, which are incorporated in the COP.

6.12.2 Beach recontouring

Beach recontouring may have implications for river birds and, when done in conjunction with clearing of vegetation from beaches, may improve the quality and/or quantum of river bird roosting and breeding habitat. McArthur et al (2015) identified four sites of value for native birds on the Otaki River including breeding colonies banded and black-fronted dotterels, and pied stilts, a nesting colony of black shag, a post breeding staging colony of pied stilts.

As this work is undertaken in the dry bed, away from the active channel, there is little risk of short term construction impacts on water quality or aquatic ecology. There is no evidence of negative impacts in the long term. (Cameron, 2015) considers the medium and long term effects of beach recontouring may be neutral to positive in terms of river bird habitat and probably neutral in respect of the aquatic ecology.

6.12.3 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 COP, 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.

6.12.4 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.

Although the activity involves mechanical disturbance of the bed, with associated aquatic habitat disturbance and temporary release of sediment to the water column, the activity is less invasive and less extensive than bed recontouring, and thus the scale of these effects is relatively less than with bed recontouring (see below).

6.12.5 Bed recontouring

Bed recontouring (formerly referred to as ‘cross-blading’) can be undertaken as a discrete exercise to address erosion of bank edges, to prepare the bed for construction of structural works, or in association with gravel extraction. The records in Appendix J relate to the former activity. They show that the amount of bed recontouring undertaken annually in the Otaki River between 1999 and 2012 has varied from 400 to 1200 lineal metres, and has been concentrated upstream of SH 1 in recent years. The average annual amount is 740 m, which compares with 542 m for the Hutt River and 184 m for the Waikanae River.

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 and macroinvertebrate and fish populations are likely to be similar to those associated with ‘wet’ gravel extraction because the two processes are very similar. However, when used to realign the low flow channel, 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 once the gravel has been pushed from the channel to the bank edges.

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 realignment 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, 2015) concludes that the medium to long term effects on the aquatic ecology of bed recontouring, where it straightens the channel, are 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. He notes, however, that it is 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 maintained.

There is also an opportunity to mitigate many of these adverse effects in the Otaki 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.

6.13 Gravel extraction

GWRC proposes to extract approximately 53,500 m^3 of gravel per year from the Otaki River in order to restore the bed to 1991 levels and to subsequently maintain them at these levels. To achieve this it is estimated that approximately 32,500 m^3 per annum will need to be extracted in the reaches between the mouth and SH 1, and a further 21,000 will need to be extracted from the reaches between SH1 and Chrystalls Bend. A combination of dry and wet extraction methods are proposed, with extraction operations to implement the formation of the proposed design meander pattern for the river. (Note: no gravel extraction occurs in the minor watercourses; clearance of silts and vegetation from these is covered in Section 6.11.2 above).

In addition, a one-off dry extraction operation to remove some of the gravel from parts of Mangahanene Island lying within the design channel alignment is also proposed; this involves removal of approximately 35,000 m^3 of gravel.

6.13.1 Potential effects in Otaki River

6.13.1.1 Disturbance of birds

Gravel extraction from beaches above the active channel (in the dry) may have implications for river bird roosting and breeding habitat, similar to those noted for beach recontouring. The report on recent bird survey work (McArthur, 2013) indicates that breeding populations of banded and black-fronted dotterel and pied stilts, all of which are river-nesting birds, are found along the length of the application area in the Otaki River. The report made a number of recommendations for minimising the risk from flood protection activities to such bird populations, and these have been included in the COP. Specifically work on dry gravel beaches between 1 August and 28 February will be preceded by a survey to identify presence of breeding birds, nests or chicks and establishment of exclusion zones.

(McArthur, 2013) also made recommendations about further monitoring to be carried out to provide quantitative data to describe on-going trends in the distribution and abundance of riverbed nesting birds; and to better quantify the impacts of flood protection activities on river nesting bird populations. Those of relevance to rivers in the western part of the Wellington Region are that:

- Two further surveys are carried out on the Hutt, Waikanae and Otaki Rivers in October-November 2013 and 2014, using the methods described in their report.
- After a period of five years a further three consecutive annual surveys on these rivers should be undertaken, and this pattern should thereafter be repeated on a regular basis with a gap of 5 years between the groups of surveys.

These provisions have been included in the COP, along with guidance on the appropriate response should monitoring detect any changes in bird populations.

6.13.1.2 Disturbance of herpetofauna

One species of lizard, the northern grass skink, has been recorded within the Otaki River flood corridor. Gravel extraction from dry beaches may affect the margins of the northern grass skink population, however lizards are likely to be, at best, sparsely distributed on these beaches, which are regularly inundated by flood flows. Accordingly the potential impact on lizard populations is assessed as negligible and no specific mitigation measures are considered to be necessary.

6.13.1.3 Fine sediment mobilisation and deposition

(Cameron, 2015) concludes that gravel extraction from the dry beaches is likely to have minimal effects on water quality of the Otaki River, although in those cases where trucks are required to cross the river there is potential for minor discharge of suspended sediment and disturbance of bed material. This can be managed by requiring vehicles to use designated crossing points.

Gravel extraction which involves working in the active channel, as is proposed in the Otaki River, entails extensive disturbance of bed material and significant release of suspended sediment into the water column, over a period of some weeks. Monitoring of river water quality undertaken by GWRC (see Section 6.3.1) indicates that this activity generates suspended solids concentrations in the river immediately downstream of the works of up to 800 mg/l, or about the same order as a one year return period flood (in the Hutt River). Monitoring results also indicate that suspended solids concentrations decrease fairly rapidly with distance downstream, and 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 more than half of each 24 hour period, including night time when much of the native fish feeding activity occurs.

6.13.1.4 Disturbance of benthic habitats

Habitat mapping studies summarised in (Cameron, 2015) show that these works 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 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.

6.13.1.5 Disturbance of macroinvertebrate communities

(Cameron, 2015) refers to a report by Fenwick et al (2003), which found that although in-stream gravel extraction operations appear to create major mechanical disturbances of benthic habitats and sedimentation effects immediately downstream, in large braided rivers like the Waimakariri River, which are characterised by frequent floods and discoloured waters, gravel extraction from the active channel does not appear to have a major effect on the benthic fauna downstream of the works area, although some changes in invertebrate faunal composition were noted. (Cameron, 2015) also cites two other reports that suggest 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. (Cameron, 2015) states that this is likely to be the case in the Otaki River where a healthy and diverse benthic community in the river upstream of the works area would be available to re-colonise disturbed reaches (as already occurs after major floods). However, that where the area of mechanical disturbance involves multiple riffles the overall productivity of that reach will be reduced, potentially reducing food supplies for fish.

6.13.1.6 Disturbance of fish communities

GWRC Environmental Science Department undertook an investigation of native fish re-colonisation on a Hutt River reach affected by gravel extraction activities in the active channel during 2012 and 2013. The results of that investigation are reported in (Perrie, 2013). The study involved 'before and after' surveys of fish abundance by EFM in three shallow riffle habitat sites on the Hutt River: one site was located in the immediate area of the gravel extraction activity; a second site was located 1.2 km downstream and a third 1.2 km upstream. The results show that juvenile koaro were abundant at all three sites in the first survey in November, numbers decreased at all three sites in the second survey in December, and no koaro were caught in the final survey in February. Perrie concluded that this reflected the annual upstream migration (whitebait run) of this species to upstream habitat. Redfin bullies were also juveniles likely to be migrating upstream. Bluegill bullies were the most abundant species and were sufficiently abundant to be compared between sites and across sampling occasions (and are expected to be resident in this part of the river system). Perrie (2013) observed that:

"Overall, given that a reduction in bluegill bully densities occurred at the upstream site, it is not conclusive that the gravel extraction caused the decline observed in the impact site. However given that the gravel extraction changed the habitat at the impact site from that considered ideal for bluegill bullies (riffles) to that considered less favourable (run), it seems highly plausible the gravel extraction contributed at least in some way to the decline in density at this site. Further work is clearly required to better understand how gravel extraction from the wetted channel may be affecting bluegill bully populations in the Hutt River."

More recently an investigation was conducted in the Hutt River at Belmont before and after channel re-alignment works over a 220m river length (Cameron, 2015). The results of that study showed that the re-alignment works caused a major change in habitat characteristics. The channel was straightened and simplified by removal of a meander and gravel bar. Several areas of swift riffle habitat were lost and had not been re-established seven weeks after completion of works. The loss of swift riffle habitat had implications for the local bluegill bully population which were the most abundant fish species in this reach. The abundance of bluegill bullies declined at the works site as a result of river engineering activities, and had not recovered seven weeks after completion of the works. It was evident that the bullies had not returned to the engineered reach because there was no good quality habitat for them there.

Death et al (2013) found that bed re-contouring on Waingawa River temporarily affected fish numbers, but, provided suitable habitat was available, the fish fauna recovered rapidly, usually after the first fresh. The authors concluded in relation to the Wairarapa Rivers that:

"…the weight of evidence provides no indication that any fish (except for trout in the Waingawa) were adversely affected by the engineering activities, in fact eels and/or bullies in some of the rivers increased in abundance".

Surveys of trout numbers undertaken by Fish & Game divers before and three months after disturbance by gravel extraction in the Hutt River found that trout were relatively abundant at both disturbed and undisturbed reaches, indicating that any adverse effects that had occurred were relatively short-lived (Cameron, 2015).

Fenwick *et al* (2003) also found that juvenile torrentfish and bullies in the Waimakariri were more abundant and had more food in their guts downstream of gravel extraction than at the control site. One explanation for this is that the in-channel disturbance caused by gravel extraction dislodged benthic invertebrates and increased drift downstream. As a result, the fish may have preferred the riffle downstream of the digger because of the increased food availability. The mayfly *Deleatidium* spp. comprised a major proportion of the foods found in the guts of juvenile torrentfish (a species that is typically a nocturnal feeder) and is probably susceptible to dislodgement and drifting downstream from in-channel gravel extraction activities. The possibility of greater availability of food for fish with in-channel disturbance is evident in the fact that some anglers prefer to fish for trout downstream of active extraction sites because of greater catch rates, believed to be due to increased feeding by fish at such sites.

(Cameron, 2015) recommends that where there is a potential for loss of important habitat due to river engineering works, consideration should 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 riffle, pool and/or backwater 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. Disruption of fish spawning and/or migration

As described in Section 3.10.4, the Otaki River application area provides spawning habitat for a variety of fish. The spawning habitat and times of these species are as follows:

- Inanga spawning habitat is located in tidal estuary edge vegetation and occurs during March, April and May. While the main-stem is not suitable for inanga spawning, the Rangiuru Stream and the Pahiko/Katihiku drain offer good habitat for inanga spawning.
- Other galaxiid species including koaro, banded kokopu, shortjaw 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 minor watercourses upstream of the application area.

- Bullies spawn in riverbed substrate, often under large rocks, between August and February. Some spawning habitat will 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 to spawn during May and June. Trout spawning habitat in the Otaki appears to be limited to upper tributaries (Strickland & Quarterman, 2001); it is thought that the main-stem of the Otaki below the gorge does not provide important trout spawning habitat due to the generally coarse nature of the bed substrate.

6.13.1.7 General comments on the potential effects of gravel extraction in Otaki River

Gravel extraction activities have the potential to cause significant adverse effects on the river ecology, at least in the short term. Bed disturbance and discharge plumes have the potential to interfere with juvenile fish migration and to disrupt spawning of inanga, bullies and torrentfish. These effects could, however, be avoided or mitigated by limiting the amount of bed disturbance that can occur during periods of peak upstream migration & spawning, as summarised in Table 26.

Table 26: Recommended constraints of works in the wetted river channel – Otaki 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>Otaki River</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4" rowspan="3">No more than 3 day’s work per site or 15 days per 10km</td></tr>
<tr><td>Otaki Estuary</td><td></td><td></td><td colspan="3">No works near inanga spawning habitat</td><td></td><td></td><td></td></tr>
<tr><td>Rangiuru/Ngatoko Streams and Pahiko/Katihiku drains</td><td></td><td></td><td colspan="3">No works near inanga spawning habitat</td><td></td><td></td><td></td></tr>
</table>

Information currently available for the lower Otaki River downstream of SH1 indicates that it, both in terms of its geomorphological characteristics and in terms of the diversity and abundance of fish, is in relatively poor condition, especially downstream of SH1.. Gravel extraction from dry beaches has very likely contributed to the formation of a uniform shallow channel in the lower river. The proposed use of wet gravel extraction to maintain the design bed level and to establish and maintain a meander pattern with a pool and riffle form, has the potential to improve in-stream habitat quality of the lower river in the longer term.

6.13.2 Potential effects in Otaki Estuary

6.13.2.1 Birds

The Otaki River mouth is identified as a “habitat of significance for indigenous birds in the Wellington Region”. This site achieved a category one score in respect of the RPS Policy 23 criteria for diversity, and category three scores for rarity and ecological context. Seven threatened or ‘at risk’ species are known to be resident or regular visitors to this site: Royal spoonbill, black shag, pied shag, banded dotterel, pied stilt, red billed gull and white fronted tern. The authors found that there are no critical times of the year during which key or threatened or ‘at risk’ bird species present at the site are particularly susceptible to human related impacts.

GWRC has indicated that a large gravel bar known as "Mangahenene Island" encroaches well into the design alignment and that gravel extraction is likely to be required in order to widen the river channel in that area. This is likely to include the partial removal of the gravel bar at its northern extent. While the operation of heavy machinery in this area may disturb feeding and roosting activity in the immediate vicinity of the works, this effect is likely to be localised and temporary. Nevertheless, consideration should be given to minimising the level of disturbance to resident and migratory bird species as part of the pre-works planning. In the longer term the proposed removal of scrub and weeds from the gravel bar will potentially improve habitat for banded dotterel, pied stilt and black-fronted dotterel.

6.13.2.2 Sediment Discharge and Deposition

The proposed gravel extraction activity at Mangahenene Island is likely to result in a temporary increase in the deposition of fine sediment in habitats downstream of the works site. The Otaki Estuary is a "shallow tidal river mouth" type estuary, dominated by river flows and well flushed, with a residence time of less than one day. Consequently it is considered to have a low susceptibility to sedimentation issues (Robertson & Stevens, 2007). It is likely that gravel extraction would temporarily increase the risk of sediment related impacts such as poor water clarity and muddy intertidal substrates, which tend to favour mud tolerant invertebrate taxa. However, in a well flushed system it is expected that such effects would be relatively minor and temporary, lasting only until the next flood event.

6.13.2.3 Disruption of inanga spawning

Inanga spawning habitat located on tidal estuary edge vegetation in the Rangiuru Stream and the Pahiko/Katihiku drain and occurs during March, April and May. Recommendations for the protection of inanga spawning habitat juvenile fish migration are summarised in Table 26 above.

6.14 Activities in the CMA

6.14.1 Removal of flood debris

This activity involves removal of any major obstructions that are either carried down the river by floods, or dumped in the river. Debris will only be removed where absolutely necessary. The activity will most likely involve use of machinery such as an excavator, and will be undertaken on an infrequent basis.

This region of the river is dominated by tidal flushing and constant morphological change. The proposed activity is not expected to have any significant effects, provided that care is taken not to disturb any sensitive areas such as inanga habitat.

6.14.2 Gravel extraction from Mangahanene Island

As noted in Section 4.5.4, some of the proposed gravel extraction in the lower Otaki River will be from parts of Mangahanene 'Island' which lies adjacent to the CMA. No extraction from the CMA is proposed; works will be undertaken only on the beach. However it may be necessary to enter the CMA at the edge of the beach in order to shape the final profile of the extracted area. Any effects on aquatic invertebrates in the CMA are expected to be temporary and minor, given that they are already adapted to the highly dynamic river channel environment and are expected to recover quickly from such disturbances. Similarly, fish would be expected to swim away from any areas of disturbance and would therefore not be expected to be significantly adversely affected.

6.14.3 Otaki 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 would disturb a section of the beach and foreshore between the river channel and the sea. 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. The effects of this are not expected to be significant.

Long term effects

(Cameron, 2015) notes that birds such as gulls and terns in particular spend time resting, bathing and preening in the Otaki Estuary, and the foreshore provides a relatively safe resting place for sea and water birds. The excavation cut may remove a small portion of this habitat, but as this habitat is readily available all along the coast, no adverse effects on bird populations are likely. Mouth re-alignment is not expected to affect habitat quality elsewhere within the estuary, which is dominated by river flows and is well flushed.

6.15 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 several 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 outlined 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.

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. 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).

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.

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, such as adherence to GWRC's erosion and sediment control guidelines (Greater Wellington Regional Council, 2006) to ensure stormwater discharges from earthwork areas are appropriately managed.

6.16 Aquatic ecology

The ecological effects of each flood protection 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, 2014) concludes that when viewed as an overall package, it seems likely that the 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.

The COP proposes baseline environmental monitoring of a number of ecological variables to build a database of information that can be used to assess the effects of flood protection activities over time. Included are; riparian vegetation, native fish & trout surveys, inanga spawning habitat, pool and riffle counts, substrate size & cover, river bank undercutting & overhanging vegetation & NCI. Event monitoring for works that involve significant disturbance of the river bed in the flowing channel, such as wet gravel extraction and bed recontouring, is also proposed. This would involve before and after monitoring of water quality, habitat quality, biological monitoring and NCI.

6.17 Birds

As noted above, the Otaki River is an important location for riverbed nesting birds. A provision to require all works on beaches between 1 August and 28 February (to cover breeding, nesting and chick-raising periods) to be preceded by a survey to identify nests or chicks, and to allow for the establishment of suitable exclusion zones, has been included in the COP.

6.18 Landscape and visual

The overall adverse effects of GWRC's flood protection activities on the visual amenity and landscape values of the Otaki River and tributaries are expected to be less than minor. Specific avoidance and mitigation can include adherence to good practice, such as:

- ensuring the use of construction materials that are compatible with the natural geology of the river environment; and
- avoidance of storage of materials or machinery in the river bed.

The effects of GWRC's on-going planting of natives, management of existing willow plantings, and works undertaken outside the river bed, together with the removal of debris and vegetation from the river bed all contribute in a positive way to the visual appeal of the river corridor (within the agreed context of a managed setting) and to the outcomes sought in the Otaki River Environmental Strategy.

6.19 Recreation

In the short-term, any adverse effects of GWRC's flood protection 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.

6.20 Neighbouring community

Based on past experience and the very small number of complaints that have 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; and
- 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.

6.21 Cultural

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

As explained further in Section 7, GWRC is continuing to work with iwi to ensure that knowledge is shared and understanding of cultural issues of importance and appropriate responses to them continue to be developed, and are incorporated into the Code. A cultural impact report has been requested from the iwi. This is expected to provide valuable further guidance for this process.

6.22 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 undertaking urgent works.

6.23 Cumulative effects

The potential for the effects of GWRC operations and maintenance activities to be increased by other similar activities undertaken in the Otaki catchment by other parties is low, principally because of the lack of significant resource consents granted for such work. Any cumulative effects arising from the construction of a new bridge across the Otaki River in conjunction with the development of the Peka Peka to Otaki Expressway are expected to be relatively short-lived. NZTA has agreed to establish the river on the design channel alignment in association with the works in the vicinity of the proposed bridge, which will have an overall positive benefit for management of the river channel in the longer term.

(Cameron, 2015) notes that although there may be a cumulative effect resulting from the extension of permanent works (particularly rip-rap linings) over time, there is evidence that fish abundance and diversity can be relatively high in river reaches that are intensively managed (for instance the Hutt River at Belmont), suggesting that the cumulative effect of flood protection activities on the riverine ecology may be relatively minor. Indeed, trout abundance is consistently higher in the Hutt River at the Melling-Belmont reach compared with unmanaged reaches upstream of the application area.

It is acknowledged, however, that the cumulative effects of multiple flood protection activities have not been systematically monitored in the past and, in the absence of suitable information, there remains some uncertainty around the long term cumulative effects of these activities.

The monitoring programme 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 river management activities affecting the Otaki River is an integral part of GWRC activities. Flood protection activities have a high profile in the Otaki community, partly because of the regularity of floods experienced in the catchment, and partly due to consultation processes undertaken by GWRC and the efforts of FOTOR. 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 along the Otaki River began in the mid-1990s, as part of preparation of the OFMP. A key component of community involvement with the river is the activity of FOTOR, which was established as an outcome of the OFMP. Their activities are supported by GWRC in various ways and includes the annual walkover of the River which attracts over 100 people each year.

7.1 Parties consulted on this application

The consultation process to date has involved:

- The Science Group;
- Nga Hapu o Otaki;
- Kapiti Coast District Council;
- Department of Conservation;
- Fish & Game NZ;
- Friends of the Otaki River;
- Infrastructure Providers (Transpower, Telstra Clear, NZTA, Wellington Electricity Lines Ltd, PowerCo, KiwiRail, Electra Ltd, Vector Ltd, Chorus Ltd);
- Winstone Aggregates; and
- Recreation Groups

The extent of consultation, comments received and, where appropriate, the GWRC response are summarised below. 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 in Section1.2, one of the key consultation components has been the establishment by GWRC of a 'Science Group' to overview 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, Massey University, David Cameron (Freshwater ecologist MWH), together with Gary Williams (consultant river management engineer) and Caleb Royal of Nga Hapu o Otaki.

The group has been instrumental in designing and undertaking environmental monitoring in the Hutt River and rivers in the Wairarapa. This has included recognition of the 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.

It is expected that the Science Group will give further consideration to the specific matters and effects arising from the proposed works in the Otaki River and tributaries as part of the application 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 Nga Hapu o Otaki

A number of hui have been held with representatives from Nga Hapu o Otaki. These Hui were held initially to discuss the wider relationship between Nga Hapu o Otaki and GWRC; discussions were wide-ranging and canvassed Joint Management Agreements (under the RMA), Catchment Management Agreements (outside the RMA) and joint consent applications. Hui more recently have touched on the specifics of this resource consent application.

GWRC's position has recently been clarified; the outcome being that the existing governance arrangements will remain as they are for now. If conditions change (pending treaty settlements and/or local government amalgamation or other changes) then existing agreements and governance models may need to be changed in the future.

GWRC has engaged Nga Hapu o Otaki to provide an updated Cultural Impact Assessment report to reflect Nga Hapu o Otaki values and the important relationships with the Otaki River and its tributaries which are the subject of this application. This report is yet to be completed, however from initial discussions we are aware that Nga Hapu o Otaki have an interest in gravel extraction at Maungahenene Island (the gravel bar), and GWRC will continue to work with iwi on this, and other matters, as the project progresses.

A representative of Nga Hapu o Otaki (Caleb Royal) is an active member of the Science Group.

7.2.3 Kapiti Coast District Council

Consultation with KCDC has been ongoing since 1996 when work started on the Waikanae FMP. GWRC officers met with KCDC officers prior to preparation of this resource consent application, and the draft Waikanae resource consent application was sent KCDC in April 2013. A final Otaki application will be sent to KCDC. No specific concerns have been raised to date, and in general officers are supportive of the work undertaken by GWRC in the Kapiti Coast area. Further discussion, particularly in relation to gravel extraction, will be undertaken and comments included as they are received.

7.2.4 Friends of the Otaki River Inc. (FOTOR)

FOTOR 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 FOTOR provides an ongoing consultative input from the community, as represented by the Friends, into its activities. The draft resource consent application was sent to FOTOR in June 2013 and GWRC have meet with FOTOR several times in the preparation of this resource consent application. Key points are as follows:

- Landowners input into the river scheme commenced prior to GWRC jurisdiction over river management with local land owners gifting some 25ha of adjoining land to the river corridor, contributing $80,000 cash in an unusual contribution from a small group of farmers. Realigning river boundary fencing was also carried out. Some 200,000 m^3 of metal extracted from the gifted land was also tendered and sold by GWRC at 50 cents per m^3 Many farmers and riparian landowners have been involved since;

- FOTOR was established 1999 and incorporated 2000. Executive comprises 18 members including a Riparian Owners representative. The group has 235 members;
- FOTOR has a major interest in the on-going plans, maintenance and activities that form the management of the Otaki River. To this end they would like to be involved in the early preparation in promulgating the objects, policies and environmental physical management of the Otaki River which are an integral part of the consent process;
- Significant values at stake include land and stock protection;
- FOTOR is keen to work alongside GWRC to achieve good flood protection and good working balance with other river values including restoration; and
- FOTOR seek to be involved in development of consent conditions and in the development and future reviews of the COP.

GWRC has noted FOTOR comments and the suggested changes have been incorporated into the application document as far as possible. GWRC will continue to work with FOTOR through the course of this application and the development of the COP.

7.2.5 Recreational Users Groups

These include Kapiti Fly Fishing and Captivate Adventures, Otaki Gorge.

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 reported in Appendix H. 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 letters to Transpower, Telstra Clear, NZTA, Wellington Electricity Lines Ltd, PowerCo, KiwiRail, Electra Ltd, Vector Ltd, Chorus Ltd and Winstones Aggregates in January 2013. GWRC has met with Winstone Aggregates to discuss the current consent application. No relevant comments have been received to date.

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

8 Mitigation

9 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.

9.1.1 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 the Otaki Floodplain Management Plan.

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.

9.1.2 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.

9.1.3 Ecological Enhancement Fund

In response to increasing the knowledge of river management activities and their effects on the Otaki 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.

9.1.4 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.

9.2 Existing mitigation

Mitigation that GWRC currently undertakes in conjunction with management of rivers in the Wellington Region includes:

- Significant native plantings in the river corridors (principally the Hutt, Waikanae and Otaki Rivers);

- Funding of a ranger for the Hutt River; and
- Assistance and funding to community groups associated with the Hutt, Waikanae and Otaki Rivers.

GWRC intends to continue all of this mitigation in relation to its wider river management programme.

10 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 K). 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.

11 Statutory assessment

11.1 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 [i.e. pursuant to the RMA];
  - a national policy statement;
  - a New Zealand coastal policy statement;
  - a regional policy statement or proposed regional policy statement; and
  - a plan or proposed plan.
- Any other matter the consent authority considers relevant and reasonably necessary to determine the application.

11.1.1 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 Otaki River and Rangiuru and Ngatoko Streams are imperative to protecting the social and economic wellbeing and health and safety of the people and assets of the Otaki floodplain and wider Kapiti Coast area.

The COP/adaptive management approach, 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.

11.1.2 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; and
- Assessing and managing contaminants in soil to protect human health.

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

11.1.3 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; and
- 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.

11.1.3.1 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 open 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 management 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

With the consent of tangata whenua and as far as practicable in accordance with tikanga 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 Otaki River, Rangiuru and Ngatoko Streams 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 is kept up to date.

Policy 3 Precautionary approach

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 COP is intended to address and manage any activities that may have the potential for significant adverse effect on the coastal environment, while the proposed Monitoring Plan is intended to build the existing database of knowledge (including information on inanga spawning habitat in the coastal environment).

Policy 6 – Activities in the coastal environment

In relation to the coastal environment:

(j) where appropriate, buffer areas and sites of significant indigenous biological diversity, or historic heritage value.

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.

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.

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.

Policy 13 – Preservation of natural character

- To preserve the natural character of the coastal environment and protect it from inappropriate subdivision, use and development;
- Avoid adverse effects of activities on natural character in areas of the coastal environment with outstanding natural character; and
- 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 Otaki 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

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 Otaki River, and Rangiuru and Ngatoko Streams 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:

- Damage to dune or other geological systems and processes; or
- Harm to ecological systems or to indigenous flora nad fauna, for example marine mammal and bird habitats or breeding areas and shellfish beds; or
- Danger to other beach uses; or
- Disturbance of the peaceful enjoyment of the beach environment; or
- Damage to historic heritage ; or
- Damage to the habitats of fisheries resources of significance to customary, commercial or recreational users; or
- Damage to sites of significance to tangata whenua.

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

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

Gravel extraction is not expected to have a significant effect on sedimentation in the Otaki Estuary, as sediment will be flushed naturally from the estuary by freshes and floods.

Policy 23 – Discharge of contaminants

- In managing discharges to water in the coastal environment, have particular regard to:
- the sensitivity of the receiving environment;
- 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;
- the capacity of the receiving environment to assimilate the contaminants;
- avoid significant adverse effects on ecosysytems and habitats after reasonable mixing;
- use the smallest mixing zone necessary to achieve the desired water quality in the receiving environment; and
- 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 assimilate 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

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

Periodic cutting of the Otaki River mouth once it has migrated beyond defined trigger points assists in the protection of the beaches and dune systems to the north and south of the Otaki estuary.

11.1.3.2 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.

11.1.4 Regulations

There are no regulations made pursuant to the RMA of relevance to the application.

11.1.5 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 L.

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.

The Otaki River is a highly modified waterway, and evidence shows that although it has high water quality, the range and numbers of native fish and macroinvertebrates is not as diverse in the Otaki as it is in the nearby Waikanae River. The proposal provides for the protection and possible enhancement of these values through the adoption of good practice at all times, and by the proposed adaptive management approach which 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 Otaki 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 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 OFMP 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 Otaki 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 through the review processes integral to the consent and as the COP and environmental monitoring are kept up to date.

11.1.6 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 L.

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 – only the Otaki catchment upstream of the Waihoanga suspension bridge, located upstream of application area, is included.	
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 Otaki 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, giant kokopu, banded kokopu and koaro). No nationally threatened indigenous aquatic plants have been located in the Otaki River.	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 Otaki River, upstream of grid reference S25 050406 (which lies approximately at the SH1 bridge) is identified in Appendix 4.	4.2.14, 5.2.3
Appendix 5	Water bodies with regionally important amenity and recreational values – water quality to be managed for contact recreation purposes	Yes – the Otaki River gorge upstream of a point at grid reference S25 952 412 (which lies approximately 1 km downstream of the upper limit of the application area) is included for ‘rafting, kayaking, tubing and angling’, and the Otaki river between grid reference S25 952 412 and the river mouth (i.e. most of 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 7	Water bodies with water quality identified as needing enhancement	No	

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 Otaki River, Rangiuru and Ngatoko Streams, Katihiku and Pahiko Drains, Waimanu Stream and Chrystalls Lagoon 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, and into the future.

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.

The proposed works will be confined to the river channel and are not expected to have any adverse effect on a threatened plant known to grow on hillsides above the river in the Otaki Gorge.

The Otaki River upstream of the SH1 Bridge 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 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 Otaki River further reinforces GWRC's desire to further understand the natural values of the river and to ensure that they are not degraded further.

Amenity value and access

Objectives 4.1.7 – 4.1.8 and Policies 4.2.15 – 4.2.17

The uppermost 1 km section of the application area in the Otaki River is identified in Appendix 5 of the RFP as having regionally important amenity and recreational values for 'rafting, kayaking, tubing and angling', and the section of the river downstream of this reach (i.e. most of the application area) is specifically for 'swimming and angling'.

GWRC's operations will be undertaken in a manner to avoid adverse effects on recreation, amenity and access as far as is practicable. 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.

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

As well as avoiding adverse effects on recreation, amenity and access, GWRC actively facilitates the use of the Otaki River and its margins for active and passive recreation, through the development and implementation of the Otaki River Environmental Strategy.

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 OFMP.

The development of the OFMP represented the culmination of a significant amount of work and gathering of information to define the flood hazard associated with the Otaki 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 Otaki River that is the subject of this application be managed for aquatic ecosystem purposes, with the area upstream of SH1 also to be managed as a trout fishery/for trout spawning. The majority of the application area (apart from the uppermost 1 km reach) is to be managed for swimming and angling, with the uppermost 1 km reach to be managed for 'rafting, kayaking, tubing and angling'. 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). The proposed works are compatible with these management objectives. The discharges associated with the proposed works are of natural silts and sediments only.

The proposed works will be undertaken in a manner that manages the water body for its intended purpose. This will be achieved by adherence to the COP.

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 flood protection activities; 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, including the adaptive management approach, 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 Otaki 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.

11.1.7 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 Otaki 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.

11.1.8 Regional Coastal Plan

The proposal is in accordance with the requirements of the Regional Coastal Plan for the Wellington Region (RCP). 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 appropriate in this area, and 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 does not include any specific matters relating to the Otaki River mouth or 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

As stated above, 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 Otaki 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 and on-going review of the COP, and into the future.

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 in extent and unlikely to have any significant adverse effect. 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. There are currently no structures located in the CMA and 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 mouth of the Otaki River 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. Other activities that GWRC proposes in the CMA – namely removal of flood debris when necessary, and minor disturbance at the edges of gravel skimming off Mangahanene Island – will have only temporary and very minor effects.

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 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. In 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.

11.1.9 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 : PNRP Objectives and Policies Assessment

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.

11.2 Additional rules in the Proposed NRP affecting flood protection activities

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

11.2.1 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).

11.3 Other matters

11.3.1 Otaki Floodplain Management Plan

The role of the OFMP and associated Otaki River Environmental Strategy has been discussed in Section 2.2.

11.3.2 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 OFMP and provides more specific detail around scheduling and funding of the works. The capital expenditure programme for the Otaki River is included in Table 27, which shows that more than $5.9 M of capital works and upgrades, and $351,000 of works related to the Otaki River Environmental Strategy are programmed for the Otaki River alone between 2013 and 2022.

The level of funding for the overall works and maintenance programme (for all rivers in the Wellington Region, including the Otaki River) is shown in Table 28. The data in this table indicate that between $12 M and $18.7 M is programmed to be spent annually in the next ten years on maintenance and operational activities in Wellington rivers (which equates to an average annual spend of over $15 M).

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 27: GWRC flood protection and control works capital expenditure programme 2012/13 to 2021/22 - Kapiti ($)

	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
Otaki River Works Mouth to SH1	–	361,000	–	330,000	–	377,000	–	375,000	–	401,000	1,844,000
Otaki River Works Chrystalls to Gorge	–	320,000	383,000	–	421,000	–	473,000	–	388,000	–	1,985,000
Lower Waitohu Improvements	850,000	392,000	–	–	–	–	–	–	–	–	1,242,000
Otaki South Stopbank Land	–	–	107,000	165,000	-	-	–	–	–	–	272,000
Otaki South Stopbank Improvements	–	–	–	–	569,000	588,000	–	–	–	–	1,157,000
Chrystalls Extended Stopbank	400,000	–	–	–	–	–	–	–	–	–	400,000
North stopbank improvements (mouth to SH1)	–	258,000	–	–	–	–	–	–	–	–	258,000
Otaki Environmental strategy implementation	55,000	67,000	24,000	25,000	50,000	48,000	24,000	19,000	19,000	20,000	351,000
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 28: 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)

11.3.3 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.

11.4 Notification

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

12 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 Otaki River. 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 Otaki area. The latter are outlined in documents such as the local government watercourses agreement between GWRC and the territorial authorities within the Wellington Region, and the OFMP (which includes the Otaki River Environmental Strategy). The application also seeks to include limited maintenance works in the following minor tributaries: Rangiuru and Ngatoko Streams, Katihiku and Pahiko Drains, Waimanu Stream and Chrystalls Lagoon.

The Otaki River and the minor watercourses within the application area have been managed and modified since the early 20th century. Today all these waterways flow through a highly modified floodplain, which supports extensive areas of agricultural and horticultural activity and contains significant areas of urban development and infrastructure. Despite this, the Otaki River has generally high water quality and supports healthy in-stream invertebrate ecology, although fish numbers tend to be lower than in the neighbouring Waikanae River. It is regarded as a significant recreational resource for the region. Water quality is not routinely monitored in the minor watercourses but it might be expected to be of lesser quality than that in the main stem of the Otaki River. Some inanga spawning habitat is known to exist in the estuarine areas near the mouths of Rangiuru Stream and Katihiku Drain.

Large volumes of gravel are transported along the Otaki River channel every year by numerous flood events. Although some of this gravel is flushed out to sea, significant volumes have accumulated in the river bed downstream of Chrystalls Bend, which has resulted in elevated bed levels in these reaches. This aggradation places significant pressure on existing river protection works and reduces the effectiveness of the flood protection scheme overall. GWRC has determined that it currently needs to extract 53,500 m^3 of gravel per annum from the Otaki River over the next five years in order to return the river to the optimum bed levels and maintain them there. Use of wet gravel extraction methods in addition to dry extraction will assist the establishment of a proposed design meander pattern within the Otaki River corridor, which is expected to have positive benefits for the natural character and aquatic ecology of the river. In addition, GWRC proposes a one-off extraction operation to remove approximately 35, 000 m^3 of gravel from the top of Mangahanene Island, located on the south bank of the Otaki River channel near the river mouth. Discussions with adjoining landowners will be undertaken prior to these latter works.

The range of activities undertaken by GWRC in the Otaki 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 river mouth realignment. Activities are undertaken both in the river bed and on land within the river corridor. In comparison, activities in the minor watercourses and drains are generally limited to removal of accumulated sediment and aquatic weeds and maintenance of outlet structures. 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. GWRC does not have any existing structures in the CMA and proposed activities within the CMA are limited to removal of flood debris, periodic cutting of the Otaki River mouth and very minor disturbance associated with gravel extraction on a beach area adjoining the CMA.

The most extensive flood protection works in the Otaki River are willow protection plantings, which line approximately 85% of the banks within the application area, followed by rock lining, which affects approximately 19% of the total river bank length. The activities having the most potential for environmental impact are gravel extraction and bed recontouring. Generally these later activities occur in limited areas of the river on an intermittent, short term basis.

The main potential adverse effects of the proposed activities can be grouped into seven categories, described below.

12.1 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, 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, as outlined further 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, such as adherence to GWRC's erosion and sediment control guidelines (Greater Wellington Regional Council, 2006) to ensure stormwater discharges from earthwork areas are appropriately managed.

12.2 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, 2015) notes that vegetative bank protection is by far the most widespread activity in the Otaki 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 and potentially improved.

GWRC mitigation of bed recontouring and gravel extraction is currently focused on incorporating final shaping of affected reaches to provide for a more natural form and 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.

12.3 Birds

Three species of river-nesting birds (banded and black-fronted dotterels and pied stilts) are found in the Otaki River, and could potentially be affected by river works. These effects will be largely avoided or mitigated by conducting pre-works surveys and allowing for adoption of exclusion zones to protect any nests and chicks as provided for in the COP.

On-going monitoring work will include the monitoring on river bird distribution and abundance, which will further inform good practice and appropriate mitigation into the future.

12.4 Recreation

In the short term any adverse effects of GWRC's flood protection 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.

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 Otaki River Environmental Strategy progresses.

12.5 Neighbouring community

Based on past experience 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:

- Communication with affected residents prior to works commencing;
- The restriction of activities to reasonable working hours;
- Good management of traffic;
- Dust suppression; and
- 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 incorporated into the COP.

12.6 Cultural

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, and is greatly assisted by the participation of an iwi representative in the Science Group.

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 Otaki 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 Otaki 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 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 quantum's, excluded from the consent conditions. Instead, GWRC proposes to adopt an adaptive management approach that will provide a framework to manage the effects of GWRC's flood protection works while allowing them to change over time in response to new information, technology and community demands.

Central to this proposal is the idea that a comprehensive COP will sit alongside the OFMP, 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) as part of the adaptive management approach. 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 will 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 working draft of the Environmental Code of Practice and Monitoring Plan 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 undertaken in the preparation of this application. GWRC intends to 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.

13 Applicability

This report has been prepared for the exclusive use of our client Greater Wellington Regional Council, 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

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Appendix A: Consent Application Forms

Appendix B: Application Area & Land Ownership

Appendix C: Certificates of Title

Appendix D: Aerial_Photographs_2013

Appendix E: Otaki River Design Meander Plans

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: Cameron (2015)

Effects of Flood Protection Activities on Aquatic and Riparian Ecology in the Otaki River. Prepared for Greater Wellington Regional Council (Flood Protection) – Final report October 2015.

Appendix H: TRC Tourism (2013)

Wellington Rivers Recreational and Tourism Assessment. Report prepared for Greater Wellington Regional Council.

Appendix I: Activity Photographs

Appendix J: GWRC works and maintenance records

- **Construction of groynes**
- **Maintenance of groynes**
- **Construction of rock lining**
- **Maintenance of rock lining**
- **Construction of debris fences**
- **Maintenance of debris fences**
- **Willow planting**
- **Tethered willows**
- **Bed recontouring**
- **Gravel extraction**
- **Channel diversion cuts**
- **River mouth realignment**

Appendix K: Proposed Conditions of Consent

Appendix L: Relevant Regional Objectives & Policies

Annex 1: Code of Practice (working draft)

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